



# San Francisco Public Works

## Engineering Standard Specifications

### Contents

Part 2	Streets and Highways . . . . .	2
Part 3	Sewerage and Drainage . . . . .	51
Part 4	Structures . . . . .	91
Part 5	Mechanical Work . . . . .	138
Part 6	Electric Work . . . . .	155
Part 7	Excavation, Backfill and Embankment . . . . .	178
Part 8	Concrete, Metalwork, Painting and Misc. . . . .	208
Part 9	Auxiliary Water Supply System for Fire Protection . . . . .	252
Part 10	Landscape Work . . . . .	275

**THIS IS NOT AN OFFICIAL DRAFT**

Official Document(s) should be accessed at the [SFPW Standard Plan Website](#).

Questions / Comments for this Draft may be directed to [christopher.logston@sfdpw.org](mailto:christopher.logston@sfdpw.org)

Last updated 2021 August 09

## Part 2

## Streets and Highways

## Table of Contents

---

200	Preparation and Compaction of Subgrade . . . . .	3
201	<i>Blank</i> . . . . .	4
202	Concrete Curb . . . . .	5
203	Combined Concrete Curb and Gutter . . . . .	8
204	Concrete Sidewalk . . . . .	9
205	Aggregate Base and Subbase . . . . .	12
206	Cement Treated Aggregate Base . . . . .	15
207	Concrete Base . . . . .	18
208	Asphalt Concrete Base . . . . .	22
209	Asphalt Concrete Base - Thick Lift . . . . .	24
210	Concrete Pavement . . . . .	26
211	Asphalt Concrete Leveling Course . . . . .	28
212	Asphalt Concrete as a Wearing Surface . . . . .	29
213	Seal Coat . . . . .	36
214	Planing Existing Asphalt Concrete Surfaces . . . . .	38
215	Raised Traffic Bars . . . . .	41
216	<i>Blank</i> . . . . .	42
217	Adjustment of Manhole Frames and Other Castings . . . . .	43
218	Redwood Headers . . . . .	45
219	Corrugated Metal and Guard Railing . . . . .	46
220	Certain Work Excluded from Pay Quantities . . . . .	48
221	Pavement Reinforcing Fabric . . . . .	49

---

## 200 Preparation and Compaction of Subgrade

### 200.01 General

Subgrade is the plane, curved, or warped surface on which subbase, base, pavement or sidewalk is to be placed. There may also be other subgrades, as that for the replacement of unsound subgrade material; the top of a layer of a material placed, considered the subgrade for the material to be placed immediately thereon; and trench subgrade.

Pavement subgrade, where untreated rock subbase is specified to be placed, will be the subgrade for such subbase.

Reference to any subgrade other than that for pavement subbase or base shall be particular and specific.

The Contractor shall do all the necessary or required shaping, grading and compacting so that the finished subgrades and graded ground within the limits of the work, will present a smooth, uniform surface and conform to the alignment, grades and contours shown on the plans and cross sections. The surfaces shall contain no local depressions that will hold water, and at intersections with undisturbed ground shall, by means of a uniform transition, conform thereto.

Areas to be paved shall be prepared to a subgrade at the proper depth below the required surface of the finished pavement. Except as otherwise specified in the Special Provisions or shown on the plans, the elevation and cross section of the subgrade shall be such that the finished roadway pavement surface will be 6 inches below the top of sidewalk curb at the gutter, and will have a crown of 1.0%, 0.8%, or 0.6% of the roadway width between sidewalk curbs, when the street grade is respectively, 0% to 3% , greater than 3%, to 6% , or greater than 6% .

Subgrade in cut shall be compacted in accordance with the requirements therefor of Section 707. Where compacted native material would produce unsound subgrade, such material shall be removed as specified in Section 700.10. Replacement. backfill therefor, and the compaction thereof, shall be in accordance with the requirements of Sections 706 and 707.

Subgrade elevations shall not be raised or adjusted to compensate for anticipated settlement under the weight of the pavement.

Before pavement base or pavement is constructed adjacent thereto, the Contractor, unless otherwise specified or specifically allowed, shall construct the concrete curb required to replace existing concrete curb or granite curb that is not true to line or grade and payment for such work will be made under the appropriate Bid Item, if the Proposal contains such Bid Item.

The Contractor, immediately prior to placing the pavement or pavement base, shall check the subgrade for irregularities by means of a rigidly constructed, spiked template furnished by him. The spikes shall be placed at intervals not greater than 3 inches, center to center. The length and shape of the template and the protruding length of the spikes shall be such that the points of the spikes, when the template is moved along the headers or previously constructed pavement, as applicable, will accurately delineate the crown curve of the portion of subgrade being checked. No pavement or base material of any kind shall be placed upon any section of subgrade not approved by the Engineer.

Unless otherwise specified in the Special Provisions, not less than 200 linear feet of subgrade shall be prepared in advance of paving operations. After a section of subgrade has been approved for pavement or pavement base construction, the Contractor, by adequate barricading, shall keep the section free of equipment and all traffic, and shall repair at his sole expense damage to any prepared subgrade from any cause whatsoever.

Where necessary, the subgrade shall be properly wetted down with water immediately in advance of laying the pavement.

### 200.02 Payment

Preparation of subgrade shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

**201**    *Blank*

## **202 Concrete Curb**

### **202.01 General**

The Contractor shall construct concrete curb, complete in place, including depressed curb, doweled curb, that combined with concrete parking strip, and that to replace existing concrete curb or granite curb that is defective, out of line or not at proper grade; all where, as, and to the lines and grades shown on the plans, and where directed, and including excavating, preparing the subgrade, constructing and removing forms, providing required keyways, providing the longitudinal and grouted vertical reinforcing in doweled curb, the required verifying and marking of side- sewer and Y-branch locations, providing construction joints, protecting, curing, backfilling, restoring pavement, painting, and all other Incidental Work. Unless otherwise specified, the nominal height of curb measured from gutter to top of curb shall be 6 inches.

Curb shall be depressed at automobile runways and driveways as shown on the plans. The fall across the curb at the driveways shall not be less than 3/4 of an inch. The length of the driveway depression shall be 9 feet exclusive of side slopes, except where directed by the Engineer, but shall not exceed 30 feet in length. Existing sidewalk flags immediately adjacent to curb to be replaced, except over sidewalk basements, shall be removed to neat flag lines to facilitate construction of curb to the required lines and grades, and to insure that sidewalk will conform to such curb. After the curb has been constructed and prior to the replacement of the sidewalk, the Engineer, to achieve more appropriate conform, may order additional flags of sidewalk removed. If the Proposal contains a Bid Item for pavement excavation and for sidewalk, removal and replacement of the sidewalk will be included for payment under such Bid Items. Under no circumstances shall concrete curb and concrete sidewalk be constructed monolithically.

### **202.02 Combined Concrete Curb and Parking Strip**

Concrete parking strip constructed monolithically with the curb will not be included for payment under a Bid Item for curb but will be paid for as concrete pavement. The line of demarcation for the purpose of payment shall be the intersection of the curb face with the concrete pavement at the gutter line. No additional payment will be made for monolithic construction.

### **202.03 Subgrade**

Subgrade for curb shall be prepared in accordance with the applicable requirements of Section 200, and at the level of the subgrade of the adjacent pavement or gutter. When untreated rock subbase is to be provided for the adjacent pavement, the subgrade for curb constructed prior to the laying of such subbase shall be level with the bottom of such subbase; if the subbase is constructed prior to the construction of curb then such compacted subbase shall extend to a line 18 inches behind the curb line and the surface thereof shall be the required subgrade for the curb.

### **202.04 Forms**

The forms shall be smooth on the edges and on the sides against which concrete is to be placed. They shall be of sufficiently heavy material to be rigid, and shall be set securely so that the curb, when completed, shall conform accurately to the lines and grades given. No concrete shall be placed before the forms are in position for at least 50 feet ahead, or for the entire length of curb to be placed. They shall be thoroughly cleaned before each setting. All wooden forms shall be wetted before concrete is deposited against them. Except as otherwise shown on the plans, or required, the top of the curb shall be 6 inches above the adjacent gutter.

The forms shall extend to the full depth of the curb and all joints must be tight and even. On the front, the plank or metal must be of one piece to a depth of 3 inches below the gutter grade. The forms must be so set that the finished curb will be 6 inches wide on top, extend at least to the full depth of the pavement, and have a batter of 1 inch in 4 inches on the front. Conform to adjoining vertical curb shall be made with a 4-foot transition from battered to vertical face. The back face shall be vertical.

If the plans show that concrete curb shall contain keyways it shall be so constructed.

### **202.05 Marking on Curb for Side Sewers, Y-Branches and Other Locations to be Verified**

After setting the forms for concrete curb and before placing concrete, the Contractor, by exposing the top 3 inches of the redwood stake placed at the end of the side sewer in conformity with the provisions of Section 307.06, shall verify the locations of all side sewers constructed, reconstructed, or replaced, as the case may be, by him, but which are not to be placed in immediate service. If, for any reason, the stake is not found, the Contractor shall excavate and expose the pipe. The Contractor shall not cover the exposed stake or pipe, as the case may be, before the concrete work on the curb has been fully completed, nor before being directed to do so by the Engineer. The letter "S" shall be stamped in the top of the curb over each side sewer which is not yet in service, as required in Section 307.06. The letter "Y" shall be stamped in the top of the curb opposite each Y-branch from which a side sewer has not been constructed, as required in Section 316.05.

### **202.06 Concrete**

The concrete shall be Class 6-3000-3/4 as specified in Section 800.11.

### **202.07 Placing Concrete**

The concrete shall be well-spaded close to the forms, properly vibrated, tamped and consolidated so that there will be no rock pockets in either the front or back surface for the full depth of the curb.

The top of the concrete shall be so tamped that an excess of mortar will be brought to the surface.

### **202.08 Construction Joints**

Construction joints shall be cold joint, or s be constructed through the curb, at each street property line, and at intervals of 15 feet along the block, and shall be placed in alignment with dummy joints in existing concrete pavement or pavement base. In curb returns, the construction joints shall be so spaced that the perimeter shall, unless otherwise specified, be divided into equal lengths of not more than 16 feet, nor less than 5 feet. The joints along the straight curb shall be perpendicular to the top and face of the curb, and those along circular curbs shall be on radial lines. The edges at the joints shall be rounded to 1/8 inch radius with the proper edging tool.

### **202.09 Finishing**

The front forms shall not be removed in less than two hours nor more than six hours after placing concrete therein; the back forms shall not be removed in less than twenty-four hours after such placement. Immediately after removing the front forms, the face and top of the curb shall be floated until the surface is true, even, and of a uniform color.

The front and back edges of the top of the curb shall be rounded to a radius of approximately 3/4 inch. These edges shall be straight and to a true grade, and no lip or shoulder shall be left between the rounded edge and the forms.

Curb shall then be troweled to smooth dense surfaces, the rounded edges thereof restored, and finally the surfaces shall be given a brush finish to achieve a non-slip slightly grainy texture. The top and face of the finished curb shall be true and straight, and the top surface of curbs shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge 10 feet long is laid on the top or face of the curb, the surface shall not vary more than 0.01 foot from the edge of the straightedge, except at grade changes or curves.

### **202.10 Protection and Curing**

The concrete shall be cured as specified in Section 800.16.

As soon as the back forms have been removed, the back of the curb shall be backfilled and an 18-inch wide berm constructed to the full height of the curb. Where curb has been constructed on fill, or the sidewalk

area is below subgrade, the berm shall be at least 3 feet wide. Such protection shall be done as Incidental Work, and shall remain in place until the sidewalk is constructed.

### **202.11 Doweled Curb**

Doweled concrete curb shall be constructed on the existing pavement where and as shown on the plans or specified. It shall be secured by No. 4 reinforcing bars grouted vertically with Class "B" mortar into holes drilled into the pavement at a spacing not greater than 4 feet on centers measured along the centerline of the curb. Such bars shall be 10 inches long and the holes therefor 6 inches deep. The Contractor shall reinforce the curb longitudinally with a continuous No. 4 bar seated one inch below the top of the vertical reinforcing and tied to it with No. 14 wire.

All requirements of this Section 202, to the extent that they reasonably can apply to the construction of doweled curb, apply in every respect. Payment for doweled curb shall include full compensation for required longitudinal and grouted vertical reinforcing bars.

### **202.12 Repair and Replacement**

Where any curb requires repair before acceptance, the repair shall be made by removing and replacing the entire section between joints and not by refinishing the damaged portion, or resetting a displaced section. Where the plans provide for the removal of existing curb and construction of curb, and the limit of the work specified does not fall on a curb joint, the curb constructed shall join the old curb at the first curb joint beyond the said specified limit.

### **202.13 Painting**

After all other work under the contract has been completed, the face and top of 8-inch concrete curb, including 8-inch doweled curb, shall be completely and uniformly painted with one coat of white traffic lacquer, or approved equal, applied in accordance with the manufacturer's recommendations.

### **202.14 Payment**

Concrete curb and doweled curb, satisfactorily constructed as specified, each will be paid for at the respective price bid per linear foot, measured horizontally along the curb line, including drop curb and the full curb return.

## **203 Combined Concrete Curb and Gutter**

### **203.01 General**

The Contractor shall construct concrete curb and gutter where, of the dimensions, and to the lines and grades shown on the plans, or where directed, complete in place, including excavating, backfilling, pavement restoration, and all other Incidental Work and in accordance with all applicable requirements of Section 202, except that, in the gutter area, the joints that are truly construction joints shall be as specified for such joints in Section 210.07 and shall be keyed, and other joints, spaced at 15-foot centers, shall be dummy joints as specified in Section 210.08.

The edge of the gutter shall be rounded with an 1/8-inch radius edging tool.

The back of the curb shall contain keyways except in drop curb sections. The longitudinal edge of the gutter shall contain keyways if shown on the plans. Where the gutter grade is less than 1%, the concrete forming the gutter, for the entire length thereof, shall be carefully hand steel troweled for a distance of one foot out from the curb.

### **203.02 Payment**

Combined concrete curb and gutter, satisfactorily constructed as specified, will be paid for at the price bid



## 204 Concrete Sidewalk

### 204.01 General

The Contractor shall construct concrete sidewalk 3 – 1/2 inches thick, where and as shown on the plans or where directed, including excavating, backfilling, preparing the subgrade, constructing and removing forms, providing the specified joints and doing the required finishing, marking, protecting, curing and all other Incidental Work.

The concrete shall be Class 5.5-2500-3/4, as specified in Section 800, and shall be darkened by the addition thereto at the mixer of either:

- 1) lampblack in dry form, in accordance with the requirements of ASTM “Standard Specifications for Lampblack”, Designation D 209, in the proportion of from 1/2 to 3/4 pound per cubic yard of concrete; or
- 2) an approved liquid or semi-paste black colorant intended for use integrally in concrete mixes. The proportion required, generally from 10 to 40 ounces liquid measure per cubic yard of concrete, may be affected by the colorant used. Curing in this case shall be by the pigmented curing compound method.

The proportion of lampblack or other approved colorant, to a great extent dependent on the color of the cement used in the mix, shall be that required to properly darken the concrete to reduce glare, and shall be subject to the approval of the Engineer. The proportion in batches for adjacent sidewalk shall be identical.

Sidewalk shall in no case be constructed monolithic with curb.

The limits of sidewalk removal and construction will be specified or shown on the plans. Beyond such limits, the removal and construction of sidewalk will be included for payment under Bid Items for such work only where specifically ordered by the Engineer.

Existing sidewalk flags immediately adjacent to curb to be reset or replaced, except over sidewalk base-ments, shall be removed to neat flag lines to facilitate the installation of curb to the required lines and grades, and to insure that sidewalk will conform to such curb. After the curb has been installed, and prior to the replacement of the sidewalk, the Engineer, to achieve more appropriate conform, may order additional flags of sidewalk removed. If the Proposal contains Bid Items for excavation and for sidewalk, removal and replacement of sidewalk will be included for payment under such Bid Items.

### 204.02 Subgrade

The subgrade for sidewalk shall be prepared at least 33 inches below the required elevation of the sidewalk surface. The Contractor shall obtain a relative compaction of not less than 90% for the top six inches of sidewalk subgrade.

### 204.03 Forms

Forms shall be not less than 3 inches in depth, clean, smooth on the upper edge and on the side against which concrete is to be placed, shall be of sufficiently heavy material and braced so as to be rigid, and shall be set so that the sidewalk, when completed, will conform accurately to the required alignment and grades. The forms shall remain in place for not less than twelve hours after the finishing has been completed.

### 204.04 Slope

Unless otherwise specified, the finished surface of the walk shall rise 1/5 inch per foot from curb grade to property line.

### 204.05 Construction

Immediately before placing concrete, the forms and subgrade shall be thoroughly wetted. Immediately after the concrete has been placed it shall be thoroughly tamped so that the mortar will flush to the top, and the surface shall then be struck off with a straight edge.

All standards, street and traffic signs, parking meters, sewer trap vent frames and covers, including adjusting the length of riser therefor, oil tank filler pipe covers, and the like, that require resetting to the new sidewalk level, shall be reset by the Contractor to the proper elevations as Incidental Work.

### **204.06 Finishing**

When the concrete has sufficiently set, it shall be floated to a true and uniform surface and finished with a steel trowel, after which the smooth surface shall be brushed transversely across the sidewalk with a bristle brush to produce a uniform, non-skid, texture. On grades over 10% a rougher surface will be required. This may be attained by lifting a wood float straight up from the surface of the concrete.

The surface shall be marked, with an 1/8-inch radius edging or scoring tool as applicable, into rectangles not less than 2.5 nor more than 4 feet on a side. These markings shall be made at every construction and weakened plane joint and the intervening space marked off equally. The markings in the completed sidewalk shall be well defined.

### **204.07 Joints**

Transverse joints in sidewalk shall extend across the entire width of the walk at right angles to the curb line. They shall be provided across sidewalk at the points of beginning and end of all curb returns, at lot lines, and additionally approximately 30 feet apart. Except for the lot line requirement, joints shall be located opposite a construction joint in concrete curb.

When the entire width of sidewalk is being replaced the Contractor shall place a transverse joint therein butting each end of each group of pull boxes.

Joints may be constructed by:

- 1) placing the concrete against 1/4-inch thick expansion joint filler material suitably supported perpendicular to the subgrade; or
- 2) cutting a neat straight line to a minimum depth of 2-inches, using an approved concrete saw; or
- 3) forming a weakened plane by use of a 2-inch x 2-inch x 1/4-inch steel tee; or
- 4) use of a keyed construction or "cold" joint.

No joint filler shall be installed when methods 2); 3) or 4) are employed.

No expansion joint material shall be placed at the juncture of the sidewalk with the curb.

### **204.08 Street Names**

On all sidewalks constructed at street intersections the names of the intersecting streets shall be impressed, opposite the crosswalk or crosswalks, as approved by the Engineer, in letters and numerals 4 inches high and 1/2-inch deep.

### **204.09 Protection and Curing**

The protection and curing of concrete sidewalk shall be as specified in Section 800.16.

### **204.10 3 1/2-Inch Concrete Pavement**

General. - 3-1/2-inch concrete pavement used to pave traffic islands shall be identical to 3-1/2-inch concrete sidewalk, except that the concrete shall not be darkened by lampblack or other colorant. Bidders shall include

in the price bid for pavement all charges for the following Incidental Work.

Sand Fill. - Where islands are to be constructed over existing pavement, the Contractor shall furnish and place sand fill to subgrade for the 3-1/2-inch concrete pavement.

Painting. - After all other work in the area has been completed, the surface of the return areas at the ends of 3-4-inch concrete center islands 4 feet or less in width shall be completely and uniformly painted with one coat of white traffic lacquer, or approved equal, applied in accordance with the manufacturer's recommendations.

## **204.11 Payment**

Concrete sidewalk and 3-1/2-inch concrete pavement, satisfactorily constructed as specified, each will be paid for at the respective price bid per square foot, measured horizontally.

The area of curb adjoining sidewalk, and areas occupied by curb inlets will not be included in measurements of area of sidewalk. The areas of poles, standards, other fixtures, and of boxed-out locations for manhole and other castings and facilities, regardless of ownership thereof, will not be deducted from the areas of concrete sidewalk or 3-1/2-inch concrete pavement for which payment will be made.

## 205 Aggregate Base and Subbase

### 205.01 General

The Contractor shall construct mineral aggregate base or Subbase, unless otherwise specified, 6 inches thick after compaction, spread and compacted to the lines, grades and dimensions shown on the plans and cross sections, and where directed, including preparing the subgrade and doing the required watering, shaping, smoothing and other Incidental Work.

### 205.02 Materials

The aggregate shall be free from vegetable matter and other deleterious substances. Aggregate for aggregate base shall consist of material of which at least 60% by weight shall be crushed particles as determined by Test Method No. Calif. 205.

The percentage composition by weight of aggregate base shall conform to one of the following gradings when determined by Test Method No. Calif. 202.

Unless otherwise specified in the Special Provisions, the particle size distribution shall be in accordance with the grading specified for 3/4-inch maximum size aggregate.

<u>Sieve Sizes</u>	<u>Percentage Passing</u>	
	<u>1 – 1/2"</u> <u>Maximum</u>	<u>3/4"</u> <u>Maximum</u>
2" .....	100	
1 – 1/2" .....	90-100	
1" .....		100
3/4" .....	50-85	90-100
No. 4 .....	25-45	35-55
No. 30 .....	10-25	10-30
No. 200 .....	2-9	2-9

The aggregate base shall also conform to the following quality requirements:

<u>Tests</u>	<u>Test Method</u>	
	<u>No. Calif.</u>	<u>Requirements</u>
Resistance (R-value)* .....	301	78 Min.
Sand Equivalent .....	217	30 Min.
Durability Index .....	229	35 Min.

\*The R-value requirement will be waived provided the aggregate base conforms to the specified grading and durability and has a sand equivalent value of 35 or more.

The aggregate shall not be treated with lime, cement or other chemicals before the Durability Index test is performed.

Material yielding a maximum dry density of less than 112 pounds per cubic foot when tested in the laboratory in accordance with ASTM "Standard Methods of Test for Moisture-Density Relations of Soils, Using 10-Lb. Rammer and 18-in. Drop", Designation D 1557, shall not be used.

Any rock, including red rock, meeting all the requirements of this Section will be acceptable. Such rock shall be plant processed at an approved processing plant.

### 205.03 Samples and Testing

At least ten working days prior to the use thereof, the Contractor shall submit to the Engineer a 120-pound sample of aggregate, graded as intended for use. This requirement shall be complied with for each aggregate and grading thereof that has not been approved. The Engineer will test the sample at no cost to the Contractor, and will determine the acceptability of the aggregate.

## 205.04 Spreading

Aggregate base material shall be delivered to the roadbed as uniform mixtures and each layer shall be spread in one operation.

At the time aggregate base is spread it shall have a moisture content sufficient to obtain the required compaction. Such moisture shall be uniformly distributed throughout the material.

The material shall be spread upon the subgrade prepared in accordance with the requirements of Section 200, by means of vehicles equipped with approved spreading devices at a uniform quantity per linear foot, which quantity will provide the required compacted thickness within the tolerances specified in Section 205.05.

Depositing and spreading shall commence at that part of the work farthest from the supply of base material and shall progress continuously without breaks, unless otherwise directed by the Engineer.

Where the required thickness is 6 inches or less, the base material may be spread and compacted in one layer. Where the required thickness is more than 6 inches, the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. Each layer shall be spread and compacted in a similar manner.

Base material placed in areas inaccessible to the spreading equipment, may be spread in one or more layers by any means that will make possible the specified compaction and surface.

When the subgrade for aggregate base consists of cohesionless sand, and written permission is granted by the Engineer, the base material may be dumped in piles upon the subgrade and spread ahead from the dumped material.

The base material, after spreading, shall be shaped by means of a blade grader to such thickness that after watering and compacting, the completed base will conform to the required grade and cross section within the tolerances specified in Section 205.05.

Segregation of aggregate shall be avoided and the base shall be free from pockets of coarse or fine material.

## 205.05 Compacting

Immediately following spreading, shaping and smoothing, the full width of the base material shall be watered as ordered by the Engineer, and compacted by rolling with a minimum of two pieces of self-propelled reversible equipment. Compaction shall be as follows:

- 1) For initial rolling use a 3-wheel steel-tired roller, weighing not less than 12 tons distributed so that the rear wheels will apply to the surface being rolled not less than 325 pounds per linear inch of rear tire width. Rolling shall commence by covering completely the outer edge of the material. Subsequent passes shall lap at least 25% on previously rolled material.
- 2) For subsequent rollings use a pneumatic-tired roller of the oscillating type, having a width of not less than 4 feet and equipped with tires of equal size and diameter. Wobble wheel rollers will not be permitted. The tires shall be so spaced that the entire gap between adjacent tires will be covered by the tread of the following tire. The tires shall be inflated to 90 pounds per square inch minimum.
- 3) To compact all areas inaccessible to the rollers, use compressed air, or gas, powered tampers.

The foregoing equipment requirements serve as a standard of adequacy.

Subject to the condition that the Contractor shall notify the Engineer at least ten days in advance, and shall secure approval for the use of each piece of compacting equipment other than that specified, selection thereof and obtainment of the specified compaction throughout the volume of base, and the specified surface, shall be solely the responsibility of the Contractor.

If compaction is not uniform or tests show it to be inadequate, or if the surface is unsatisfactory, the Engineer may require the use of other or additional equipment.

Should low or high spots develop during rolling operations, such spots shall be smoothed out by blading with a self-propelled and pneumatic-tired motor grader having a wheelbase not less than 15 feet long and a blade not less than 10 feet long. Aggregate base shall be watered after compaction. Water shall be applied at the rate and in the quantities ordered by the Engineer.

The relative compaction of aggregate base, determined by tests of the in place, field compacted base shall be not less than 95% of the maximum compaction at optimum moisture content determined by ASTM Methods of Test, Designation D 1556 and Method C of Designation D 1557. The tests will be conducted and evaluated in the laboratory by the City at no cost to the Contractor.

The surface of the finished aggregate base at any point shall not vary more than 0.05 foot above or below proper grade, and such surface shall contain no ridges, valleys or sharp breaks. Finished base that does not conform to the foregoing requirement shall be reshaped or reworked, watered, and thoroughly recompacted to conform thereto.

The Contractor shall not allow any completed untreated rock base to be subjected to public or construction traffic, except the latter necessary to the completion of the overlying surface course.

### **205.06 Payment**

Aggregate base, or subbase, of the specified thickness after compaction, satisfactorily constructed as specified, will be paid for at the price bid per square foot, measured horizontally, or at the price bid per ton, as specified in the Schedule of Bid Prices.

If paid for by the square foot, aggregate base or subbase constructed adjoining curb will be measured from the face of the curb at a depth of 6 inches below the top of curb, irrespective of the actual depth.

If paid for by the square foot, the areas of poles, standards, other fixtures, and of boxed-out locations for manholes and other castings and facilities, regardless of ownership thereof, will not be deducted from the areas of aggregate base or subbase for which payment will be made. If paid for by the ton, the weight of all water above that contained by the aggregate at optimum moisture content will be deducted from the weight to be paid for.

If paid for by the ton, all satisfactorily completed aggregate base or subbase constructed in conjunction with the setting and resetting, as the case may be, of castings and, in accordance with the requirements of Section 217, specified to be done by the Contractor, will be paid for under the Bid Item for aggregate base or subbase.

## 206 Cement Treated Aggregate Base

### 206.01 General

The Contractor shall construct cement treated aggregate base, unless otherwise specified 6 inches thick after compaction, where and to the lines and grades shown on the plans or directed, including submitting the required aggregate samples, preparing the subgrade, doing the required watering, spreading, compacting, and trimming, furnishing and applying curing seal, and doing other Incidental Work.

### 206.02 Portland Cement

Portland cement shall be in accordance with Section 800. The quantity of cement to be added to the aggregate shall be between 2-4% and 5% by weight of the dry aggregate. The actual percentage to be used shall be as required to achieve design strength.

### 206.03 Mineral Aggregate

Aggregate for cement treated aggregate base, immediately prior to mixing, shall conform to the following requirements:

Aggregate shall be clean and free from vegetable matter and other deleterious substances, and shall not be treated with lime, cement or other chemicals prior to being tested for Sand Equivalent value. The aggregate, prior to mixing with cement, shall have a Sand Equivalent of not less than 30 when tested by Test Method No. Calif. 217.

Aggregate shall be of such quality that when mixed with portland cement in an amount not exceeding 5% by weight of the dry aggregate and compacted at optimum moisture content, the compressive strength of a sample of the compacted mixture shall not be less than 750 pounds per square inch at 7 days, when tested by Test Method No. Calif. 312 modified as follows:

- 1) Optimum moisture content of the cement treated aggregate base shall be determined using the procedures outlined in ASTM "Standard Methods of Test for Moisture-Density Relations of Soils, Using 10-lb. Rammer and 18-in. Drop", Designation D 1557.
- 2) Compaction of the test specimens shall be as outlined for Method C in ASTM Methods of Test, Designation D 1557.
- 3) Capping compound shall be sulphur instead of plaster of Paris.

The percentage composition by weight of aggregate shall conform to the following grading when determined by Test Method No. Calif. 202, modified by Test Method No. Calif. 105 when there is a difference in specific gravity of 0.2 or more between the coarse and fine portion of the aggregate or between blends of different aggregates. Coarse aggregate is material retained on the No. 4 sieve and fine aggregate is material passing the No. 4 sieve.

<u>Sieve Sizes</u>	<u>Percentage Passing</u>
1" .....	100
3/4" .....	90 - 100
No. 4 .....	40 - 70
No. 30 .....	12 - 40
No. 200 .....	3 - 15

### 206.04 Mixing

Cement treated aggregate base shall be mixed at a central mixing plant by either batch type mixing using revolving blade or rotary drum mixers or continuous mixing. Weight or volumetric proportioning may be employed. The resulting mix shall be equal to that produced by weight proportioning and batch type mixing.

The water shall be proportioned by weight or volume and there shall be means by which the Engineer may readily verify the amount of water per batch or the rate of flow for continuous mixing. The time of the addition of water or the points at which it is introduced into the mixer, shall be as approved by the Engineer.

Cement shall be added in such a manner that it is uniformly distributed throughout the aggregates during the mixing operation.

The mixers used must be able to produce uniformly mixed batches. The charge in a batch mixer, or the rate of feed to a continuous mixer, shall not exceed that which will permit complete mixing of all the material. The materials shall be mixed for not less than thirty seconds after all the ingredients are in the mixer.

The mixer materials shall be protected by covers against moisture loss while being transported to the site.

### **206.05 Spreading**

The subgrade, prepared in accordance with the requirements of Section 200, shall be moistened immediately prior to the spreading operation. The mixing materials shall be deposited and spread with a self-propelled spreader, ready for compaction with a minimum of shaping with a motor grader. Equipment not propelled by the unloading vehicle will be considered self-propelled. The spreader shall be provided with a screed that strikes off and distributes the materials to the required width and thickness.

Depositing and spreading shall commence at that part of the work farthest from the supply of base material and shall progress continuously without breaks, unless otherwise directed by the Engineer.

If a spreader box is used, it shall at all times during the simultaneous operation thereof and receipt of materials thereby, push the vehicle that has transported the cement treated base material in a manner such that the latter exerts a downward force on the spreader box sufficient to force spreading and screeding at the proper grade with no "riding up" on the deposited material. Further, in all cases there shall be positive provision preventing the spreader box from contacting the rear wheels of the transporting vehicle during the pushing operation.

The mixed materials shall be deposited and spread in one lift if the thickness is to be not more than 6 inches, and in this case depositing in layers will not be allowed. If the thickness is to be more than 6 inches, the base shall be spread and compacted in two layers of approximately equal thickness, and the surface of the compacted material shall be kept moist until covered with the next layer.

Cement treated aggregate base placed in areas inaccessible to the spreading equipment may be spread by any means that will achieve the specified compaction and surface.

### **206.06 Compacting**

Immediately following the spreading operation, the mixed materials shall be compacted in the manner and to the degree and accuracy of surface specified in Section 205.05, except that the shifting of material by a motor grader to smooth low and high spots that develop during rolling will not be allowed, nor will any reshaping or reworking of the cement treated aggregate base, although high spots may be trimmed, provided the excess material is removed and immediately disposed of, no loose material is left on the base, and the area is again rolled.

Except for the aforementioned trimming, cement treated aggregate base, the finished surface of which is outside the specified tolerances, or which is otherwise unsatisfactory, shall be neatly cut out, immediately removed from the site and replaced with fresh material properly compacted as hereinbefore specified.

When cement treated base is spread and compacted in more than one layer, each lower layer shall be compacted to the required degree of compaction before placing the next layer.

Not more than two hours shall elapse between the time water is added to the aggregate and cement, and the time of completion of initial rolling. Not more than three hours shall elapse between the time water is added to the aggregate and cement and the time of completion of final rolling after any required trimming.

The surface of the compacted cement treated aggregate base shall be kept moist until the curing seal is applied.



The Contractor shall not allow any completed cement treated aggregate base to be subjected to public or construction traffic, except the latter necessary to the completion of the overlying surface course.

### **206.07 Construction Joints**

At the end of each day's construction and when cement treated base operations are delayed or stopped for more than two hours, a construction joint shall be made in the thoroughly compacted material, normal to the centerline of the roadway. Additional material shall not be placed until the construction joint has been approved by the Engineer.

Longitudinal joints when necessary shall be constructed by cutting vertically into the existing edge for approximately 3 inches. Material cut away may be disposed of in the adjacent area to be constructed. The face of the cut joints shall be moistened in advance of placing the adjacent base.

### **206.08 Curing Seal**

The complete surface of the cement treated aggregate base shall be covered with an emulsified asphalt curing seal. Emulsified asphalt shall be as specified in Section 212.06, and in accordance with the specifications for Grade SS-1 of the Asphalt Institute. Application shall be at the rate of 0.15-gallon per square yard.

The emulsion may be diluted with water up to a ratio of one to one, as required, as determined by the Engineer, for the application of a thin uniform coat. The rate of application of the originally specified emulsion, however, shall remain 0.15-gallon per square yard regardless of dilution. The curing seal shall be applied as soon as possible, but not later than eight hours after completion of final rolling.

### **206.09 Payment**

Cement treated aggregate base of the specified thickness after compaction, satisfactorily constructed as specified, will be paid for at the price bid per square foot, measured horizontally. Cement treated aggregate base constructed adjoining curb will be measured from the face of curb at a depth of 6 inches below the top of curb, irrespective of the actual depth.

The areas of poles, standards, other fixtures, and of boxed-out locations for manhole and other castings and facilities, regardless of ownership thereof, will not be deducted from the areas of cement treated aggregate base for which payment will be made.

## **207 Concrete Base**

### **207.01 General**

The Contractor shall construct concrete base where and as shown on the plans, 6 inches thick unless otherwise specified, including preparing subgrade, constructing and removing side forms, providing the specified joints, and calcium chloride in the mix if required or used, and doing the required finishing, protecting, curing and other Incidental Work. The concrete therefor shall be properly and uniformly distributed and thoroughly and adequately vibrated, screeded and tamped by a machine or machines, self-propelled and supported on the required side forms, or on adjacent pavement base or pavement in accordance with the hereinafter specified restrictions on such support. Vibrators independent from the self-propelled machine shall not rest on the side forms.

### **207.02 Subgrade**

The adjustment of manhole frames and other castings and the preparation of subgrade shall be as specified in Sections 200 and 217, respectively. The Contractor shall obtain a relative compaction of not less than 95% for the top 6 inches of subgrade for concrete base.

### **207.03 Side Forms**

Side forms shall be used. Wood forms shall be a minimum of 2 inch nominal thickness and shall be properly supported by blocking or other approved means so that no settlement occurs. They shall be clean, straight, of uniform section, free from defects, and shall be constructed to form parallel strips not more than 24 feet, nor less than 4 feet, wide. Side forms shall be of the required depth in one piece, and be such as to form the keyway hereinafter specified for longitudinal joints. The strips shall be constructed to coincide with vehicular traffic lanes unless otherwise specified or shown.

Where, as specified in Section 207.05, a self-propelled vibrating, screeding and tamping machine is not required, the maximum width of strip shall be reduced to 14 feet. :

The forms shall be placed true to line and grade and rigidly stayed. There shall be no lateral or vertical movement of the forms while the concrete is being spread or finished.

Top surfaces of side forms shall be set to the same elevation as that of the finished concrete base. The depth of side forms shall be equal to the specified thickness of the concrete base.

After the side forms have been accurately and securely set to line and grade, the Contractor shall check the subgrade with a scratch template as specified in Section 200.01. The template shall be supported on the side forms, previously poured concrete strips, or both, as applicable, and shall be carefully drawn the full length of the subgrade to check the grade. High spots shall be cut down to grade and low spots filled and satisfactorily compacted to grade.

At least 200 feet of subgrade and side forms shall be prepared in advance of the placement of concrete. After the subgrade and side forms for any strip have been prepared and accepted, barricades shall be so placed that there will be no equipment or traffic of any kind thereon.

No adjustment shall be made in the subgrade to allow for anticipated settlement under the pavement load, and no direct or additional payment will be made for additional concrete used, or claimed to have been used, on account of such settlement.

### **207.04 Concrete**

Concrete for concrete base shall be Class 5.5-3000-13, in accordance with the requirements of Section 800.

The Contractor, with the approval of the Engineer, may use the admixture of 2 pounds calcium chloride per sack of cement to accelerate the setting of the concrete in accordance with the provisions of Section 800.08.

## 207.05 Placing Concrete

The use of an approved self-propelled, mechanical, concrete vibrating, screeding and tamping machine will be required unless otherwise specified in the Special Provisions, or unless restricted space does not permit the use thereof.

Immediately before placing concrete, the subgrade shall be watered with a spray nozzle to the extent that it will not absorb any moisture from the concrete, but there shall be no standing water on the subgrade. After the subgrade has been wetted in the manner set forth hereinbefore, the concrete shall be placed in accordance with the requirements of Section 800.14, and spread so that the vibrated, screeded and tamped base will be of the required thickness and cross section and at the required grade.

The self-propelled, mechanical, concrete vibrating, screeding and tamping machine used shall have, in addition to the spreading, screeding, and vibratory compaction action, a tamping or kneading action, and shall produce a surface satisfactory to the Engineer.

The machine may ride on adjacent existing or newly constructed pavement base or pavement. Such arrangement, however, must satisfy the Engineer, and the Contractor shall make any required correction to the surface of such base or pavement and provide required protection of the surface and of the edge thereof.

The concrete shall be evenly distributed in front of the machine to prevent unequal loads against the front cut-off screed or screeds.

The machine shall be maintained in perfect operating condition, and the screeds shall hold their crown as set.

Coordination of the forward speed of the machine and the lateral movement of the screeds must be such as to prevent ridging of the concrete surface.

The final action of the vibrating, screeding and tamping machine shall in all cases be accomplished by the use of burlap, leather or other approved type of flexible drag, attached properly to the rear of the machine. The drag shall leave the surface of the concrete ridgeless, even and uniform. Should there be any rock pockets or voids in the surface after the passage of the machine, they shall be immediately repaired by adding concrete, thoroughly working it in, and restoring the surface of the base.

The finished surface of the concrete base shall be smooth and free from texture disfigurations caused by floats or any other type of equipment or tools used to remove surface defects. Such tools may be used, but after their use a final pass must be made with the machine.

The vibrating, screeding and tamping machine shall back up and pass over the surface as many times as are necessary to establish a true and even crown and a ridgeless, even and uniform surface over the entire pavement base area.

If an approved vibrating, screeding and tamping machine is not used, all concrete placed shall be vibrated in accordance with the requirements of Section 800.14, and then tamped with a transverse tamper until the surface is dense and smooth. Should there be any rock pockets or voids in the surface after tamping, they shall be immediately repaired by adding concrete, thoroughly working it in, and retamping to restore the surface of the base.

## 207.06 Construction Joints

General. - At the beginning and end of every strip not in contact with existing pavement base, at the end of each day's construction, or where the placing of concrete is interrupted for a period of one hour or more, a vertical construction joint shall be provided prior to the resumed placing of concrete. The construction joint shall be formed by finishing the base square across the strip against a header, 3 inches thick, of a width equal to the depth of the base, and shaped so that it will form a keyway as shown on the plans. The header shall conform to the correct cross section of the base, shall be placed perpendicular to the subgrade, and its top shall be at all points at the correct elevation at the top of the base.

The concrete shall not be edged.

Prior to the resumption of work, surplus concrete on the subgrade shall be cleared away, and the header shall be removed in such a manner as to avoid damage to the edge of the concrete.

Longitudinal Joints. - Longitudinal joints between adjacent pours of concrete base, between concrete base and concrete parking strip or gutter, and between concrete base and curb, shall be keyed as shown on the plans.

The keyway shall be formed in the first of adjacent pours.

Where adjacent pours are 8-inch thick concrete base and concrete parking strip or gutter, the vertical position of the keyway and key shall be as shown on the plans.

The concrete shall not be edged.

### 207.07 Dummy Joints

General. - Transverse dummy joints shall be placed at 15 feet on centers, for the full width of the pavement, in alignment with the joints of adjacent concrete pours, and at right angles to the centerline of the street. Each joint shall be constructed by forming a transverse groove in the pavement base and installing therein a formed strip of joint insert, as shown on the plans.

Joint Filler Strip. - Each joint filler strip shall be an approved one-piece premolded strip at least 1-3/4 inches, and not more than 2 inches, wide, sufficiently long to extend the full width of the pavement less 1/2-inch. Splicing of a joint filler strip will not be permitted, except that where pour widths exceed 12 feet one splice will be permitted. The thickness of the strip shall not exceed 1/4-inch and shall be uniform within a variation of not more than 10%. Joint filler strip shall be in accordance with the requirements of ASTM "Standard Specifications for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction", Designation D 1751.

Construction. - Following the pass of the vibrating and screeding equipment, but before the final dragging or brushing, the joint groove shall be formed by means of an iron cutter with a blade at least 3 inches in depth and 1/4-inch thick. The cutter shall have some means of controlling the depth of insertion and shall not have any horizontal surfaces, except the edge, that contact the concrete. A movable bridge supported on the forms or adjacent concrete shall be provided to assure minimum disturbance to the concrete during joint construction operations. The bridge shall be at least 2 inches clear of the concrete surface when loaded with 300 pounds at its center and supported on the forms or adjacent pavement.

The depth of the groove shall be at least equal to, and not more than 1/4-inch greater than the width of the filler strip to be used.

The steel cutter shall be cleaned after each insertion into the concrete, or the Contractor may use any means approved by the Engineer that will prevent adherence of mortar and aggregate to the cutter and resultant disturbance of the concrete during cutting operations.

The steel cutter shall be mechanically vibrated at a rate of 3,500 vibrations per minute by use of at least one vibrator. At all times during the cutting operations, such vibrators shall be activated.

The joint filler strip shall then be placed in the groove by means of a metal installing device consisting of sheet metal backing plates with one side the full depth of the strip and the other side extending down 3/4-inch along the opposite side of the strip. The ends of the installing device shall be equipped with an adjustable gauge resting on each side form to control the depth to which the strip is placed. The installing device shall be sufficiently rigid to hold the strip in exact position, and the overall thickness shall not be greater than that necessary to install and release the strip readily.

The Engineer reserves the right to order discontinued, the use of any equipment or material which in his opinion fails to produce a satisfactory joint under the methods employed by the Contractor.

The filler strip shall be placed into the groove completely across the width of the slab, so that the top of the strip is within 1/4-inch of the adjacent concrete surface. Any strip damaged in installing, or during any work on the pavement base, shall be replaced with an undamaged strip.

The concrete shall not be edged and shall be continuous over the insert.

After pavement side forms have been removed, any concrete which has flowed around the ends of the strip shall be removed.

Expansion joints shall not be constructed in concrete base.

### 207.08 Protection and Curing

Concrete base shall be protected and cured in accordance with the requirements of Section 800.16.

No equipment, or public or other traffic shall be allowed on concrete pavement base, nor shall asphalt concrete wearing surface be placed thereon until ten days after the pavement base has been placed, except

that when calcium chloride is used in accordance with the requirements of Section 800.08 as an admixture to accelerate the setting of concrete base, public traffic may be allowed thereon only after at least twenty-four hours have elapsed since the completion of all placement of such concrete.

The placement of asphalt concrete wearing surface on such pavement base by use of a self-propelled spreading and finishing machine, however, will not be allowed until forty-eight hours have elapsed since the completion of the placement of the concrete. In no case shall concrete base remain without wearing surface for more than fourteen days.

### **207.09 Payment**

Concrete base of the specified thickness, satisfactorily constructed, complete in place as specified, will be paid for at the price bid per square foot, measured horizontally.

Concrete pavement base constructed adjoining curb will be measured from the face of curb at a depth of 6 inches below the top of curb, irrespective of the actual depth.

The areas of boxed-out locations for manhole and other castings and facilities, regardless of ownership thereof, will not be deducted from the areas of concrete pavement base for which payment will be made.

## 208 Asphalt Concrete Base

### 208.01 General

The Contractor shall construct asphalt concrete base, 6 inches thick unless otherwise specified, consisting of asphalt and graded mineral aggregate proportioned and mixed at a central mixing plant, and spread and compacted to the lines, grades, cross sections and thicknesses shown on the plans, or where directed, including preparing the subgrade, furnishing and applying paint binder, and doing all other necessary or required Incidental Work.

### 208.02 Asphalt

Asphalt shall be AR-4000 steam refined paving asphalt, in accordance with all current applicable requirements and specifications of the Asphalt Instituted and the Uniform Pacific Coast Specifications for Paving Asphalt. The amount thereof to be used shall be between 4 and 5.5% by weight of the dry mineral aggregate.

A test report shall be furnished in accordance with the requirements of Section 212.02.

### 208.03 Aggregate

Mineral aggregate shall be in accordance with the quality requirements set forth in Section 212.03.

The combined dry mineral aggregate shall have a particle size distribution such that the percentage composition by weight, determined by test using standard sieves of square mesh wire construction, will be in accordance with the following grading requirements:

<u>Sieve Sizes</u>	<u>Percentage Passing</u>
1" .....	100
3/4" .....	95 - 100
3/8" .....	65 - 80
No. 4 .....	49 - 54
No. 8 .....	36 - 40
No. 30 .....	18 - 21
No. 200 .....	3 - 8

### 208.04 Proportion and Mixing

The mineral aggregate shall be prepared and proportioned, and mixed with the asphalt, as specified in Section 212.05.

### 208.05 Subgrade

Before placing asphalt concrete base, the subgrade shall be prepared as provided in Section 200. The Contractor shall obtain a relative compaction of not less than 95% for the top 6 inches of subgrade for asphalt concrete.

### 208.06 Paint Binder

Paint binder, mixing type asphaltic emulsion, SS-1, shall be furnished and applied as specified in Section 212.06.

### 208.07 Spreading Equipment and Spreading

Spreading, and equipment therefor, shall be in accordance with the requirements of Sections 212.07 and 212.08, supplemented as follows: Unless the specified thickness of the base after compacting is 3 inches or less the base shall be spread and compacted in two or more courses, each in the manner specified.

No asphalt concrete base shall be spread when the temperature is below 50° Fahrenheit or when the subgrade is wet.

## 208.08 Compaction

Immediately after the base has been spread it shall be compacted with power rollers in first-class mechanical condition. Roller sprinkler systems shall operate satisfactorily in all respects.

The Contractor shall furnish and use, for each asphalt paver furnished, a minimum of two rollers of the types and employed as follows:

- 1) Initial or breakdown rolling shall consist of one complete coverage with a steel-tired three-axle tandem, two-axle tandem or three-wheel roller, weighing not less than 12 tons, operating with a drive wheel toward the paver.
- 2) Final rolling shall follow the initial or breakdown rolling and shall consist of three complete coverages with a pneumatic-tired roller while the temperature of the mixture is at or above 150°F.

The pneumatic-tired roller shall be the oscillating type having a width of not less than 4 feet and equipped with pneumatic tires of equal size and diameter. Wobble-wheel rollers will not be permitted. The tires shall be so spaced that the gap between adjacent tires will be covered by the tread of the following tire. The tires shall be inflated to 90 pounds per square inch or such lower pressure designated by the Engineer, and maintained so that the air pressure will not vary more than 5 pounds per square inch from the designated pressure. The roller shall be so constructed that its total weight can be varied to produce an operating weight per tire of not less than 2,000 pounds. The total operating weight of the roller shall be varied as directed by the Engineer.

When the total amount of asphalt concrete base included in the contract is 1,000 tons or less, rolling may be in accordance with the following alternative requirements:

The Contractor shall furnish and use a minimum of one steel-tired 2-axle tandem roller, weighing not less than 8 tons, provided it is demonstrated to the satisfaction of the Engineer that such a roller can perform the work.

Rolling shall consist of sufficient coverages to produce a surface thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. Restricted areas inaccessible to power rollers may be compacted by rolling with the wheels of a loaded truck of not less than 5 tons capacity, or by hot tampers.

## 208.09 Payment

Asphalt concrete base of the specified thickness, satisfactorily constructed, complete in place as specified, will be paid for at the price bid per square foot, measured horizontally, or at the price bid per ton, as specified in the Schedule of Bid Prices.

If paid for by the square foot, asphalt concrete base constructed adjoining curb will be measured from the face of the curb at a depth of 6 inches below the top of curb, irrespective of the actual depth. The areas of boxed-out locations for manholes and other castings and facilities, regardless of ownership thereof, will not be deducted from the areas of asphalt concrete base for which payment will be made.

If paid for by the ton, all satisfactorily completed asphalt concrete base constructed in conjunction with the setting and resetting, as the case may be, of castings and, in accordance with the requirements of Section 217, specified to be done by the Contractor, will be paid for under the Bid Item for asphalt concrete base.

## **209 Asphalt Concrete Base - Thick Lift**

### **209.01 General**

The Contractor shall construct thick lift asphalt concrete base, consisting of asphalt and graded mineral aggregate proportioned and mixed at a central mixing plant, and spread and compacted in layers not exceeding 5 inches compacted thickness to the lines, grades, cross sections and thicknesses shown on the plans, or where directed, including preparing the subgrade, and doing all other necessary or required "Incidental Work".

The Contractor shall give the Engineer 24 hours notice prior to placing asphalt concrete.

### **209.02 Asphalt**

Asphalt shall be AR-4000 steam refined paving asphalt, in accordance with all current applicable requirements and specifications of the Asphalt Institute and the Uniform Pacific Coast Specifications for Paving Asphalt. The amount thereof to be used shall be between 5 and 6.5% by weight of the dry mineral aggregate. The exact percent to be used shall be determined by the Engineer.

A test report shall be furnished in accordance with the requirements of Section 212.02.

### **209.03 Aggregate**

Mineral aggregate shall be 3/4-inch maximum aggregate in accordance with the quality and grading requirements set forth in Section 212.03.

### **209.04 Proportioning and Mixing**

The mineral aggregates and asphalt binder shall be mixed at a central mixing plant. The aggregates and asphalt binder may be proportioned either by weight or by volume.

Aggregate shall be stored dried, heated and proportioned in a manner that will give a combined grading within the specified grading limits and satisfactory to the Engineer.

Drying shall continue for a sufficient time and at a sufficiently high temperature to reduce the average moisture content so that at the completion of mixing operations and also at the time of spreading the mixture, the amount of moisture in the mixture shall not exceed 1%.

The drier shall be provided with a heat indicating device in order that the temperature of the aggregate leaving the drier may be determined. The heat indicating device shall be accurate to the nearest 10°F, and shall be installed in such a manner that a fluctuation of 10°F in the aggregate temperature will be shown by the heat indicating device within one minute.

Any evidence of segregation, degradation, or improper combining of aggregate will be cause for rejection of the asphalt concrete containing such aggregate.

Uniformity of distribution of asphalt will be determined by extraction tests in accordance with Test Methods Nos. Calif. 309 or 310. The weight-of asphalt per 100 pounds of dry aggregates shall not vary by more than 5% above or 10% below the amount designated by the Engineer. This requirement shall apply to samples taken from a single batch, successive batches, at different locations in the plant, or at any location or operation designated by the Engineer.

Paving asphalt used as binder shall be added to the aggregate at a temperature of not less than 275°F, nor more than 375°F.

When paving asphalt is used as a binder, the temperature of the aggregates at the time of adding the binder shall not be less than 250°F, nor more than 325°F.

Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced. In general, the time of mixing shall not be less than 30 seconds, except that the time may be reduced when in the opinion of the Engineer the sizes of aggregate are uniformly distributed and all particles are thoroughly and uniformly coated with asphalt binder.



### **209.05 Spreading and Equipment and Spreading**

Asphalt concrete base shall be placed and spread with a paving machine or other approved spreading device. All mixture shall be spread at a temperature not less than 250°F, or as directed. The base may be spread and compacted in layers not exceeding 5 inches compacted thickness. The first layer shall be at least 4 inches thick.

### **209.06 Compaction**

Immediately after the base has been spread it shall be compacted with power rollers in the following operating sequence:

Either (1) initial or breakdown rolling with a steel-wheeled roller, final rolling with a pneumatic-tired roller and finish rolling with a steel-wheeled roller, or (2) initial or breakdown rolling with a pneumatic-tired roller and final rolling with a steel-wheeled roller.

A minimum of ten complete rolling coverages shall be completed prior to the time the mix temperature falls below 200°F in the center of the lift. Rolling from the center to the edge will be permitted for layers in excess of 3 inches compacted thickness.

Steel-tired roller shall be three-axle tandem, two-axle tandem or three-wheel roller weighing not less than 12 tons.

Pneumatic-tired roller shall be as follows:

- 1) for initial rolling, equipped with 9.00 x 20 tires capable of being loaded to 4,000 pounds at 80 pounds per square inch inflation pressure;
- 2) for final rolling, equipped with 8.0 x 15 tires capable of being loaded to 3,000 pounds at 80 pounds per square inch inflation pressure.

The tires of the pneumatic roller shall be treated with a parting compound or other suitable agent to prevent "pickup".

### **209.07 Payment**

Asphalt concrete base, satisfactorily constructed, complete in place, as specified, will be paid for at the price bid per ton.

All satisfactorily completed thick lift asphalt concrete base constructed in conjunction with the setting and resetting, as the case may be, of castings and, in accordance with the requirements of Section 217, specified to be done by the Contractor, will be paid for under the Bid Item for thick lift asphalt concrete base.

## **210 Concrete Pavement**

### **210.01 General**

The Contractor shall construct, where and as shown on the plans, concrete pavement 7 inches thick, and concrete parking strip 8 inches thick monolithic with the adjacent concrete curb, unless other thicknesses are specified, including preparing subgrade, constructing and removing side forms, providing the specified joints, and calcium chloride in the mix if required or used and doing the required finishing, protecting, curing and other Incidental Work. The concrete therefor shall be properly uniformly distributed, and thoroughly and adequately vibrated, screeded and tamped by a machine or machines, self-propelled and supported on the required side forms, or on adjacent pavement base of pavement in accordance with the hereinafter specified restrictions on such support. Use of the machine will not be required where the steepness of slope precludes the practical use thereof. Vibrators independent from the self-propelled machine shall not rest on the side forms.

Concrete pavement 3<sup>1</sup>/<sub>2</sub> inches thick shall be constructed as specified in Section 204.10.

Concrete curb constructed monolithic with concrete pavement will not be included for payment under a Bid Item for concrete pavement. No additional payment will be made for monolithic construction.

Where concrete pavement gutter grade adjacent to the curb is less than 1%, the concrete forming the gutter, for the entire length thereof, shall be carefully hand steel troweled for a distance of one foot out from the curb.

### **210.02 Subgrade**

The adjustment of manhole frames and other castings and the preparation of subgrade shall be as specified in Sections 217 and 200, respectively. The Contractor shall obtain a relative compaction of not less than 95% for the top 6 inches of concrete pavement subgrade.

### **210.03 Side Forms**

Metal side forms shall be constructed in accordance with the requirements of Section 207.03, and the other provisions of such Section shall be complied with.

### **210.04 Concrete**

Concrete for concrete pavement shall be Class 5.5-3000-17, in accordance with the requirements of Section 800, except that when construction is monolithic with curb the concrete shall be Class 6-3000-3/4.

The Contractor, with the approval of the Engineer, may use the admixture of 2 pounds calcium chloride per sack of cement to accelerate the setting of concrete in accordance with the provisions of Section 800.08, except the use of calcium chloride will not be allowed in construction monolithic with curb.

### **210.05 Placing Concrete**

Placing concrete shall be as specified in Section 207.05.

### **210.06 Finishing**

The concrete shall be finished with a rigid straight edge float, not more than 18 feet, or less than 16 feet, in length, having a smoothing surface from 8 to 10 inches in width. The straight edge float shall be operated from bridges with its length parallel to the centerline of the pavement, and shall be dragged with a combined longitudinal and transverse motion, planing off the high places and filling in depressions.

The surface shall then be floated with a light wood float of the same length as the aforementioned rigid float, but from 6 to 8 inches in width and 1/2 to one inch in thickness, and equipped with reversible handles at each end. The light wood float shall be operated from bridges with its length parallel to the centerline of the pavement, and shall be dragged transversely across the pavement with its forward edge raised slightly so the smoothing will be done by the back edge.

Immediately following the float finishing, the surface shall be brushed transversely across the pavement with a bristle brush to produce a uniform, nonskid texture. The brushes shall be maintained clean and free from encrusted mortar. Brushes that cannot be cleaned shall be discarded. The brushing shall not be done until the concrete has become slightly sticky. This will require the finishers to remain on the work for a considerable length of time after the spreading so that the concrete will have sufficiently set before being given the final finish.

The finished pavement shall be to the required grade and cross section, and shall not vary from the required surface more than 1/8-inch in 10 feet.

### **210.07 Construction Joints**

The location and forming of construction joints shall be in accordance with the requirements therefor specified in Section 207.06. The concrete shall in no case be edged.

Where concrete pavement base will be poured against concrete parking strip or gutter, the Contractor shall construct the required keyway in such pavement, parking strip or gutter. The longitudinal centerline of the keyway shall be one inch below the horizontal centerline of the vertical face in which it is formed.

### **210.08 Dummy Joints**

Transverse dummy joints shall be placed at 15 feet on centers, for the full width of the pavement, in alignment with the joints of adjacent concrete pours, and at right angles to the centerline of the street. On curves they shall be constructed on radial lines.

Dummy joints shall be as specified in Section 207.07, shall under no circumstances be edged, and shall be continuous over the insert.

Expansion joints shall not be constructed in concrete pavement.

### **210.09 Protection and Curing**

Concrete pavement shall be protected and cured in accordance with the requirements of Section 800.16.

No equipment, or public or other traffic shall be allowed on concrete pavement until ten days after the pavement has been placed, except that when calcium chloride is used in accordance with the requirements of Section 800.08 as an admixture to accelerate the setting of concrete, public traffic may be allowed thereon only after at least twenty-four hours have elapsed since the completion of all placement of such concrete.

### **210.10 Payment**

Concrete pavement of the specified thickness, satisfactorily constructed, complete in place, as specified, will be paid for at the price bid per square foot of each specified thickness, measured horizontally.

Concrete pavement constructed adjoining curb will be measured from the face of curb at a depth of 6 inches below the top of curb, irrespective of the actual depth.

The areas of boxed-out locations for manhole and other castings and facilities, regardless of ownership thereof, will not be deducted from the areas of concrete pavement for which payment will be made.

## **211 Asphalt Concrete Leveling Course**

### **211.01 General**

The Contractor shall construct asphalt concrete leveling course, where and of the thickness necessary, to obtain the grades and cross sections shown on the plans, including cleaning existing pavement or preparing the subgrade, as the case may be, and doing all other necessary or required Incidental Work.

### **211.02 Materials**

Asphalt concrete leveling course materials shall be in all respects in accordance with the asphalt concrete wearing surface specified in Section 212 and the Special Provisions.

### **211.03 Certificates of Weight**

Certificates of weight, if required, shall be furnished to the Engineer in accordance with the requirements of Section 111.02.

### **211.04 Payment**

Asphalt concrete leveling course satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per ton of asphalt concrete wearing surface.

## 212 Asphalt Concrete as a Wearing Surface

### 212.01 General

The Contractor shall construct asphalt concrete wearing surface, 2 inches thick unless otherwise specified, consisting of asphalt and graded mineral aggregate, proportioned and mixed at a central mixing plant, and spread and compacted to the lines, grades, cross-sections and thicknesses shown on the plans, or where directed, including cleaning the area to be paved; repairing cracks, spalls and chuckholes; furnishing and installing paint binder; and doing all other necessary or required Incidental Work.

Asphalt concrete types are designated by the maximum size particle in the constituent graded aggregate. In general, use shall be as follows: 3/4" Max. on new pavement base. 1/2" Max. for resurfacing and for conform pavement, and 3/8" Max. when the total compacted thickness to be placed is less than 1-1/4 inches or where the surfacing is exclusively for pedestrian use.

Asphalt concrete specified to be used to construct asphalt concrete curb, sidewalk, ditch and dike, if the Proposal contains a Bid Item for asphalt concrete wearing surface, will be included in the quantity thereof for which payment will be made. The Contractor shall give the Engineer 24 hours notice prior to placing asphalt concrete.

### 212.02 Asphalt

General. - Asphalt shall be AR-4000 steam refined paving asphalt, in accordance with all current applicable requirements and specifications of the Asphalt Institute, and the Uniform Pacific Coast Specifications for Paving Asphalts. The amount thereof to be used for the three mix types, in percent by weight of the dry aggregate, shall be:

3/4" Max. and 1/2" Max .....	4 to 6
3/8" Max .....	5.5 to 6.5

Records of Delivery. - Records of delivery of asphaltic materials to the supplier, showing contract and purchase order numbers, shipment numbers, dates and quantities, and material designations, shall be available for inspection by the Engineer.

### 212.03 Aggregate

General. - Aggregate for asphalt concrete surface course mixes shall consist of a mixture of coarse and fine aggregates, which shall be clean, hard, durable material, free from decomposed materials, vegetable matter and other deleterious substances.

Coarse aggregate is material retained on the No. 4 sieve and fine aggregate is material passing the No. 4 sieve.

The combined dry mineral aggregate shall consist of material of which at least 60% by weight shall be crushed particles as determined by Test Method No. Calif. 205.

Grading. - The combined dry mineral aggregate shall have a particle size distribution such that the percentage composition by weight when tested in accordance with Test Method No. Calif. 202, will be in accordance with one of the grading requirements set forth as follows:

**SURFACE COURSE AGGREGATE GRADING REQUIREMENTS**  
Percentage Passing

<u>Sieve Sizes</u>	<u>3/4" Max</u>	<u>1/2" Max</u>	<u>3/8" Max</u>
1" .....	100	.....	.....
3/4" .....	95 - 100	100	.....
1/2" .....	.....	95 - 100	100
3/8" .....	65 - 80	75 - 90	95 - 100
No. 4 .....	49 - 54	55 - 61	73 - 77
No. 8 .....	36 - 40	40 - 45	58 - 63
No. 30 .....	18 - 21	20 - 25	29 - 34
No. 200 .....	3 - 8	3 - 7	3 - 10

The gradings specified hereinbefore are based on materials of a uniform specific gravity. Correction of grading limits to compensate for difference in specific gravity of 0.2 or more between portions of the aggregate shall be modified by Test Method No. Calif. 105.

Minimum durability index, when tested in accordance with Test Method No. Calif. 229, shall be 50.

The combined gradings within the specified limits shall be of such uniformity that the materials during any day's run will not vary more than the following:

Maximum range in the percentage of material passing No. 4 sieve. ....	6
Maximum range in the percentage of material passing No. 30 sieve ....	5

## 212.04 Samples and Testing

At least ten working days prior to the use thereof, the Contractor shall submit to the Engineer a 120-pound sample of aggregate, graded as intended for use. This requirement shall be complied with for each aggregate and grading thereof that has not been approved. The Engineer will test the sample at no cost to the Contractor, and will determine the acceptability of the aggregate.

The combined aggregate shall also conform to the following quality requirements immediately prior to mixing with asphalt binder:

<u>Tests</u>	<u>Test Method No. Calif.</u>	<u>Requirements</u>
Los Angeles Rattler (after 500 revolutions) .....	211	50% Max
Both Ke and Kf-Factors (obtained from Centrifuge Kerosene Equivalent Test) .....	303	1.7 Max
Sand Equivalent .....	217	45 Min.

The combined aggregate mixed with the required percent of asphalt shall also conform to the following quality requirements:

<u>Tests</u>	<u>Test Method No. Calif.</u>	<u>Requirements</u>
Stabilometer Value* .....	366	35 Min.
Moisture Vapor Susceptibility (Stabilometer Value) .....	307	25 Min.
Swell .....	305	0.030" Max.

\* When the 3/8" Max. aggregate grading is specified for use, the above Stabilometer Value requirement will be 30 Min.

The exact proportions of aggregate and amount of asphalt binder shall be subject to control by the Engineer and may be varied within the limits set forth in order to produce a satisfactory mix.

In general, within the grading limits, a higher content of material passing the No. 200 sieve will require an amount of asphalt binder closer to the upper limit.

During construction, samples of asphalt concrete aggregate will be collected for grading tests. If the results of grading tests are not within the requirements, the asphalt concrete represented by these tests shall be removed unless the Engineer determines that said asphalt concrete is structurally adequate and may remain in place. If this asphalt concrete is left in place, the Contractor shall pay to the City \$1.75 per ton for such asphalt concrete. The City may deduct this amount from any payments due, or that may become due, the Contractor under the contract. No single grading test shall represent more than 500 tons of asphalt concrete or one day's paving, whichever is smaller.

### **212.05 Proportioning and Mixing**

The mineral aggregates and asphalt binder shall be mixed at a central mixing plant. The aggregates and asphalt binder may be proportioned either by weight or by volume.

Aggregate shall be stored, dried, heated and proportioned in a manner that will give a combined grading within the specified grading limits and satisfactory to the Engineer.

Drying shall continue for a sufficient time and at a sufficiently high temperature to reduce the average moisture content so that at the completion of mixing operations and also at the time of spreading the mixture, the amount of moisture in the mixture shall not exceed 1%.

The drier shall be provided with a heat indicating device in order that the temperature of the aggregate leaving the drier may be determined. The heat indicating device shall be accurate to the nearest 10°F, and shall be installed in such a manner that a fluctuation of 10°F in the aggregate temperature will be shown by the heat indicating device within one minute.

Any evidence of segregation, degradation, or improper combining of aggregate will be cause for rejection of the asphalt concrete containing such aggregate.

Uniformity of distribution of asphalt will be determined by extraction tests in accordance with Test Methods No. Calif. 309 or 310. The pounds of asphalt per 100 pounds of dry aggregates shall not vary by more than 5% above or 10% below the amount designated by the Engineer. This requirement shall apply to samples taken from a single batch, successive batches, at different locations in the plant, or at any location or operation designated by the Engineer.

Paving asphalt used as binder shall be added to the aggregate at a temperature of not less than 275°F, nor more than 375°F.

When paving asphalt is used as a binder, the temperature of the aggregates at the time of adding the binder shall not be less than 250°F, nor more than 325°F.

Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced. In general, the time of mixing shall not be less than 30 seconds, except that the time may be reduced when in the opinion of the Engineer the sizes of aggregate are uniformly distributed and all particles are thoroughly and uniformly coated with asphalt binder.

### **212.06 Paint Binder**

General. - Paint binder shall be applied to all surfaces on or against which an asphalt concrete course is to be laid, except a preceding asphaltic course of the same pavement laid within the preceding 24 hours, or except temporary pavement.

Paint binder shall be emulsified asphalt Type SS-1 in accordance with the Asphalt Institute Specifications.

Before applying paint binder the Contractor shall remove all loose particles, sand, dust, and other foreign materials by power brooming with an approved street sweeping machine.

Large cracks, spalls and chuckholes, particularly reflective cracks occurring in the existing asphaltic surface over the joints of concrete roadway base, shall be thoroughly cleaned and repaired with asphalt slurry mixture or other asphaltic materials as directed by the Engineer.

The repair shall be done at least 24 hours before the paving, unless otherwise directed by the Engineer. A sample of the slurry mixture or asphaltic materials shall be submitted to the Engineer for approval three

working days prior to the repair.

Applying. - Paint binder shall be applied at the rate of 0.05 to 0.10 gallons per square yard by means of a vehicle-mounted pressure-operated, sprayer-type distributor which shall operate at a continuous, even pressure of not less than 20 pounds per square inch.

Paint binder shall not be applied during cold or rainy weather.

Emulsified asphalt or paving asphalt, as applicable, shall be applied at temperatures suitable for uniform and effective binder coat.

Should, from any cause, an excess of paint binder be applied, that excess shall be immediately removed. Paint binder shall be applied by spraying, and not in any other manner.

Paint binder shall be applied to all vertical surfaces of pavements, curbs, gutters, and manhole and catchbasin frames against which asphalt concrete materials are to be placed.

Curbs, sidewalks, and gutters shall be protected from paint binder. Any emulsified asphalt sprayed on adjoining improvements shall be immediately cleaned off.

## 212.07 Spreading Equipment

Asphalt paving machines shall be self-propelled mechanical spreading and finishing equipment, provided with a screed or strike-off assembly capable of distributing the material to not less than the full width of a traffic lane. Screed action shall include any cutting, crowding or other practical action which is effective on the mixture without tearing, shoving or gouging, and which produces a surface texture of uniform appearance. The screed shall be adjustable to the required section and thickness. The paving machine shall be provided with either a full width roller or tamper or other suitable compacting devices. Paving machines that leave ridges, indentations or other marks in the surface that cannot be eliminated by rolling or prevented by adjustment in operation shall not be used.

The asphalt paving machine shall operate independently of the vehicle being unloaded or shall be capable of propelling the vehicle being unloaded in a satisfactory manner and, if necessary, the load of the haul vehicle shall be limited to that which will insure satisfactory spreading. While being unloaded, the haul vehicle shall be in contact with the machine at all times and the brakes on the haul vehicle shall not be depended upon to obtain contact between the vehicle and the machine. The use of a paving machine is mandatory for the construction of more than 800 square feet of wearing surface unless the use thereof is physically impossible.

## 212.08 Spreading

Before placing and spreading asphalt concrete wearing Surface the Contractor shall remove all loose particles, sand, dust and other foreign materials by power brooming, by an approved street sweeping machine.

All mixtures, except open graded mixtures shall be spread at a temperature of not less than 225°F and all initial rolling or tamping shall be performed when the temperature of the mixture is such that the sum of the air temperature plus the temperature of the mixture is between 300°F and 375°F. Open graded mixture shall be spread at a temperature not less than 200°F and not more than 250°F, unless a higher temperature is directed by the Engineer.

The Contractor shall always furnish and always use tarpaulins to cover all loads.

Open graded mixtures shall be placed only when the atmospheric temperature is above 60°F and all other mixtures shall be placed only when the atmospheric temperature is above 40°F.

All layers shall be spread with an asphalt paving machine as specified in Section 212.07. Asphalt paving machines shall be operated in such a manner as to insure continuous and uniform movement thereof. Segregation shall be avoided and the surfacing shall be free from pockets of coarse or fine material.

Before placing asphalt concrete wearing surface adjacent to cold transverse construction joints, such joints shall be trimmed to a vertical face in a neat line. The location of the proposed joint shall be tested with a 10-foot straightedge and cut back so that when the straightedge is laid on the finished surface parallel with the centerline of the street, the surface shall in no place vary from the lower edge of the straightedge more than 1/8-inch.

Before placing asphalt concrete adjacent to any existing asphalt concrete, the face of the existing asphalt concrete shall be trimmed to a vertical face in a neat line. Where asphalt concrete wearing surface is placed



adjacent to a Portland cement concrete gutter or parking strip, the asphalt concrete wearing surface shall be so spread that its surface, after compaction, will be approximately 1/4-inch above the surface of the adjacent concrete.

The maximum depth of wearing surface which may be spread and rolled in one course shall not exceed a compacted thickness of 2 inches. Where such thickness exceeds 2 inches, it shall be spread and rolled in courses each not to exceed a compacted thickness of 1-1/2 inches unless otherwise specified in the Special Provisions.

The completed mixture shall be deposited at a uniform quantity per linear foot, which quantity will provide the required compacted thickness without resorting to spotting, picking-up or otherwise shifting the mixture. Longitudinal joints in the top course shall correspond with the edges of proposed traffic lanes.

At locations where the asphalt concrete is to be placed over areas inaccessible to the specified spreading and rolling equipment, the asphalt concrete shall be spread by handwork to obtain the specified results and shall be thoroughly compacted to the lines, grades and cross sections by means of pneumatic tampers, or by other methods that will produce the same degree of compaction as pneumatic tampers.

## 212.09 Compaction

Immediately after the wearing surface has been spread it shall be compacted with power rollers in first-class mechanical condition. Roller sprinkler systems shall operate satisfactorily in all respects.

After the first pass of the roller, any low or grainy spots shall be broken up and more material worked in to insure a surface of uniform texture and maximum density.

The Contractor shall furnish and use, for each asphalt paver furnished, a minimum of three rollers, of the types, and employed as follows:

- 1) Initial or breakdown rolling shall consist of one complete coverage with a steel-tired three-axle tandem, two-axle tandem, or three-wheel roller, weighing not less than 12 tons, operating with the drive wheel toward the paver.
- 2) Intermediate rolling shall follow the initial or breakdown rolling and shall consist of three complete coverages with a pneumatic-tired roller while the temperature of the mixture is at or above 150°F.

The pneumatic-tired roller shall be the oscillating type having a width of not less than 4 feet and equipped with pneumatic tires of equal size and diameter. Wobble-wheel rollers will not be permitted. The tires shall be so spaced that the gap between adjacent tires will be covered by the tread of the following tire. The tires shall be inflated to 90 pounds per square inch or such lower pressure designated by the Engineer, and maintained so that the air pressure will not vary more than 5 pounds per square inch from the designated pressure. The roller shall be so constructed that its total weight can be varied to produce an operating weight per tire of not less than 2,000 pounds. The total operating weight of the roller shall be varied as directed by the Engineer.

Final rolling shall immediately follow intermediate rolling and shall consist of sufficient coverages with a steel-tired two-axle tandem roller, weighing not less than 8 tons, to produce a surface thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities.

When the total amount of asphalt concrete wearing surface included in the contract is 1,000 tons or less, rolling may be in accordance with the following alternative requirements:

- 1) The Contractor shall furnish and use a minimum of one steel-tired 2-axle tandem roller, weighing not less than 8 tons, provided it is demonstrated to the satisfaction of the Engineer that such roller can perform the work.
- 2) Rolling shall consist of sufficient coverages to produce a surface thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities.

Areas inaccessible to power rollers shall be compacted with hot tampers.

The finished surface of the pavement shall be true to grade and cross section, free from high spots, depressions, or grainy spots, and shall show a uniform distribution of aggregate. A straightedge 10 feet

long laid on the finished surface parallel to the centerline of the pavement shall disclose no more than the following irregularities per lane-mile in the pavement:

<u>Irregularity Range</u>	<u>Max per Lane per Mile</u>
3/16 inch to 1/4 inch .....	200 irregularities
1/4 inch to 5/16 inch .....	100 irregularities
5/16 inch or greater .....	0 irregularities

In addition, the above criteria shall be used as a basis for calculating the maximum allowable amount of irregularities for each block throughout the project limits. The maximum allowable amount of irregularities per lane-block shall be calculated by multiplying the maximum allowable number of irregularities per lane-mile by the length of the block in feet and dividing by 5,280 feet.

The City shall have the option of requiring correction of pavement irregularities in excess of the maximum allowable or a reduction of payment due the Contractor based on the official rolling-straightedge report. The reduction of payment shall be as follows:

<u>Irregularity Range</u>	<u>Payment per Irregularity beyond Max</u>
3/16 inch to 1/4 inch .....	\$10.00
1/4 inch to 5/16 inch .....	\$50.00
5/16 inch or greater .....	\$100.00

The Contractor shall transport the City-furnished straightedge from Room 62, City Hall, San Francisco, or other place of storage, to the site of the work and return said equipment to the place of storage when the need therefor has ended.

The City will perform the rolling-straightedge operation at no cost to the Contractor.

The Contractor shall furnish the Engineer with all necessary, or required, labor and equipment, other than 10-foot rolling straightedge, to complete the inspection of the finished pavement.

## 212.10 Conform Areas

Conforms shall, where possible, be made along straight or regular lines carefully located to assure a smooth surface and proper crown.

All edges of existing pavement along a trench or butt conform shall be painted with paint binder before depositing asphalt concrete. In areas of the standard butt conform a wedge shaped course, as shown on the plans, shall be laid prior to 4 p.m. of the same day the wearing surface is removed. The new wearing surface shall be placed with the finishing machine within two days of the placing of the wedge.

The asphalt concrete wearing surface shall be spread evenly at the trench or butt conform, to a thickness of at least 1/4-inch above the existing pavement to insure proper rolling and compaction. After the first pass of the roller all low or grainy spots shall be broken up with a hot rake and more material worked in to bring the surface up to the proper level and insure uniform texture and maximum density.

Other conform consisting of asphalt concrete wearing surface placed on areas prepared with paint binder shall be used as a variable thickness pavement course to adjust the surface of existing pavement to the surface of new pavement, or where shown on the plans or directed by the Engineer.

The limit of the paint binder on the existing pavement shall parallel, and shall project 6 inches beyond, the conform line. The conform pavement shall be raked back to a depth of 1/4-inch to 3/8-inch before rolling.

Particular care shall be taken in the work adjacent to the conform line, where the conform pavement is to be less than 1 inch thick. The existing surface shall be well cleaned and the paint binder properly applied. Very hot hand irons shall be used to smooth the edge of the conform, soften the existing surface and insure a good bond between the new and old materials.

If the Proposal contains a Bid Item for asphalt concrete wearing surface, that used in conform areas will be included in the quantity thereof for which payment will be made.

**212.11 Castings**

Temporary and permanent asphalt concrete wearing surface constructed in conjunction with setting or resetting, as the case may be, of castings, will not be included for payment under a Bid Item for asphalt concrete wearing surface, but shall be constructed as work incidental to the setting or resetting of castings.

**212.12 Certificates of Weight**

Certificates of weight for asphalt concrete wearing surface shall be furnished to the Engineer in accordance with the requirements of Section 111.02.

**212.13 Payment**

Asphalt concrete wearing surface satisfactorily constructed, in place, as specified, will be paid for at the price bid per ton.

Asphalt concrete wearing surface constructed over and around areas of excavation required under the contract, for sewer, drainage, AWSS, electrical and other facilities, where the proposal contains a per ton Bid Item therefor, will be paid for under such Bid Item, regardless of whether such sewers and other facilities are within, or are outside of, the limits for the construction of asphalt concrete wearing surface shown on the plans.

## 213 Seal Coat

### 213.01 General

The Contractor shall construct, including doing all necessary or required Incidental Work, emulsified asphalt seal coat on roadway or other surfaces shown on the plans, or where directed, and in accordance with the requirements set forth herein.

The seal coat shall consist of two applications of emulsified asphalt and screenings as follows:

Screenings Size	Rate of Application per Square Yard	
	Screenings (lbs)	Emulsified Asphalt (Gal)
1 <sup>st</sup> Application 1/2" to No. 4 .....	25	0.3
2 <sup>nd</sup> Application 1/4" to No. 10 .....	15	0.15

### 213.02 Materials

Emulsified asphalt shall be type RS-2, conforming to the provisions of the Asphalt Institute Specifications. A test report, if requested by the Engineer, shall be furnished in accordance with the requirements of Section 212.02.

Screenings shall consist of broken stone, crushed gravel, or both, shall be hard, tough, durable and sound, and shall be in accordance with the quality requirements set forth in Section 212.03. At least 90% by weight of the screenings shall consist of crushed particles as determined by Test Method No. Calif. 205.

Screenings shall be clean, free from deleterious materials, and shall be graded as follows:

Sieve Size	Percentage by Weight Passing Sieves	
	1/2" to No. 4	1/4" to No. 10
3/4" .....	100	...
1/2" .....	90 - 100	...
3/8" .....	50 - 80	100
No. 4 .....	0 - 15	60 - 85
No. 8 .....	0 - 5	0 - 25
No. 16 .....	...	0 - 5
No. 30 .....	...	0 - 3
No. 200 .....	0 - 2	0 - 2

Screenings shall also conform to the following quality requirements:

Tests	Test Method No. Calif.	Requirements
Los Angeles Rattler (after 100 revolutions) .....	211	10% Max
Los Angeles Rattler (after 500 revolutions) .....	211	40% Max
Film Stripping .....	302	25% Max
Cleanness Value .....	227	80 Min.

### 213.03 Surface Preparation

Immediately before applying the emulsified asphalt, the surface to be sealed shall be cleaned of all dirt and loose material.

When seal coats are to be applied to rock base or other untreated material, a prime coat of the type specified in the Special Provisions shall be applied to the material in place at a rate of from 0.20 to 0.33 gallon per square yard, as specified.

### **213.04 Applying Emulsified Asphalt**

Emulsified asphalt shall be applied by means of a vehicle-mounted, pressure-operated, sprayer-type distributor which shall operate at a continuous, even pressure of not less than 20 pounds per square inch at a specified rate of application. The distributor shall be equipped with an accurate pressure gauge that can be easily read by a person walking alongside the distributor vehicle.

The distributor system shall be capable of being operated at any width of application less than the maximum width by shutting off individual sprayer nozzles.

In order to secure uniform distribution, the flow of emulsified asphalt shall be halted before the rate of flow decreases due to depletion of the emulsion supply tank. After the supply tank has been refilled, the specified application rate shall be attained at the sprayer nozzles before resuming application.

Emulsified asphalt shall not be applied during cold or rainy weather. No more emulsified asphalt shall be applied to the surface than can be immediately covered with screenings and rolled the same day.

### **213.05 Distributing, Spreading and Rolling Screenings**

Screenings shall be evenly distributed, immediately following the preceding application of emulsified asphalt, by means of approved spreading devices attached to the rear of the haul vehicles. The haul vehicles shall back up while distributing the screenings so that the wheels will not come in direct contact with the emulsified asphalt. Following each application, the distributed screenings shall be carefully spread and trued up with a suitable blade or a drag broom, or other approved equipment, and all high or low spots shall be corrected by the removal or addition of screenings, as applicable. Each application of screenings shall be rolled, with a power roller weighing not less than 6 tons, until a smooth dense even surface has been obtained.

### **213.06 Payment**

Seal coat, satisfactorily constructed, complete in place, as specified, will be paid for at the price bid per square yard, measured horizontally. No deduction will be made from the quantity to be paid for on account of castings, or boxed-out areas therefor, which exist within the limits of the seal coat.

## 214 Planing Existing Asphalt Concrete Surfaces

### 214.01 General

The Contractor, at each area to be planed, shall furnish, operate on existing asphalt concrete pavement, supply with fuel, maintain, pay all labor costs in connection with, and remove from the site as his property upon conclusion of use thereof, one or more power-driven road surface cold planer machines, satisfactorily remove all planed material, and do Incidental Work.

The exact locations to be planed, within or adjacent to the areas shown on the plans or specified in the Special Provisions and except as hereinafter specified the number and depth of cuts, and other factors affecting the work depending on the type of asphalt concrete paving, will be determined in the field by the Engineer and will be subject to possible minor changes as the work progresses.

The asphalt concrete wearing surface shall be constructed in any one block no later than seven days after the cold planing work has been completed, unless otherwise specified in the Special Provisions.

### 214.02 Planer Machine

The machine shall be of a make and design that has operated successfully on work comparable with that proposed to be done under the contract, and shall be operated by an experienced operator.

The machine shall be self-propelled; and shall be equipped with a dust suppression system, a sensing skis device or profile control system to regulate the cutting drum (any device or system which must utilize the curb for control will not be permitted), and a minimum 42-inch wide cutting drum, which can be adjusted laterally for slope and depth, with replaceable carbide tip cutting teeth placed in stagger-laced pattern. The machine shall be so designed that the operator, thereof, can observe the cutting drum's operation or as an option, the machine can be equipped with a remote control unit to allow a secondary operator at ground level to control the cutting drum's operation.

The machine shall be capable of operating at speeds from 0- to 125-feet per minute and cutting depths from 0- to 2-inches through the surface material, without producing fumes or smoke, gouging, shoving, or tearing the pavement, to a predetermined grade in one pass for a continuous and smooth surface finish.

The machine to be used under the contract shall be manufacturer equipped. The number of rows, or columns, of cutting teeth and tooth-spacing of the cutting drum shall be installed and maintained per manufacturer's specifications. A machine with wobble cutting drum will not be permitted. The type and size of the machine shall be subject to the approval of the Engineer.

### 214.03 Conduct of the Work

Cuts made with a cold planer machine shall be of the width, depths, and to the alignment shown on the plans or specified, and shall result in a uniform surface conforming to the required cross section.

The juncture of cold planed and unplaned areas shall be neat and uniform.

The material planed from the street surface will be the property of the Contractor and shall be immediately removed by him from the site of the work at his own expense. Any planed material which is deposited on any concrete parking lane shall be immediately removed therefrom by brooming. The removal crew shall follow within 50 feet of the planer unless otherwise directed by the Engineer.

The Contractor shall provide one power broom and one front-end loader for each planing machine to be used in the project. Further, the Contractor shall provide a minimum of one laborer for each front-end loader to work along side of said loader whenever subject loader is operating. If the Contractor elects to, or is specifically required by the Special Provisions to perform holiday, weekend or night planing work, he shall provide one each additional broom and front-end loader as emergency back-up equipment. For example, if there are two planing machines in operation there shall be three power brooms and three front-end loaders available. Said power brooms and front-end loaders shall be on the jobsite and their working order satisfactorily demonstrated no later than 9:00 A.M. of the last weekday prior to the holiday or weekend that planing work is to be performed. Planing operations shall not be carried out at any time where, in the opinion of the Engineer, weather conditions do not permit efficient operation.

Cold planer operation, in general, will consist of, and for payment will be divided into work of, one or more of the following types:

- 1) Operation of the cold planer machine adjacent to the curb, for a 1 inch cut, on a linear foot basis. If underlying concrete, brick or cobblestone pavement base is exposed before the shown or specified depth of curb is attained, the planing shall be terminated. The quantity to be paid for on this basis shall be that, not including as footage any additional passes of the machine, required to make a cut 7-foot wide, a minimum of 1-inch deep at the curb, and wedge-shaped in section.
- 2) Operation of the cold planer machine adjacent to the curb, for a 3/4-inch cut, on a linear foot basis. The quantity to be paid for on this basis shall be that, not including as footage any additional passes of the machine, required to make a cut 7-foot wide, a minimum of 3/4-inch deep at the curb, and wedge-shaped in section.
- 3) Operation of the cold planer machine adjacent to the concrete parking lane or gutter, for a 1/2-inch cut, on a linear foot basis. The quantity to be paid for on this basis shall be that, not including as footage any additional passes of the machine, required to make a cut 7-foot wide, a minimum of 1/2-inch deep at the parking lane or gutter, and wedge-shaped in section. Asphaltic pavement which has crawled over existing concrete parking lanes and gutters shall be removed as Incidental Work.
- 4) Operation of the cold planer machine adjacent to the street railway tracks, for a 1/2-inch cut, on a linear foot basis. The quantity to be paid for on this basis shall be that, not including as footage any additional passes of the machine, required to make a cut 7-foot wide, a minimum of 1/2-inch deep on the track side, and wedge-shaped in section.
- 5) Operation of the cold planer machine in conform areas, for a 1-inch cut, on a linear foot basis. The quantity to be paid for on this basis shall be that, not including as footage any additional passes of the machine, required to make a cut 7-foot wide, a minimum of 1 inch deep, and wedge-shaped in section.
- 6) Operation of the cold planer machine adjacent to curb, concrete parking lane or concrete gutter, tracks, or other conform areas, 13-inch cut or other specified cut of full-depth rectangular shape in section, on a square foot basis. The quantity to be paid for on this basis shall be that, not including as footage any additional passes of the machine to obtain the required depth of cut.
- 7) Directed operation on an hourly basis. The time for which payment will be made on this basis, will be the aggregate of the periods during which the machine is actually cold planing.

Conforms and conforms around castings which are deeper than 1-inch shall be immediately ramped with cold-mix asphalt concrete as Incidental Work, all to the satisfaction of the Engineer.

All hand work of asphalt concrete removal around inlets and other castings in the planing area, areas adjacent to curbs, gutters, concrete parking strips and all conform lines will be done as Incidental Work.

No payment will be made for time required for refueling or for moving the machine between areas to be planed, and such refueling and movement will be considered Incidental Work.

As the work progresses, the Engineer may designate other areas to be cold planed. The additional locations, number and depth of cuts, the extent to which cold planing shall be done and the appropriate basis of operation in these areas will be determined by the Engineer.

## 214.04 Payment

Planing existing asphalt concrete surfaces, satisfactorily done as specified, will be paid for at the appropriate following unit bid prices:

- 1) adjacent to the curb, at the price bid per linear foot, per inch of depth of cuts;
- 2) adjacent to the curb, at the price bid per linear foot, per 3/4-inch of depth of cut;
- 3) adjacent to the concrete parking lane or concrete gutter, at the price bid per linear foot, per 1/2-inch of depth of cut;
- 4) adjacent to the street railway tracks at the price bid per linear foot, per 1/2-inch of depth of cut;

- 5) in conform areas, at the price bid per linear foot, per 1-inch of depth of cut;
- 6) adjacent to curb; concrete parking lane or concrete gutter; tracks; or conforms, at the price bid per square foot, per 1<sup>1</sup>/<sub>2</sub>-inch or other specified depth of cut;
- 7) at the price bid per hour of directed operation.



## **215 Raised Traffic Bars**

### **215.01 General**

The Contractor shall fabricate and install raised traffic bars of the dimensions shown, complete in place, and shall clean and place adhesive on the pavement in preparation therefor, all where shown on the plans or directed, and shall do all Incidental Work. The bars shall be of Class 6-3000-3/4 concrete, except with a maximum slump of 3 inches, made with white Portland cement, and may be precast, cast in place, or extruded, at the option of the Contractor. Approved substitute aggregate materials may be used.

### **215.02 Testing**

When required by the Engineer raised bars will be tested in the City's laboratory at no cost to the Contractor. After curing, each bar shall be capable of supporting a minimum load of 400 pounds when tested as a simple beam with the base in tension on roller supports at 20-inch centers and loaded at midspan through a saddle one inch wide shaped to conform to the contour of the bar. The load shall be applied at a uniform rate or in increments not in excess of 50 pounds.

### **215.03 Installation**

Raised bars shall be placed, cast or extruded, on the finished pavement with an adhesive consisting of polyvinyl acetate emulsion, asphaltic emulsion, or approved equal. If asphaltic emulsion is used, no clay or similar substances shall be used in its manufacture as emulsifying or stabilizing agents. The adhesive shall be of a consistency suitable for heavy trowel application at atmospheric temperature. It shall develop a tenacious bond on setting. Before placing the adhesive, the surface of the pavement shall be cleaned free of dust, loose material or oil. The adhesive shall be applied in such quantity that a firm, uniform bearing is obtained throughout the area of contact. Excess adhesive shall be squeezed from under the bar and the excess shall be removed. When bars are placed over a joint or crack, an open joint shall be made through the bars.

At the conclusion of all other work in the area, the bars shall be painted with one coat of white traffic lacquer, or approved equal, applied in accordance with the manufacturer's recommendations. Adequate precautions shall be taken, and, upon completion of the painting, adjacent and other pavements shall have on them no paint or discoloration caused thereby.

### **215.04 Payment**

Raised traffic bars, satisfactorily fabricated and installed as specified, will be paid for at the price bid per linear foot of adhered bar, measured horizontally along the longitudinal centerline thereof.

## **216**    *Blank*

## **217 Adjustment of Manhole Frames and Other Castings**

### **217.01 General**

In order to insure a true, smooth pavement wearing surface, all frames and castings of manholes, catch-basins, curb inlets, vaults, valves, handholes, monuments, and other installations in the street and sidewalk area, hereinafter referred to as “castings”, shall be reset accurately to the final finished pavement surface. Resetting includes extending or shortening the cones, barrels or risers of such structures as required for the proper adjustment of the castings. The work to be done by the Contractor and the “Owner”, respectively, in connection with the required removal and resetting of such castings and the paving work relative thereto, shall be in accordance with the requirements hereinafter specified. The term “Owner”, as used in this Section, means an owner of utilities as defined in Section 104.

In the case of castings owned by the Department of Public Works, Department of Electricity, Police Department, Fire Department, and of the Auxiliary Water Supply System, the Contractor shall perform all necessary work in connection therewith, including the work herein specified to be performed by the Owner. All such castings shall be reset to finished pavement grade, and the subsequent repaving adjacent to the castings shall be completed, not later than 7 calendar days after the surrounding wearing surface has been constructed unless otherwise specified in the Special Provisions.

The Contractor shall restore pavement around each casting after such casting has been properly reset to new pavement grade. If the pavement around such castings is not restored by the Contractor within twenty-four hours, the Contractor shall provide temporary bridging over each of the casting cut-out areas with a steel plate, approved by the Engineer, ramped to the adjacent pavement and secured against any movement. The bridging, including material and work related to, shall be done at the Contractor’s sole expense. The Contractor may enter into a private agreement with the Owner to do work that is the responsibility of the Owner, provided that such work will be done at no cost to the City.

### **217.02 Construction or Reconstruction of Pavement**

Where pavement, or pavement base and wearing surface, is to be constructed, or if existing, is to be removed and reconstructed, the Contractor shall construct a box around each casting. The box shall be 5 feet square around sewer and vault manholes and proportionately dimensioned for other castings. The construction of pavement shall be temporarily omitted within the confines of the boxes. The Owner of each casting will then remove his castings, after which the Contractor shall carefully cover the openings in the exposed structures with planks not less than 2 inches thick and shall fill the boxed-out areas with a temporary pavement consisting of at least 4 inches of graded rock and 1 inch of asphalt concrete wearing surface.

After the pavement surrounding the boxes has been constructed, the Owners of the castings will remove the boxes and the temporary pavement from within them and will reset the castings to conform accurately with the finished pavement surface. Resetting will be done in a workmanlike manner using Class 6-3000-3/4 concrete, bricks set in Class “B” mortar, or rings or other approved devices.

After each casting has been satisfactorily reset to the finished pavement surface, the Owner will place, and compact, asphalt concrete in the entire boxed-out area around the casting to within 1 1/2 inches of finished pavement grade, upon which he will construct asphalt concrete wearing surface to finished pavement grade.

### **217.03 Resurfacing Over and in Place of Existing Wearing Surface**

Where resurfacing is to be done and asphalt concrete wearing surface is to be constructed over existing pavement wearing surface regardless of type, the Contractor shall construct the wearing surface continuously over all castings, except valve castings. It will be the responsibility of the Owners of the castings so covered to reference them in advance in such manner that they may later be located readily. The Contractor may construct the wearing surface continuously over valve castings provided that he uncovers the valve castings immediately after constructing the wearing surface. After the resurfacing has been completed, the Owner will cut through the pavement around each casting and reset the casting to conform accurately with the finished pavement surface. Resetting the castings and subsequent repaving in the cut out areas will be done by the Owner in the manner specified hereinbefore.

Where castings exist in an area from which existing wearing surface is to be wholly or partially removed, and the final grade is to be lowered, the Owner shall cut through the pavement and remove each casting. The Contractor shall then provide the planking and a satisfactory temporary riding surface over the openings as specified in Section 217.02, except that the box will not be required.

After the wearing surface surrounding an opening has been constructed, the Owner will remove the temporary pavement from within the cut out area, reset the casting, and repave as hereinbefore specified.

Pavement in cut-out areas around adjusted castings shall be constructed with 1½ inches of asphalt concrete wearing surface on 8 inches of concrete base.

#### **217.04 Alternative Methods**

The Owners and the Contractor may agree to any modification of, or alternative to, the hereinbefore specified methods of resetting castings, provided that application for the use of such modification or alternative is made in writing to, and is approved by, the Engineer.

#### **217.05 Payment**

Adjustment of existing City-owned manhole frames and covers and other existing street castings, satisfactorily done complete in place, as specified, including the pavement in cut-out areas around such castings, will be paid for under the appropriate Bid Item, at the respective price bid for a set consisting of a frame and either a cover or a grating. City-owned means Governmentally-owned as opposed to non-Governmentally-owned as defined in Section 104.

If the Proposal contains pavement or pavement base Bid Items, no deduction will be made in the pay quantities thereof because of the presence of, or the adjustment of, castings.

## **218 Redwood Headers**

### **218.01 General**

The Contractor shall construct “Heart Structural” grade redwood headers 2 inches thick and of a width equal to the thickness of the pavement or walk which they are to be bound, complete in place, including supporting stakes, scabs, wood preservative treatment, nailing, and Incidental Work. The headers shall be placed on edge, and securely nailed inside of supporting stakes driven into the subgrade. They shall be set so as to conform to the finished surface of the pavement. The supporting stakes shall be “Heart Structural” grade redwood set with their sawed tops conforming with the surface of the finished pavement or walk, of such size and number as may be necessary to rigidly support the headers in place during the construction operations. The headers shall have squared top edges and squared butt joints against the stakes, and shall be held in place with at least 2 galvanized nails of the necessary length in each stake, except at butt joints where not less than 4 shall be used. In sandy or loose soil, or wherever necessary to hold headers to proper line and grade, the joints in the headers shall be reinforced with a 1-inch x 6-inch x 18-inch redwood scab, securely nailed. Headers shall be placed where indicated on the plans, and along the unprotected edges of all pavements and sidewalks, except concrete sidewalks at property lines, even though not called for on the plans.

After being cut to length, the headers, stakes and scabs shall receive on-the-job treatment with a 5% solution of the pentachlorophenol preservative specified in Section 415.06. Preservatives containing arsenic or creosote will not be permitted.

### **218.02 Payment**

Redwood headers, satisfactorily constructed as specified, will be paid for at the price bid per linear foot, measured horizontally along the line thereof.

## 219 Corrugated Metal and Guard Railing

### 219.01 General

The Contractor shall construct corrugated metal guard railing consisting of galvanized, straight and precurved corrugated metal railing elements and flared terminal sections mounted on treated timber posts, all complete in place, with hardware, and shall do all related Incidental Work. The railing shall be constructed true to the lines and grades therefor designated on the plans and in accordance with the directions of the manufacturer, and after erection shall be cleaned and painted.

### 219.02 Materials

Timber posts shall be S4S, 8 inches x 8 inches x 4 feet 8 inches, No. 1 stress grade or better Douglas fir free of boxed heart, chamfered as shown on the plans or specified, and in accordance with the requirements of Section 414.01. The posts shall be pressure treated with pentachlorophenol in accordance with the requirements of Section 415.06 after being surfaced, chamfered and cut to length. The minimum retention of preservative shall be that specified for ground contact.

The steel plate forming the corrugated rail element shall be rolled from steel from which a 2-inch test specimen shall elongate not less than 12%.

The plate shall be shaped into a beam not less than 12 inches wide and with two corrugations not less than 3 inches deep. The plate shall not be less than 12 gauge, subject to standard mill tolerances for gauge. The manufacturing tolerance for width and depth shall be minus 1/8-inch and the edges of the rail shall be smooth after fabrication. The rail shall develop a minimum tensile strength of 50,000 pounds for the rail element and joints. A section of rail freely supported at each end, on 12-foot centers, shall support a concentrated load at the center of 1,400 pounds with a maximum deflection of 4 inches.

The ends of each length of railing shall be fitted with a section, also of 12-gauge metal, extending at least 18 inches beyond the center of the end post, and so formed that its end shall be at least 7 inches back of the face of the rail. Along curvilinear alignments, guard rail elements used shall be shop precurved to radii of curvature such that deviation from the alignment shown on the plans will not at any point exceed 2 inches.

Straight elements may be used where the radius of curvature or the alignment is greater than 110 feet.

The hardware for the guard rail shall consist of:

- 1) at each rail to rail splice, eight 5/8-inch x 1<sup>1</sup>/<sub>4</sub>-inch oval shoulder button head splice bolts with nuts and washers;
- 2) at each rail to terminal section splice, four 5/8-inch x 1<sup>1</sup>/<sub>4</sub>-inch oval shoulder button head splice bolts, and nuts; and
- 3) at each splice, for fastening to timber post, one 5/8-inch x 10<sup>1</sup>/<sub>2</sub>-inch oval shoulder button head post bolt with nuts and washers.

### 219.03 Galvanizing

All guard rail elements, terminal sections, and hardware shall be hot-dip galvanized in accordance with the applicable requirements of Section 807; however, the guard rail elements and terminal sections may be galvanized either before or after fabrication, the total of the weights of the two galvanizing coatings, one on each side of any sheet, element, or section, shall not be less than 2.0 ounces per square foot, and such galvanizing shall be in accordance with the requirements of ASTM "Standard Specification for General Requirements for Delivery of Zinc-Coated (Galvanized) Iron or Steel Sheets, Coils, and Cut Lengths Coated by the Hot-Dip Method", Designation A 525.

### 219.04 Construction

The height of the guard rail and of the posts above ground shall be as shown on the plans. Posts shall be placed at equal intervals, not to exceed 12 feet 6 inches, measured horizontally between center lines of adjacent posts.

A post shall be installed at each rail splice and at each terminal section splice.

All posts shall be installed vertically.

After the posts are set, the space around them shall be filled with selected earth free from rock. . Fill material shall be placed in layers approximately 4 inches thick, and each layer shall be thoroughly watered and tamped in place to hold the posts securely in position.

All metalwork shall be fabricated in the shop, and no punching, cutting, or welding will be permitted in the field. Metal railing shall be installed in accordance with the directions of the manufacturer of the particular railing. The railing shall be installed in smooth curves and transitions with no abrupt changes in alignment.

The guard railing in the final position shall be rigid and without any loose joints or connections.

Any rail element dented, bent, broken, warped or otherwise damaged, shall be immediately and satisfactorily repaired or replaced, as applicable, by the Contractor at his sole expense.

Ends of guard railing facing the direction of traffic flow shall be flared and buried in concrete.

### **219.05 Painting**

After erection, corrugated metal guard railing shall be painted in accordance with the requirements of Section 809. Galvanized surfaces shall not be brushed with copper sulphate solution. The Contractor shall, however, exercise special care to remove, with solvent, all grease or oil film from galvanized surfaces to be painted.

All surfaces of the rail, including the end sections and all hardware, shall be painted with one coat of an approved galvanized metal primer which shall be allowed to dry thoroughly. Two coats of an approved white enamel shall then be applied to all the above primed surfaces.

Timber posts shall be painted with one coat of an approved wood primer and two coats of an approved fast-drying white finish paint for wood, and at least 4 inches of post painted with all coats shall be below the ground surface. All exposed surfaces of corrugated metal guard railing that become soiled or damaged before acceptance of the work shall be cleaned or repainted at the Contractor's expense.

### **219.06 Payment**

Corrugated metal guard railing, satisfactorily constructed as specified, will be paid for at the price bid per linear foot measured along the face of straight and precurved corrugated metal elements between extreme ends of each section of railing including terminal sections thereof as constructed.

## 220 Certain Work Excluded from Pay Quantities

Pavement excavation, earthwork, and the construction of sidewalk, curb, gutter, parking strip, pavement base and pavement, within the limits shown or specified therefor, will be paid for under the respective Bid Items therefor. Such work, necessary or required as a result of constructing, installing, relocating or removing, structures, and water, sewer, drainage, landscaping, lighting, traffic control, fire alarm, AWSS, and other facilities and appurtenances, and outside the limits within which excavation and construction or pavement elements are shown or specified to be paid for under Bid Items, will not be paid for but shall be done as Incidental Work.

Asphalt concrete wearing surface required to be constructed, if the Proposal contains a per ton Bid Item therefor, will be paid for whether or not the construction thereof is within the limits shown on the plans for the construction of asphalt concrete wearing surface.

Except as otherwise specified in the Special Provisions, asphalt-topped roadway pavement damaged or removed by the Contractor, and not specified for removal as part of the contract, shall be restored with 8-inch thick concrete base and 1<sup>1</sup>/<sub>2</sub>-inch thick asphalt concrete wearing surface at the Contractor's expense.

Concrete roadway pavement (non-asphalt-topped) damaged or removed by the Contractor, and not specified for removal as part of the contract, shall be restored with 8-inch thick concrete pavement at the Contractor's expense.

Existing gutter, parking strip, curb and sidewalk, damaged or removed by the Contractor, and not specified for removal as part of the contract, shall be restored to match the existing in design and material at the Contractor's expense. Damaged or removed sidewalk shall be restored to existing flag lines to match the adjacent existing sidewalk in design and material.



## 221 Pavement Reinforcing Fabric

### 221.01 General

The Contractor shall furnish and place pavement reinforcing fabric on existing pavement to be resurfaced or between layers of asphalt concrete complete, in place, including all necessary or required Incidental Work, where and as shown on the plans or where directed by the Engineer.

Pavement reinforcing fabrics shall be furnished in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

### 221.02 Placing Reinforcing Fabric

Before placing the pavement reinforcing fabric, a binder of paving asphalt shall be applied to the surface to receive the pavement reinforcing fabric at the rate of 0.25-gallon per square yard of surface covered. The binder shall be applied to a width equal to the width of the fabric mat plus 3 inches on each side.

The fabric shall be stretched, aligned, and placed with no wrinkles that lap. The test for lapping shall be made by gathering together the fabric in a wrinkle. If the height of the doubled portion of extra fabric is 1/2 inch or more, the fabric shall be cut to remove the wrinkle, then lapped in the direction of paving. Lap in excess of 2 inches shall be removed.

Pavement reinforcing fabric shall not be placed in areas of conform tapers where the thickness of the overlying asphalt concrete is 1 inch or less.

If manual laydown methods are used, the fabric shall be unrolled, stretched, aligned, and placed in increments of approximately 30 feet.

Adjacent borders of the fabric shall be lapped 2 to 4 inches. The preceding roll shall lap 2 to 4 inches over the following roll in the direction of paving at ends of rolls or at any break. At fabric overlays, both the tack coat and the fabric shall overlap the previously placed fabric by the same amount.

Seating of the fabric with rolling equipment after placing will be permitted. Turning of the paving machine and other vehicles shall be gradual and kept to a minimum to avoid damage.

A small quantity of asphalt concrete, to be determined by the Engineer, may be spread over the fabric immediately in advance of placing asphalt concrete surfacing in order to prevent fabric from being picked up by construction equipment.

Public traffic shall not be allowed on the bare reinforcing fabric; except that public cross traffic shall be allowed to cross the fabric, under traffic control, after the Contractor has placed a small quantity of asphalt concrete over the fabric.

Care shall be taken to avoid tracking binder material onto the pavement reinforcing fabric or distorting the fabric during seating of the fabric with rolling equipment. If necessary, exposed binder material shall be covered lightly with sand.

### 221.03 Fabric

Pavement reinforcing fabric shall be manufactured from polyester, polypropylene, or polypropylene-nylon material. The fabric shall be nonwoven, and shall conform to the following:

Weight, ounces per square yard ASTM Designation: D 1910 .....	3.0 to 8.0
Grab tensile strength (1-inch grip), pounds, min. ASTM Designation: D 1117 .....	90
Elongation at break, percent, min. ASTM Designation: D 1117 .....	40
Fabric thickness, mils. ASTM Designation: D 461 .....	12 to 100

A Certificate of Compliance shall be furnished with each lot of fabric delivered to the work and the lot so certified shall be clearly identified in the certificate. The certificate shall be signed by the manufacturer of the fabric and shall state that the fabric involved complies in all respects with the requirements of the specifications.

Fabric used on the basis of a Certificate of Compliance may be sampled and tested at any time. Fabric used on the basis of a Certificate of Compliance shall not relieve the Contractor of responsibility for incorporating

fabric in the work which conforms to the requirements of the plans and specifications, and any such fabric not conforming to such requirements will be subject to rejection whether in place or not.

The City reserves the right to refuse to permit the use of fabric on the basis of a Certificate of Compliance. The form of the Certificate of Compliance and its disposition shall be as directed by the Engineer.

#### **221.04 Payment**

Pavement reinforcing fabric, satisfactorily furnished and placed as specified, including all necessary or required Incidental Work, will be paid for at the price bid per square yard of actual area covered.

END PART 2

## Part 3

# Sewerage and Drainage

### Table of Contents

300	General Requirements for Sewers and Related Work . . . . .	52
301	Handling and Disposal of Seepage . . . . .	54
302	Removing, Plugging and Filling . . . . .	56
303	Cast-in-Place Concrete Sewer and Structures . . . . .	58
304	Precast Reinforced Concrete Pipe Sewer . . . . .	61
305	Vitrified Clay Pipe Sewer . . . . .	66
306	Vitrified Clay Pipe Culvert . . . . .	68
307	Vitrified Clay Pipe Side Sewer . . . . .	69
308	Ductile Iron Pipe . . . . .	71
309	Corrugated Metal Pipe Culvert . . . . .	72
310	Manholes . . . . .	74
311	New Frames and Covers on Existing Manholes . . . . .	75
312	Catchbasins . . . . .	76
313	New Frames and Gratings on Existing Catchbasins . . . . .	77
314	Storm Water Inlets . . . . .	78
315	New Frames and Gratings on Existing Storm Water Inlets . . . . .	79
316	VCP Side Sewer Connections to Mains Sewers . . . . .	80
317	Connections to and between Sewer Structures and Culverts . . . . .	82
318	Side Sewer Trap . . . . .	83
319	Low Pressure Testing . . . . .	84
320	Brickwork for Sewers . . . . .	85
321	Vitrified Clay Pipe Subdrain . . . . .	87
322	Polyethylene Pipe Sewer . . . . .	89

## **300 General Requirements for Sewers and Related Work**

### **300.01 General**

The Contractor shall do all excavating of pavement and earth materials, sheet piling, and lagging, all as set forth in Part 7 of these Standard Specifications, and shall do all other work, including investigation of locations, elevations and flows, traffic routing work, and salvaging of castings, necessary for the satisfactory completion of the required sewer and drainage work, all in accordance with the requirements of the Special Provisions and these Standard Specifications.

The Contractor, in accordance with the requirements of Sections 703, 707 and 109, shall do all backfilling and restore all pavements and related improvements removed, destroyed, damaged or undermined as a result of his operations.

### **300.02 Records of Existing Sewers and Sewer Structures**

Certain maps and records of the existing Sewers and sewer structures in the vicinity of, and interconnected with, the work are on file in the City Engineer's Office, and may be examined by the Bidder. The Bidder should note, however, that these structures may have been altered by repairs at various times and may differ from the records on file, and that no representation is made nor responsibility taken by the City as to the accuracy of the records or the locations shown thereon.

### **300.03 Elevations and Locations**

Elevations and locations of existing structures, Sewers, side sewers, culverts, and other facilities shown on the plans are approximate only. Exact elevations of connections must be determined in the field before commencing excavation operations. If no manhole opening or other access is readily available for determining the elevation or location of the connection points, the Contractor shall expose the existing sewer or structure, as necessary to make such determinations.

### **300.04 Elevational Control**

The elevational control consists of the slope and the vertical distance above or below San Francisco City Datum to the invert of the sewer or sewer structure.

Approximate Elevation ( $\pm$ ) - Elevations of ground surface and inverts of sewers or sewer structures are shown for informational purposes only. Rim elevations of sewer structures are to be constructed to conform to existing street grades or to match new street grades. See existing elevation and invert/conform elevation on the plans.

Existing Invert Elevation - Elevations of inverts of existing sewers or sewer structures are approximate and are shown on the plans for informational purposes only.

Invert/Conform Elevation - Elevation of the new pipe, channel, or flow surface of sewer or sewer structure to be constructed shall coincide with elevation of the existing pipe, channel, or flow surface of sewer or sewer structure. Field adjustment may be necessary to match existing invert and to determine slope of new pipe.

Invert Elevation - Elevation of the new pipe, channel or flow surface of sewer or sewer structure to be constructed.

Slope - Invert slope of pipe or channel; construction slope of pipe between two invert elevations or invert/conform elevations. Field adjustment of slope may be necessary after verification by the Contractor of invert/conform elevations of sewers or sewer structures.

The descending order of precedence shall be as follows:

- 1) Invert Elevation

- 2) Invert/Conform Elevation
- 3) Slope
- 4) Existing Invert Elevation
- 5) Approximate Elevation

### **300.05 Pavement Cutting**

The Contractor shall use, but not limited to, pavement concrete saw cutting or vibratory pavement breaker. The Contractor may not use any machine or device that breaks pavement by blows struck by a falling or driven hammer or weight.

Such prohibition, however, shall not be construed as barring the use of hand tools or manually operated air tools such as jackhammers.

### **300.06 Delivery of Salvaged Castings**

The Contractor shall salvage manhole, catchbasin and storm water inlet frames, covers, and gratings, removed from the work, and not specified to be reused in the work, as City property, and deliver to the City Yard located at 2323 Army Street, San Francisco. The Contractor shall contact the Bureau of Street and Sewer Repair at Telephone No. 415-695-2096, for appointment, 24 hours prior to delivery of such castings. Upon delivery, the castings shall be placed where directed by Yard personnel.

Castings to be salvaged are Standard 26-inch Manhole Frame and Cover and Cast Iron Frame And Grating For Catchbasin Type A.

All other removed sewer castings shall be removed from the site of the work as the Contractor's property and disposed of in a legal manner.

The delivery of salvaged castings shall be done as Incidental Work.

## **301 Handling and Disposal of Seepage**

### **301.01 General**

The Contractor shall dispose of water from all sources; Shall keep excavations dry; shall do all necessary work to suitably and adequately divert all sanitary, ground water, tide water, and storm water flow; and shall furnish all necessary pumps and related equipment; all in accordance with the requirements set forth herein and in Section 700.08.

Subdrains and crushed rock, if constructed, shall be in accordance with Sections 321 and 712.

The Contractor will be responsible for familiarizing himself with sewers which are interconnected with the work. Sewer information is available as set forth in Section 300.02.

The Contractor is cautioned that any quantities of flows shown on the plans or included in the Special Provisions are estimated and are furnished to the Contractor for general guidance only, and that the City takes no responsibility for the accuracy of these estimates nor for any deductions or conclusions that the Contractor may make therefrom. In any case, the Contractor will not be relieved of any responsibility for the handling and disposal of water and sewage.

### **301.02 Sanitary Sewage**

All sanitary sewage shall be carried in closed conduits, or other means approved by the Engineer, and will not be allowed to flow exposed on the street, or in gutters, trenches, or excavations. The Contractor may use, to the limit of their capacity, subdrains in accordance with Section 321.

### **301.03 Backflow**

Should the construction of any dam or dams cause sewage or storm water to back up and flow on private property through side sewers, or by other means, the Contractor shall immediately take corrective measures to stop the backflow, remove the sewage and storm water from the private property, clean and disinfect the premises, and repair any damage caused by backflow.

### **301.04 Subdrains**

Where subdrains are used, side sewers cut along the line of the work shall be temporarily connected to the subdrains by means of pipes and fittings. When permanent side sewer connections are re-established, openings for temporary connections shall be sealed with brickwork or concrete, and the pipe and fittings used for such connections removed from the site by the Contractor as his property.

### **301.05 Diversions and Dams**

The Contractor shall not obstruct the normal flow in any existing sewer, but where necessary shall divert such flow around or through the work or discharge such flow into other approved sewers or places.

The Contractor shall not divert any flow from any source that will result in additional flow in sewers leading to pumping stations.

All flow including storm water flow shall be carried around or through the work by the Contractor at his own expense by diverting the flow to other sewers, by pumping or by bypassing the work with pipes or other conduits, unless otherwise specified. All sewage flow, including storm water flow, shall be diverted to sewers leading to treatment plants and shall not be diverted to a sewer or structure leading directly to the Bay or Ocean.

The Contractor shall not construct a dam in any sewer or sewer structure without the prior written consent of the Engineer. Regardless of such consent, the Contractor shall be responsible for any damage resulting from the construction of any dam or dams in the sewerage system.

Dams, diversion devices, or other obstructions placed in sewers or manholes for diverting flow during the work, shall be removed by the Contractor at the completion of the work, or when directed by the Engineer. Any damage to sewerage or drainage facilities resulting from the Contractor's handling and disposing of seepage, storm water, and sewage, shall be satisfactorily repaired by the Contractor at his expense.

### **301.06 Payment**

Handling and disposal of seepage, storm water, and sewage shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## 302 Removing, Plugging and Filling

### 302.01 General

The Contractor shall remove, plug, and fill, or break open, sewers and related structures where and as shown on the plans, or where necessary for the proper completion of the work, including all excavating, backfilling, restoring pavement, and other Incidental Work.

All openings and outlets of sewers or related structures abutting sections to be removed or broken open shall be satisfactorily sealed at all open ends with brick and mortar or concrete and all contained sewage removed unless otherwise specified.

### 302.02 Remove

Existing sewers, manholes, catchbasins, other sewerage and drainage structures, and appurtenances, including vitrified clay pipe sewers, side sewer and culverts, which have been or are to be abandoned, and lie within a sewer trench or sewer structure excavation, shall be removed from within the limits of required excavation necessary for the work.

All sewerage facilities, except side sewers and culverts, to be abandoned shall be removed to a depth at least three feet below street grade or ground surface, as the case may be, and all contained sewage removed.

### 302.03 Break Open

Inverts of partially removed facilities shall be broken open to freely drain, and the facility backfilled, or, if specified, filled with slurry grout.

### 302.04 Plug and Fill

Main sewers 12 inches or greater in diameter to be abandoned, which lie three feet or deeper below street grade or ground surface, shall be thoroughly sealed at all open ends, and at the structures in which they terminate, as applicable, and shall be filled with an approved slurry grout.

The plugging at the ends of sewers and sewer facilities to be filled with slurry grout may be accomplished by the use of temporary plugs or bulkheads which shall be removed after the slurry mix has set.

### 302.05 Plug

6-inch and 8-inch Side sewers and 10-inch culverts to be plugged shall be sealed at all open ends and at the structures in which they terminate, as applicable, with brick and mortar or concrete plugs. Plug

thicknesses for Sections 302.04 and 302.05 shall conform to the following schedule:

Pipe Diameter	Plug Thickness
Smaller than 24" .....	4" Minimum
24" to 36" .....	8" Minimum
Larger than 36" .....	12" Minimum

### 302.06 Fill with Slurry Grout

Sewers 12 inches or greater in diameter and related structures to be plugged and filled shall be filled with a slurry mixture containing a minimum of 2 sacks of Type II cement per cubic yard of mixture.

Filling with slurry may be accomplished by pumping or gravity, at the option of the Contractor, and will be checked by comparing the computed volume of the sewer facility with the volume of mixture used. If the computed volume is more than 10% greater than the actual volume of slurry used, the Contractor shall excavate two exploratory holes where directed, and shall do all work necessary to satisfactorily fill any encountered voids.



Any damage to existing facilities resulting from the use of slurry grout shall be satisfactorily repaired by the Contractor at his own expense and no direct or additional payment will be made for such repair.

Side sewers and culverts shall not be filled with slurry grout, unless specified.

### **302.07 Payment**

The satisfactory removal, plugging, plugging and filling, or opening, of sewers and sewer structures will be paid for at the respective prices bid therefor when such work is set forth for payment in the Schedule of Bid Prices. All such work shown or specified and not so set forth shall be done as Incidental Work.

## **303 Cast-in-Place Concrete Sewer and Structures**

### **303.01 General**

The Contractor shall construct cast-in-place reinforced concrete sewer and sewer structures including all excavating, lagging, forming, waterproofing, backfilling, restoring pavement and other Incidental Work, necessary or required, for a complete, satisfactory installation, where and as shown on the plans, or where directed. Such sewer and sewer structures shall be of Class 6-3000-3/4 concrete constructed in accordance with the plans, the applicable requirements of Sections 411 and 800, and these specifications. Cement shall be Type II.

All appurtenances for structures, such as manhole-cones, frames, covers, gratings, steps, VCP stub inlets, and VCP stub inverts shall be furnished and installed where and as shown on the plans and as specified .

### **303.02 Formwork**

Lagging or shoring shall not be used as a surface against which concrete is placed unless permitted in the Special Provisions. Sufficient clearance shall be maintained between the formwork and lagging so that the alignment and cross section of the work as shown on the plans can be obtained by adjustment of such formwork.

In the event that the Special Provisions permit concrete to be placed against the lagging or shoring, a bond breaker shall be placed between the concrete and the shoring or lagging and shall be a maximum of 1/4" thick plywood, interior grade, or approved equal. Maximum overpour shall be limited to two (2) inches.

No concrete shall be placed in formwork unless such formwork is constructed to the required alignment, grade and cross sections, and is approved by the Engineer. Such approval shall in no way relieve the Contractor of the responsibility for obtaining, in the completed work, the alignment, grade and cross sections shown on the plans. The Contractor shall provide access for the Engineer to inspect reinforcements prior to pouring the concrete.

The use of twisted wire loops as form ties will not be permitted.

Smooth forms accurate held on line and grade shall be used. Forms and centers may be made of either metal or timber. The surfaces of all timber forms that come in contact with the inside surfaces of concrete sewers and sewer structures shall be laid with close joints and oiled with non-staining mineral oil. Sharp corners shall be chamfered one inch, and 3/4-inch x 3/4-inch triangular fillets shall be used in all angles of formwork unless otherwise shown on the plans or directed by the Engineer.

### **303.03 Invert Forms**

Inverts of sewers and sewerage structures shall be formed by the use of fixed and rigid forms when the invert radius is 2'-0" or less. Inverts with a radius larger than 2'-0" and smaller than 2'-6" shall also be formed by the use of fixed and rigid forms unless the Engineer approves otherwise. Such approval will depend on the concrete's slump and its ability to satisfactorily form the invert shape by screeding. When fixed and rigid formwork is required, shaping the inverts with screeds or other means will not be allowed.

### **303.04 Construction**

The invert of the sewer or structure, up to the Key joint,. shall be constructed first. The concrete shall be carefully and properly placed and vibrated. No traffic of any kind will be permitted on the invert for at least twenty-four hours after placing. Concrete for the sides and tops of sewers and sewer structures not on piles shall not be placed until at least forty-eight hours have elapsed after the placement of invert concrete; and in the case of sewers and sewer structures on piles not until at least seventy-two hours have elapsed after the placement of invert concrete.

No more wall and top section shall be started than can be completed the same day. Wall and top section construction joints with proper keyways shall be made at the end of each pour. Construction joints in invert and walls shall not be in the same plane, but shall be staggered. Immediately after the removal of the forms and centers, all rubbish and surplus materials shall be removed from the sewer or structure in order to prevent any possibility of their entering the City's sewer system.

### 303.05 Form Removal

The period of time and the strength of concrete required before the removal of forms shall be in accordance with Section 411.09 except that formwork for arch type concrete sewers and sewer structures need only remain in place for a minimum period of seventy-two hours after the placement of concrete therein. If forms are removed before a period of seven days, extra care shall be taken in the removal of forms in order not to spall the “green” concrete.

Formwork, maximum size of 1/4” plywood, may be left in place, provided it is on the outside of the sewer or sewer structure.

Invert forms shall be removed at the proper time to allow thorough steel troweling.

Unless otherwise specified, all formwork and trench support material shall be removed by the Contractor.

### 303.06 Finishing

Interior concrete surfaces of sewers and sewer structures shall be given an “Ordinary Surface Finish” in accordance with the requirement of Section 411.10, except that the completed work need not be sacked. However, such surfaces shall receive a coat of neat cement mortar applied with a brush, and shall be kept free from sewage for a minimum period of thirty-six hours after the cement has been applied. Inverts of sewers and sewer structures shall be steel troweled to a smooth uniform surface.

The channelization shall be done with Class “B” mortar.

### 303.07 Curing

Cast-in-place reinforced concrete sewers and sewer structures shall be cured by water or impervious membrane curing in accordance with these specifications.

No traffic of any kind will be allowed over the sewer during the curing period. The minimum curing period shall be seven days or until the concrete has attained a compressive strength of at least 2,500 pounds per square inch based on field cured cylinders.

Immediately after the sewer invert has been poured, it shall be covered with wet burlap and kept wet for the curing period. The Contractor may, after twenty-four hours, replace the burlap with straw, sawdust, or earth kept thoroughly wet until the expiration of the curing period.

The concrete in the top and sides of the sewer or structure shall be cured by being kept continuously moist, either by sprinkling, wet burlap, or wet earth, for the curing period.

Concrete curing by means of an impervious membrane shall be done using an approved liquid which will form an impervious, non-slippery membrane when dry. The liquid shall have a temporary color sufficient to indicate the extent of its application. The membrane shall form a hard film and thoroughly waterproof the concrete surface within thirty minutes.

No membrane will be allowed on steel reinforcement. The Contractor shall protect exposed steel reinforcement during membrane application. Any and all membrane on steel reinforcement shall be removed before additional placement of concrete will be allowed.

Membrane curing liquids shall be applied under pressure with a spray nozzle at such a rate as to seal the surface uniformly and completely. The membrane seal shall be protected from injury for ten days and any breaks in the membrane during this period shall be repaired immediately by a fresh application of the liquid.

### 303.08 Frames, Covers and Gratings

Cast iron frames, covers, and gratings shall be furnished and installed on sewer structures, where and as shown on the plans, or where directed. The cast iron shall be in accordance with the requirements of Section 801.01.

Each casting shall have its weight indicated thereon with white paint.

Care shall be exercised to cast the contact surfaces in a true plane and free from irregularities. These surfaces shall be machined or ground to insure uniform contact between frame and cover or grating.

### **303.09 Taper Cones**

The taper cone for precast and cast-in-place manholes shall be of the eccentric type. The vertical wall of the cone shall be upstream or as otherwise directed by the Engineer.

### **303.10 Steps**

All steps for sewer structures shall be fabricated from approved Class 316 stainless steel or approved polypropylene conforming to Type II, Grade 16906, and in accordance with the requirements of ASTM D2146 with 1/2-inch grade 60 steel reinforcement conforming to ASTM A615, and in accordance with the details shown on the plans.

### **303.11 Construction Joints**

The Contractor shall construct joints in accordance with Section 800.15, unless otherwise specified, and shall furnish and install approved keylock polyvinyl chloride waterstops and flexible silicon rubber joint filler material in all transverse construction joints. Water stops and filler material shall be omitted on longitudinal construction joints.

The Contractor shall submit for the Engineer's approval, the manufacturer's specifications for the flexible joint filler material.

### **303.12 Payment**

Cast-in-place reinforced concrete sewer satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of sewer between the outside surfaces of structures, or to the limits as constructed, as applicable. No deduction will be made from the length of cast-in-place reinforced concrete sewers because of manholes constructed thereon.

Cast-in-place reinforced concrete sewer structures satisfactorily constructed complete, in place, will be paid for at the respective lump sum price bid therefor. Appurtenances, such as manholes, cones, frames, covers, gratings, steps, stub inlets, and VCP inverts shall be considered as part of the structure and no direct or additional payment will be made thereof.

## 304 Precast Reinforced Concrete Pipe Sewer

### 304.01 General

The Contractor shall construct precast reinforced concrete pipe (RCP) sewer including all excavating, lagging, backfilling, restoring pavement, and other Incidental Work, necessary or required, for a complete, satisfactory installation, where and as shown on the plans, or where directed.

Precast reinforced concrete pipe shall be manufactured by the Centrifugally Spun or Vertically Cast method with bell and spigot joints in accordance with the plans and ASTM "Standard Specifications for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe", Designation C76, except as modified by the plans, the Special Provisions, and these specifications.

Precast pipe shall have cylindrical interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness. The interior and exterior surfaces shall be concentric at transverse cross sections.

Precast reinforced concrete pipe shall be furnished from a manufacturer who must have had at least five years experience in manufacturing such pipe. The Contractor shall, if requested by the Engineer, submit a list of representative pipe installations for which the manufacturer has furnished pipe during the last five years.

Each section of pipe shall be plainly painted on the inside surface, at the spigot end, with letters and numerals not less than 1-1/2 inches in height designating the following:

Project specification number;

Date of manufacture;

Method of manufacture;

"D-Load" or "Class" rating;

Top Center (when elliptical reinforcement is used), or alternative markings as approved by the Engineer.

The Contractor shall notify the Engineer in writing a minimum of 5 days prior to beginning the manufacture of the pipe to be supplied. To facilitate inspection and testing, each day's run of pipe shall be marked and stored so that pipe manufactured on any particular day may be easily identified.

The strength requirements of the pipe shall be designated in terms of "D-Load" or "Class". "D-Load" is defined as the load, in pounds per square foot of projected internal diameter, that the pipe will withstand under the standard ASTM 3-edge bearing test before any crack having a width of 0.01 inch or more, and a length of 12 inches or more, occurs.

If precast RCP is specified by Class, the D-Load shall be as follows:

Class	D-Load
I .....	800
II .....	1000
III .....	1350
IV .....	2000
V .....	3000

The minimum "D-Load" shall be 2000-D unless otherwise specified.

### 304.02 Concrete

Cement shall be Type II in accordance with Section 800.02. Concrete shall be in accordance with ASTM Standard Specifications, Designation C76 and shall contain 6 sacks of cement per cubic yard of concrete as therein specified. Pipe shall not be transported from the plant until the full design strength is developed. Each section of pipe shall be steam or water cured, or cured using a combination of the two methods, and shall be kept continuously moist for at least 7 days. Curing shall commence within three hours following fabrication. Compression test specimens shall be made, cured in the same manner as the pipe, and tested in accordance with requirements of ASTM "Standard Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe", Designation C76, except as modified by the testing specifications of Section 304.13.

### 304.03 Centrifugally Spun

Pipe manufactured by the centrifugally spinning method shall have smooth interior surfaces free from excessive brush marks or other rough textures. Float rock or other light materials appearing on the inside surface of the pipe will be cause for rejection, unless such imperfections are repaired to the satisfaction of the Engineer.

### 304.04 Vertically Cast

Pipe manufactured by the vertical cast method shall have smooth interior surfaces, relatively free from pits and airholes. The concrete shall be placed between rigid internal and external forms extending the full length of the pipe and compacted by high frequency vibration.

The vibrators shall be rigidly attached to the exterior of the form by bolting, clamping, or welding. The vibrators shall be adequate in size and number and of sufficient frequency to properly compact the concrete.

The vibrators shall be operating at all times during the placement of concrete

### 304.05 Dimensions and Tolerances

Pipe shall be furnished in lengths not less than 6 feet; except for the closing sections to structures, where cast or cut lengths not less than 3 feet in length may be used. Pipe sections 6 feet in diameter and larger, in which manhole openings are provided, shall be not less than 7 feet long.

The minimum wall thickness of pipe, unless otherwise specified, shall be "B Wall" thickness in accordance with ASTM "Standard Specifications for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe", Designation C76. Pipe 42 inches in diameter and larger shall have a minimum protective covering of concrete over steel reinforcement of 1-1/2 inches from the outer surface and one inch from the inner surface.

The minimum thicknesses of bells at the base and spigots shall be in accordance with the following schedule:

12-inch diameter through 24-inch diameter, inclusive: Pipe bells and spigots each shall be at least 1-3/4 inches thick.

27-inch diameter through 60-inch diameter, inclusive: Pipe bells and spigots each shall be at least 2-1/4 inches thick.

63-inch diameter and larger size diameters, inclusive: Pipe bells and spigots each shall be at least 45% of the thickness of the respective pipe barrel wall.

In determining minimum thicknesses no reduction will be made from the thickness of spigots because of normal gasket grooves. However, in any case, gasket grooves shall not be made so as to leave less than 3/4-inch of concrete cover on reinforcing steel.

### 304.06 Contractor to Furnish Details

The Contractor shall furnish to the Engineer for approval six copies of the complete design details of the precast reinforced concrete pipe, including joints, and where applicable, cross-bracing, he intends to furnish.

### 304.07 Handling and Storing

Pipe shall be handled and stored so as to prevent damage thereto, or to existing improvements. Pipe, when stored, shall be properly secured to prevent rolling.

Any pipe which, in the opinion of the Engineer, has been damaged to the extent of being beyond repair, will be marked “rejected” and shall be immediately and permanently removed from the site of the work by the Contractor.

Cross-bracing is required for all precast pipes six feet in diameter and larger. The cross-bracing shall be placed inside the pipe such that no deformation will occur. The cross-bracing shall be installed prior to any transportation or handling of the finished pipe. The cross-bracing shall not be removed until the trench has been fully backfilled and compacted. In no case shall there be less than two sets of cross-bracing installed per pipe length.

### 304.08 Cutting Pipe

Cut lengths of pipe shall be neatly cut to a smooth transverse edge with a masonry saw or other approved means in such manner as to not spall the concrete from the surfaces of the pipe or unnecessarily expose the reinforcing steel.

Any pipe damaged by cutting to an extent that it is unsatisfactory shall be replaced with a new and undamaged length of pipe by the Contractor at his expense, or if allowed by the Engineer, shall be repaired in an approved manner. Spalled areas to be repaired shall be satisfactorily filled with Class “A” mortar and reinforcing steel shall be cut back where necessary and the holes filled, also with Class “A” mortar, so that the mortar covering the steel is not less than 2-1/2 inches thick, measured from the cut face of the pipe.

Hand cutting of pipe will be permitted if holes outlining the line of the cut are cleanly drilled and the intervening concrete satisfactorily cut out with approved hand tools. Light pneumatic chipping hammers that, in the opinion of the Engineer, will cut satisfactorily without shattering the adjacent concrete, may be used. The use of sledge hammers or pneumatic jack hammers will not be permitted.

### 304.09 Joints: General

Pipe joints shall be bell and spigot. Spigot ends shall be reinforced concrete with an annular groove formed into the outer surface containing a continuous round neoprene gasket compressed therein by the inner surface of a reinforced concrete bell. The joint shall be self-centering and designed so as to prevent the neoprene gasket from supporting the weight of the pipe.

Each joint shall be watertight, (without imperfections), and approved by the Engineer before another section of pipe is installed. The location of the neoprene gasket within the completed joint will be determined by the use of a feeler gauge.

While joining sections of pipe, the Contractor shall use a “comealong” to seat the pipe section being installed.

The joint gap on the inside of the sewer between sections of pipe shall not exceed 3/4 inch. If the joint gap is 3/8 inch or more, the Contractor shall fill such gap with an approved epoxy mortar, mixed to stiff consistency, and finished flush with the pipe walls.

Joints connecting pipes to structures shall be integrally cast with the structure or made with Class “A” cement mortar. Imperfections of cast joints shall be repaired with Class “A” cement mortar.

Cement mortar shall be in accordance with the requirements of Section 800.09.

The pipe section that cannot be laid to give a proper joint with the approved overlap shall be replaced with a suitable pipe section or the joint shall be reinforced with an approved concrete collar not less than 6 inches thick and 12 inches long, containing not less than 3-circumferential No. 4 steel reinforcing bars with suitable spacers. The outside surface of the pipe at the joint shall be roughened to provide satisfactory bond with the collar.

A cut end of pipe may only be used for the closing connection with concrete structures and manhole bases. The cut end shall extend into the wall of the structure or manhole base. The wall of the structure or manhole shall be placed around the end of the cut length of pipe.

### 304.10 Bell and Spigot Ends of Pipe

The outside surfaces of the spigot, and the inside surfaces of the bells, shall be accurately formed to provide readily made close fitting joints, the average clearance of which shall not exceed 0.08 inch.

The taper on the conic surface of the inside of the bell and the outer surface of the spigot shall not be more than 3 degrees measured from a longitudinal trace on the inside surface of the pipe.

The joint lap distance at each spigot shall be at least 3-3/8 inches.

The bell reinforcement and the spigot reinforcement shall each be at least equal in quantity and quality to the steel in the pipe barrel wall with extra steel being added, as necessary, to reinforce ends of pipe against normal construction and shipping stresses.

### 304.11 Bevel Joints

Bevel joints, when specified in the Special Provisions, shall be of the bell and spigot type as set forth in Section 304.09 and the horizontal deflection thereof shall not exceed 5 degrees. The longitudinal centerline of pipe at each bevel joint shall be located on the indicated centerline of the sewer. Horizontal deflections will be permitted only at bevel joints or within structures.

### 304.12 Neoprene Gaskets

Each gasket shall be continuous ring of such size and cross section as to completely fill the groove in the spigot when the pipe joint is assembled. The gasket shall make the joint watertight under normal conditions of service including expansion, contraction, and normal earth settlement. Neoprene gaskets shall be made in accordance with ASTM "Standard Specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets", Designation C443.

Each gasket, the groove containing it, and the inside surface of the bell or collar compressing it, shall be coated with an approved manufacturer's recommended lubricant immediately prior to installation.

### 304.13 Material Testing

The Contractor shall make available testing equipment and samples, and shall test or have tested precast reinforced concrete pipe by standard 3-edge bearing and compression tests in accordance with ASTM "Standard Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe". Designation C76, except as modified by the plans and these specifications.

The Contractor shall furnish the Engineer with Compression Test results for each manufacturer's run, size, and "D-Load" of pipe specified. If the test cylinder fails to reach the design strength, the Contractor shall at his own expense provide core samples where directed by the Engineer. The core shall be cut and tested in accordance with the requirements of Methods ASTM C497. The core holes shall be plugged and sealed in accordance with ASTM C76.

At the option of the Engineer, the Contractor shall furnish complete test data of the pipe he intends to furnish, two standard concrete cylinders, and two core samples from each run, size, and "D-Load" of the specified pipe for testing by the City.

The Engineer may select from each size, "D-Load", or 400-linear feet of pipe one length for 3-edge bearing testing, and at the Engineer's request all tests shall be performed in his presence. The minimum length for 3-edge bearing testing shall be 6-linear feet. For each pipe that fails to meet the "D-Load" requirements two additional lengths of the same run, size, and "D-Load" shall be tested. If these pipes meet the "D-Load" requirements the shipment will be accepted. If these pipes do not meet the "D-Load" requirements, testing shall be continued as determined by the Engineer until he approves or rejects the shipment.

For precast pipe sizes larger than 108-inch diameter the 3-edge bearing test will not be required. In lieu thereof, the Contractor shall submit to the Engineer notarized certificates obtained from the pipe manufacturer to verify:

- 1) The 28-day strength of the concrete, as determined from crushing tests in accordance with ASTM Designation C76 on (a) standard concrete cylinders, or (b) core samples; the latter being in addition to the former and at the option of the Engineer;



- 2) The density of the concrete as in the finished pipe product;
- 3) The strength and type of steel used;
- 4) That production of the pipe is in compliance with ASTM Designation C76, except as modified by the plans and these specifications.

In addition to the samples, tests, and test results required herebefore, the City reserves the right to require additional samples, tests, and test results to properly examine the precast reinforced concrete pipe.

#### **304.14 Payment**

Precast reinforced concrete pipe sewer satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of sewer, exclusive of manholes and structures, between the outside surfaces of manholes and structures, or to the limits as constructed if the sewer does not terminate in manholes or structures.

Precast reinforced concrete pipe sewer connecting to a manhole or structure by a collar or boss shall be measured to the outside surface of such collar or boss at the point of connection with the pipe.

No deduction will be made from the measured length of precast reinforced concrete pipe sewer because of collars constructed thereon to reinforce the joint between sections of precast pipe. The collars constructed to reinforce the joint shall be done as Incidental Work.

No deduction will be made from the measured. length- of precast reinforced concrete pipe sewer because of manhole cones constructed thereon.

## **305 Vitrified Clay Pipe Sewer**

### **305.01 General**

The Contractor shall construct vitrified clay pipe sewer (including encasement in reinforced concrete, plain concrete base, or reinforced concrete foundation, as the case may be) including all excavating, lagging, backfilling, restoring pavement, and other Incidental Work, necessary or required for a complete, satisfactory sewer installation, where and as shown on the plans, or where directed.

### **305.02 Pipe**

Vitrified Clay Pipe (VCP) shall conform to the ASTM “Standard Specifications for Extra Strength Clay Pipe”, Designation C700, except as modified by the plans, the Special Provisions and these specifications.

VCP main sewers and fittings for pipe diameter larger than 12 inches shall be of the bell and spigot type.

The minimum thickness of the pipe barrel shall conform to the Regional Western Standard of the Clay Pipe Institute.

### **305.03 Joints**

Bell and spigot joints shall be constructed with factory fabricated Compression type gasket joints in accordance with ASTM “Standard Specification for Vitrified Clay Pipe Joints Using Materials Having Resilient Properties”, Designation C425. Joints shall be made up in the field in accordance with the manufacturer’s recommendations. All joints shall be tight fitting, watertight, and without imperfections. Only factory recommended lubricants shall be used.

Joints connecting pipes to manhole structures shall be made with a short stub. The straight segment of stub barrel may not exceed 6-inch maximum from face of the structure. Joints for VCP plain-end pipe sewers 12-inch or smaller in diameter may be rubber compression couplings with stainless steel bands type 316. Rubber compression couplings with Class 316 stainless steel bands shall be in accordance with the requirements of ASTM designation C425.

### **305.04 Testing**

The Contractor shall test vitrified clay sewer pipe and joints, if required by the Special Provisions, in the presence of the Engineer. The Contractor shall notify the Engineer, at least 48 hours in advance, of the time and place of such tests.

Vitrified clay pipe shall be tested for strength, absorption, and acid resistance, in accordance with ASTM “Specification for Extra Strength Clay Pipe”, Designation C700, except that the number of pipes to be tested shall be one.

Joints in VCP pipes shall be tested in accordance with ASTM “Specification for Compression Joints for Vitrified Clay Bell and Spigot Pipe”, Designation C425, except that:

- 1) The number of joints to be tested shall be one;
- 2) Duration of hydrostatic shear test shall be 10 minutes;
- 3) The field performance tests will not be required;
- 4) In the event of a failure of a test, two additional joints from the same lot of pipe shall be tested.

### **305.05 Contractor to Furnish Details**

The Contractor shall furnish to the Engineer for approval prior to shipment of the VCP pipes six copies of the certified report of the actual test results meeting the requirements of ASTM C700.

### **305.06 Handling and Storing**

Pipe shall be handled and stored so as to prevent damage thereto, or to existing improvements. Pipe, when stored, shall be properly blocked to prevent rolling.

### 305.07 Construction

Pipe sections of the main sewer shall be ordered in short lengths, as necessary if “T” or “Y” branches will be used, in order that such branches will be located opposite or within 2 feet down downstream of existing side sewer locations.

Pipe sewers shall be so constructed and the sections so installed that the sections of pipe laid together form a continuous uniform line of pipe with a smooth regular interior surface. Pipe shall be laid uphill from structure to structure with the bell end upgrade. Each pipe shall be laid in the proper position, on a firm 4-inch deep sand bed, and shall have uniform support and bearing for its entire length. Bells shall be cleaned before the spigot of the succeeding pipe is inserted. A bell hole shall be dug at the end of each pipe to accommodate the bell and facilitate the making of the joint.

Pipe sewers shall be laid in conformity to the prescribed lines and grades, which shall be obtained for each pipe by measuring from a tightly stretched line running parallel with the grade and supported over the center line of the sewer by bars placed across the trench. The pipe sections shall be tightly fitted together. All adjustments of pipe to line and grade shall be made by scraping away or filling in and tamping the earth under the body of the pipe, not by blocking or wedging up. Supporting blocks shall not be used under the pipe. Pipe shall not be laid within 4 inches of any rock or other rigid object.

The Contractor shall not lay pipe in water and he shall use crushed rock, subdrains, or some other method approved by the Engineer to maintain an appropriately dry trench. Crushed rock bedding for pipe sewers shall be uniformly graded from No. 4 to 3/4-inch sieve size. Compaction shall be obtained by shovel slicing, using care not to disturb the pipe. Jetting will not be allowed to get proper compaction of the crushed rock bedding.

Pipe sewers in encasements or on foundations shall have the bottom reinforcing steel of the encasement or foundation run continuously through all sewerage structures constructed along or at the end of such sewers.

When pipe is being encased in reinforced concrete, the Contractor shall support the pipe during placement of the concrete encasement, shall prevent any “floating” or movement of the pipe, and shall carefully maintain the required line and grade. The support and method thereof shall be approved by the Engineer prior to placing encasement but such approval will not relieve the Contractor of his responsibility - for execution of the work so that the pipe will be true in line and grade and satisfactory in every respect.

### 305.08 Payment

Vitrified clay pipe sewer (including encasement in reinforced concrete, plain concrete base, or reinforced concrete foundation, as the case may be) satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of the sewer, exclusive of manholes and structures, between the outside surfaces of manholes and structures, or to the limits as constructed if the sewer does not terminate in manholes or structures. Supporting piles, and the driving thereof, will not be included for payment under a Bid Item for vitrified clay pipe sewer, but will be paid for under the appropriate Bid Items.

Vitrified clay pipe sewer connecting to a manhole or structure by a collar or boss shall be measured to the outside surface of such collar or boss at the point of connection with the pipe.

No deduction will be made from the measured lengths of vitrified clay pipe sewer because of side sewer connections.

## **306 Vitrified Clay Pipe Culvert**

### **306.01 General**

The Contractor shall construct vitrified clay pipe culvert (including encasement in reinforced concrete, plain concrete base, or reinforced concrete foundation, as the case may be) including all excavating, lagging, backfilling, restoring pavement, and other Incidental Work, necessary or required for a complete, satisfactory installation, where and as shown on the plans, or where directed.

### **306.02 Pipe**

Vitrified clay pipe for culvert shall be the same as specified for main sewers in Section 305.02, except that the culvert and replaced fittings may be of the spigot type using composition couplings and stainless steel bands to make the joints.

### **306.03 Joints**

Joints for vitrified clay pipe culverts shall be the same as specified for main sewers in Section 305.03, except that rubber compression couplings with stainless steel bands may be used for the applicable joints. Rubber compression couplings with Class 316 stainless steel bands shall be in accordance with the requirements of ASTM "Tentative Specifications for Compression Couplings for Vitrified Clay Plain-end Pipe", Designation C425.

### **306.04 Contractor to Furnish Details**

The Contractor shall furnish to the Engineer for approval six copies of the certified report of the actual test results meeting ASTM C700 and design details of the rubber compression couplings.

### **306.05 Handling and Storing**

Pipe shall be handled and stored so as to prevent damage thereto, or to existing improvements. Pipe, when stored, shall be properly secured to prevent rolling.

### **306.06 Construction**

Vitrified clay pipe culvert shall be constructed in accordance with the requirements for main sewers as specified in Section 305.07. Culvert shall be laid on a grade of not less than 2% (approximately 1/4-inch per foot). Horizontal and vertical bends in side sewer runs shall not exceed 45 degrees (1/8 pend), using approved mitered joints.

### **306.07 Payment**

Vitrified clay pipe culvert (including encasement in reinforced concrete, plain concrete base, or reinforced concrete foundation, as the case may be) satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of the culvert, between the outside surfaces of sewerage and drainage structures, or to the limits as constructed if the culvert does not terminate in sewerage or drainage structures.

## **307 Vitrified Clay Pipe Side Sewer**

### **307.01 General**

The Contractor shall construct vitrified clay pipe side sewer, including all excavating, lagging, backfilling, restoring pavement and other Incidental Work necessary, or required for a complete, satisfactory installation, where and as shown on the plans, or where directed.

### **307.02 Pipe**

Vitrified clay pipe for side sewers shall be the same as specified for main sewers in Section 305.02, except that the side sewers and related fittings may be of the spigot type.

### **307.03 Joints**

Joints for vitrified clay pipe side sewers shall be the same as specified for main sewers in Section 305.03, except that rubber compression couplings with Class 316 stainless steel bands may be used for the applicable joints. Composition couplings with Class 316 stainless steel bands shall be in accordance with the requirements of ASTM "Tentative Specification for Compression Couplings for Vitrified Clay Plain-End Pipe", Designation C425.

### **307.04 Handling and Storing**

Pipe shall be handled and stored so as to prevent damage thereto, or to existing improvements. Pipe, when stored, shall be properly blocked to prevent rolling.

### **307.05 Contractor to Furnish Details**

The Contractor shall furnish to the Engineer for approval, six copies of the certificate of compliance to ASTM C700 and design details of the rubber compression couplings.

### **307.06 Construction**

Vitrified clay pipe side sewers shall be constructed in accordance with the requirements for main sewers specified in Section 305.07. Side sewers shall be connected to the main sewer in accordance with the requirements for side sewer connections as specified in Section 316.

Where side sewers are connected to concrete sewers a stub of the proper size shall be installed in the main sewer and the side sewer connected thereto.

Where the diameter of the existing side sewer is smaller than the diameter of a specified connection, such connection shall be made with an appropriate size increaser.

Horizontal and vertical bends in side sewer runs shall not exceed 45 degrees (1/8 bend), using approved mitered joints. Normal joints shall not be deflected greater than that recommended by the manufacturer.

Side sewers shall be laid on a straight grade which grade shall in no case be less than 2% (approximately 1/4-inch per foot).

The upper end of each side sewer shall be 12 inches behind the curb line at a depth sufficient to provide adequate sewerage for the property served. In no case shall the depth of the invert of a side sewer at the curb line be less than 4 feet below curb grade.

In connecting new side sewer to existing side sewer, the new side sewer shall be laid on a straight grade from the main sewer to the point of junction with the existing side sewer. The deflection angle at the junction shall not exceed 45 degrees, using approved mitered joints.

The ends of side sewers not in service before the side sewer trenches are backfilled shall be closed with a VCP stopper and marked by the letter "S" placed on the top of the curb directly over the side sewer. The end of each such side sewer shall also be marked by a 2-inch x 2-inch redwood stake running vertically from the bottom of the trench to a point 6 inches below the surface of walk or ground. In new concrete curbs the "S" shall be stamped in the fresh concrete. In the tops of other curbs it shall be neatly cut.

Before marking the "S" on the curb the Contractor shall verify the location of the side sewer by excavating to the top of the redwood stake. If for any reason the stake is not found, the Contractor shall excavate and expose the pipe. In no case shall probing with a bar, or other method, be permitted as a substitute for actual exposure of the stake or pipe.

### **307.07 Payment**

If the Proposal contains a side sewer Bid Item, all side sewers necessary or required for the reconnection of existing side sewers within the main sewer trench and to the limits of 12 inches outside the lagging or 12 inches outside the limits of excavation for the main sewer, if not lagged, shall be constructed as Incidental Work. Side sewer, outside such limits, satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of the side sewer, from the above limits to the end of the side sewer.

If the Proposal does not contain a side sewer Bid Item, side sewers necessary or required for reconnection of existing side sewers (i.e., replacement of side sewer removed by the operations of the Contractor) within the main sewer trench and to the limits of 12 inches outside the lagging or 12 inches outside the limits of excavation for the main sewer if not lagged, shall be constructed as Incidental Work. Side sewer necessary or required for reconnection outside such limits will be paid for as Extra Work in accordance with Section 112.

If the Proposal does not contain a side sewer Bid Item, the two lengths of side sewer required by Section 316.05 at inlets and branches not in service shall be furnished and installed as Incidental Work.

## **308 Ductile Iron Pipe**

### **308.01 General**

The Contractor shall furnish and install ductile iron sewer pipe, where and as shown on the plans or where directed, including all excavating, lagging, backfilling, pavement restoration, and all other related Incidental Work necessary, or required, for a complete satisfactory sewer installation.

### **308.02 Ductile Iron Sewer Pipe**

Ductile iron sewer pipe shall be bell and spigot, rubber gasketed, water main pipe conforming to the applicable requirements of ANSI/AWWA Standards C101, C104, C106, C110, C111, C150 and C151. Side sewer connections shall be made with fittings or approved saddles.

### **308.03 Contractor to Furnish Details**

The Contractor shall furnish to the Engineer for approval six copies of the complete design details of the ductile iron pipe, including joints, he intends to furnish.

## 309 Corrugated Metal Pipe Culvert

### 309.01 General

The Contractor shall furnish and install galvanized corrugated metal pipe, complete with coupling bands, paving, coating, lining, fittings and end sections, as the case may be, including all excavating, lagging, backfilling, restoring pavement, and other Incidental Work, necessary or required for a complete, satisfactory installation, where and as shown on the plans, or where directed.

### 309.02 Materials

Corrugated metal pipe materials shall be galvanized and shall conform to the specifications of AASHTO Designation M36.

The paving of inverts, bituminous coating and lining of pipes shall conform to the specifications of AASHTO Designation M190.

### 309.03 Identification

Each section of a pipe shall bear the name of the sheet manufacturer, the brand, or trade mark, and the gauge. This identification shall be stamped on the sheets by the manufacturers of the sheet. Pipe having any sections not so stamped shall be rejected. The manufacturer of the pipe shall roll the sheet so that the identification shall appear on the outside of each section.

### 309.04 Manufacture

All pipes shall be circular, unless otherwise specified, of lap joint construction, and all joints shall be fabricated by riveting, welding, or using a continuous lock seam so that jointed pipe shall be straight and rigid.

The corrugations shall be not more the 2-3/4 inches wide and not less than 1/2-inch deep.

### 309.05 Dimensions and Weight

The sheet length before forming, the gauge of the uncoated metal, and the weight per foot of the finished pipe, shall not be less than shown in the following Table. A maximum variation of plus or minus 5% will be allowed from the weight specified in the Table.

Nominal Diameter (Inches)	Length of Sheet Before Forming (Inches)	Min. Gauge U.S. Standard Uncoated Metal -	Weight per Foot of Finished Culvert (Pounds)
12 .....	41 .....	16 .....	10.8 .....
15 .....	50 .....	16 .....	13.1 .....
18 .....	60 .....	16 .....	19.3 .....
24 .....	79 .....	14 .....	25.4 .....
30 .....	98 .....	14 .....	43.6 .....
36 .....	117 .....	12 .....	52.0 .....
42 .....	136 .....	10 .....	75.6 .....
48 .....	156 .....	10 .....	88.1 .....
60 .....	298 .....	8 .....	136.8 .....

Where pipe is to be placed under fills 20 feet or more in depth, the gauge of the sheets may be increased, such increase to be noted on the plans or in the Special Provisions.



### **309.06 Riveting**

Rivets shall not be less than 5/16-inch in diameter for 14-gauge sheets or lighter, and they shall not be less than 3/8 inch for sheets heavier than 14-gauge. All rivets shall be thoroughly galvanized or sherardized.

Longitudinal joints shall be riveted in each outside groove, and for pipes of 30-inch diameter or larger, double riveted in each outside groove. In the transverse joints, rivets shall be placed uniformly not more than 6 inches apart.

Round heads of rivets shall have a diameter of not less than 1.5 times the diameter of the rivet, plus 1/8-inch, and flat heads shall have a thickness of not less than 3/5 of the diameter of the rivet.

### **309.07 Coupling Bands**

Field connections shall consist of bands not less than 12 inches in width, made from the same material as the pipe. They may be fitted with malleable cast iron lugs, or with angles having minimum dimensions of 1 1/2-inches x 1 1/2-inches and of a length equal to the full width of the band, and provided with galvanized bolts not less than 1/2-inch in diameter. The coupling bands shall be fabricated so that connections may be easily made in the field. A continuous band-type neoprene gasket not less than 7 inches wide by 3/8-inch thick shall be placed between the coupling band and abutting sections.

### **309.08 Contractor to Furnish Details**

The Contractor shall furnish to the Engineer for approval six copies of the complete design details of the corrugated metal pipe, including joints, and connections, he intends to furnish.

### **309.09 Construction**

The pipe shall be carefully handled to prevent damage to the galvanizing, and shall in no case be dragged along the ground. Such damage will be sufficient cause for rejection of the pipe. If permitted by the Engineer, small areas, on which the galvanizing is damaged or destroyed, may be repaired by the application of two coats of hot asphaltic paint. The pipe shall be laid on a 4-inch thick sand bed and the trench backfilled in accordance with Section 703.

### **309.10 Payment**

Corrugated metal pipe satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of the corrugated metal pipe between the outside surfaces of structure, or to the limits as constructed, as applicable.

## **310 Manholes**

### **310.01 General**

The Contractor shall construct manholes complete with cones, frames, covers, gratings, steps, VCP stub inlets, and including excavating, lagging, backfilling, restoring pavement and other Incidental Work, necessary or required for a complete satisfactory installation, where and as shown on the plans, or where directed.

Manholes shall be constructed to conform to the improved street surface. In unimproved areas if the ground surface is below the official grade, the manhole shall be constructed to conform to such official grade unless otherwise indicated on the plans; and if the ground surface is above the official grade, the manhole shall be so constructed that the internal diameter, at the proper elevation to conform to the official grade, is 24 1/2 inches, and shall be continued upward, with the same diameter, to conform to the ground surface.

Manholes shall be constructed of precast concrete sections in accordance with the requirements of ASTM "Standard Specifications for Precast Reinforced Concrete Manhole Sections", Designation C478, or cast-in-place in accordance with the applicable requirements of Section 303. Precast concrete manholes shall be supported on a cast-in-place concrete base.

The Contractor shall submit for approval detail drawings of any equivalent alternative method that he may propose, other than that shown on the plans, for installing, anchoring and protecting the required steps in precast manholes.

### **310.02 Special Manholes**

Drop manholes and other special manholes shall be constructed as shown on the plans and in accordance with the requirements set forth herein. Drop manholes shall include the drop connection and drop pipe as part of its structure.

### **310.03 Manhole Frames, Covers, Gratings, Taper Cones and Steps**

Cast iron manhole frames, covers, gratings, and taper cones, Class 316 stainless steel or polypropylene Type II, Grade 16906 with 1/2-inch grade 60 steel reinforcement steps shall be furnished and installed as shown on the plans and as specified in Sections 303.08, 303.09 and 303.10.

### **310.04 Payment**

Manholes, including special manholes, satisfactorily constructed complete, in place, as specified, will be paid for at the unit price bid therefor.

The unit price bid for a manhole on a reinforced concrete sewer shall include all expense due to such manhole, over and above the cost of the sewer without the manhole.

Appurtenances, such as manhole cones, frames, covers, gratings, steps, stub inlets and VCP inverts will be considered part of the manhole and no direct or additional payment will be made therefor.

## **311 New Frames and Covers on Existing Manholes**

### **311.01 General**

The Contractor shall remove and salvage, as City property, the frames and covers from existing manholes, and shall furnish and install in place thereof new manhole frames and covers in accordance with the requirements of Section 303.08, all where and as shown on the plans, or where directed, including all Incidental Work necessary, or required, for a satisfactory installation.

### **311.02 Payment**

Manhole frame and cover furnished and installed on an existing manhole, complete in place, as specified will be paid for at the price bid for a set, consisting of one frame and one cover.

## **312 Catchbasins**

### **312.01 General**

The Contractor shall construct catchbasins complete with curb inlets, frames, gratings, traps, and including excavating, lagging, backfilling, restoring pavement, and other Incidental Work, necessary or required for a complete, satisfactory installation, where and as shown on the plans, or where directed.

Catchbasins shall be constructed of Class 6-3500-1 1/2 concrete precast sections in accordance with the applicable requirements of Section 304 or cast-in-place in accordance with the applicable requirements of Section 303. Precast catchbasins shall be supported on a cast-in-place concrete base.

Unless otherwise shown on the plans, catchbasin gratings shall be 9 inches below curb grade, except that catchbasin gratings to be installed in travel lanes shall conform to the gutter elevations.

### **312.02 Curb Inlets**

Curb inlets shall be constructed as shown on the plans and shall comply with the requirements for concrete curbs.

When two inlets are specified for catchbasins with multiple curb inlets, the center inlet shown on the Standard Plan shall be eliminated.

The curb inlets, or slabs, as the case may be, shall conform to the adjacent curb and sidewalk.

### **312.03 Catchbasin Frames, Gratings and Traps**

Cast iron catchbasin frames, gratings, and traps shall be furnished and installed on catchbasins as shown on the plans. The cast iron shall be in accordance with the requirements of Section 801.01.

Each casting shall have its weight indicated thereon with white paint.

Care shall be exercised to cast the contact surfaces in a true plane and free from irregularities. These surfaces shall be machined or ground to insure uniform contact between the grating and frame.

### **312.04 Payment**

Catchbasin satisfactorily constructed complete in place, as specified, will be paid for at the unit price bid therefor.

## **313 New Frames and Gratings on Existing Catchbasins**

### **313.01 General**

The Contractor shall remove and salvage, as City property, the frames and gratings from existing catchbasins, and shall furnish and install in place thereof new catchbasin frames and gratings in accordance with the requirements of Section 312.03, all where and as shown on the plans, or where directed, including all Incidental Work, necessary, or required, for a satisfactory installation.

### **313.02 Payment**

Catchbasin frame and grating satisfactorily furnished and installed on an existing catchbasin, complete in place, as specified, will be paid for at the price bid for a set, consisting of one frame and one grating.

## **314 Storm Water Inlets**

### **314.01 General**

The Contractor shall construct storm water inlets complete with frames, gratings, and including excavating, lagging, forming, backfilling, restoring pavement, and other Incidental Work necessary or required for a complete, satisfactory installation, where and as shown on: the plans, or where directed.

Storm water inlets shall be concrete unless otherwise specified.

### **314.02 Concrete Storm Water Inlets**

Concrete storm water inlets shall be constructed of cast-in-place Class 6-3500-1 1/2 concrete in accordance with Sections 411 and 800. Construction shall be in accordance with the applicable requirements of Section 303.

### **314.03 Brick Storm Water Inlets**

Brick storm water inlets shall be constructed of common bricks and Class "B" mortar in accordance with Sections 320 and 800.09. The entire inner surface of the brickwork shall be plastered with a smooth coat of Class "A" mortar, which shall be at least 1-inch thick on the invert and 3/8-inch thick on the walls. In soft ground, the foundation slab shall be constructed of Class 6-3500-1 1/2 concrete.

### **314.04 Storm Water Inlet Frames and Gratings**

Storm water inlet frames and gratings shall be furnished and installed where and as shown on the plans and in accordance with Section 312.03.

### **314.05 Payment**

Storm water inlet satisfactorily constructed complete, in place, as specified, will be paid for at the unit price bid therefor.

## **315 New Frames and Gratings on Existing Storm Water Inlets**

### **315.01 General**

The Contractor shall remove and salvage, as City property, the frames and gratings from existing storm water inlets, and shall furnish and install in place thereof new storm water inlet frames and gratings in accordance with the requirements of Section 312.03, all where and as shown on the plans, or where directed, including all Incidental Work, necessary, or required, for a satisfactory installation.

### **315.02 Payment**

Storm water inlet frame and grating satisfactorily furnished and installed on an existing storm water inlet, complete in place, as specified, will be paid for at the price bid for a set, consisting of one frame and one grating.

## **316 VCP Side Sewer Connections to Mains Sewers**

### **316.01 General**

The Contractor shall connect each side sewer to the main sewer by using:

in VCP main sewer, at his option, a VCP T-branch, a VCP Y-branch, or by tapping the main sewer by drilling a hole and securing therein a VCP stub;

in precast concrete pipe main sewer, a VCP stub inlet; and, in cast-in-place sewers and sewer structures, a VCP stub inlet;

in each case including all Incidental Work necessary or required for a complete satisfactory installation, where and as shown on the plans or where directed.

VCP stubs and stub inlets shall be vitrified clay and in accordance with the requirements of Section 305.02.

Tapping a VCP sewer will be permitted only where the diameter of the main sewer is at least twice the diameter of the side sewer.

T-branches, Y-branches and stub inlets shall be not less than 6 inches in diameter in residential districts, and not less than 8 inches in diameter in industrial and commercial districts. If any existing side sewer is of larger diameter, the branch inlet shall be of such diameter.

### **316.02 T-Branch or Y-Branch**

T-branches and Y-branches shall be made of vitrified clay in accordance with the applicable requirements of Section 305.02, and installed in accordance with the applicable requirements of Section 305.

### **316.03 VCP Stub in Tapped VCP Main Sewer**

The Contractor, in lieu of using T-branches or Y-branches in VCP main sewers, may connect side sewers by drilling the proper size neat round hole in the wall of the main sewer, inserting therein either a rubber and plastic compression fitting with VCP stub or a VCP stub in place with epoxy mortar. The VCP stub shall be cut to fit flush with the inside surface of the main sewer. The clearance between the outside diameter of the stub and the drilled hole shall be such as to properly contain the epoxy mortar and produce a strong, watertight joint.

The epoxy mortar used for bonding the VCP stub and main sewer shall have a set time or curing time not to exceed thirty minutes regardless of temperature. The manufacturer's specifications for epoxy mortar shall be submitted in writing to the Engineer for approval.

Substitute methods or devices for tapping the VCP main sewer and installing a side sewer connection shall be submitted to the City Engineer for approval. The submittal must include manufacturer's -specifications and details.

The clear length of VCP main sewer, between drilled holes, or between a drilled hole and the spigot end, shall be not less than 18 inches.

Each length of VCP main sewer that has been drilled shall be inspected before being placed in the trench and will be rejected if it does not "ring true" when tapped with a hammer. Before VCP main sewer is laid in the trench, the Contractor shall set each VCP stub in the holes in such pipe with an approved epoxy resin joint material applied in accordance with the manufacturer's instructions.

Each VCP stub shall be the proper size for the tapped main sewer and for the side sewer. Aluminum stubs will not be allowed.

### **316.04 Stub Inlet in Concrete Sewer or Structure**

Each stub installed in a Sewer or structure shall be mortared in place with Class "A" cement mortar, or an approved epoxy mortar.



Stub inlets shall be set with the back of the bell placed as close as practicable to the outside surface of the sewer or manhole, and shall be of such length that the inner spigot end shall be flush with the inside surface. They shall be securely fastened in the formwork of east-in-place sewers and sewer structures so that they will not be displaced from their correct positions during placing of the concrete. All holes in precast concrete pipe for stub inlets shall be cut in accordance with the plans and the requirements of Section 304.08; the method specified in Section 316.03 may be used. Reinforcing bars within the hole shall be cut so as to clear the stub by not less than one inch.

Where the edge of the hole is less than 18 inches from the end of a pipe, or where the clearance between two holes is less than 18 inches, a ring bar of No. 5 reinforcing steel shall be welded to each cut bar. The hole shall be cut sufficiently large to provide a 1-inch clearance between the ring bar and the stub. Clearance between two cut holes or between a cut hole and the end of the pipe shall not be less than 6 inches.

### **316.05 Stub Inlets and Branches not in Service to be Closed and Marked**

The Contractor shall furnish and install two lengths of VCP side sewer connected to the bell ends of all VCP stub inlets, stubs, and branches not in service before backfilling, and shall close the resulting bell ends with vitrified clay stoppers properly secured and made watertight. Each such stoppered bell end to which no connection is made, shall be marked by a 2-inch x 2-inch redwood stake, running vertically from the bottom of the trench at the stoppered bell to a point one foot below the surface of the street. Care shall be taken to maintain the stake in its correct position during backfilling. In addition to the redwood stake, the letter "Y" shall be stamped or neatly chipped in the top of the curb opposite each stoppered bell from which a side sewer has not been constructed.

### **316.06 Side Sewer Investigation**

The Contractor shall confirm that each property has been provided with a satisfactory connection for all its side sewers.

The Contractor shall perform the following for all side sewers:

- 1) Confirm connection points of active side sewers by dye-testing at sidewalk vents.
- 2) Investigate, locate, and confirm active side sewers not identified by sidewalk vents by dye-testing at building fixtures and/or rodding.
  - 1) Side sewers rodded to show lengths short of one (1) foot behind the curb shall be considered as inactive.
  - 2) Side sewers rodded to show lengths beyond one (1) foot behind the curb are to be assumed as active and shall be connected to the new sewer.
- 3) Record locations of active side sewers and provide the City with a copy of the record.

### **316.07 Payment**

VCP side sewer connection to main sewer made by T-branch, Y-branch, VCP stub secured in drilled hole in VCP main sewer, or VCP stub inlet in RCP or cast-in-place main sewer, satisfactorily completed and in place, as specified, and including, if the Proposal does not contain a side sewer Bid Item, furnishing and installing the two lengths of side sewer required at inlets and branches not in service, will be paid for at the unit price bid for a side sewer connection for the respective kind and size of main sewer and size of side sewer.

No deduction in the measured length of main sewer will be made for VCP side sewer connections.

Connection of side sewers to the hereinbefore specified side sewer connections and to existing side sewers shall be done as Incidental Work.

Investigation, locating by dye-testing, abandoning inactive side sewers, if any, and rodding of side sewers shall be done as Incidental Work.

## **317 Connections to and between Sewer Structures and Culverts**

### **317.01 General**

The Contractor shall make all connections to and between sewerage and drainage structures, sewers, and culverts, where and as shown on the plans, including constructing stub inlets for culverts, and doing all other work necessary or required in order that the completed work will function as an integral part of the sewerage system.

Connections shall be constructed in a manner to produce smooth junctions, and those of new to existing concrete shall be done in accordance with the applicable requirements of Section 800.15.

Unless otherwise specified, where pipe sewer is to be connected to a brick or concrete sewer or structure, the Contractor shall keep the opening therefor to a practicable minimum, and shall make the joint with Class "A" cement mortar.

Stubs and stub inlets for culvert connections to catchbasins, storm water inlets, manholes and sewer structures shall be 10 inches in diameter unless otherwise specified, and shall be in accordance with the applicable requirements of Section 316.

### **317.02 Payment**

Connections to and between sewers, sewerage and drainage structures and culverts, including constructing stubs and stub inlets for culverts, shall be done as Incidental Work and payment therefor shall be included in the price and prices bid.

## **318 Side Sewer Trap**

### **318.01 General**

The Contractor shall furnish and install new vitrified clay pipe side sewer traps, complete with vitrified clay air vent risers, cast iron inlet frames with malleable iron gratings, fittings, connections, extensions, and appurtenances; and including excavating, backfilling, restoring pavement and all other Incidental Work, necessary or required for a complete, satisfactory installation, where and as shown on the plans, or where directed.

Fittings and soil pipe extensions on the house side of the trap connecting the trap to existing facilities shall be of the same type material as existing facilities or of vitrified clay pipe. Extensions connecting side sewer traps to existing facilities shall not extend beyond the property line.

### **318.02 Installation**

Traps shall have spigot ends and connections shall be made with rubber compression couplings with Class 316 stainless steel bands as specified for vitrified clay pipe side sewer in Section 307.03, or an approved equal joint connection.

### **318.03 Payment**

Side sewer trap satisfactorily constructed complete, in place, as specified will be paid for at the unit price bid therefor.

## **319 Low Pressure Testing**

### **319.01 General**

The Contractor shall do all low pressure testing specified in the Special Provisions or indicated in the plans, including all Incidental Work, necessary or required, to satisfactorily demonstrate watertightness of the installed system.

### **319.02 Inspection and Testing**

The Engineer and the Contractor shall make a visual inspection of each pipe joint prior to backfill. Joints deemed unsatisfactory by the Engineer shall be repaired or remade to a proper standard of workmanship and appearance.

Upon approval by the Engineer the Contractor shall backfill the sewer, leaving the joints exposed, and perform a low pressure, 10 p.s.i.g. hydrostatic test on the pipe for a duration of at least 30 minutes without adding test fluid. The Contractor shall provide all equipment necessary to perform the test. Failure to maintain the test pressure shall be cause for the Engineer to order additional tests and order the remaking of joints and additional tests until all leaks are eliminated.

Balloon plugs may be used at side sewer connections to limit tests to main sewer joints.

If approved by the Engineer, the Contractor may substitute an approved equivalent air test in lieu of the hydrostatic test.

### **319.03 Payment**

Low pressure testing satisfactorily completed, as specified will be paid for at the price bid therefor when such work is set forth for payment in the Schedule of Bid Prices. Low pressure testing specified on the plans or in the Special Provisions and not set forth for payment in the Schedule of Bid Prices shall be done as Incidental Work, and no direct or additional payment will be made therefor.

## 320 Brickwork for Sewers

### 320.01 General

The Contractor shall do all brickwork for sewers, as specified, including all Incidental Work, necessary or required for complete satisfactorily constructed masonry, where and as shown on the plans, or where directed.

Brickwork shall be done in accordance with the requirements of Section 416 and this Section 320.

Mortar for brickwork shall be Class “B” or “C” as required by Section 800.09 and these specifications.

### 320.02 Brick

Brick shall conform to the requirements of ASTM “Standard Specifications for Sewer and Manhole Brick (Made From Clay or Shale)”, Designation C32. Inverts and side walls shall use brick graded either “SS” or “SM”:

Grade SS - Brick intended for use in structures requiring imperviousness and resistance to the action of sewage carrying large quantities of abrasive material at velocities exceeding 8 ft. (2.4 M)/S.

Grade SM - Brick intended for use in structures requiring imperviousness and resistance to the action of sewage carrying abrasive materials at velocities less than 8 Ft. (2.4 M)/S.

Grade of sewer brick shall be as specified in the Special Provisions. Manhole cone risers and frame supports shall use brick grade “MS”.

### 320.03 Construction

Excavations for brick shall be sufficient to leave a clear space of not less than 6 inches between the brickwork and the side of the excavation or lagging, to give ample room for plastering.

The brick shall be clean and well wetted before being laid, and every brick shall be laid in a full joint of mortar on bed, end, and side in one operation. Every fifth course of brick shall be a header course, and vertical joints shall be broken. Horizontal mortar joints shall be as uniform as possible, and shall not exceed 3/8-inch in thickness. The bottom of the structure shall consist of a first course of brick laid flat and close on an even surface. This course shall be grouted with thin grout composed of equal parts cement and sand. Subsequent courses shall be laid in mortar as hereinbefore specified.

Particular care must be taken in forming the channels and shelves of the structures along pipe sewers; they shall be built in strict accordance with the plans, and must conform to the bottoms of the existing sewers. Brick channels shall be built of selected bricks set on edge, laid in Class “C” mortar, and well bonded. The structure floor and the channels shall be plastered with Class “C” mortar 1/2-inch thick, the channels being finished to a true and smooth circular section.

A bull’s eye with one rowlock course of brick shall be built into the structure for each entering pipe.

The joints in the brickwork on the inside of the structure shall be neatly struck, and the outside shall be plastered with Class “B” mortar at least 1/2-inch in thickness.

When a brick invert is specified, the brick shall be vitrified brick, and shall be placed as soon as the concrete is sufficiently set, though not less than twenty-four hours after the placing. The brick shall be laid with the better surface exposed, in a full joint of mortar on bed, end, and side in one operation.

The Contractor shall construct brick inverts of new sewers to conform to the inverts of existing sewers so as to provide smooth, straightline changes in invert grades and smooth flow surfaces.

The bricks shall be laid as stretchers, and shall break joints with those of the adjoining courses. The courses shall be kept straight and parallel to the axis of the sewer, and at a true grade, by the use of a template.

Brickwork shall not be constructed upon a concrete foundation until at least twenty-four hours after such foundation has been placed. No brick shall be laid in water, nor shall water be permitted to stand or run on any brickwork until the mortar has thoroughly set.

Upon completion, brick masonry shall be kept continuously damp for at least 2 days.

### **320.04 Payment**

Brickwork shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **321 Vitrified Clay Pipe Subdrain**

### **321.01 General**

The Contractor shall furnish and install subdrains complete with tees, risers, burlap, oakum, mortar, concrete, crushed rock, including the subsequent removal or plugging of such facilities, as the case may be, and all other Incidental Work, necessary or required for a complete satisfactory installation, where and as shown on the plans or where directed.

When a Bid Item or Items for subdrains of a specified size or sizes are included in the Proposal, the Engineer will, under such Bid Items, order sufficient subdrains, in his opinion, to maintain an appropriately dry excavation, free from ground water, and to temporarily carry the flow of cut side sewers, if any. Main sewer flow and storm water flow shall be diverted as required in Section 301, except that excess capacity of ordered subdrains may be used to temporarily carry main sewer flow.

Additional or larger subdrains may be used by the Contractor if he so desires but no payment will be made on account of such increase in extent or size of subdrains.

### **321.02 Pipe**

Subdrain pipe and fittings shall be in accordance with the requirements of Section 305.02.

### **321.03 Construction**

Subdrains for pipe sewers shall be located at one side of the sewer trench, and subdrains for encased pipe sewers and pipe sewers on concrete foundations shall be located either at one side of the sewer trench or beneath such main pipe sewer. Subdrains for cast-in-place concrete sewers shall underlie or be below and adjacent to the sewer and be connected to the invert by tees and risers placed in a manner which will allow plugging the subdrain upon completion of the sewer.

Upon conclusion of the need therefor, subdrains for pipe sewers, unless specifically required to remain as permanent subdrains, shall be removed or plugged with concrete at intervals not greater than 100 feet.

Subdrains underlying a cast-in-place concrete sewer shall be temporarily connected to the sewer invert by vitrified clay pipe tees and risers of the same diameter as the subdrain at intervals not greater than 100 feet. Before the sewer is put into service the subdrains at the risers, and the risers, shall be permanently plugged with concrete.

Subdrain pipe laid in soil other than sand shall be covered with crushed rock extending at least 6 inches laterally from each side of the pipe and 12 inches vertically above the top of the pipe. Where subdrains pass through areas free of ground water, the joints shall be filled with lean mortar and crushed rock may be omitted. Crushed rock shall be uniformly graded from No. 4 to 3/4-inch sieve size.

When required in the Special Provisions, the aforementioned crushed rock shall be completely dammed with a concrete cutoff wall at specified intervals so as to prevent any possibility of continuity of ground water flow along the line of the sewer or structure. Cutoff walls shall be not less than one foot thick, shall block the entire width of the rock fill, and shall extend not less than one foot into the ground below the crushed rock. Concrete used for this purpose shall be Class 4-2000-1 1/2 or better. Where tees and risers have been installed, the cutoff walls shall be located at the tees and risers. If the crushed rock is specifically required to remain in use in conjunction with a permanent subdrain no cutoff walls will be required.

Open subdrains joints shall be wrapped with burlap and, in addition, when the pipe is laid in sand, shall be loosely packed with oakum.

### **321.04 Side Sewers**

Side sewers cut along the line of the work shall be temporarily connected to the subdrain by means of pipes and fittings. When side sewers are permanently reconnected, temporary connections shall be removed from the site by the Contractor as his property and the subdrains shall be plugged with concrete and brickwork at the temporary connection openings.

**321.05 Payment**

Vitrified clay pipe subdrain satisfactorily constructed, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of the subdrain within the limits ordered by the Engineer. No deduction will be made in the measured length because of fittings.



## **322 Polyethylene Pipe Sewer**

### **322.01 General**

The Contractor shall do all excavating, lagging, backfilling, restoration, and other Incidental Work necessary or required for a complete, satisfactory polyethylene pipe (PEP) sewer liner installation, all where and as shown on the plans, or where directed by the Engineer. Installation plans and procedures shall be submitted for review and approval prior to start of work.

### **322.02 PEP and Fittings**

The sewer liner pipe and fittings shall be made of a polyethylene pipe compound that meets the requirements for Type III, Class C, Category 5, Grade 34, as defined in ASTM D1348 and D3350.

### **322.03 Joints for PEP Sewer**

Joints for PEP sewer shall be made on the job site by butt-fusion in accordance with ASTM D2657 and ASTM D3350, using equipment and procedures recommended by the manufacturer. Closing joints required within the installation pits may be made using rubber compression couplings with Class 316 stainless steel bands, butt fusion, or shrink sleeves, at the Contractor's option.

### **322.04 Certificate of Compliance**

Tests for compliance with this specification shall be made as specified herein and according to the applicable ASTM specification.

Upon request, a certificate of compliance with this specification shall be furnished by the manufacturer for all material furnished under this specification.

### **322.05 Sewerage Diversion**

The Contractor shall divert the sewage around the section or sections of the line that are to be sliplined if the annular space and pulling head openings are incapable of handling the flow.

At the end of each working day, temporary tie-ins shall be made between the relined section and the existing system and the by-pass plug removed.

### **322.06 Line Obstructions**

Prior to sliplining, the Contractor shall clean the line that is to receive the polyethylene liner to clear the line of any protruding service connections or solids that might prevent the pulling of the lines through the existing sewer.

### **322.07 Insertion Trench**

Insertion trench will be required at intermediate manholes, or other intermediate points, where the liner pipe will be "fed" into the existing sewer or where there are minimum utility conflicts.

Where excavations for insertions of the polyethylene liner are made in a line section between two manholes, the polyethylene pipe shall be joined together with a circle seal clamp such as neoprene connector with Class 316 stainless steel bands, or equivalent connection. The exposed liner and clamp shall then be encased with one foot of slurry grout per Section 302.06.

### **322.08 Insertion of Linear Pipe**

Where installation of liner pipe is to be made through an access shaft, the top of the existing main shall be exposed to springline for the full length of the shaft prior to removal of the crown portion of a section of the existing main.

A power winch shall then be connected to the end of the liner by use of a pulling head, so the liner can be fed into the existing sewer. Precautions shall be taken not to damage the liner or break any of the joints. Length of the liner pipe to be pulled into an existing sewer at any one time shall be governed by the size of sewer being sliplined and condition of the existing sewer.

### **322.09 Side Sewer Connections to PEP Sewer**

After the liner has been pulled into place and secured in the manhole walls and pressure tested, each existing side sewer connection shall be reconnected to the new liner. A portion of the existing sewer around each side sewer connection shall be removed to expose the liner pipe and provide sufficient working space for making the new service connection.

Side sewer connections to PEP sewer shall be made using polyethylene saddles strapped to the line with Class 316 stainless steel bands or fused to the main line as recommended by the pipe manufacturer.

### **322.10 PEI Connections to Manholes**

The PEP sewer shall be connected to manholes with butt-fused flanges or by removing the top of the liner throughout the length of the manhole.

### **322.11 Stabilization of Liner**

The polyethylene liner may contract after insertion because of residual stresses imposed during pulling, and thermal stresses from temperature differences between the liner and sewer. Residual stresses can be relieved by pushing or pounding on the end of the liner at the entrance pit until the tension at the winch is relieved. The liner should be allowed to stabilize for 12 hours before grouting the annular space between the existing sewer and the PEP liner, or connecting existing side sewers.

### **322.12 Plug and Fill the Annular Space with Slurry Grout**

The annular space between the existing sewer and the polyethylene liner shall be plugged at both ends and filled with slurry grout per Section 302.06.

The plugging at the ends of the annular space to be filled with slurry grout may be accomplished by the use of temporary plugs or bulkheads which shall be removed after the slurry mix has set.

### **322.13 Payment**

PEP sewer satisfactorily furnished and installed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of the PEP sewer between the outside surfaces of manholes and structures, or to the limits as constructed if the sewer does not terminate in manholes or structures.

Plugging and filling of the space between the existing sewers and the new PEP with slurry grout shall be done as Incidental Work.

END PART 3

## Part 4

# Structures

### Table of Contents

---

400	Furnish Pile Driving Equipment . . . . .	92
401	Driving Piles . . . . .	94
402	Furnish Timber Piles . . . . .	97
403	Timber Test Piles . . . . .	99
404	Ordered Timber Pile Splice . . . . .	100
405	Furnish and Construct Concrete-Filled Steel Pipe Piles . . . . .	101
406	Furnish and Construct Concrete-Filled Steel Shell Piles . . . . .	102
407	Furnish Precast Concrete Piles . . . . .	103
408	Concrete Piles Cast in Drilled Holes . . . . .	104
409	Furnish Steel H-Beam Piles . . . . .	105
410	Metal Driving Shoe for Piles . . . . .	106
411	Concrete Structures . . . . .	107
412	Prestressed Concrete Construction . . . . .	116
413	Steel and Other Metal Structures . . . . .	125
414	Timber Structures . . . . .	127
415	Wood Preservative Treatment . . . . .	129
416	Masonry . . . . .	132
417	Air-Blown Mortar . . . . .	133
418	Waterproofing Concrete and Masonry . . . . .	137

---

## 400 Furnish Pile Driving Equipment

### 400.01 General

The Contractor shall furnish and maintain at the site, and subsequently remove from the site as his property, all equipment, and appurtenances, including spuds, jets, and pumps, and shall do all Incidental Work, all as required to satisfactorily drive all piles furnished under the contract, all in accordance with the requirements set forth herein.

The Contractor shall include the cost of moving the pile-driving equipment between the various pile locations in the price bid for furnishing pile-driving equipment.

For the purpose of computing progressive payments, the work shall be prorated as set forth in the following table:

a)	Furnish all necessary pile-driving equipment at the site site and satisfactorily driving the first pile .....	60%
b)	Maintaining all necessary pile-driving equipment and completing and completing the satisfactory driving of all piles under the contract .....	30%
c)	Removing all pile-driving equipment from the Site .....	<u>10%</u>
Total:		100%

For purpose of payment, no work shall be considered performed until the first pile has been satisfactorily driven. The work allocated under b), above, for maintaining the pile-driving equipment and completing all pile-driving shall be prorated in accordance with the percentage of the number of piles satisfactorily driven.

### 400.02 Pile Driver

The pile driver shall have fixed leads which shall be-capable of guiding the hammer from the highest to the lowest point of travel and holding the pile firmly in axial alignment with the hammer. The leads shall be secured to the body of the crane or supporting tower by rigid members in a manner that will prevent movement and maintain alignment of the leads during driving operations.

The pile hammer shall be an approved steam, air, or diesel hammer, and shall be of such weight that when operating at the rated number of blows per minute specified by the manufacturer it will be capable of delivering to the pile at least 15,000 foot pounds of energy per blow. The adequacy of the hammer for a particular job shall be subject to approval by the Engineer.

Steam or air hammers shall be furnished with boiler or air capacity at least equal to that specified by the manufacturers of the hammers to be used. The boiler or compressor shall be equipped with an accurate pressure gauge at all times. The valve mechanism and other parts of steam, air, or diesel hammers shall be maintained in first class condition so that the length of stroke and number of blows per minute for which the hammer is designed will be obtained. Inefficient steam, air, or diesel hammers shall not be used.

Suitable anvils, driving caps, or cushions shall be used to prevent damage to the pile butts.

Equipment for the driving of test piles shall be the same as that for driving all other piles under the contract.

The use of vibratory hammers and other vibratory equipment will be subject to the approval of the Engineer; however, such approval does not relieve the Contractor of the responsibility for any damages or injuries resulting from the use thereof.

The use of high frequency vibrating equipment, or sonic equipment, for the driving or withdrawal of sheet piling is prohibited.

### 400.03 Follower

The use of a follower will be permitted provided the follower is of the type that will-adequately and properly, as determined by the Engineer, transmit the energy of the hammer blow to the pile head. The

follower shall have a minimum length of 20 feet, and its average weight shall not be less than 80 pounds per foot. The use of a timber follower of any type will not be permitted.

The Contractor shall submit to the Engineer for approval complete detailed data on the follower he intends to use, prior to commencement of use thereof.

Further, if the Contractor proposes to drive piles using a follower, he shall drive all piles, including test piles, using the same follower.

#### **400.04 Jetting Equipment**

Jetting equipment shall be capable of delivering, and shall be outfitted with, the following:

- 1) A constant supply of water at 300 to 500 gallons per minute, as necessary, at the nozzle of the jet pipe;
- 2) A minimum pressure of 250 psi at the nozzle of the jet pipe;
- 3) A jet nozzle of 3/4 inch to 1 inch diameter with four to six side holes 1/8 inch in diameter, evenly spaced around the nozzle;
- 4) Sufficient jet pipe to reach the specified depth;
- 5) Jet pipe permanently and visibly marked in five foot increments commencing at 40 feet from the tip of the nozzle.

The pressure and the discharge rate of the water at the jet shall be adequate to freely erode materials adjacent to the pile.

#### **400.05 Spud**

If a spud is used, the size and the strength thereof shall be adequate to drive through miscellaneous fill materials such as gravel, small boulders, rubble, and timbers.

#### **400.06 Payment**

Furnish pile-driving equipment will be paid for at the lump sum price bid to satisfactorily furnish, maintain and remove the specified equipment and appurtenances.

## **401 Driving Piles**

### **401.01 General**

The Contractor shall drive piles, including test piles, spliced piles, and batter piles, where and as shown on the plans, or where directed, and shall do all Incidental Work, all in accordance with the requirements set forth herein.

### **401.02 Boring Data**

In most cases, prior to pile driving, the City will have completed under separate contracts soil borings in close proximity of the work. Generally in such cases, the logs and locations of the borings and the results of soil tests made on samples taken during the borings will be shown on the plans. In the event such information is made available to the Contractor, it shall be understood that the City will assume no responsibility for the accuracy of such information nor for any deductions or conclusions that the Contractor may make therefrom.

### **401.03 Observation and Recording of Pile Behavior**

The Contractor shall provide the Engineer with every reasonable facility for properly observing and recording the behavior of each pile during the entire driving operation, including allowing access to the behavior information recorded by the Contractor. The Contractor shall clearly mark the piles in identifiable five foot increments, and when directed by the Engineer shall clearly mark the piles in one foot increments.

When driving is interrupted before final penetration is reached, the record for penetration shall not be taken, except as otherwise directed by the Engineer, until twelve inches of penetration have been obtained on resumption of driving.

### **401.04 Existing Piles**

Should existing piles conflict in location with piles to be driven, substitute pile locations will be determined by the Engineer. Piles shall be driven at such substitute locations at no extra cost to the City.

### **401.05 Obstructions**

If, during driving, an obstruction, such as a large boulder, prevents further driving or jetting of a pile, the pile may be ordered abandoned by the Engineer and another pile ordered by him to be driven close by. A pile so abandoned shall be cut off as Incidental Work one foot below normal cut-off elevation. Payment, under the appropriate Bid Item, for the furnishing of each abandoned pile will be for the ordered length or for the length from tip to cut-off, as applicable. Payment for the driving of each such pile will be made under the appropriate Bid Item.

### **401.06 Driving**

Driving of piles, steel pipe, or steel shells within 50 feet of newly constructed concrete structures or cast-in-place concrete piles will not be permitted until the concrete in such structures or piles has attained a compressive strength of at least 2500 psi based on field cured cylinders.

The Contractor prior to driving piles, steel pipe, or steel shells shall either excavate to cut-off elevation or provide a hole for the piles, steel pipe, or steel shells by either spudding or drilling to at least the cut-off elevation in accordance with Section 401.07.

In addition, for steel piles or steel shells, when necessary to obtain the specified penetration or to prevent damage to the pile during driving, the Contractor shall provide special driving tips or heavier pile sections or take other measures as approved by the Engineer.

Unless otherwise noted, all piles shall be driven to "refusal"; "refusal" shall be defined as a blow count of 10 blows per inch of penetration. However, should any pile meet "refusal" in a stratum underlain by weak, highly compressible soils, the Engineer may direct the Contractor to drive the pile through the weak layer or layers to a stratum capable of supporting such pile, all as determined by the Engineer.

When it is desirable to penetrate a sand stratum and high resistance is encountered, jetting, if specified in the Special Provisions shall be employed to facilitate the driving of the piles all as directed by the Engineer.

After the specified jetting, the piles, steel pipe, or steel shell, shall be driven to the required penetration or to "refusal" all as determined by the Engineer.

In all cases in the driving of test piles, jetting if specified shall be employed as necessary, as determined by the Engineer, for the full ordered length or to the elevations set forth in the Special Provisions or shown on the plans.

The heads of concrete piles or casings shall be protected from direct impact of the hammer by a cushion driving block. The cushion shall be maintained in good condition during the entire driving operation. The cushion driving block shall be so arranged that any reinforcing bars projecting above the piles will not be displaced or injured in driving.

Precast concrete piles shall not be driven until 14 days after casting.

All piles shall be driven plumb for vertical piles and at the batter indicated for batter piles, and shall be located true to line and spacing as shown on the plans. Each pile, at cut-off elevation, shall not be more than 4 inches out of place. If such allowable deviation is exceeded, the pile shall be abandoned and another driven, unless the Contractor constructs, on top of the driven pile, an approved equivalent support. All such abandoned piles or additional construction or other work caused by piles being out of place, shall be at the sole expense of the Contractor.

### **401.07 Spudding or Drilling**

In order to decrease the frictional resistance for all piles, the Contractor shall, by means of spudding or drilling, provide holes completely through the overburden to the cut-off elevation, or if specified, to the elevation set forth in the Special Provisions. The minimum diameter of each spudded or drilled hole shall be 2 inches greater than the butt diameter of the pile to be driven.

The hole shall be cleared sufficiently of materials so as to allow the placing of the tip of the pile at the bottom of the hole with the aid of no more than the weight of the hammer on the pile. Any hole which does not permit such placing of the pile shall be respudded or redrilled, and, if necessary, repeatedly respudded or redrilled and/or protected by the use of casing, to the extent that the hole will be sufficiently clear to allow the placing of the pile in the spudded hole in the manner specified.

After driving the pile the space around the pile shall be filled to ground surface with dry sand or pea gravel.

In the event the Contractor provides holes as specified by drilling, he shall furnish and operate, at his own expense, the necessary drilling apparatus.

### **401.08 Jetting**

In order to obtain the required penetration, when specified in the Special Provisions, the Contractor shall supply and operate water jets with adequate pumping equipment. Jetting shall start only after refusal has been reached.

Where jets have been employed, they shall be withdrawn and jetting not permitted once the final bearing stratum has been reached. Jetting shall be done with care so as not to loosen adjoining piles already driven. Piles that have lifted shall be redriven at the sole expense of the Contractor.

Jets shall not be used at locations where the stability of embankments or other improvements would be endangered.

When jetting is specified, the Contractor shall continuously maintain on the pile driver, jet pipes and jetting equipment in good operating condition, so that they will be available for immediate use when necessary. No pile-driving will be permitted unless such jetting equipment is available, and the cost of any and all delays caused by non-compliance with this requirement will be at the sole expense of the Contractor.

Should City water from hydrants be required by the Contractor for jetting purposes, he shall first obtain written permission from the Chief of the San Francisco Fire Department, and shall then contact the Water Distribution Division Manager of the San Francisco Water Department for final approval.

### **401.09 Unsatisfactory Pile, Steel Pipe, or Steel Shell**

Any pile, steel pipe, or steel shell misaligned or damaged as a result of the Contractor's operations to an extent that will make it incapable, in the opinion of the Engineer, of performing the function for which it was designed, will be considered unsatisfactory. Such unsatisfactory pile, steel pipe, or steel shell shall be withdrawn and removed by the Contractor as his property, or, if approved by the Engineer, abandoned with the upper section removed to at least one foot below the cut-off elevation.

The Contractor shall satisfactorily replace all such removed or abandoned piles, steel pipe, or steel shells. Such satisfactory replacements will be paid for under the appropriate Bid Items therefor. However, as set forth under Section 401.10, no payment will be made for unsatisfactory piles.

### **401.10 Payment**

Driving of a pile, satisfactorily as specified, will be paid for at the applicable unit price bid per pile as set forth in the Proposal, including test piles, spliced piles, and batter piles.

For the purpose of payment for driving, a spliced pile, regardless of length, the circumstances of splicing, and the number of component parts, will be considered a single pile.

In the event several length categories for driving are included in the Proposal, the length of a pile shall be as measured between the tip and the cut-off.

No payment will be made for furnishing, driving, withdrawing, removing, or abandoning unsatisfactory piles, steel pipe, or steel shells, which are defective, or damaged as a result of the Contractor's operations, or are otherwise unsatisfactory as set forth in Section 401.09. However, piles which during driving encounter obstructions will be paid for as set forth under Section 401.05.

Ordered jetting time for piles will be paid for at the price bid per minute of actual satisfactorily effective jetting done as specified, including jetting required to lower the jet pipe to proper elevation for ordered jetting but not including any time for setting up equipment or any other time when the jets are not functioning as intended. When refusal has been met and jetting ordered by the Engineer, the jetting time shall be recorded in minutes from initial jetting until the pile has "broken through" the resistive material.

The ordered jetting time for each pile shall be recorded on a City-furnished pile-driving form. The form shall be initialed by the Resident Engineer and the Contractor, or his representative, over their last names printed on the form. When the form has been initialed, it will signify that both the City and the Contractor have agreed on the accuracy of the pile driving record.



## 402 Furnish Timber Piles

### 402.01 General

The Contractor shall furnish timber piles of lengths ordered by the Engineer, or specified, including certifying, handling, storing, treating, splicing, disposing of stubs and surplus piles, and doing all other related Incidental Work, all in accordance with the requirements set forth herein.

Checks in untreated timber piles, and checks prior to treatment for treated timber piles, shall not exceed 1/4-inch in width or be continuous for 10 feet in length. After treatment, checks shall not exceed 3/8-inch in width or be continuous for 15 feet in length. Checks shall be considered continuous unless separated from other checks by at least 1/2-inch thickness of wood. Checks shall be defined as a separation along the grain, the greater part of which occurs across the rings of annual growth.

Splits in untreated and treated timber piling shall not be longer than the butt diameter of the pile. A split shall be defined as a lengthwise separation along any continuous path through the cross section of the pile and common to, and apparent at, two locations on the circumference of the pile. Lengthwise separations not extending through the pile shall conform to the limits specified for checks.

All timber piles shall be clean-peeled Douglas fir Class "A" piles in accordance with the requirements of ASTM "Standard Specification for Round Timber Piles", Designation D 25.

Timber piles to be creosoted shall be inspected prior to creosoting.

Timber piling shall be protected with steel straps placed at not more than 10-foot centers along the pile. Five additional straps shall be placed on each pile; one each at 3 inches, 6 inches, and 12 inches from the tip and 2 within 2 feet of the butt.

Steel strapping shall be approximately 14 inches wide, 0.030-inch in nominal thickness and shall be fabricated from cold-rolled heat-treated high tensile strapping. Strapping shall develop a tensile strength of at least 5,000 pounds. Straps shall be held in place with clips which are secured by crimping twice in the clip length with a notch-type sealer. The clip shall be approximately 24 inches long and fabricated from 0.036-inch thick steel. The clip joint shall develop at least 75% of the strap tensile strength. Straps shall encircle the pile once and shall be tensioned as tight as possible either by hand operated or pneumatic tensioning tools.

Timber piles shall be fresh-headed and square and when permitted by the Engineer, the heads of the piles may be protected by means of heavy steel or wrought iron rings. During driving operations timber piling shall be restrained from lateral movement at intervals not to exceed 20 feet over the length between the driving head and the ground surface. During driving operations, the timber pile shall be kept moving by continuous operation of the hammer.

### 402.02 Certification

Certification, in writing, by an independent recognized testing laboratory approved by the City, that the piles furnished are Douglas fir and conform to the specifications for Class "A" piles of ASTM Designation D 25, to these specifications, and to the Special Provisions, will be required. Two copies of the certification for each shipment shall be delivered to the Engineer prior to the shipment of the piles.

Positive identification of each approved pile shall be effected by burning or indelibly imprinting a characteristic stamp or mark of the testing laboratory thereon at the time of inspection. No direct or additional payment will be made for the above certification, and the Contractor shall include all costs thereof in his bid prices.

### 402.03 Creosoting

Timber piles, when specified in the Special Provisions or indicated on the plans to be treated, shall be pressure treated with creosote in accordance with Section 415. For spliced piles, treatment will only be required for the upper components. The heads of all treated piles shall receive a brush coat of creosote, in accordance with Section 415.09.

#### **402.04 Spicing**

Pile splices shall be in accordance with the details shown on the plans and will only be permitted to be used in the following instances:

- 1) When the length of pile, ordered by the Engineer, is 70 feet or longer, the Contractor, at his option, may use a spliced pile. For such spliced pile, only one splice will be permitted, and the splice shall be placed at least 30 feet below the cut-off elevation, unless otherwise specified. In this instance, materials furnished for the pile splice, and the construction of the splice, shall be at the sole expense of the Contractor, and no direct or additional payment will be made therefore;
- 2) (2) When a pile, whole or spliced, as permitted under (1) above, has been driven to its full ordered length without having reached the bearing result desired by the Engineer, the Engineer will order the splicing of an additional length of pile. In this instance, the ordered pile splice will be paid for as set forth under Section 404.

Tip diameters, of other than the lowest component, of a spliced pile shall be 11 inches.

#### **402.05 Cut Off and Extension**

Timber piles shall be cut off square at the elevation designated. Piles inaccurately cut off shall be replaced or, when permitted by the Engineer, shall be extended with approved reinforced concrete caps, all at the sole expense of the Contractor.

Extensions for piles, necessary as replacements for those portions of damaged piles which were cut off due to brooming or splitting, shall be constructed at the sole expense of the Contractor.

#### **402.06 Disposing of Stubs and Surplus Piles**

After the completion of all pile driving operations, all timber pile stubs and surplus timber piles, except those marked by the Engineer to be retained by the City, shall remain the property of the Contractor and shall be disposed of by him as his property. The City will assume the responsibility for the loading and removal of those pile stubs and surplus piles to be retained by the City.

#### **402.07 Payment**

Timber piles, as specified, satisfactorily furnished at the site, will be paid for at the price bid per linear foot.

## 403 Timber Test Piles

### 403.01 General

When required in the Special Provisions, the Contractor shall drive timber test piles where shown on the plans, or where directed, and in accordance with the requirements set forth herein.

The Contractor shall furnish all equipment in accordance with Section 400 and timber piles in accordance with Section 402. He shall drive the timber test piles in accordance with Section 401.

The approximate locations and lengths of test piles to be driven shall be as shown on the plans and specified in the Special Provisions. From the results obtained in driving test piles, the Engineer will determine the lengths of all other piles to be used under the contract and will furnish to the Contractor the pile length list for the piles located between each four consecutive test piles within ten working days after the satisfactory driving of such test piles. Timber pile lengths, as measured from cut-off elevations, will be given in standard stock lengths and will include allowances for cut-offs as well as allowable variations in lengths set forth under ASTM Designation D 25.

Nothing in the above, however, shall be construed as preventing the Contractor, in the interest of expediting work, from supplying himself, in advance, at his own risk, with some piling at the job site to commence pile driving operations.

Test piles shall be so located that they may be cut off and become a part of the completed structure. Test piles shall be driven using the same type of equipment and the same procedures that will be used in driving all other piles under the contract.

If the information obtained from a required test pile is, in the opinion of the Engineer, inconclusive, he will order the driving of an additional test pile in the immediate vicinity at a location designated by him. Upon the completion of the driving of all test piles, unused additional test piles will be considered piles ordered from the pile list and payment will be made for the full ordered lengths of such unused test piles.

If, at the option of the Contractor, test piles are driven in the street area prior to excavation, each pile butt shall be driven or cut off below the existing street pavement grade, and, immediately following the driving of the pile, the opening in the street shall be backfilled and topped with a minimum of 2 inches of temporary pavement. Such work shall be done as Incidental Work and no additional payment will be made therefor.

Test piles will be ordered in lengths measured from the cut-off elevations. If at the Contractor's option test piles are to be driven prior to excavation, allowance should be made for the additional lengths required, or a follower should be used. Such furnishing of the additional lengths of piles, or the use of the follower shall be at the Contractor's sole expense and no additional payment will be made therefor.

### 403.02 Payment

Timber test piles will be paid for as set forth under Sections 400, 401 and 402, as applicable, and no direct or additional payment over and above that provided under such Sections will be made by virtue of any pile being a test pile.

## **404 Ordered Timber Pile Splice**

### **404.01 General**

In each instance where the length of a timber pile ordered by the Engineer is insufficient to attain the required bearing result and a splice is ordered by the Engineer, the Contractor shall furnish materials for and construct such ordered timber pile splice where directed by the Engineer, including doing all related Incidental Work.

In accordance with Section 402.04, approved timber pile splices constructed by the Contractor at his option for piles ordered to be 70 feet or longer will not be included for payment under this Section but shall be done as Incidental Work.

### **404.02 Payment**

Ordered timber pile splice satisfactorily furnished and constructed, complete in place, as specified, will be paid for at the unit price bid therefor.

## **405 Furnish and Construct Concrete-Filled Steel Pipe Piles**

### **405.01 General**

The Contractor shall furnish and construct concrete-filled steel pipe piles where and as shown on the plans or where directed, including steel pipe, splices, concrete, reinforcing steel, welded steel end plates, and all other related Incidental Work, all in accordance with the requirements specified herein.

The Contractor shall drive steel pipes in accordance with Section 401. Each steel pipe shall be driven to the required bearing value before being filled with concrete.

After being driven and prior to the placing of reinforcing steel and concrete, each steel pipe shall be examined for damage or reduced diameter at any point. Any pipe improperly driven or broken, or which shows partial collapse to an extent that will materially decrease its bearing value, will be rejected as unsatisfactory and shall be replaced by the Contractor.

Driven pipe shall be free of water before reinforcing steel and concrete are placed.

The Contractor shall have available at all times a suitable light for inspecting the entire length of each pipe before placing reinforcing steel and concrete.

### **405.02 Steel Pipes**

Steel pipe piles shall be constructed using steel pipe with an O.D. of 10 3/4 inches and a minimum wall thickness of 0.188 inch.

Steel pipe shall be new steel pipe conforming to the requirements for Grade 2 of ASTM "Standard Specification for Welded and Seamless Steel Pipe Piles", Designation A-252. The Contractor shall furnish to the Engineer, written certification from the pipe manufacturer or from an independent recognized testing laboratory that the pipe supplied meets the requirements of such ASTM Specifications. The welded end plate shall be watertight with a diameter not more than 1/4-inch larger than the pipe shell.

Each length of pipe shall be legibly marked with the manufacturer's identifying symbol, together with size, weight, length, wall thickness, and the words "Grade 2 Piling" as required in the ASTM Specifications.

### **405.03 Concrete**

Concrete for steel pipe piles shall be Class 7-4000-1/4 as set forth in Section 800.11.

The Concrete shall be vibrated in the length of the pipe. Reinforcement for concrete shall be in accordance with Section 411.05.

### **405.04 Splicing**

The Contractor shall determine the component lengths of pipe for the piles. His attention is directed, however, to required minimum tip elevations and the allowable number of splice connections.

Steel pipes may be spliced before or during driving operations. Each splice connection shall be made by a continuous butt weld in accordance with the requirements of Section 806. The pipe sections shall be properly aligned so that the longitudinal axis of each completed pile will be in a straight line.

The number of splice connections in any pile shall not exceed 3, unless otherwise specified or permitted by the Engineer.

### **405.05 Payment**

Concrete-filled steel pipe piles satisfactorily furnished and constructed complete, in place, as specified, except for driving which will be paid for as set forth in Section 401, will be paid for at the price bid per linear foot.

The quantity to be paid for will be the aggregate length of concrete-filled steel pipe piles measured in place along the longitudinal centerlines thereof between tip and cutoff.

## **406 Furnish and Construct Concrete-Filled Steel Shell Piles**

### **406.01 General**

The Contractor shall furnish and construct concrete-filled steel shell piles where and as shown on the plans or where directed, including steel shells, splices, concrete, and reinforcing steel, and all other related Incidental Work, all in accordance with the requirements specified herein.

The Contractor shall drive steel shells in accordance with Section 401. Each steel shell shall be driven to the required bearing value before being filled with concrete.

After being driven, and prior to the placing of reinforcing steel and concrete, each steel shell shall be examined for damage or reduced diameter at any point. Any shell improperly driven or broken, or which shows partial collapse to an extent as to materially decrease its bearing value will be rejected as unsatisfactory. Rejected shells shall be removed and replaced, or a new shell driven adjacent thereto. Rejected shells which cannot be removed shall be filled with concrete by the Contractor at his expense.

Driven shells shall be free of water before reinforcing steel and concrete are placed.

The Contractor shall have available at all times a suitable light for inspecting the entire length of each shell before placing reinforcing steel and concrete.

### **406.02 Steel Shells**

Steel shells shall be of sufficient strength and rigidity to permit driving, and to prevent distortion caused by soil pressures or the driving of adjacent piles, until filled with concrete. The shells shall also be sufficiently watertight to exclude water.

The shells may be cylindrical or tapered, step-tapered, or a combination of either, with cylindrical sections. The tip diameter shall not be less than 8 inches and the butt diameter shall not be less than 12 inches.

Shells to be driven without a mandrel shall be equipped with heavy steel driving tips, and all splices in the shell shall be continuously welded to develop the full strength of the section.

### **406.03 Concrete**

Concrete for steel shell piles shall be Class 7-4000-3/4, as set forth in Section 800.11.

The bottom of each shell shall be filled with mortar to a depth of not less than 2 feet immediately before placing the concrete. The mortar shall consist of one part Portland Cement to 3 parts fine aggregate mixed to a suitable consistency, or Class 7-4000-3/4 Concrete with the 3/4-inch and larger aggregate removed.

The Concrete shall be vibrated for the length of the shell. Reinforcement for concrete shall be in accordance with Section 411.05.

### **406.04 Payment**

Concrete-filled steel shell piles satisfactorily furnished and constructed complete, in place, as specified, except for driving which will be paid for as set forth in Section 401, will be paid for at the price bid per linear foot.

The quantity to be paid for will be the aggregate length of concrete-filled steel shell piles measured in place along the longitudinal centerlines thereof between tip and cut-off.

No payment will be made for an unsatisfactory pile.

## **407 Furnish Precast Concrete Piles**

### **407.01 General**

The Contractor shall furnish precast concrete piles of the lengths ordered by the Engineer, or specified, including handling, storing, and doing all other related Incidental Work, all in accordance with the requirements specified herein.

Precast concrete piles shall be constructed of Class 7-4000-3/4 Portland Cement Concrete in accordance with the requirements of Sections 800.11, 411 and 412, as applicable.

Reinforcing steel shall be in accordance with Section 411.05 and pre-stressing steel in accordance with Section 412.03.

Concrete for precast concrete piles shall be placed in smooth mortar-tight forms, so supported as to prevent appreciable deformation or settlement during placing or curing. When removed from the form, the pile shall present true, smooth, even surfaces free from honeycombs and voids and shall be so straight that a line stretched from butt to tip on any face will not be more than 1 inch from the face of the pile at any point.

Concrete piles, both conventionally reinforced and prestressed, shall be cured as provided in Section 800.16.

When raising or transporting precast concrete piles, the Contractor shall provide slings or other equipment to avoid any appreciable bending of the pile or cracking of the concrete. Piles materially damaged in handling or driving shall be replaced by the Contractor at his expense. Concrete piles shall be handled at all times so as to avoid breaking or chipping the edges.

### **407.02 Payment**

Precast concrete piles, as- specified, satisfactorily furnished at the site will be paid for at the price bid per linear foot.

## **408 Concrete Piles Cast in Drilled Holes**

### **408.01 General**

The Contractor shall construct concrete piles cast in drilled holes where and as shown on the plans, or where directed, including drilling holes, installing casing, furnishing and placing steel reinforcement and concrete, and doing all other related Incidental Work, all in accordance with the requirements specified herein.

### **408.02 Drilled Holes**

Holes for cast concrete piles shall be drilled so that the maximum deviation of the longitudinal axis at any point from the axis specified shall not be more than 1% of the length of the hole.

All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed before placement of concrete therein.

The use of water for drilling operations or for any other purpose where it may enter the hole will not be permitted. Surface water shall not be permitted to enter the hole and all water which may have infiltrated into the hole shall be removed before placement of concrete therein.

### **408.03 Casing**

The Contractor, where necessary for the construction of the piles, or the safety of workmen, shall furnish and drive casing in the drilled holes, and shall subsequently withdraw from the holes, and remove, such casing from the site as his property.

Casing shall be removed from the hole as concrete is placed therein. The bottom of the casing shall be maintained not more than 5 feet, nor less than one foot, below the top of the concrete during withdrawal and placing operations.

Should it be necessary to leave sections of casing in place in drilled holes, such sections of casing shall become the property of the City at no cost to the City.

### **408.04 Concrete**

Concrete shall be Class 7-4000-3/4 as set forth in Section 800.11.

The concrete shall be vibrated for the length of the pile.

The reinforcing cage shall be placed and secured symmetrically about the axis of the pile and shall clear the sides of the hole.

The Contractor shall place the reinforcing steel and concrete within 24 hours after completion of each uncased pile hole.

Steel reinforcement shall be in accordance with Section 411.05.

### **408.05 Payment**

Concrete piles cast in drilled holes satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot.

The quantity to be paid for will be the aggregate length of concrete piles cast in drilled holes measured in place along the longitudinal axis from the lower limit to cutoff.



## **409 Furnish Steel H-Beam Piles**

### **409.01 General**

The Contractor shall furnish steel H-beam piles, as required, including splices, steel plate caps, and all other related Incidental Work, all in accordance with the requirements specified herein. The Contractor shall drive piles in accordance with Section 401.

### **409.02 H-Beams**

H-beams shall be of structural steel conforming to ASTM "Standard Specification for Structural Steel", Designation A 36. If approved by the Engineer manufactured welded sections may be used.

### **409.03 Splices**

The length of a steel H-beam pipe may consist of spliced sections. The section shall be of identical cross sections and may be spliced before or during driving operations. Splice connections shall be made by full butt welding the entire cross section in accordance with the requirements of Section 806. The sections shall be properly aligned so that the longitudinal axis of each completed pile will be a straight line. The number of splice connections in the length of a pile shall not exceed 2 unless otherwise permitted by the Engineer.

### **409.04 Cutoff**

Piles shall be accurately cut off and capped with a steel plate as shown on the plans. Piles not accurately cut off shall be extended, or provided with an approved equivalent construction, all at the sole expense of the Contractor.

### **409.05 Payment**

Steel H-beam piles satisfactorily furnished complete, in place, as specified, except for driving which will be paid for as set forth in Section 400, will be paid for at the price bid per linear foot.

The quantity to be paid for will be the aggregate length of steel H-beam piles measured in place along the longitudinal centerlines thereof between tip and cutoff.

## **410 Metal Driving Shoe for Piles**

### **410.01 General**

The Contractor shall furnish and install metal driving shoes, where and as specified or shown on the plans, or where directed, including all related incidental Work, all in accordance with the requirements specified herein.

Piles equipped with metal driving shoes shall be driven to rock. The pile shall penetrate the rock 18 inches and driving shall terminate with a blow count of not less than 10 blows per inch. However, if the required blow count is reached before the penetration has been attained, the Contractor shall thereafter continue driving until 120 blows into such rock have been delivered to the pile or until the required penetration has been reached, whichever occurs first.

### **410.02 Payment**

Metal driving shoe satisfactorily furnished and installed complete in place, as specified, will be paid for at the unit price bid therefor.

## 411 Concrete Structures

### 411.01 General

The Contractor shall construct plain and reinforced concrete structures, including constructing falsework and formwork, and removal thereof, furnishing and placing reinforcing steel, furnishing, mixing, placing, protecting and curing concrete, surface finishing waterproofing, and all other necessary, or required, Incidental Work, all where and as shown on the plans and in accordance with the requirements specified herein.

### 411.02 Concrete

Concrete and related materials and work, including mixing, placing, protecting and curing, shall be in accordance with Section 800. The Contractor shall use Class 6-3500-1<sup>1</sup>/<sub>2</sub> unless otherwise specified on the plans or in the Special Provisions. However, if reinforcement clearances will not permit the use of 1<sup>1</sup>/<sub>2</sub> inch aggregate, as determined by the Engineer, then a Class 6.5-3500-<sup>3</sup>/<sub>4</sub> concrete shall be used, and any additional cost therefor will be paid for as Extra Work.

### 411.03 Falsework

The Contractor shall furnish, in accordance with the requirements of Section 106.08, to the Engineer for his approval, plans of falsework to be used for the work. The design of the falsework shall provide for the traffic lanes and widths necessary to comply with the specified traffic routing requirements. Falsework vertical clearance less than 15'-0" shall be clearly signed, both at and preceding the impaired clearance from both directions. Approval by the Engineer shall not be construed as relieving the Contractor of full responsibility for the accuracy of dimensions and strength and safety of the falsework during construction. If required in the Special Provisions, the Contractor shall engage a registered civil engineer to prepare the plans, and supervise the installation of the formwork.

Falsework and forms shall be constructed to produce in the finished structures the lines and grades indicated on the plans. Suitable jacks, wedges, or camber strips shall be used in conjunction with falsework or centering to set the forms to the required grade or camber and to take up any settlement in the formwork either before or during the placing of concrete.

Removal of falsework shall be in accordance with the applicable requirements of Section 411.09.

All falsework materials shall be completely removed upon completion of the work, and all debris and refuse resulting from the work shall be removed and the premises left in a neat and presentable condition.

### 411.04 Formwork

**General.** - Forms shall be constructed of sound material, mortar tight, and shall be of the correct shape and dimensions. Formwork shall be braced and tied together, sufficiently and in such manner as to prevent movement or displacement occasioned by any phase of the construction operations. In addition, formwork shall be designed for easy removal.

Form supports shall be placed on adequate foundations and shall have sufficient strength and bracing to prevent settlement or distortion from anticipated loading. Supports shall rest on double wedge shims, or other approved devices so that the forms will be maintained at the proper grade.

Form panels for exposed surfaces shall be plywood conforming to or exceeding the requirements of U.S. Product Standard PS 1 for Exterior B-B (Concrete Form) Class I Plywood or any material other than plywood which will produce a smooth uniform concrete surface substantially equal to that which would result from the use of such plywood. Only form panels in good condition free of defects, such as scars, dents or delaminations, shall be used for exposed surfaces.

The inside surfaces of forms shall be cleaned of all dirt, mortar and foreign material. Forms which will later be removed shall be thoroughly coated with form oil prior to use. The form oil shall be a commercial quality form: oil or other equivalent coating which will permit the ready release of the forms and will not discolor the concrete.

Joints in form materials shall be located as directed, so that the resulting marks in the concrete conform to the general lines of the structure. Plywood shall be used in full sheets not less than 4 feet by 8 feet in size

except where shape and size of the form prevents the use of a full sheet, or where the plywood is retained in a fabricated metal frame or patent form.

Fillets and chamfers shall conform to the size and design shown on the plans or specified in the Special Provisions. Forms for exposed surfaces shall be constructed with triangular fillets not less than 3/4" by 3/4" attached so as to prevent mortar runs and to produce smooth straight chamfers at all sharp edges of the concrete.

Forms for exposed concrete surfaces shall be designed and constructed so that the formed surface of the concrete does not undulate excessively in any direction between studs, joists, form stiffeners, form fasteners, or wales. Undulations exceeding either 3/32 inch or 1/270 of the center to center distance between studs, joists, form stiffeners, form fasteners or wales will be considered to be excessive. Should any form or forming system, even though previously approved for use, produce a concrete surface with excessive undulations, its use shall be discontinued until modifications satisfactory to the Engineer have been made. Portions of concrete structures with surface undulations in excess of the limits herein may be rejected by the Engineer.

All exposed surfaces of each element of a concrete structure shall be formed with the same forming material or with materials which produce similar concrete surface textures, color and appearance.

Forms for exposed surfaces shall be faced with form panels. A form panel shall be considered to be the continuous section of form facing material, unbroken by joint marks, against which the concrete is placed.

Curved surfaces shall be formed with metal, plywood, or adequately supported, surfaced and match Douglas fir boards not more than 4 inches wide.

Form marks shall not be readily discernible and the number thereof shall be kept to a practicable minimum.

Handrails, balustrades and similar small or intricate structures, or parts thereof, shall be formed with metal, or clear lumber providing an impervious approved non-staining surface. The workmanship of the lumber forms for such work shall be the equivalent of first-class pattern work.

Openings shall be located at the bottom of forms where necessary, to facilitate the clearing out of sawdust, wood scraps and debris and to provide drainage. Such openings shall be closed with watertight and secure cover pieces prior to placing concrete. In addition, inspection holes, and covers therefor, shall be provided in the formwork where directed.

Form fasteners consisting of form bolts, clamps or other devices shall be used as necessary to prevent spreading of the forms during concrete placement. The use of ties consisting of twisted wire loops to hold forms in position will not be permitted.

Anchor devices may be cast into the concrete for later use in supporting forms or for lifting precast members. The use of driven types of anchorages for fastening forms or form supports to concrete will not be permitted.

Form fasteners and anchors shall be of such types that they can be removed as required for form bolts in Section 411.10 without chipping, spalling, heating or otherwise damaging the concrete surface.

Plumbing, Leveling, Repairing and Maintaining Forms. - Before concrete is placed in any form, the horizontal and vertical position, or the line and grade, as the case may be, of the form shall be carefully verified and all inaccuracies corrected. All wedging and bracing shall be completed in advance of the placing of concrete. All formwork must be approved by the Engineer before any concrete is placed therein.

Forms that have been damaged, or that have checked or warped prior to placing of concrete, shall be replaced or corrected in an approved manner.

The Contractor shall assign a sufficient number of men to maintain the forms and reinforcement, and to satisfactorily remedy any displacement or looseness thereof occurring during the placing of concrete.

#### 411.05 Reinforcing Steel

General. - Reinforcing steel bars, welded wire fabric, and all required appurtenances, shall be furnished and installed where and as shown on the plans and in accordance with the requirements specified herein.

Reinforcing steel bars, numbers 3 through 18, inclusive, shall be in accordance with ASTM "Standard Specifications for Deformed Billet-Steel Bars for Concrete Reinforcement", Designation A 615, Grade 60, unless otherwise specified on the plans or in the Special Provisions.

Spiral reinforcement shall conform to the strength requirements of ASTM Designation A 615, Grade 60 or shall be cold-drawn steel wire conforming to ASTM "Standard Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement", Designation A 82.

Reinforcing steel number 2 bars are plain bars and shall conform to the strength requirements of ASTM Designation A 615, Grade 40 or Grade 60.

Identification. - Each bundle of steel shall be tagged at the mill with an identifying mill tag showing the name of the mill and the melt or heat number. This tag shall be a metal tag attached with a lead seal and placed in an exposed position for easy identification by the Engineer.

A certified mill copy of mill tests on each heat showing physical and chemical analyses shall be furnished to the Engineer. Two or more samples, each 2 feet long, may be taken at random from each size in each melt or heat.

No reinforcing steel shall be incorporated in the work until it has been tested, if required, and approved by the Engineer.

Drawings. - The Contractor shall submit to the Engineer for approval reinforcing steel shop drawings, in sextuplicate, showing a complete list of materials, dimensions, and bending details. No reinforcing steel shall be installed until after such shop drawings have been approved.

No deviation from the approved lists will be permitted, unless by written consent of the Engineer.

Approval by the Engineer shall not be construed as relieving the Contractor from full responsibility for the accuracy of said shop drawings.

Storage. - Reinforcing steel shall be stored in a manner that will prevent rusting, or coating by dirt or other objectionable matter, or loss of identification after bundles are broken. All steel which cannot be properly identified will be rejected, and shall be immediately removed from the work.

Bending and Straightening. - Reinforcing steel bars shall be shop bent. Field bending not be permitted, except that Number 5 and smaller bars may be bent in the field when allowed by the Engineer.

Bars shall not be damaged in bending or straightening, and bars with kinks or improper bends shall not be used.

Hooks shall be as recommended by, and conforming to, the provisions of the Building Code Requirements for Reinforced Concrete (ACI 318-63) of the American Concrete Institute.

Cleaning. - Before placing concrete, the reinforcement shall be cleaned of mortar, oil, grease, dirt, loose mill scale, loose rust, and any other coating of a character that would destroy or reduce the bond.

Placing. - Reinforcing bars shall be firmly and securely held in position by wiring with No. 14 and No. 16-gauge black annealed wire at intersections, and by using precast mortar blocks or metal chairs, spacers, metal hangers, supporting wires, and other approved devices of sufficient strength to resist crushing under full load.

Metal supports which extend to the surface of the concrete shall have plastic dipped feet. Wooden supports shall not be used.

Placing bars on layers of fresh concrete as the work progresses, or adjusting bars during the placing of concrete, will not be permitted.

Reinforcing steel adjacent to bottom forms may be supported on precast mortar blocks of a thickness sufficient to provide the required clearance from the face of the concrete. Concrete protective covering from the face of vertical forms to the reinforcing steel shall be provided by the use of temporary supports which shall be removed as the concrete is placed and rising in the forms.

Minimum clear protective covering for reinforcement adjacent to concrete surfaces shall be in accordance with the "Building Code Requirements for Reinforced Concrete" (ACI 318-63) of the American Concrete Institute except that all members exposed to sewage shall have 2 inches of protective concrete covering.

The minimum clear bar spacing shall be in accordance with the "Building Code Requirements for Reinforced Concrete", (ACI 318-63) of the American Concrete Institute.

Splicing of Reinforcing Steel. - Splices of the main reinforcement shall be located where shown and at

points of minimum stress.

Splices of adjacent reinforcing bars shall be staggered unless otherwise indicated.

Splicing shall be accomplished by placing the bars in contact with each other and wiring together in such manner as to maintain the required clear distance to the other bars and to the surface of the concrete.

Splicing of reinforcing bars shall be in accordance with the "Building Code Requirements for Reinforced Concrete", (ACI 318-63) of the American Concrete Institute.

In no case shall any splice be less than 24 nominal bar diameters, and 12 inches, in length.

Welded Splices. - Where welded splices are required for reinforcing bars, the splices shall be full penetration butt welds conforming to the requirements of AWS D2.0 and AWS D12.1 and the requirements of these specifications and the Special Provisions.

Welding operators shall be prequalified in accordance with Section 806.02 of these Standard Specifications. Welded splices shall be subjected to radiographic or other non-destructive testing unless otherwise specified by the Engineer.

Inspection. - No concrete shall be deposited until the Engineer has inspected the reinforcement and given permission to place concrete.

Welded Steel Wire Fabric. - Welded steel wire fabric for concrete and air blown mortar welded reinforcement shall be fabricated from steel wire and electrically welded at all joints and points of intersection, all in accordance with the requirements of ASTM "Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement", Designation A 185.

The wire used in the manufacture of welded wire fabric shall conform to ASTM "Standard Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement", Designation A 82.

Where wire fabric is used as reinforcement for air blown mortar on flat surfaces such as walls and slabs, it shall be 4 X 4-6/6. Where wire fabric is bent around members for protection, repair or reinforcing thereof by the use of air blown mortar, it shall be 2 X 2-12/12.

Where wire fabric is used as reinforcement for concrete pavement slabs, it shall be 6 X 6-6/6.

Splicing for Welded Steel Wire Fabric. - Splices in structural slabs shall be lapped not less than 12 inches; other splices shall be lapped not less than two meshes.

Epoxy-Coated Reinforcing Bars. - In addition to the requirements set forth above, the following requirements apply to epoxy-coated reinforcing bars.

All epoxy-coated reinforcing bars shall conform to ASTM "Standard Specification for Epoxy-Coated Reinforcing Steel Bars", Designation A 775.

When required, damaged epoxy-coating shall be repaired with patching material conforming to ASTM A 775. Repair shall be done in accordance with the patching material manufacturer's recommendations. Hereinafter, all references to repair of damaged epoxy-coating shall imply the use of the above procedure.

Bar mats shall conform to ASTM A 184. Bar mats may be fabricated from epoxy-coated reinforcing bars. Metal clips shall be epoxy-coated. Non-metallic clips may be used. Coating damage at the clipped or welded intersections shall be repaired as described hereinbefore.

All reinforcement shall be bent cold unless otherwise permitted by the Engineer.

Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable materials. Wire bar supports shall be coated with dielectric material for a minimum distance of 2 inches from the point of contact with the epoxy-coated reinforcing bars. Reinforcing bars used as support bars shall be epoxy-coated. In walls having epoxy-coated reinforcing bars, spreader bars where specified by the Engineer, shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion-resistant material.

Epoxy-coated reinforcing bars shall be fastened with nylon-, epoxy-, or plastic-coated tie wire, or other acceptable materials.

Splices of reinforcing bars shall be made only as required or permitted by the Contract Documents, or as authorized by the Engineer. Welded splices, when required or permitted, shall conform to AWS D

1.4. Unless otherwise permitted, welding of crossing bars (tack welding) for assembly of reinforcement is prohibited. Suitable ventilation shall be provided when welding epoxy-coated reinforcing bars.

After completion of welding on epoxy-coated reinforcing bars, coating damaged shall be repaired as specified hereinbefore. All welds, and all steel splice members when used to splice bars, shall be coated with the same material used for repair of coating damaged.

Mechanical connections, when required or permitted, shall be installed in accordance with the splice device manufacturer's recommendations. After installing mechanical connections on epoxy-coated reinforcing bars, coating damage shall be repaired as specified hereinbefore. All parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damaged.

Reinforcing bars partially embedded in concrete shall not be field bent, except as indicated on the Contract Documents or permitted by the Engineer. When heat is used to field bend epoxy-coated reinforcing bars, suitable ventilation shall be provided. When epoxy-coated reinforcing bars are field bent, coating damaged shall be repaired as specified hereinbefore.

Unless permitted by the Engineer, reinforcing bars shall not be cut in the field. When epoxy-coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage. Equipment for handling epoxy-coated bars shall have protected contact areas. Bundles of coated bars shall be lifted at multiple pick-up points to minimize bar-to-bar abrasion from sags in the bundles. Coated bars or bundles of coated bars shall not be dropped or dragged. Coated bars shall be stored on protective cribbing. Fading of the color of the coating shall not be cause for rejection of epoxy-coated reinforcing bars. Coating damage due to handling, shipment and placing need not be repaired in cases where the damaged area is 0.1 square inches or smaller. Damaged areas larger than 0.1 square inches shall be repaired as specified hereinbefore. The maximum amount of damage including repaired and unrepaired areas shall not exceed 2% of the surface area of each bar.

#### **411.06 Expansion Joints and Filler**

Expansion Joints. - All walls, steps, copings, and other concrete structures extending above the ground shall have expansion joints placed not more than sixty feet apart. Expansion joints shall also be placed at the junction of steps with other structures, and at the top and bottom of any flight of steps.

Joints shall be made with expansion joint filler, 1/4-inch in thickness, in accordance with the requirements specified hereinafter.

The edges of concrete, at the joints, shall be edger finished.

Expansion Joint Filler. - Expansion joint filler shall consist of preformed strips of a durable, resilient, nonextruding compound.

Preformed joint filler material shall be in accordance with the requirements of ASTM "Standard Specifications for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)", Designation D 1751, or ASTM "Standard Specifications for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Non-bituminous Types)", Designation D 1752, as designated in the Special Provision or most suitable for the purpose intended. The filler, further, shall meet the requirements of ASTM "Standard methods of Testing Preformed Expansion Joint Fillers for Concrete (Nonextruding and Resilient Types)", Designation D. 545.

Where stiffness is lacking in preformed expansion joint filler, the strips shall be encased in saturated felt, asphalt-impregnated cotton webbing, or other satisfactory material. Any material or fabric used for encasement shall be firmly sealed to the body of the joint filler and shall not become detached therefrom after immersion in water for a period of forty-eight hours.

If 10% or more of any lot or shipment of expansion joint filler is of nonuniform or improper construction, the entire lot or shipment may be rejected.

Expansion joint filler shall be installed so that it will not be displaced when concrete is deposited against it. Where it is necessary to use more than one piece of filler to cover any surface, the abutting pieces shall be placed in close contact, and the joint shall be covered with a layer of 2-ply roofing felt adhered with hot asphalt to insure proper retention. Any concrete or mortar that has filled the void spaces where expansion

joint sealant is to be placed shall be neatly cut and removed.

Expansion Joint Sealant. - Expansion joints shall be sealed with expansion joint sealant when specified in the Special Provisions.

The sealant shall be mixed and placed strictly in accordance with the manufacturer's directions and to the depth of joint shown on the plans.

Concrete surfaces against which the sealant is placed shall be thoroughly cleaned by wire brushing and shall be dry. The concrete surfaces shall then be given a prime coat of the primer specified, or that recommended by the manufacturer. The primer shall be worked into the concrete.

The primer shall be allowed to dry tack-free before application of the sealant.

Liquid sealant placed in vertical joints shall be retained with forms lined with polyethylene film.

The joint sealant shall, in all cases, be installed flush with the concrete surfaces on either side of the joint.

### 411.07 Waterstops

Waterstops shall be furnished and installed where and in accordance with the details shown on the plans and specified herein.

Waterstops, unless otherwise specified, shall be natural rubber, synthetic rubber or polyvinyl chloride (PVC), at the option of the Contractor.

Natural rubber waterstops shall be manufactured from stock containing not less than 72% by volume of new plantation rubber. When tested in accordance with ASTM "Standard Method of Tension Testing of Vulcanized Rubber", Designation D 412, the tensile strength shall not be less than 3,500 pounds per square inch with an elongation at breaking of 550%. The unit stresses producing 300% and 500% elongation shall be not less than 1,100 pounds and 2,800 pounds per square inch, respectively. When tested in accordance with ASTM "Standard Method of Test for Indentation Hardness of Rubber and Plastics by Means of a Durometer", Designation D 2240, the Shore durometer indication (hardness) shall be between 55 and 65. When tested in accordance with ASTM "Standard Method of Test for Accelerated Aging of Vulcanized Rubber by the Oxygen-Pressure Method", Designation D 572 and after seven days in air at 158 degrees Fahrenheit ( $\pm 2^\circ\text{F}$ ), or after forty-eight hours in oxygen at 158 degrees Fahrenheit ( $\pm 2^\circ\text{F}$ ) and 300 pounds per square inch pressure, the tensile strength and elongation shall not be less than 65% of the original.

Synthetic rubber waterstops shall be manufactured from a compound containing not less than 70% by volume of neoprene or GRS. When tested in accordance with ASTM Designation D 412, the tensile strength shall be not less than 2,500 pounds per square inch with an elongation at breaking of 425%. When tested in accordance with ASTM Designation D 676, the Shore durometer indication (hardness) shall be between 50 and 70. When tested in accordance with the test method of ASTM Designation D 572, and after seven days in air at 158 degrees Fahrenheit ( $\pm 2^\circ\text{F}$ ), or after forty-eight hours in oxygen at 158 degrees Fahrenheit ( $\pm 2^\circ\text{F}$ ) and 300 pounds per square inch pressure, the tensile strength shall be not less than 65% of the original.

Polyvinyl chloride waterstops shall be manufactured from polyvinyl chloride conforming to the Corps of Engineers Specification Number CRD-C572. A certificate shall be furnished with the test sample supplied stating that the sample complies with all of the performance requirements specified under paragraph 6 of said Specification.

Waterstops shall be manufactured with an integral cross-section which shall be uniform within plus or minus 1/8-inch in width, and the web thickness or bulb diameter, within plus 1/16-inch and minus 1/32-inch. The number of splices shall be kept to a minimum... Strips and special connection pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous and free from all porosity. All junctions in the special connection pieces shall be full molded. During the vulcanizing period, the joint shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross section.

Field splices for either natural or synthetic rubber waterstops shall be vulcanized, or mechanical using stainless steel parts, or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a full-sized tensile strength of 100 pounds times the width in inches.



Field splices for polyvinyl chloride waterstops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's directions. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt, but not char, the plastic.

Waterstops shall, when being installed, be cut and spliced at changes in direction as may be necessary to avoid buckling or distortion of the web or flange.

#### 411.08 Elastomeric Bearing Pads

Elastomeric bearing pads shall be made of neoprene, cast in molds under pressure and heat, and shall have the properties listed hereinafter, as determined by ASTM "Standard Methods of Compound and Sample Preparation for Physical Testing of Rubber Products", Designation D15:

- 1) Tensile strength, ASTM Designation D 412 .....2,500 psi minimum
- 2) Elongation at break, ASTM Designation D 412 ..... 350 minimum
- 3) Compression set, ASTM Designation  
D 395, Method "B" 22 hours at 158 degrees Fahrenheit .....25% maximum
- 4) Tear strength, ASTM  
Designation D 624, Die "C" ..... 275 lbs. per inch of thickness, minimum
- 5) Durometer hardness, Shore "A", ASTM  
Designation D 2240 ..... 55  $\pm$  3
- 6) Change in durometer hardness, ASTM  
Designation D 573, heat aged, 70 hours  
at 212 degrees Fahrenheit ..... +10 points, maximum

In addition to these requirements, the material shall show no checking when subjected to an exposure of 110 hours in an atmosphere containing 100 +20 parts of ozone per 100,000,000 parts of air to conform with ASTM "Standard Method of Test for Accelerated Ozone Cracking of Vulcanized Rubber", Designation D 1149.

Elastomeric bearing pads shall be of the thickness, width and length indicated on the plans. The pads shall be neatly punched to receive dowels where necessary or indicated.

The Contractor shall furnish the Engineer a certification by the manufacturer that the elastomer in the elastomeric bearing pads to be furnished conforms to all of the requirements specified hereinbefore. The certification shall be supported by a certified copy of the results of tests performed by the manufacturer upon samples of the elastomer to be used in the pads, covering all of the hereinbefore mentioned requirements.

#### 411.09 Removal of Forms

Side forms for footings, foundations, slabs on grade, or other components that do not resist bending shall not be removed in less than forty-eight hours after pouring of concrete. At times of low temperature or other adverse weather conditions, the Engineer may increase the required time to five days.

The falsework and forms supporting concrete girders, beams, joists, slabs, or other members subject to bending stress, shall not be removed or released in less than fourteen days after the concrete has been placed, or if the members are constructed of Type III (high-early strength) Portland cement, in less than seven days after the concrete has been placed. The addition of one-half sack of cement per cubic yard of concrete will be considered a satisfactory substitute for Type III Portland cement provided no additional water is added. In any case, the falsework and forms supporting the members shall not be removed until the concrete has attained a compressive strength of at least 2,500 pounds per square inch based on field, cured cylinders. Furthermore, such members shall not be loaded until the concrete has attained its 28-day compressive strength.

The removal of forms for sewers and sewer structures shall be in accordance with the requirements of Section 303.05, unless otherwise specified in the Special Provisions.

### **411.10 Ordinary Surface Finish for Structural Components**

Unless otherwise Specified, all surfaces of concrete, Shall be given Ordinary Surface Finish, except that such surfaces, or portions thereof, covered by backfill in the completed work need not be “sacked”.

Immediately after the forms have been removed, the Contractor shall remove all form bolts or ties to a depth of at least 13 inches below the surface of the concrete. All holes and depressions caused by the removal or setting back of the form bolts or ties shall be cleaned out. All fins caused by form joints and other objectionable projections, shall be removed, except in cases where they are buried or otherwise not visible in the completed structure and do not interfere with the designed function of the structure. All rock pockets shall be chipped back and cleaned out. All depressions caused by the removal of form bolts, tie rods, rock pockets or other imperfections shall be filled with Class “B” mortar containing no more water-than that necessary for complete hydration. Care shall be exercised to obtain a perfect bond with the concrete, and to obtain the same color in the mortar as in the surrounding concrete. In areas visible in the completed work, cement shall be used in sufficient quantity to obtain the required color. While the mortar filling is still “green”, it shall be wiped smooth or have the form grain imprinted in it. Steel finishing tools will not be permitted. At the same time, all surfaces shall be “sacked” by wiping with a folded hemp sack on which a sufficient amount of mortar has been placed to substantially fill the small holes that commonly appear in concrete surfaces.

### **411.11 Class 1 Surface Finish**

After the completion of Ordinary Surface Finish, all surfaces shall be thoroughly rubbed with coarse carborundum stones and all unsightly bulges or depressions, caused by form marks or other imperfections, shall be removed so that a smooth surface of uniform texture and appearance is obtained. A mechanical finisher may be used for this purpose, in which case not less than four days shall elapse between the time the concrete is poured and the finishing started. If the surface is rubbed by hand, a period of not less than two days will be required.

After the hereinbefore referred to process has been completed, the surface shall be washed with water to remove stains and free particles which adhere to the surface after rubbing.

### **411.12 Class 2 Surface Finish**

Where Class 2 Surface Finish is specified, Ordinary Surface Finish and Class 1 Surface Finish shall be completed in succession. A thin cement mortar, consisting of one part Portland cement and one part fine sand, all of which will pass a No. 20 sieve, to which has been added two pounds of calcium chloride per sack of cement, shall then be brushed on the surface. When the cement film has set so that the sand particles or cement will not drag out of the surface pinholes, but before final set has taken place, the entire surface shall be rubbed thoroughly with fine carborundum stones, Nos. 25 to 30, until a smooth, even surface of uniform texture is obtained. No greater amount of mortar shall be applied in advance of rubbing than can be completely rubbed before final setting takes place. Immediately after the rubbing process, the finished surface shall be thoroughly washed with water.

This finish shall be deferred until all other work which would in any way mar or affect the final finish is completed.

### **411.13 Exposed Aggregate Finish**

Exposed aggregate finish, when specified, shall be obtained by using “Control-Set”, as manufactured by the Conrad Sovig Company, San Francisco, or equal, retardant. Methods and details of application shall conform to the manufacturer’s directions.

In areas to receive exposed aggregate finish, wall forms, including their abutting edges, shall be coated with two coats of “Control-Set” and such coating shall be protected from removal, or damage by water or otherwise, from the time of coating to the time of pouring. Such forms shall be stripped two days after pouring, unless otherwise directed by the Engineer. The surface of the concrete shall be washed and rinsed using a stiff brush, and if necessary shall be sandblasted to remove the mortar film surrounding the aggregate to a minimum depth of 1/8-inch.

#### **411.14 Broom Finish**

Walkway surfaces on overpass and ramp structures shall be given a light broom finish by floating to a true and dense finish with a wood float or power floating machine, followed by steel troweling after the concrete has hardened sufficiently to prevent excess fine material from working to the surface. The finish shall be brought to a smooth surface free from defects and blemishes. No dry cement, or mixture of dry cement and sand, shall be sprinkled on the surface of the concrete to absorb moisture or to stiffen the mix.

The concrete wearing surface shall be given a final finish by brooming lightly, in a direction transverse to the path of travel, with a fine hair broom to produce a uniform nonskid surface.

#### **411.15 Dampproofing of Concrete Structures**

All surfaces of concrete structures specified on the plans or in the Special Provisions to be dampproofed, and all back surfaces on concrete abutment walls, wing walls and retaining walls, shall be dampproofed with at least two coats of approved emulsified asphalt, allowing adequate drying time between coats, unless some other dampproofing procedure has been stipulated.

Structure and wall surfaces shall be clean and dry and weather conditions suitable, as approved by the Engineer, with an air temperature of not less than 50 degrees Fahrenheit, at the time of applying the emulsified asphalt coatings.

When waterproofing is called for it shall be done in conformance with Section 418 of these Specifications.

#### **411.16 Drainage for Relief of Hydrostatic Head Behind Walls Under Concrete on Grade**

When shown on the plans or specified in the Special Provisions, the Contractor shall construct adequate drains and appurtenances behind walls and under concrete on grade. Unless otherwise specified, pipe to carry such drainage shall be perforated vitrified clay pipe of adequate size, but not less than 6 inches in diameter.

Such perforated vitrified clay pipe shall be “extra strength”, of the bell-and-spigot type, and in accordance with the applicable requirements of ASTM “Standard Specifications for Standard and Extra Strength Perforated Clay Pipe”, Designation C 211, except that the minimum thickness of the barrel of the pipe shall conform to the Regional Western Standard of the Clay Pipe Institute. Perforated vitrified clay pipe shall be installed with tight-closed joints, but without any mortar or other joining material. The pipe shall be sloped as shown on the plans and each piece of pipe shall be placed, with the perforations facing downward, on a 3-inch deep minimum bed of filter material.

The section of filter material to be placed around drains shall be as shown on the plans or specified in the Special Provisions, and when not shown or specified shall be at least 3 inches thick all around the pipe.

Placement of filter material and the backfill thereover shall be as specified in Section 711.

#### **411.17 Payment**

Concrete structures, satisfactorily constructed as specified, each will be paid for at the lump sum price bid therefor. Any concrete structure for which the Proposal does not contain provision for payment shall be constructed as Incidental Work.

## 412 Prestressed Concrete Construction

### 412.01 General

The Contractor shall construct prestressed concrete structures and structural components, where and as shown on the plans or where directed, and shall do all related Incidental Work. Unless otherwise specified, prestressing may be done by either pretensioning or post-tensioning. Equipment, methods, and operations shall be in accordance with these specifications, with what is considered generally acceptable for prestressing construction, and with the applicable requirements of the Building Code, Part II, Chapter I of the San Francisco Municipal Code.

Prior to starting prestressed construction, the Contractor shall submit to the Engineer for approval, in accordance with Sections 106.08 and 107.04, complete details including substantiating calculations of the prestressing system and of the methods, material and equipment he proposes to use. Any proposed deviations during construction must likewise be submitted. Such details shall outline the method of prestressing, and shall include the amount, arrangement, and complete specifications of prestressing steel in the members, the quantity and arrangement of the mild steel reinforcement in anchorage areas in the members, the proposed locations of bar couplers, if used, anchoring stresses, sequence of cutting or releasing prestressing steel, type of post-tensioning ducts, and specifications and details of anchoring devices, distribution plate or assemblies if required, and pressure-grouting materials and equipment for post-tensioning, together with complete drawings of the forms proposed for casting the member. Such details, calculations and drawings shall be prepared by a Civil Engineer licensed by the State of California.

Approval of new prestressing systems will be contingent on prequalification testing as directed by the Engineer, at the Contractor's expense, of complete tendon assemblies and other devices peculiar to the system as proposed for use and the submittal of written information as requested by the Engineer.

Approval or the part of the Engineer of any proposed method, materials, or equipment shall not be construed of relieving the Contractor, in any respect, of full responsibility for successfully completing prestressing operations in accordance with the specified requirements.

Longitudinal steel, prestressed by the post-tensioning or pretensioning method, shall maintain the path of the center of gravity of prestressing force as shown on the plans.

Suitable horizontal and vertical spacers shall be provided as required to hold the tendons in place in true position in the enclosures. Deflection devices shall be removed, after transfer of the prestressing force, to a depth of 1/2-inch below the surface of the unit and grouted flush therewith.

The prestressing tendons shall be deflected in such a manner that they are not damaged or distorted and so that there is no appreciable variation in tension over the length of the tendon due to frictional losses at the yokes.

When prestressing steel for pretensioning is placed in the stressing bed and is exposed to the elements for more than 36 hours prior to encasement in concrete, adequate measures shall be taken by the Contractor, as approved by the Engineer, to protect said steel from contamination or corrosion.

Whenever electric welding is performed on or near members containing prestressing steel, the welding ground shall be attached directly to the steel being welded.

All pretensioned prestressing steel shall be cut off flush with the end of the member and the exposed ends of the prestressing steel and a one-inch strip of adjoining concrete shall be cleaned and painted. Cleaning shall be by wire brushing or abrasive blast cleaning to remove all dirt and residue which is not firmly bonded to the metal or concrete surfaces. The surfaces shall be coated with one thick coat of zinc rich paint conforming to the requirements of Military Specification MIL-P-21035. The paint shall be thoroughly mixed at the time of application and shall be worked into any voids in the prestressing tendons.

The minimum horizontal or vertical clear spacing between pretensioning steel elements at ends of members shall be 3 times the diameter of the steel, or 1-1/3 times the maximum size of the coarse aggregate, whichever is greater.

Where pretensioning steel is harped or deflected, strands may be grouped together at midspan with 3 strands in a vertical row or 2 strands in a horizontal row. The minimum clear distance between groups shall be 1-1/8 inches for 3/8-inch strands, and 1-1/2 inches for 7/16-inch strands.

The strands shall be separated at the ends to provide minimum spacing between strands as indicated above which shall be maintained for a minimum distance of 3 feet at each end of the member. Precast units

shall be stored, transported and placed so that they will not be overstressed or damaged.

Units shall be listed using suitable approved lifting devices located at points which will produce minimum deflection during installation. Lifting devices shall be removed 1 1/2 inches below the surface of the concrete and the resulting holes filled with an approved expansive grout after units are installed in place.

Post-tensioned precast members shall not be moved until at least 24 hours after pressure-grouting of enclosures. Prestressed members shall not be lifted by attachment at any point more than 3 feet from the ends or points of final support of such members. Prestressed members shall be lifted in the same position with regard to top and bottom faces as that of the final installation of the members and shall be handled so that there will be no sideway, tipping, or racking. The minimum clear concrete cover for prestressed units shall be as specified in Section 7.7 of the latest edition of the ACI code.

## 412.02 Concrete

Concrete and related work for prestressed concrete construction shall be in accordance with the following specifications and the applicable requirements of Sections 411 and 800.

The maximum size of aggregate used in prestressed concrete shall be one-inch.

Cement used in prestressed concrete construction shall be either Type I or Type II Portland cement at the option of the Contractor. The Contractor shall not however, for the purpose of producing increased strength at an early date, increase the amount of cement from that specified, unless such increase has been specifically approved by the Engineer.

Type III (high-early strength) Portland cement, or calcium chloride as an admixture, shall not be used in the construction of any prestressed concrete structure, nor shall calcium chloride be used in the construction of any concrete member of any other structure in contact with the prestressed steel reinforcement.

Unless otherwise specified, prestressed concrete shall have a minimum strength of not less than 5,000 psi at 28 days, as determined from breaks of test cylinders made and cured under laboratory conditions in accordance with the requirements of ASTM "Standard Method of Test for Compressive Strength of Molded Concrete Cylinders", Designation C 39.

The Contractor shall be responsible for furnishing satisfactory materials for the manufacture of the concrete, proportioned to contain not less than 7 nor more than 8 1/2 sacks of cement per cubic yard of concrete with the maximum net water content not to exceed 5 gallons per sack of cement, that will produce a workable concrete complying with the foregoing requirements for strength.

Five sets of test cylinders, consisting of 2 cylinders per set, shall be taken during the concreting operations from each day's pour, but not less than 5 sets from each 50 cubic yards of concrete poured, in accordance with Section 106.15. One-half the number of cylinders shall be stored for laboratory curing and testing. The remainder of the cylinders shall be cured at the site under conditions of curing identical to those of the prototype structure.

Compression tests shall be taken at 3, 7, 14 and 28 days for the purpose of ascertaining when tensioning of post-tensioned prestressing steel or release of pretensioning steel may be commenced, which will be determined based on the strength of the field cured cylinders. Concrete shall be fully vibrated and consolidated. Approved external vibrators shall be used for the consolidation of concrete inaccessible for adequate internal vibration in the prestressed members. The forms shall be designed and constructed to provide the necessary rigidity to resist displacement or damage as a result of such external vibration. Concrete shall be cured according to "Curing Precast Concrete Members" as specified in Section 800.16.

Attention shall be given to the prevention of shrinkage or settlement cracks due to rate or sequence of pouring. If shrinkage cracks appear during the curing process for post-tensioning the Contractor, at no extra cost to the City, shall partially prestress the girder, as directed by the Engineer.

## 412.03 Prestressing Steel

**General.** - Prestressing steel shall be high-tensile wire conforming to ASTM Designation: A 421, high-tensile wire strand conforming to ASTM Designation: A 416, or uncoated high-strength steel bars conforming to ASTM Designation: A 722, including all supplementary requirements.

In addition to the requirements of ASTM Designation: A 722, for deformed bars, the reduction of area shall be determined from a bar from which the deformations have been removed. Such a bar shall be

machined no more than necessary to remove the deformations over a length of 12 inches, and reduction will be based on the area of the machined portion.

All bars in any individual member shall be of the same grade, unless otherwise permitted by the Engineer.

When bars are to be extended by the use of couplers, the assembled units shall have a tensile strength of not less than the manufacturer's minimum guaranteed ultimate tensile strength of the bars. Failure of any one sample to meet this requirement will be cause for rejection of the heat of bars and lot of couplers. The location of couplers in the member shall be subject to approval by the Engineer.

Wires shall be straightened if necessary to produce equal stress in all wires or wire groups or parallel lay cables that are to be stressed simultaneously or when necessary to insure proper positioning in the ducts.

Where wires are to be button-headed, the buttons shall be cold formed symmetrically about the axes of the wires. The buttons shall develop the minimum guaranteed ultimate tensile strength of the wire. No cold forming process shall be used that causes indentations in the wire.

Buttonheads shall not contain wide open splits, more than 2 splits per head, or splits not parallel with the axis of the wire.

All prestressing steel shall be protected against physical damage and rust or: other results of corrosion at all times from manufacture to grouting or encasing in concrete. Prestressing steel that has sustained physical damage at any time shall be rejected. The development of visible rust or other results of corrosion shall be cause for rejection, when ordered by the Engineer.

Prestressing steel shall be packaged in containers or shipping forms for the protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor which prevents rust or other results of corrosion shall be placed in the package or form, or shall be incorporated in a corrosion inhibitor carrier type packaging material, or when permitted by the Engineer, may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Packaging or forms damaged from any cause shall be immediately replaced or restored to original condition.

The shipping package or form shall be clearly marked with a statement that the package contains high-strength prestressing steel, and the type of corrosion inhibitor used, including the date packaged.

Prestressing steel for post-tensioning which is installed in members prior to placing and curing of the concrete, shall be continuously protected against rust or other corrosion, until grouted, by means of a corrosion inhibitor placed in the ducts or applied to the steel in the duct. The corrosion inhibitor shall conform to the requirements specified herein.

When steam curing is used, prestressing steel for post-tensioning shall not be installed until the steam curing is completed. All water used for flushing ducts shall contain either quick lime (calcium oxide) or slaked lime (calcium hydroxide) in the amount of 0.1-pound per gallon. All compressed air used to blow out ducts shall be oil free.

When acceptable prestressing steel for post-tensioning is installed in the ducts after completion of concrete curing, and if stressing and grouting are completed within 10 days after the installation of the prestressing steel, rust which may form during said 10 days will not be cause for rejection of the steel. Prestressing steel installed, tensioned and grouted in this manner, all within 10 days, will not require the use of a corrosion inhibitor in the duct following installation of the prestressing steel. Prestressing steel installed as above but not grouted within 10 days shall be subject to all the requirements in this section pertaining to corrosion protection and rejection because of rust.

#### 412.04 Prestressing

All prestressing steel shall be tensioned by means of hydraulic jacks so that the force in the prestressing steel shall not be less than the value shown on the plans.

Unless otherwise specified or shown on the plans, the average working stress in the prestressing steel shall not exceed 60% of the specified minimum ultimate tensile strength of the prestressing steel. The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed 75% of the specified minimum ultimate tensile strength of the prestressing steel. The prestressing steel shall be anchored at stresses (initial stress) that will result in the ultimate retention of working forces of not less than those shown on the plans, but in no case shall the initial stress exceed 70% of the specified minimum ultimate tensile strength of the prestressing steel.

Working force and working stress will be considered as the force and stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, creep of steel, losses in post-tensioned prestressing steel due to sequence of stressing, friction and take up of anchorages, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

The loss in stress in post-tensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, and sequence of stressing shall be assumed to be 32,000 pounds per square inch for wire or strand and 22,000 pounds per square inch for bars. If lightweight concrete is used, said loss shall be assumed to be 40,000 pounds per square inch.

The loss in stress in pretensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, and elastic compression of concrete shall be assumed to be 45,000 pounds per square inch. If lightweight concrete is used, said loss shall be assumed to be 50,000 pounds per square inch.

The following formula and friction coefficients shall be used in calculating friction losses in tendons:

$$T_0 = T_x e^{(Ua + Kl)}$$

Where

$T_0$  = steel stress at jacking end;

$T_x$  = steel stress at any point x;

$e$  = base of Napierian (natural) logarithms;

$U$  = friction curvature coefficient;

$a$  = total angular change of prestressing steel profile in radians from jacking end to point x;

$K$  = friction wobble coefficient;

$l$  = length of prestressing steel from jacking end to point x

Type of Steel	Type of Duct	K	U
Wire or Strand	Galvanized - rigid .....	0.0002	0.25
Plain bars	Galvanized .....	0.0002	0.15
Deformed bars	Galvanized .....	0.0003	0.30

Each jack used to stress tendons shall be equipped with either a pressure gauge or a load cell for determining the jacking stress, at the option of the Contractor. The pressure gauge, if used, shall have an accurately reading dial at least 6 inches in diameter and each jack and its gauge shall be calibrated as a unit with the cylinder extension in the approximate position that it will be at final jacking force, and shall be accompanied by a certified calibration chart. The load cell, if used, shall be calibrated and shall be provided with an indicator by means of which the prestressing force in the tendon may be determined. The range of the load cell shall be such that the lower 10% of the manufacturer's rated capacity will not be used in determining the jacking stress.

The prestressing force shall be tested by a qualified independent testing agency. The Contractor shall provide sufficient labor, equipment, and material to install and support such testing equipment at the prestressing tendons and to remove the testing equipment after the testing is complete, as ordered by the Engineer. Prior to post-tensioning any member, the Contractor shall demonstrate to the satisfaction of the Engineer that the prestressing steel is free and unbonded in the duct.

Prestressing forces shall not be applied to cast-in-place concrete until at least 10 days after the last concrete has been placed in the member to be prestressed and until the concrete complies with one of the following requirements:

- 1) When the concrete is designated by compressive strength, the concrete compressive strength shall have reached the strength shown on the plans at the time of stressing.

- 2) When the concrete is designated by Class or cement content, either the concrete compressive strength shall have reached the strength shown on the plans at the time of stressing, or at least 28 days shall have elapsed since the last concrete to be prestressed has been placed, whichever occurs first.

Subject to prior approval by the Engineer, a portion of the total prestressing force may be applied to a precast member when the strength of the concrete in the member is less than the value shown on the plans and the member may then be moved. Approval by the Engineer of such partial prestressing and moving shall in no way relieve the Contractor of full responsibility for successfully constructing the members.

Prestressing steel in pretensioned members shall not be cut or released until the concrete in the member has attained a compressive strength of not less than the value shown on the plans or 4,000 psi, whichever is the greater.

When ordered by the Engineer, prestressing steel strands in pretensioned members, if tensioned individually, shall be checked by the Contractor for loss of prestress not more than 3 hours prior to placing concrete for the members. The method and equipment for checking the loss of prestress shall be subject to approval by the Engineer. All strands which show a loss of prestress in excess of 3% shall be pretensioned to the original computed jacking stress.

When prestressing steel in pretensioned members is tensioned at a temperature appreciably lower than the estimated temperature of the concrete and the prestressing steel at the time of initial set of the concrete, the calculated elongation of the prestressing steel shall be increased to compensate for the loss in stress, but in no case shall the jacking stress exceed 75% of the specified minimum ultimate tensile strength of the prestressing steel.

The cutting and releasing of prestressing steel in pretensioned members shall be performed in such an order that lateral eccentricity of prestress will be a minimum.

The tensioning process as applied to post-tensioned members shall be so conducted that tension being applied and the elongation of the prestressing steel may be measured at all times.

Except as provided herein, tendons in continuous post-tensioned members shall be tensioned by jacking at each end of the tendon. Where one-end stressing is shown on the plans, tensioning of such tendons shall be done by jacking from one end or both ends of the tendon at the option of the Contractor.

Prestressing tendons in simple span post-tensioned members may be tensioned by jacking from one end only.

#### 412.05 Ducts for Prestressed Steel

Duct enclosures for prestressing steel shall be rigid ferrous metal, galvanized, mortar tight, and accurately placed at the locations shown on the plans or approved by the Engineer.

Ducts shall be fabricated with either welded or interlocked seams. Galvanizing of the welded seam will not be required. Ducts shall have sufficient strength to maintain their correct alignment during placing of concrete. Joints between sections of duct shall be positive metallic connections which do not result in angle changes at the joints. Waterproof tape shall be used at the connections. Ducts shall be bent without crimping or flattening. Transition couplings connecting said ducts to anchoring devices need not be galvanized.

All ducts or anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing.

Ducts for prestressing steel when bars are used shall have a minimum inside diameter  $3/8$  inch larger than the diameter of the bars to be used.

Ducts for prestressing steel shall be securely fastened in place to prevent movement.

After installation in the forms, the ends of ducts shall at all times be covered as necessary to prevent the entry of water or debris. If prestressing steel is to be installed after the concrete has been placed, the Contractor shall demonstrate to the satisfaction of the Engineer that the ducts are free of water and debris immediately prior to installation of the steel.

Vents shall be placed at not more than 400 foot intervals in all ducts and shall be located within 6 feet of a high point in the duct profile. Vents shall be  $1/2$  inch minimum diameter standard pipe or suitable plastic pipe. Connections to ducts shall be made with metallic or plastic structural fasteners. Plastic components, if selected, shall not react with the concrete or enhance corrosion of the prestressing steel, and shall be free of water soluble chlorides. The vents shall be mortar tight, taped as necessary, and shall provide means for



injection of grout through the vents and for sealing the vents. Ends of vents shall be removed one inch below the roadway surface after grouting has been completed.

#### **412.06 Bonding and Grouting**

Post-tensioned prestressing steel shall be bonded to the concrete by completely filling the entire void space between the duct and the tendon with grout.

Grout shall consist of portland cement and water, and may contain an admixture if approved by the Engineer.

Portland cement shall conform to the provisions in Section 800.02, "Portland Cement".

Water shall comply with the provisions in Section 800.07, "Water". The use of admixtures shall comply with the provisions in Section 800.08, "Admixtures", except that the admixtures shall not contain chloride ions in excess of 0.25% by weight of admixture and the admixtures may be dispensed in solid form.

Water shall be first added to the mixer followed by cement and admixture.

The grout shall be mixed in mechanical mixing equipment of a type that will produce uniform and thoroughly mixed grout. The water content shall be not more than 5 gallons per 94 pounds of cement. Retempering of grout will not be permitted. Grout shall be continuously agitated, until it is pumped.

The quality of the grout shall be determined by the Engineer in accordance with California Test 541. The efflux time of a grout sample immediately after mixing shall be not less than 11 seconds.

Grouting equipment shall be capable of grouting at a pressure of at least 100 pounds per square inch.

Grouting equipment shall be furnished with a pressure gauge having a full-scale reading of not more than 300 pounds per square inch.

When vents are required, standby flushing equipment capable of developing a pumping pressure of 250 pounds per square inch and of sufficient capacity to flush out any partially grouted ducts shall be provided.

All ducts shall be clean and free of water and deleterious materials that would impair bonding of the grout or interfere with grouting procedures.

All grout shall pass through a screen with 0.07-inch maximum clear openings prior to being introduced into the grout pump.

Grout injection pipes shall be fitted with positive mechanical shutoff valves. Vents and ejection pipes shall be fitted with valves capable of withstanding the pumping pressures. Valves shall not be removed or opened until the grout has set.

Leakage of grout through the anchorage assembly shall be prevented by positive mechanical means.

Grout shall be pumped through the duct and continuously wasted at the outlet until no visible slugs or other evidence of water or air are ejected and the efflux time of ejected grout is not less than 11 seconds. The outlet valve shall then be closed and the pumping pressure held momentarily. The valve at the inlet shall then be closed while maintaining this pressure.

When hot weather conditions would contribute to quick stiffening of the grout, the grout shall be cooled by approved methods as necessary to prevent blockages during pumping operations.

When freezing weather conditions will prevail during and following the placement of grout, the Contractor shall provide adequate means to protect the grout in the ducts from damage by freezing or other causes.

The surfaces of concrete against which concrete encasement over anchorage assemblies is to be placed shall be abrasive blast cleaned and clean aggregate exposed after grouting of the ducts has been completed.

#### **412.07 Distribution Plates and Anchorages for Post-Tensioned Prestressing Steel**

All post-tensioned prestressing steel shall be secured at the ends by means of approved permanent type anchoring devices.

All anchorage devices for post-tensioning shall hold the prestressing steel at a load producing a stress of not less than 95% of the specified ultimate tensile strength of the prestressing steel.

When headed wires are used, the outside edge of any hole for prestressing wire through a stressing washer or through an unthreaded bearing ring or plate shall not be less than 1/4 inch from the root of the thread of the washer or from the edge of the ring or plate.

The load from the anchoring device shall be distributed to the concrete by means of approved devices that will effectively distribute the load to the concrete. Such approved devices shall conform to the following requirements:

- 1) The final unit compressive stress on the concrete directly underneath the plate or assembly shall not exceed 3,000 pounds per square inch.
- 2) Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed the yield point of the material or cause visible distortion in the anchorage plate when 95% of the specified ultimate tensile strength of the tendons is applied as determined by the Engineer.

Should the Contractor elect to furnish an anchoring device of a type which is sufficiently large and which is used in conjunction with a steel grillage embedded in the concrete that effectively distributes the compressive stresses to the concrete, the steel distribution plates or assemblies may be omitted.

If loop tendon anchorages are used, they shall be enclosed in ducts for their entire length.

Where the end of a post-tensioned assembly will not be covered by concrete, the anchoring devices shall be recessed so that the ends of the prestressing steel and all parts of the anchoring devices will be at least 2 inches inside of the end surface of the members, unless a greater embedment is shown on the plans. Following post-tensioning, the recesses shall be filled with grout, and finished flush. The grout shall consist of one part cement and 2 parts sand.

#### **412.08 Testing and Prestressing Steel and Anchorage Assemblies**

General. - The City will designate an independent recognized testing laboratory to which the Contractor shall deliver, for testing, the necessary samples from each lot of prestressing steel and anchorage assemblies to be used in the work. Lengths of samples, practicable for testing, shall be as required by such laboratory.

All testing in the laboratory will be done at City expense and at no cost to the Contractor.

Sampling and testing shall conform to the specifications of ASTM Designation: A 416 and ASTM Designation: A 421 and as specified herein.

Samples from each size and each heat of prestressing bars, from each manufactured reel of prestressing steel strand, from each coil of prestressing wire and from each lot of anchorage assemblies and bar couplers to be used shall be furnished for testing. With each sample of prestressing steel wires, bars or strands furnished for testing, there shall be submitted a certification stating the manufacturer's minimum guaranteed ultimate tensile strength of the sample furnished.

All bars of each size from each mill heat, all wire from each coil, and all strand from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each such lot can be accurately identified at the job site. Each lot of anchorage assemblies and bar couplers to be installed at the site shall be likewise identified. All unidentified prestressing steel, anchorage assemblies or bar couplers received at the site will be rejected.

The following samples of materials and tendons, selected by the Engineer from the prestressing steel at the plant or job site, shall be furnished by the Contractor to the Engineer well in advance of anticipated use:

- 1) For wire or bars, one 7-foot long sample and for strand, one 5-foot long sample, of each size shall be furnished for each heat or reel.
- 2) If the prestressing tendon is a bar, one 7-foot length shall be furnished and in addition, if couplers are to be used with the bar, two 4-foot lengths of bar equipped with one coupler and fabricated to fit the coupler shall be furnished.

Each wire or strand sample shall be cut from separate spools. For post-tensioning strand, samples shall be furnished with anchorage units attached and complete with any distribution plates or assemblies required.

In addition, the Contractor shall furnish at least 2 post-tensioning anchorage assemblies, complete with distribution plates, of each size or type to be furnished, if anchorage assemblies are required and are not attached to reinforcement samples.

All samples submitted shall be accompanied by a written certification from the Contractor that the samples were taken from, and are representative of, each lot to be furnished.

All of the material specified to be furnished for testing shall be furnished to the laboratory free of cost to the City, and it shall be the Contractor's responsibility to make certain that such materials shall be furnished well in advance of the desired time of use in order that there will be ample time for testing and no delay in the work.

For prefabricated tendons, the Contractor shall give the Engineer at least 10 days notice before commencing the installation of end fittings or the heading of wires. The Engineer will inspect end fitting installations and wire headings while such fabrication is in progress at the plant and will arrange for the required testing of the material to be shipped to the site.

No prefabricated tendon shall be shipped to the site without first having been released by the Engineer, and each tendon shall be tagged before shipment for identification purposes at the site. All unidentified tendons received at the site will be rejected. Job site or site as referred to herein shall be considered to mean the location where the members are to be manufactured whether at the structure site or a removed casting yard.

The release of any material by the Engineer shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

#### **412.09 Grouted Keyways and Connections**

Keyways and connections shall be grouted with Class "C" mortar in accordance with the following specifications and the applicable requirements of Section 800.09. The water/cement ratio by weight shall be between 0.30 and 0.35. The consistency shall be such that, upon squeezing a portion of the mortar in the hand, the mortar will form a hard ball without oozing through the fingers or showing surplus moisture on the outside.

The mortar shall be placed in the joint in layers not to exceed 3 inches in thickness. Each layer shall be firmly tamped before the next layer is placed.

No equipment or other loads will be allowed until the grout in keyways and connections has attained a compressive strength of 3,000 psi.

#### **412.10 Inspection and Testing of Precast Units at Off-Site Plant**

If precast units are fabricated at off-site plants, the Contractor shall furnish the Engineer, or his designated representative, ready access to such plant at all times work on the units is in progress, and shall provide suitable facilities for inspecting and testing tensioning, casting, and curing operations, including the taking and storage of concrete test cylinders.

The Contractor shall notify the Engineer, in writing, at least four weeks in advance of the approximate date of start of fabrication of the units, and subsequently shall notify the Engineer three days in advance of the specific date for start of fabrication.

#### **412.11 Staging and Falsework**

Staging and falsework shall be in accordance with the requirements of Section 411.03.

#### **412.12 Removal of Forms and Falsework**

Falsework and forms supporting cast-in-place prestressed concrete members shall not be released until after the prestressing steel for all elements of the structure has been tensioned. Retention of falsework beyond this time may be required under certain structural conditions.

#### **412.13 Safety Requirements**

The Contractor shall post adequate signs prohibiting public access to the site of prestressing operations, and at each end of the member in which prestressing tendons are to be tensioned shall erect barriers adequate to absorb the energy of flying material should any failure occur. During stressing operations he shall adequately prevent passage by anyone between the barriers and the unit being stressed, and shall make

sure that no workmen are in the line of the tendons. Further, the Contractor's attention is drawn to the requirement for safety specified in Section 108.13.

**412.14 Payment**

Prestressed concrete construction shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## 413 Steel and Other Metal Structures

### 413.01 General

The Contractor shall construct steel and other metal structures and shall do related work where and as shown on the plans and in accordance with the applicable requirements specified herein. Materials, workmanship, fabrication, erection, fireproofing, and design of steel structures and related metalwork shall be in accordance with the applicable requirements of the San Francisco Building Code and the following specifications, as applicable:

- 1) Bridges. - “Standard Specifications for Highway Bridges”, of the American Association of State Highway Officials (AASHTO), and “Specifications for Steel Railway Bridges”, of the American Railway Engineering Association (AREA);
- 2) Buildings and Other Structures. - “Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings”, of the American Institute of Steel Construction (AISC); and
- 3) Aluminum Alloy Structures and Metalwork. - “Suggested Specifications for Structures of Aluminum Alloys 6061-T6, 6062-T6, 6063-T5 and 6063-T6”, American Society of Civil Engineers (ASCE).

### 413.02 Shop Drawings

The Contractor shall furnish shop drawings, in accordance with the requirements of Section 106.08, for all steel structures and related metalwork.

### 413.03 Materials

Unless otherwise specified, materials shall be in accordance with the applicable of the following ASTM Specification Designations:

<u>Materials Designation</u>	<u>ASTM</u>
Structural Steel .....	A 36
Structural Rivet Steel .....	A 502
Bolts and Nuts .....	A 307
High Strength Steel Bolts, Nuts and Washers .....	A 325
Carbon Steel Forgings for Pins and Rollers .....	A 235, Class C1
Cold-Finished Carbon Steel for Pins and Rollers .....	A 108
Cast Steel .....	A 27, Grade 65-35
Malleable Iron Castings .....	A 47, Grade 32510
Steel Pipe for Columns and Railing .....	A 53
Light Gauge Steel Sheets .....	A 245
Bronze Castings .....	B 22
 <u>Aluminum-Alloys</u>	 <u>ASTM</u>
Sheet and Plate .....	B 209
Drawn and Seamless Tubes .....	B 210
Bars, Rods and Wire .....	B 211
Extruded Bars, Rods, Shapes, and Tubes.....	B 221
Standard Structural Shapes .....	B 308

### 413.04 Tests of Materials

Unless the Contractor furnishes certified test results from an approved independent recognized testing agency, or mill laboratory, or mill, to prove that the materials are in accordance with the requirements set forth herein, such materials shall be limited to use in minor parts not affecting the strength of the structure.

**413.05 Storage of Materials**

Materials to be stored shall be placed above the ground on platforms, skids, or other supports, and shall be kept free from dirt, grease, and other foreign materials and properly drained and protected from corrosion.

Long members, such as columns and chords, shall be uniformly supported on skids sufficient in number to prevent undue deflection.

**413.06 Bolts, Nuts and Washers**

Unless otherwise specified, all bolts, nuts and washers, including anchor bolts, shall be galvanized. Unless otherwise specified, high strength steel bolts, nuts and washers shall not be galvanized and the method of installation shall be in accordance with the applicable requirements of Section 802.02.

**413.07 Welding**

Welding shall be in accordance with the applicable requirements of Section 806.

**413.08 Galvanizing**

Galvanizing of metalwork shall be in accordance with the applicable requirements of Section 807.

**413.09 Painting**

Painting of metalwork shall be in accordance with the applicable requirements of Section 809.

**413.10 Payment**

Steel structures and related metalwork, satisfactorily constructed as specified, each will be paid for at the lump sum price bid therefor. Any steel structure or related metalwork for which the Proposal does not contain provision for payment shall be constructed as Incidental Work.

## 414 Timber Structures

### 414.01 General

The Contractor shall construct timber structures where and as shown on the plans and in accordance with the applicable requirements specified herein.

Materials, workmanship, fabrication, erection, fireproofing and design of timber structures shall be in accordance with the applicable requirements of the San Francisco Building Code and the “National Design Specification for Stress Grade Lumber and its Fastenings” published by the National Lumber Manufacturers’ Association, which shall be referred to herein as the National Design Specification.

### 414.02 Shop Drawings

The Contractor shall furnish shop drawings, in accordance with the requirements of Section 106.08, for all timber structures.

### 414.03 Materials

Structural Framing Members. - All structural framing members for wood shall be Douglas fir construction grade (1500 f), as graded by the West Coast Lumbermen’s Association. Other species of wood and grade specified shall be in accordance with the applicable requirements of the National Design Specification.

Treated Wood. - All treated wood shall be pressure-treated with creosote. The pressure treatment with creosote, and other preservatives when specified, shall be in accordance with the applicable requirements of Section 415.

Plywood. - All plywood used in locations exposed to weather shall be Douglas fir plywood C-C Grade, and in all other locations, C-D Grade, in accordance with the applicable requirements of the “Douglas Fir Technical Data Handbook”, published by the Douglas Fir. Plywood Association.

Glued Laminated Lumber. - Glued laminated lumber shall be in accordance With the applicable requirements of the “Standard Specifications for Structural Glued Laminated Douglas Fir Lumber”, as published by the West Coast Lumbermen’s Association.

Fasteners for Wooden Members. - Fasteners for wooden members, such as wood connectors, bolts with the required nuts and washers, lag screws, wood screws, spikes, nails, etc., shall be in accordance with the applicable requirements of the National Design Specification. All bolts and lag screws shall be provided with malleable iron or plate washers under heads and nuts. All fasteners shall be galvanized when used in locations exposed to the weather.

### 414.04 Handling and Storage of Wood Members

Lumber and timber shall be protected by the Contractor from the elements, to the satisfaction of the Engineer, until incorporated into the structure for which it is intended.

Untreated lumber and timber shall be open-stacked at least 12 inches above the ground. Lumber and timber that has been treated with preservative shall be close-stacked and piled to prevent warping.

Lumber and timber shall be piled so that it may be readily inspected, and shall be handled in a manner that will avoid injury or breakage. Treated lumber and timber shall be handled with rope slings. Cant hooks, peaveys, or other sharp instruments shall not be used in handling lumber and timber. Undue injury in handling will be cause for rejection.

Materials exposed to the elements through improper storage or transportation shall be subject to reinspection. Materials failing to meet the original requirements of grade and moisture content in reinspection shall be replaced at the sole expense of the Contractor.

### **414.05 Framing of Wood Members**

All wooden members shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full depth, and tenons shall fit snugly. No shimming will be permitted when making joints nor will open joints be allowed.

Wooden columns or posts shall be framed to true end bearings. Mud sills shall be firmly and evenly bedded in solid material. Wooden members shall be connected together in a secure manner so that all forces will be adequately transferred from one member to another. Holes for drift pins and dowels in untreated lumber and timber shall be bored, with a bit 1/16-inch less in diameter than the pin or dowel to be used.

Holes for drift pins and dowels in treated lumber and timber shall be bored with a bit of the same diameter as the pin or dowel. Holes for rods shall be bored with a bit 1/16-inch greater than the rod diameter.

Holes for lag screws shall be bored with a bit not larger than the base of the thread. Holes in small timbers for boat or wire spikes shall be bored with a bit of the same diameter or smallest dimension of the spike, when necessary to prevent splitting.

The use of bolts and other fastenings for the connection of wooden members shall be in accordance with the applicable requirements of the National Design Specification.

Countersinking shall be done whenever smooth faces are required. Recesses therefor shall be saturated with preservative, when specified, in accordance with the requirements of Section 415.01.

Minimum nailing of different connections shall be in accordance with the San Francisco Building Code.

### **414.06 Payment**

Timber structures, satisfactorily constructed as specified, each will be paid for at the lump sum price bid therefor, except as otherwise specified in the Special Provisions.

When timber structures are specified to be paid for on the basis of the quantity of lumber and timber incorporated into a structure, measurement will be made in accordance with the applicable requirements of Section 111.04.

Any timber structure for which the Proposal does not contain provision for payment shall be constructed as Incidental Work.



## 415 Wood Preservative Treatment

### 415.01 General

The Contractor shall treat lumber and timber, required to be treated, with wood preservative, in accordance with the requirements set forth in the Special Provisions and herein.

Timber piles required to be treated shall be pressure treated with creosote unless otherwise specified on the plans or in the Special Provisions.

So far as practicable, all cutting, adzing, boring, chamfering, gaining, mortising, surfacing, and the like, shall be done prior to treatment.

All pressure treatment shall be done in accordance with the applicable requirements of Federal Specification TT-W-571, "Wood Preservation; Treating Practices", and other specifications therein included, except as modified herein, on the plans or in the Special Provisions.

Maximum possible penetration shall be obtained with whatever preservative and vehicle is specified and used, and such penetration shall conform to or exceed that outlined as minimum in the hereinbefore referred to Federal Specification. The depth of penetration, measured at right angles to the surface of the wood, shall be determined by means of borings. After testing, the bored holes shall be filled with tight-fitting treated plugs. Test borings in piles shall be made midway between the ends.

Treated lumber, timber, and timber piles, the surface of which have been damaged by cutting, gouging, boring, or otherwise, in such manner as to reduce the effectiveness of the treatment, will be rejected unless, in the opinion of the Engineer, the damaged treated areas can be satisfactorily repaired. The repair of damaged areas, when permitted, shall be by saturating or coating with a preservative material furnished by the company that pressure treated that particular lot of wood, in accordance with the recommendations of that company.

Unless permitted by the plans or Special Provisions in the case of small quantities of materials, no creosoted or otherwise treated material from stock will be accepted.

When specifically permitted on the plans or in the Special Provisions, small quantities of untreated wood members may receive on-the-job preservative treatment, after cutting, surfacing, boring and the like, by dipping or brushing with the preservative material specified on the plans or in the Special Provisions. Three saturating coats shall be successively applied to every surface, including borings, with adequate drying time allowed between coats, the last coat being applied after the wood members have been framed in place.

Wood members specified for on-the-job preservative treatment, unless otherwise specified, shall not be incised on the surfaces as set forth hereinafter. Preservative shall not be applied to wet wood or to wood surfaces on which free moisture is present.

### 415.02 Inspection

All lumber and timber to be treated shall be in accordance with the applicable requirements of Section 414 and grade marked prior to treatment. Timber piles shall be in accordance with the requirements of Section 402. After treatment, all lumber, timber and timber piles shall be inspected, with respect to the treatment, by an inspector from an independent recognized testing laboratory, or inspection service, approved by the Engineer. Each piece shall be stamped by the inspector with a mark different from that used for grade marking. No preservative treatment inspection stamp will be required for on-the-job dip or brush treatment.

The Contractor shall furnish the City with the official inspection certificate of the laboratory or inspection service.

Treated lumber, timber, and timber piling shall be subject to inspection by the Engineer after arrival at the site or after being placed in the completed structure, and no previous inspection at the plant shall bar rejection in the completed structure.

### 415.03 Handling

All treated lumber, timber, and timber piles shall be carefully handled with rope slings without sudden dropping, breaking of the outer fibers, bruising, or penetration of the surface. Cant dogs, hooks, pike poles or similar tools shall not be used except in the case of creosoted piles where such tools may be used within 3 feet of either end of the piles.

Treated lumber, timber, and timber piles, the surfaces of which have been damaged in handling, will be rejected or shall be repaired as specified hereinbefore in Section 415.01.

#### 415.04 Preparation and Treatment

Lumber, timber, and timber piles which are to be creosoted or otherwise treated shall be air-seasoned, or seasoned by boiling under a vacuum, until all water which would interfere with the treatment process has been removed.

Before treatment, all sawed lumber and timber 2 inches or more in thickness shall be incised on all 4 sides by means of a suitable power-driven machine with cutting teeth designed to give a uniform penetration and a regular pattern. The spacing of the incisions shall be in accordance with the recommendations of the manufacturer of the preservative, and the depths of the incisions shall not be less than the depths set forth in the following table:

<u>Thickness of Timber</u>	<u>Depth of Incision</u>
6" and over .....	3/4"
Over 3" and under 6" .....	1/2"
Over 2" and under 3" .....	1/4"

#### 415.05 Pressure Treatment with Creosote

Pressure treatment with creosote shall be in accordance with the requirements of Table I of Federal Specification TT-W-571, and shall be with the creosote-vehicle combination specified, or if not specified, best suited for the material, its condition and intended use. The creosote used shall be in accordance with the requirements of the ASTM "Standard Specifications for Creosote", Designation D 390. The minimum net retention of preservative shall be 12 lbs. per cubic foot for coal-tar creosote and for creosote-coal tar solutions, and 14 lbs. per cubic foot for creosote-petroleum solution.

#### 415.06 Pressure Treatment with Pentachlorophenol

Pressure treatment with pentachlorophenol, including the preservative solution used, and the degree of retention and penetration, shall be in accordance with the requirements of Table II of Federal Specification TT-W-571 and other specifications therein included, unless otherwise specified.

Pentachlorophenol shall be used where the treated material will not be in contact with salt water, where the use of creosote would be objectionable, where the surfaces shall be paintable, or where specified on the plans or in the Special Provisions, except that unless otherwise specified it shall not be used for timber piles. Special attention shall be given to the type of petroleum solvent used and the period of seasoning after treatment where the requirements of Section 415.08, the plans, or the Special Provisions require the surface to be paintable.

When pentachlorophenol-liquefied petroleum gas solution is used, the solution, retention, and penetration shall conform to the following requirements:

- 1) The solution shall be made up of:
  - pentachlorophenol conforming to requirements of Federal Specification TT-W-570 and;
  - volatile petroleum solvents having a distillation end point not greater than 40°F.
- 2) The retention of pentachlorophenol shall not be less than the following:
  - Under 5" thick .....0.50-pound per cubic foot;
  - 5" thick or over .....0.40-pound per cubic foot
- 3) The penetration in inches or percent of sapwood penetration of pentachlorophenol shall not be less than the following:
  - Under 5" thick .....3/8" penetration or 90% of sapwood;
  - 5" thick or over .....1/2" penetration or 90% of sapwood.

### **415.07 Pressure Treatment with Water-Borne Preservatives**

Pressure treatment with water-borne preservatives, including the preservative solution used, and the degree of retention and penetration, shall be in accordance with the requirements of Table III of Federal Specification TT-W-571 and other specifications therein included, unless otherwise specified.

Treatment with water-borne preservatives shall be used where specifically permitted on the plans or in the Special Provisions, for moderate leaching conditions where there is no exposure to marine borers, and where wood treated with oil-borne preservatives would not be satisfactory due to odor, color, oily surface or possible unpaintability.

Lumber and timber treated with water-borne preservatives shall be dried to a moisture content that will not interfere with the application or retention of paint.

### **415.08 Arsenic and Creosote Preservatives Prohibited Where Accessible to Public**

Wood treated with solutions containing any form of arsenic, creosote or other agent similarly toxic or otherwise hazardous to persons, livestock or domestic animals, shall not be used in locations accessible to persons, livestock or domestic animals, especially in locations where food or beverages are to be prepared, consumed or stored. Preservatives used in such locations shall be of the type that can be satisfactorily painted over without bleeding, and shall be painted over.

### **415.09 Treatment of Timber Pile Heads**

The heads of all treated piles which are not embedded in concrete shall be treated by one of the following methods, after the piles have been driven and cut off to the proper elevation:

- 1) An application of wood preservative conforming to the provisions specified in Section 415.01 shall first be applied to the head of the pile and a protective cap shall then be built up by applying alternate layers of loosely woven fabric and hot asphalt or tar similar to membrane waterproofing, using 3 layers of asphalt or tar and 2 layers of fabric. The fabric shall measure at least 6 inches more in each direction than the diameter of the pile and shall be turned down over the pile and the edges secured by binding with 2 turns of No. 10 galvanized wire. The fabric shall be wired in advance of the application of the final layer of asphalt or tar which shall extend down over the wiring.
- 2) The sawed surface shall be covered with 3 applications of a hot mixture of 60% creosote and 40% roofing pitch, or thoroughly brushcoated with 3 applications of hot creosote and covered with hot-roofing pitch. A covering of galvanized sheet iron shall be placed over the coating and bent down over the sides of each pile to shed water.

The method to be used shall be at the option of the Contractor, unless otherwise provided on the plans or in the Special Provisions.

The treatment of pile heads encased in concrete will not be required.

### **415.10 Fire Retardant Treated Wood**

Fire retardant treated wood shall meet the requirements, for the specific use intended, of the Building Code, Part II, Chapter I, of the San Francisco Municipal Code.

### **415.11 Payment**

Wood preservative treatment, satisfactorily performed, including inspection and handling, shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **416 Masonry**

### **416.01 General**

The Contractor shall do all masonry work, including all Incidental Work necessary or required, to complete all brickwork, concrete block structures, or other masonry, where and as shown on the plans, or where directed, and in accordance with the requirements specified herein.

Materials, workmanship, and installation shall be in accordance with the applicable requirements of the San Francisco Building Code. Mortar used for jointing masonry units shall be Class “B” or “C” in accordance with the requirements of Section 800.09. Mortar shall be mixed with the minimum amount of water necessary to secure proper hydration.

### **416.02 Brick**

Brick shall conform to the requirements of ASTM “Standard Specifications for Building Brick (Solid Masonry Units Made from Clay or Shale)” Designation C 62, Grade MW.

### **416.03 Construction**

All masonry work shall be of the highest quality.

Masonry units shall be built plumb and true to lines, with the courses level, and shall be constructed with tight joints. Bricks, blocks, or other units for walls, shall be laid with the vertical joints aligning over the center of the unit below (running bond). All joints shall be approximately 3/8-inch thick and be completely filled with mortar. Masonry units shall be shoved into place; buttering will not be permitted. Excess mortar shall not be struck off in such a manner as to pull the mortar from adjoining unit faces. Joints shall be finished flush.

### **416.04 Waterproofing of Masonry Walls**

Masonry walls against which earth is to be placed shall be waterproofed as specified in Section 418. The waterproofing shall be a minimum of one square yard per linear foot of wall, unless otherwise specified on the plans or in the Special Provisions, and shall be placed where directed by the Engineer. The remaining portion of the wall against which earth is placed shall be dampproofed as specified in Section 411.15.

### **416.05 Payment**

Masonry and the accompanying waterproofing shall be constructed as Incidental Work and payment therefor shall be included in the price or prices bid.

## **417 Air-Blown Mortar**

### **417.01 General**

The Contractor shall construct air-blown mortar where and as shown on the plans, or where directed, including furnishing the necessary equipment, preparing the surface to receive air-blown mortar, furnishing and installing reinforcement, coloring, placing, finishing, curing, and doing all other related Incidental Work, all in accordance with the requirements set forth herein.

Air-blown mortar shall not be placed during freezing or other adverse weather conditions unless approved protective measures are taken.

Only experienced foremen, gunmen, nozzle men and rodmen shall be employed and, if requested, the Contractor shall furnish satisfactory written evidence of such experience to the Engineer.

### **417.02 Operating Requirements**

Not less than 500 cubic feet of “air per minute, (manufacturer’s rated compressor capacity) at a minimum pressure of 45 psi in the gun chamber, shall be required for proper air-blown mortar placement and adequate “blowout” jet requirements. Water under a pressure of at least 15 psi in excess of air pressure shall also be required. Pressure requirements shall be increased with the height of the operation above the gun and length of hose required.

The cement gun shall be operated with a minimum air pressure of 45 psi in the gun tank when 100 feet or less of hose is used and the pressure should be increased 5 psi for each additional 50 feet of hose required.

### **417.03 Wire Mesh Reinforcement**

Steel wire mesh reinforcement shall be in accordance with the requirements of Section 416.05.

The wire mesh shall be firmly secured in place so that no vertical or transverse displacement will occur during placement of the gunite.

The wire mesh shall be supported on concrete blocks of a thickness sufficient to provide the required clearances.

### **417.04 Materials**

Air-blown mortar shall be a mixture of Portland cement and sand, mixed dry, passed through a cement gun, or other similar device, hydrated at the nozzle and properly shot by air pressure into its final position.

Air-blown mortar shall have the proportion of one part Portland cement by volume, to not more than 4 parts loose, dry sand, by volume.

The word “dry” as applied to the sand means that it shall not contain more than 5% nor less than 3% of moisture.

Sand for air-blown mortar shall consist of material of siliceous, granitic or igneous origin, and shall be hard and durable. It shall be free from oil and injurious amounts of clay, shale, mica or other objectionable materials.

When tested in accordance with the requirements of the ASTM “Method of Test for Amount of Material Finer than No. 200 Sieve in Mineral Aggregates by Washing”, Designation C 117, no more than 4% by weight shall pass the No. 200 sieve.

When tested in accordance with the requirements of ASTM “Method of Test for Organic Impurities in Sands for Concrete”, Designation C 40, sand shall not show a solution color darker than the standard color solution.

The dry sand shall have a particle size distribution such that the percentage composition by weight, determined by test using standard sieves of square mesh wire construction, will conform to the following grading requirements:

<u>Sieve Size or Number</u>	<u>Percent by Weight Passing</u>
3/8" .....	100
No. 4 .....	93 - 100
No. 16 .....	42 - 88
No. 50 .....	7 - 38
No. 100 .....	2 - 10

No particle shall be larger than 3/8-inch in diameter. The sand shall have a fineness modulus of between 2.50 and 3.30. Any variation in the fineness modulus during the progress of the work greater than 0.20 plus or minus from the initial value of the accepted sand, shall be cause for rejection of the sand for further use.

The cement and dry sand shall be thoroughly mixed for not less than one minute in a dry state in a mechanical mixer, except that, where specifically permitted small quantities shall be mixed by hand. Mixed materials, if not placed within one hour after preparation, or if allowed to become damp, shall be rejected.

Air-blown mortar at the age of 7 days shall develop a compressive strength of not less than 3,000 psi, and at 28 days not less than 4,000 psi, unless calcium-aluminate, as specified in Section 417.05, is required.

#### **417.05 Calcium Aluminate**

Calcium-aluminate cement shall be used in accordance with the directions of the manufacturer. The amount of calcium-aluminate cement added to the mix shall not exceed 20% of the total amount of cement used. The time of initial set shall not be less than 15 minutes nor more than 30 minutes. The 7-day and 28-day strengths of the air-blown mortar to which calcium-aluminate cement has been added shall not be less than 1,500 psi and 3,000 psi, respectively.

#### **417.06 Coloring**

When coloring is required, the Contractor, prior to the commencement of work, shall furnish the Engineer samples of the specified color. The Engineer will select the shade. The coloring agent shall be integrally mixed with the air-blown mortar in strict accordance with the manufacturer's recommendations. The color and shade of the completed and cured air-blown mortar shall be uniform.

#### **417.07 Surface Preparation**

All bonding surfaces upon which air-blown mortar is to be applied shall first be satisfactorily cleaned of dirt, vegetable matter, grease, oil, rust, scales and all other substances that would prevent complete and adequate bond.

Concrete surfaces to receive air-blown mortar shall be prepared by wire brushing, using high pressure air and water, sandblasting, combinations thereof, or approved equivalent means, to remove all foreign and loose materials.

Earth surfaces to receive air-blown mortar shall be prepared by removing vegetation, debris, and loose materials; by excavating and constructing embankment, if specified; by moistening and compacting the area to receive air-blown mortar in order to form a firm foundation; and applying an approved soil sterilizing agent prior to placing wire mesh.

#### **417.08 Placing**

Air-blown mortar shall be applied only to those surfaces approved by the Engineer.

Air-blown mortar shall not be applied to surfaces upon which there is free water, but the surface shall be sufficiently damp to prevent absorption.

Ground or gauging wires shall be used as alignment guides to establish thicknesses, surface planes and finish lines.. The wires shall be located at intervals sufficiently close to assure proper thickness of the air-blown mortar throughout, shall each be stretched tight between individual supports, and shall remain undisturbed in place until the finish coat of air-blown mortar has been applied.

Expansion joints shall be constructed as shown on the plans. Expansion joint filler shall be in accordance with Section 411.06. The top or outer 1/2-inch of all expansion joints shall be filled with an approved asphalt-latex emulsion joint sealant. Any mortar that has sealed across any expansion joint shall be neatly cut and removed.

Air and water shall be supplied to the air-blown mortar placing machine under such pressure as necessary to produce the most satisfactory results. The pressure shall be constant and free from pulsation.

The consistency of the air-blown mortar shall be such that there is no tendency for it to flow down the slope or separate while being placed.

In spraying the hydrated mixture on any surface, the nozzle shall generally be held about 3 and not more than 5 feet from the surface. The nozzle shall be held so that the stream will impinge, as nearly as possible, normal to the surface, with the material arriving at the nozzle uniform in stream and texture. Care shall be taken to prevent the occurrence of sand pockets, and if any develop, they shall be immediately cut out and satisfactorily replaced with mortar.

The time interval between successive applications in sloping, vertical or overhanging work must be sufficient to allow initial, but not final, set to develop. At the time the initial set is developing, the surface shall be lightly and carefully broomed to remove all laitance and provide a better bond with succeeding applications.

Construction joints, or the day's work joints, shall be sloped off to a thin, clean, regular edge at a 45 degree slope. Before placing the adjoining work, the sloped edges and the surrounding air-blown mortar shall be thoroughly cleaned and wetted with water, following which the free water shall be blown off with an air jet or removed by other approved means.

Materials that have been mixed for more than 45 minutes and have not been incorporated in the work shall not be used, unless permitted by the Engineer.

#### **417.09 Test Cylinders**

When required by the Engineer, test cylinders shall be taken representing the quality of the air-blown mortar placed by each nozzleman. Each cylinder shall be dated, numbered, and the name of the nozzleman noted, together with the part of the structure into which he placed the gunite. Test cylinders shall be made by shooting air-blown mortar into a mold of 3/4-inch metal mesh (hardware cloth) to make cylinders 6 inches in diameter and 12 inches long. The excess material outside the mold shall be trimmed off with a sharp-edged trowel. About 24 hours after making the cylinders, the hardware cloth form shall be removed and the cylinders stored for curing and testing in accordance with the requirements of ASTM "Methods of Test for Compressive Strength of Molded Concrete Cylinder", Designation C 39.

#### **417.10 Rebound**

Material which rebounds and does not fall clear of the work shall be blown off and removed from the work in a suitable manner, and shall not be reused. When an air blow-out jet is used to remove rebound, care must be taken to avoid interference with the flow of air-blown mortar, or the work of the nozzleman. No rebound material shall be dumped upon streets, into catchbasins, or otherwise into the City sewer system.

#### **417.11 Finishing**

Air-blown mortar surface finish shall be "Class 1, Nozzle Finish" unless specified otherwise. Air-blown mortar finishes shall be of the following classes:

Class 1, Nozzle Finish. - The air-blown mortar shall be brought during application to an even plane and to well-formed corners by working up to ground wires or other thickness or alignment guides.

Class 2, Screeded and Flashcoated Finish. - High spots shall be trimmed off and low spots exposed by using a thin edge screed, by working up against gravity and by employing a slicing motion. A thin finishing flash coat shall be applied to remove rough areas after the ground wires have been removed.

Class 3, Float Finish. - A Class 1, nozzle finish shall first be attained, then lightly rubbed with a flat burlap or rubber pad with a circular or spiral motion. No hand patching will be allowed.

Class 4, Trowel Finish. - A Class 2, screeded and flashcoated finish Shall first be attained, then steel troweled to obtain more-free smooth surfaces with a minimum of trowel pressure. Troweling shall be done not more than an hour after placing the air-blown mortar.

#### **417.12 Curing**

Air-blown mortar lining shall be cured in accordance With the requirements of Section 800.16.

#### **417.13 Payment**

Air-blown mortar satisfactorily constructed, complete in place, as specified, will be paid for at the price bid per sack of cement incorporated into the completed gunite lining.

Each sack of cement shall contain 94 lbs. of cement, net weight. As the cement sacks are emptied, they shall be neatly bundled into bundles of 50 to facilitate counting by the Engineer.



## **418 Waterproofing Concrete and Masonry**

### **418.01 General**

The Contractor shall furnish and apply membrane waterproofing consisting of a coat of primer and a firmly bonded membrane composed of two layers of saturated glass fabric and 3 moppings of waterproofing asphalt, to the surface of concrete or masonry, where and as shown on the plans or specified, including doing all Incidental Work necessary or required for a complete, satisfactory job.

### **418.02 Materials**

Waterproofing asphalt shall conform to the requirements for Type I asphalt of ASTM "Standard Specifications for Asphalt for Use in Constructing Built-Up Roof Coverings", Designation D 312.

Fabrics shall conform to the requirements of ASTM "Standard Specifications for Woven Glass Fabrics Treated with Bituminous Substances for Use in Waterproofing", Designation D 1668.

Primer for use with asphalt in waterproofing shall conform to the requirements of ASTM "Standard Specifications for Primer for Use With Asphalt in Dampproofing and Waterproofing", Designation D 41.

### **418.03 Application**

All concrete and masonry surfaces which are to be waterproofed shall be reasonably smooth and free from holes and projections which might puncture the membrane. The surfaces to be waterproofed shall be dry and shall be thoroughly clean of dust and loose materials.

Primer and asphalt shall be applied in accordance with the manufacturer's specifications. No primer or asphalt shall be applied in wet weather, nor when the temperature is below 65° F., without authorization in writing from the Engineer. The primer shall be applied onto the surface and allowed to dry before the first coat of asphalt is applied. The waterproofing asphalt shall be applied at a temperature of not less than 300° F., nor more than 350° F..

Beginning at the low point of the surface to be waterproofed, the waterproofing asphalt shall be thoroughly mopped onto the primed surface. A strip of fabric of half the width of the roll shall be rolled onto the hot asphalt immediately, and carefully pressed into place so as to eliminate all air bubbles and obtain close conformity with the surface. This strip, and an adjacent section of the surface of the width equal to slightly more than one-half the width of the fabric being used, shall then be mopped with hot asphalt and a full width of the fabric shall be rolled into this, completely covering the first strip, and shall be pressed into place as before. This second strip and an adjacent section of the concrete surface shall then be mopped with hot asphalt and the third strip of fabric shingled on so as to lap the first strip by not less than 2 inches. This process shall be continued until the specified surface is covered, each strip of fabric lapping at least 2 inches over the last strip but one. The specified surface shall then be mopped with hot asphalt. Special care shall be taken at all laps to see that they are thoroughly sealed down.

The work shall be so regulated that at the close of each day's work the final mopping of asphalt shall have been applied to all the fabric in place.

### **418.04 Protection of Membrane**

The Contractor shall submit, for the approval of the Engineer, the method he intends to use to protect the membrane waterproofing during construction.

Any waterproofing membrane which loses its bond with the concrete or masonry shall be removed and replaced with new membrane waterproofing by the Contractor at his expense.

### **418.05 Payment**

Membrane waterproofing satisfactorily applied, complete in place, as shown on the plans or specified, will be paid for at the price bid per square yard of surface to which the waterproofing is bonded and covers.

END PART 4

Part 5

Mechanical Work

Table of Contents

---

500	General Requirements . . . . .	139
501	Steel Work . . . . .	141
502	Piping, Tubing, Fittings, Valves, Appurt. - Mat. and Inst. . . . .	143
503	Ductwork, Appurt. and Access. Mat. and Inst. . . . .	152

---

## **500 General Requirements**

### **500.01 Rules and Regulations**

Mechanical work, equipment and materials, including the installations thereof, shall be in full accordance with the requirements of the National Board of Fire Underwriters; the Pacific Fire Rating Bureau; the State Fire Marshal; the Safety Orders issued by the Division of Industrial Safety, Department of Industrial Relations of the State of California; the San Francisco Building, Fire and Plumbing and Gas Appliance Codes; and any other prevailing codes and regulations pertinent to adequate protective measures and prevention of hazardous conditions.

### **500.02 Permits**

The Contractor shall obtain, at his own expense, prior to start of any mechanical work in buildings and in other locations outside of street areas, all necessary permits from the Department of Public Works for the work covered by the specifications, except as such permits may have been previously obtained by the City.

### **500.03 Adjustment or Relocation of Existing Facilities**

If required to permit the prosecution of the work, adjustment or relocation, as approved by the Engineer, of existing electrical conduit and contained wires, existing pipes or existing ducts, where such conduit and pipes are 1-1/4 inches or less in nominal diameter and the ducts are one square foot or less in cross-sectional area, shall be considered Incidental Work. The adjustment or relocation of larger sized existing facilities, however, unless specifically indicated for such adjustment or relocation on the plans or in the Special Provisions, if necessary as determined by the Engineer, shall be done as directed, as Extra Work in accordance with the requirements of Section 112.

### **500.04 Floor, Wall and Ceiling Openings**

The Contractor shall secure the Engineer's approval of the locations for holes and openings in floors, walls and ceilings, necessary for the installation of mechanical equipment, ducts, piping and appurtenances, and shall keep to a practicable minimum the size of such holes and openings. He shall conduct his operations in such manner as to prevent cracking or otherwise damaged floors, walls and ceilings. He shall close all holes and openings, and repair, in an approved manner, all damage resulting from his operations, leaving no impairment of structural, functional, or architectural quality and shall match the configuration, texture and color of the adjacent existing surfaces. He shall, except as otherwise specified, paint all patched surfaces, with one coat of primer and two coats of finish paint to match the surrounding area. Painting and preparation therefor shall be in accordance with the applicable requirements of Section 809. Holes and openings in or through existing concrete or masonry floors, walls and ceilings shall be made by drilling with proper size carboloy-tipped twist drills, diamond drill bits, or diamond core drills. The use of impact drills of any type will be permitted only with the approval of the Engineer.

### **500.05 Uninspected Work not to be Closed In**

The Contractor shall not cover up nor enclose any of his work until it has been tested by him in the presence of the Engineer and until it has been inspected and approved by the Engineer. Should any of the work be enclosed or covered up before such inspection and test, the Contractor shall, at his own expense, uncover the work, and after it has been inspected, tested and approved, restore such covering and enclosure.

Backfilling shall not commence until after structures, mechanical equipment, piping and appurtenances have been properly constructed, or furnished and installed, as applicable, and inspected, and, if required tested.

**500.06 Damage by Leaks or Breaks**

Damage to any part of the premises or its improvements caused by leaks or breaks in the equipment, piping or appurtenances installed by the Contractor, or caused by leaks or breaks in existing equipment, piping or appurtenances resulting from his operations, shall be considered defects in the work or damage to existing improvements, as the case may be, as set forth in Section 105.10, and as such shall be the responsibility of the Contractor for a period of one year following the date of acceptance of the work in the case of surface improvements.

**500.07 Water Meter Installations**

When water meters are required in conjunction with the contract work, the Engineer will make all necessary arrangements with the San Francisco Water Department for the installation of such meters and, if required, the removal of any existing meters, all at the locations shown on the plans. The installation of each meter, including the service piping thereto, and the connection of such piping to City water mains, will be accomplished by San Francisco Water Department personnel, but all fees and costs therefor shall be solely the responsibility of the Department of Public Works.

The Contractor shall notify the Engineer not less than fifteen days prior to the date on which the Contractor intends to make use of the City-furnished water for contract work, in order to allow San Francisco Water Department personnel sufficient time to complete their respective work.

The Contractor shall make a complete downstream piping connection to each installed water meter.

**500.08 Gas Meter Installations**

When gas meters are required in conjunction with the contract work, the Contractor shall make all necessary arrangements with the Pacific Gas and Electric Company for the installation of such meters at the locations shown on the plans. The installation of each meter, including the service piping thereto, and the connection of such piping to Pacific Gas and Electric Company gas mains and pressure reducing valve, where required, between the meter and the gas mains, will be accomplished by Pacific Gas and Electric Company personnel, but all fees and costs therefor shall be solely the responsibility of the Contractor.

The application for new service shall be made not less than thirty (30) days prior to the completion date of the contract in order that the Pacific Gas and Electric Company may perform the work within the specified contract period.

## 501 Steel Work

### 501.01 Steel and Hardware

Steel, and the fabrication and installation thereof, shall be in accordance with the applicable requirements of Section 802.

All bolts and nuts shall conform to ASTM “Standard Specification for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A 307, Grade “B” and shall be standard machine bolts with cold pressed hexagonal nuts, except as otherwise specified. All bolts and nuts specified to be galvanized shall have a free running fit. Anchor and assembly bolts shall be of ample size and strength for the purpose intended. No existing bolts, nuts, washers, etc., shall be reused in contract work, unless specifically indicated for such reuse on the plans or in the Special Provisions.

### 501.02 Welding

General. - All welding shall be performed in accordance with the applicable requirements of the latest “Standard Code for Arc and Gas Welding in Building Construction”. Serial Designation D 1.0, of the American Welding Society, or the latest Specifications for Fusion Welding of the American Institute of Steel Construction, and Section 806 of these Standard Specifications.

Only those welders who are experienced and have passed qualification tests under the AWS “Standard Qualification Procedures” shall be employed and the Contractor may be required to show Certified employment and test records for each welder.

All welding shall be done in the shop before galvanizing, if the latter is required, except as specifically otherwise permitted by the Engineer.

All welding work to be subsequently galvanized shall be thoroughly cleaned and prepared so as not to impair the quality of galvanizing.

Surfaces to be welded shall be cleaned by wire brushing, chipping or hammering away any loose mill scale, rust, paint or other foreign matter present on the metal. The cleaning shall extend at least two inches on each side of the weld, except as otherwise specified. Welds shall be cleaned each time the electrode is changed.

In assembly and during welding, the component parts shall be held by sufficient clamps or other adequate means to keep the parts in the proper positions and in close contact.

Welds shall show uniform sections, smoothness of metal, feather edges without undercuts or overlays and freedom from cracks, porosity or clinkers. Visual inspection of edges and ends of fillets and butt joint welds shall indicate good fusion with and penetration into the base metal. All burrs and lumps of metal shall be removed, leaving a neat and workmanlike appearance.

All weld slag and spatter shall be completely removed before galvanizing or painting.

Any welds or portions of welds found defective, in opinion of the Engineer, shall be removed and replaced.

Welding of Steel Pipe and Fittings. - All welded joints for steel pipe, attachments and fittings, less otherwise shown on the plans or specified in the Special Provisions, shall be fusion-welded in accordance with the AWS Code for Industrial Piping, using suitable welding rods as recommended by the American Welding Society. All joints shall be open, single “V” type with all pipe and fitting ends scarfed on an approved angle to within 1/16-inch of the inside wall of the pipe or fitting. The abutting ends shall be separated and properly spaced and aligned before tacking. All finished welds shall be of sound metal and shall present a neat and workmanlike finish. All welded pipes and fittings shall be subjected to a hydrostatic test pressure not less than that specified in the Special Provisions, followed by a soap-and-water test for leaks. All defects in the welding shall be corrected. All welds that leak or sweat are defective, and shall be cut away. The pipe and/or fittings shall then be resurfaced and new welds made and retested.

### 501.03 Galvanizing

Galvanizing shall be done where shown on the plans or when specified.

Equipment and materials to be galvanized shall be hot-dip galvanized in accordance with the requirements of Section 807.

## 502 Piping, Tubing, Fittings, Valves, Appurt. - Mat. and Inst.

### 502.01 General

All piping, tubing, fittings, valves and other piping system appurtenances shall be free of defects, and of the make, brand and quality specified, or approved equal. All such piping, tubing and appurtenances shall be installed by the Contractor where and as shown on the plans, or where directed by the Engineer.

The kind and size of pipe, tubing and appurtenances to be used for the particular application shall be as shown on the plans and/or as specified in the Special Provisions. Workmanship shall be of the highest quality, and installation shall be in accordance with the practices recognized as best by the plumbing trade.

When sizes and strengths of pipes are omitted from the plans and not set forth in the Special Provisions, the sizes and strengths shall be adequate for the functions to be performed, as determined by the applicable codes and regulations and as approved by the Engineer, unless heavier materials or more stringent requirements are indicated, in which case the indicated sizes will govern.

All piping shall be erected to accurate lines and grades, and where possible, pipes shall be laid horizontally or vertically, and parallel or

perpendicular to each other and to building walls, to make a workmanlike installation.

All lines, fittings, valves and appurtenances in buildings or elsewhere shall be located so that they can be easily removed or repaired without disturbing other parts of the lines; shall be adequately stayed, braced and anchored, and shall be installed in a neat and workmanlike manner. Appearance as well as utility shall be given consideration.

All vertical lines in buildings shall be supported by brackets or standard clamps and shall not depend upon resting or hanging from other pipelines or equipment.

Maximum clearance beneath overhead piping in buildings shall be maintained.

Union shall be provided at all points where necessary to facilitate the assembly of screwed piping. Fittings required but not shown on the plans shall be furnished and installed by the Contractor at his sole expense to the extent required by Section 103.03.

No hot water line shall parallel a cold water supply line at less than 10-inch center-to-center distance except where necessary in the immediate vicinity of a plumbing fixture being served.

Except as otherwise specified, piping installed in lawn and other planted areas, or under center or traffic island pavement, shall have a minimum of 10 inches of cover; under sidewalk areas, a minimum of 24 inches of cover; and under roadway pavement, a minimum of 30 inches of cover; all measured from the finished ground or pavement grade, as applicable.

### 502.02 Steel Piping and Fittings

General. - Where weight or strength of pipe is referred to in the Special Provisions or on the plans by "Schedule Number" such "Schedule Number" refers to Standard B-36.10 as adopted by American National Standards. Standard Weight pipe is referred to as "Schedule 40" and extra strong pipe is referred to as "Schedule 80".

Steel pipe and fittings used for domestic hot and cold water piping, waste and vent piping, and gasoline piping, shall be galvanized.

Fittings and Flanges. - Screwed fittings for steel pipe, unless otherwise specified, shall be threaded, square band, malleable or cast iron and cut with full threads. Fittings for steel pipe used for waste lines, unless otherwise specified, shall be of the long sweep pattern, east iron drainage fittings.

Flanged fittings for steel pipe, unless otherwise specified, shall be 125-pound cast iron, and shall be in accordance with the requirements of ANS Specification B 16.1 American Standard dimensions, facing and drilling.

Steel butt-welding fittings shall be in accordance with the requirements of ANS Specification B 16.9.

Flanges for steel pipe, unless otherwise specified, shall be forged steel "slip-on" welding flanges, 150-pound standard, welded. inside and outside, or forged steel welding neck flanges, 150-pound standard. Where steel flanges are bolted to 125-pound cast iron flanges, the raised faces on the steel flanges shall be removed.

Fittings and flanges shall be as specified on the plans or in the Special Provisions. Only one make of fittings and flanges will be permitted in the “roughing-in” of the piping system.

Making Up Screwed Joints. - Piping shall be cut square and true, and ends of pipe shall be carefully reamed open to full diameter removing all burrs and sharp edges. Pipes shall be free from tool marks.

Threads on pipes shall be carefully cut with clean dies so that the axes of screwed fittings will coincide with the axes of the pipe to which they are attached.

Threads on stainless steel pipe shall be carefully cut with dies manufactured specifically for cutting threads on stainless steel pipe, and shall be cut in accordance with the pipe manufacturer’s recommendations.

Screwed joints, except for gasoline and diesel fuel oil piping and high pressure hydraulic (oil) system piping, shall be made up with graphite red lead and linseed oil, or approved joint compound.

Pipe make-up dope for gasoline and diesel fuel oil piping shall be a product approved for use in petroleum piping, nonsoluble in gasoline or oil.

Screwed joints for high pressure hydraulic (oil) system piping shall be made up with approved teflon tape thread sealant, suitable for high pressure oil systems.

Screwed fittings shall be run up a minimum of eight full threads. Joint compound shall be applied to the male thread only when assembly is made and all excess compound shall be wiped off all joints. Care shall be taken to keep pipe free from dirt and debris, and compound shall be applied in such a manner that it will not enter pipe lines. Cord, string, caulking, etc., will not be permitted on threaded piping to make joints tight.

Making Up Flanged Joints. - Flanged joints shall be made in accordance with the best standard practice. When making up joints for flanged pipe and fittings, the Contractor shall furnish and install gaskets where necessary, or required.

Gaskets, unless otherwise specified, shall be ring type gasket at least 1/16-inch thick, and made of the material specified in the Special Provisions. Gaskets for 125-pound cast iron flanged joints, or for steel flanges with faces removed which are bolted to 125-pound cast iron flanges, shall be full face.

Flanges shall be carefully cleaned before being gasketed and bolted. Flanged joints shall be made up square with even pressure on gaskets and shall be watertight.

Flanged joint bolts shall be standard machine bolts with cold pressed hexagonal nuts, and both shall be galvanized steel. Flanged joint bolts for pipe submerged in water or sewage shall be of high strength cast iron having a minimum tensile strength of 50,000 pounds per square inch.

### **502.03 Bell and Spigot Cast Iron Piping and Fittings for Plumbing Work**

General. - All cast iron pipe and fittings for sewers, soil lines, wastes, leaders and vents shall conform to the requirements of ASTM “Standard Specification for Cast Iron Soil Pipe and Fittings”, Designation A 74, or Commercial Standard CS-188-59, “Cast Iron Soil Pipe and Fittings”, and shall be marked as specified therein.

All underground sewer, soil, waste and vent lines shall be of extra heavy (XH) weight cast iron soil pipe and fittings.

All cast iron piping for above ground soil lines, wastes, leaders and vents shall be of service (SV) weight cast iron soil pipe and fittings.

All cast iron pipe and fittings shall be concentric, sound, free from all defects, and completely coated inside and outside with coal tar pitch, applied hot.

Fittings for cast iron pipe used in plumbing work shall be of the same make, material, and inside diameter as the pipe with which they are used, and shall be of equal quality and weight, coated both inside and outside with coal tar pitch, applied hot.

Lead for joints shall be in accordance with the requirements for Common Delivered Lead ASTM “Standard Specifications for Pig Lead” Designation B 29.

Making Up Joints and Installation. - The Contractor shall make all joints in accordance with the following requirements:

The spigot end of each piece of pipe shall be inserted into the corresponding bell and full depth of the bell and the spigot adjusted in the bell so as to give a uniform space for the joint, which shall be made of



first quality oakum and pig lead. The oakum shall be thoroughly and evenly packed into the bell so as to fill it tightly for a depth of one inch (allowance shall be made in each joint for not less than one pound of lead for each inch of nominal pipe diameter). The remaining space shall then be filled with pure lead, which has been brought to the proper temperature and cleaned of scum, a bead being left on the outside of the face of the bell sufficient to allow for caulking so that when the joint is properly caulked the lead will be flush with the face of the bell. The use of cold plugs will not be allowed.

In pouring lead, the melting pot shall be kept near the joint to be poured and only one pour shall be made for each joint. The joint shall be perfectly clean and dry when the lead is applied. Dross shall not be allowed to accumulate in the melting pot.

Care shall be taken in making joints to provide suitable escape for the air in the joint when it is being poured.

The joints shall be thoroughly caulked by competent workmen using proper and satisfactory tools, in such a manner as to secure a tight joint without overstressing the iron in the bells. In all cases, the caulking shall be done towards the gate and other points where the lead is likely to be porous, so as to compact it there.

In disconnecting existing pipe and fittings, the joints shall be melted out. The faces of all bells, and six inches of the spigots of all pipe and fittings, shall be thoroughly cleaned of all dirt, scale and other foreign matter before new lead joints are made.

Where pipe is buried underground, trenches shall be excavated so that the barrel of the pipe will have an even bearing along its entire length, and with sufficient clearance provided for any necessary operations in connection with the laying of the pipe. Pipe shall be supported for the entire length, not by the bell ends only, on the required sand bed. Bell holes shall be excavated for each pipe bell or joint and shall be of sufficient size to ensure proper making of joints.

Backfilling for the pipe shall be as specified in Section 703. Where pipes are laid on grades, the pipes shall be installed with the bells upgrade.

#### **502.04 Cast Iron Pressure Piping and Fittings**

General. - Pressure type cast iron pipe shall be in accordance with ANSI Specification for "Cast Iron Pipe Centrifugally Cast in Metal Molds for Water or Other Liquids", Designation A 21.6. Barrel thickness of pipe shall be as specified in the Special Provisions.

Mechanical joints and Tyton joints for cast iron pipe shall conform with ANSI Specification A 21.11.

Flanged joint pipe, unless otherwise specified, shall be made up by threading plain end pipe, screwing the flanges on, and machine-tightening until the pipe protrudes past the face of the flange. The pipe end and the flange shall then be faced giving a flush surface across the end of the pipe and the face of the flange.

Flanges shall be faced and drilled in accordance with ANSI Specification B16.1 for Class 125 and ANSI Specification B 16.2 for Class 250.

Flanged joints shall be made in accordance with the best standard practice and as specified hereinbefore in Section 502.02.

Fittings - Fittings for mechanical and Tyton joint pipe shall be short body, cast iron fittings in accordance with ANSI Specification A 21.10 and joints therefor shall be mechanical joints conforming to ANSI Specification A 21.11. Fittings for cast iron flanged pipe shall be cast iron flanged fittings in accordance with ANSI Specification B16.1 for Class 125 and B 16.2 for Class 250.

Cement Lining. - All cast iron pipe and fittings, unless otherwise specified, shall be cement lined. Cement lining shall be in accordance with ANSI Specification for "Cement Mortar Lining for Cast Iron Pipe and Fittings", Designation A 21.4, except for the thickness requirement, which shall be 1/16-inch minimum.

#### **502.05 Copper Tuning and Fittings**

General. - Copper tubing unless otherwise specified, shall be Type "K" for underground and Type "L" for above ground, hard temper tubing, and shall conform to ASTM "Standard Specification for Seamless Copper Water Tube", Designation B 88. Soft temper tubing shall be used, when specified on the plans or in the Special Provisions, or where directed by the Engineer, for cases where flexibility or a minimum of

joints are desired or in the case of limited access. No bends shall be made in copper tubing except by use of preformed fittings or with tools insuring smooth bands without kinks.

Fittings. - Fittings for copper tubing shall be of the sweated-type, wrought copper, solder-joint type, fabricated in accordance with ANS Specification B 16.22 and meeting ASTM "Standard Specification for Seamless Copper Tube", Designation B 75.

Union shall be the ground joint type and of copper or bronze. Long screw or other similar packed joints will not be permitted.

Elbows, tees and other fittings installed in the vicinity of plumbing fixtures shall be of the drop-ear or flanged type and shall be securely anchored to a suitable backing or to the building framework, as directed by the Engineer, so as to permit no pipe movement at the fixtures.

Dielectric type unions, connectors or couplings, or 6-inch long bronze nipples shall be used at all connections of copper tubing to ferrous metal piping and equipment, unless otherwise specified in the Special Provisions.

All fittings shall be sweated except at connection to equipment and valves where screwed, flared, or flanged fittings shall be used or as otherwise specified. All valves shall be bronze and shall have Iron Pipe Size (IPS) screwed connections or solder type connections.

Making Up Joints. - Copper tubing shall be cut with a tubing cutter or hacksaw, full length with square ends, and shall be fully reamed with a tubing reamer and sandpapered clean before soldering. Cutters designed for steel pipe shall not be used. After cutting, the tubing shall be sized with a sizing tool, if required.

Joints shall be made either with 95-5 tin-antimony or 95-5 lead-tin solder, ASTM "Tentative Specifications for Solder Metal", Designation B 32, Grade 5A, unless otherwise specified. Joints shall be made with torches designed for the purpose; the use of blow torches will not be permitted.

Copper-to-copper joints for condensate return tubing and other tubing to be used for carrying high temperature fluids shall be made by brazing with phosphor-bearing 5% silver solder. If copper-to-ferrous metal soldered joints are specifically called for in tubing for carrying high temperature fluids, such joints shall be made with 35 to 50% silver, phosphor-free solder and an appropriate flux. Extreme care and enough welding tips shall be used to prevent overheating of silver brazed joints. Any joints showing evidence of overheating shall be removed and replaced at the Contractor's expense. Finished silver brazed joints shall show a fillet of bright silver alloy completely around the edge of the joint.

Fastening of Tubing. - Copper tubing shall be fastened to buildings or structures at six-foot intervals to prevent excess noise and vibration, shall be braced to prevent excess swaying, and shall be separated from steel at hangers, straps, etc., with three thicknesses of dielectric tape, except in cases where hangers are of a special copper-plated type.

## **502.06 Hydraulic Fluid Line Tubing and Fittings**

General. - Hydraulic (oil) line tubing shall be American Materials Standard (AMS) 5050E of cold-drawn seamless low carbon steel, annealed for bending and flaring.

Tubing shall be specially processed to insure a clean interior necessary in hydraulic (oil) systems. When delivered to the job site, both ends of each section of tubing shall be capped to protect the interior of the tubing from foreign matter. Tubing shall be of the sizes and wall thickness as shown on the plans.

Tubing fittings shall be as specified in the Special Provisions or as indicated on the plans.

Tubing and fittings shall conform to the specifications and recommended practice of the Joint Industry Conference (JIC) "Hydraulic Standards for Industrial Equipment".

Minimum Bend Radii - When installing tubing, the minimum bend radius of tubing bends shall be as shown in the following schedule:

Tubing Sizes Outside Diameter (Inch)	Minimum Radius to Tubing Center Line (Inch)
1/4 .....	9/16
3/8 .....	15/16
1/2 .....	1 - 1/2
5/8 .....	2 - 1/4
3/4 .....	3
7/8 .....	3 - 1/2
1 .....	4

Tubing shall be free of kinks and flat spots causing an area reduction of more than 20%.

**Making Up Joints.** - When making joints, the burrs shall be removed from the inside of the tubing end and, for flare type fittings, the flare carefully made so that there are no cracks or flaws in the surface coming in contact with the fitting. When tubing is used for high pressure hydraulic (oil) systems, screwed joints to equipment, cylinders, valves, etc., shall be made up with approved teflon tape thread sealant, suitable for high pressure oil systems.

**Fastening or Tubing.** - Tubing shall be supported securely with Super Strut, or equal, channels and O.D. tubing pipe clamps, hot-dip galvanized after fabrication. Supports shall be spaced in accordance with the following schedule.

Tubing Sizes Outside Diameter (Inch)	Distance Between Support (Feet)
1/4, 5/16, 3/8, 1/2	4
5/8, 3/4, 7/8, 1	5

**Cleaning of Lines** - After final assembly, but before making final connections to equipment, and before final tests, all tubing line shall be cleaned by washing with alkaline solution or benzine.

## 502.07 Piping, Tubing, and Fittings of other Materials, Classes and Types

The piping, tubing, and fittings specified hereinbefore in Section 502.02 through 502.06, inclusive, are of those materials, classes and types used most frequently in Bureau of Engineering mechanical construction, replacement and reconstruction, and maintenance and repair jobs. Not precluded is the use of piping, tubing, and fittings as otherwise may be specified in the Special Provisions, including, but not limited to, the following:

Alloy steel pipe and fittings;

Seamless stainless steel tubing and flared-tube fittings;

High silicon iron alloy pipe and fittings, bell and spigot type, extra heavy weight, of "Duriron", "Corrosiron", or equal;

Red brass pipe and fittings;

Asbestos-cement pressure pipe and fittings;

Polyvinyl chloride (PVC) and other plastic pipe and fittings;

Vitrified clay pipe and fittings.

## 502.08 Valves

Valves shall be installed with the stems vertically up, but may, if necessary and approved by the Engineer, be installed with stems in a horizontal position.

Gate valves shall be used where the service requires valves to be either wide open or shut tight.

Globe and angle valves shall be installed so that the pressure is under the disc and shall be placed where and as shown on the plans or where throttling is required.

All valves shall be of the same size as the piping to which they are connected, unless otherwise specified on the plans or in the Special Provisions, or equal. Only valves of one manufacturer shall be furnished and installed, if possible.

No valves, existing in piping to be replaced under any contract, shall be reused or relocated unless specifically designated on the plans or in the Special Provisions for such reuse or relocation.

## 502.09 Insulation of Piping and Appurtenances

Unless otherwise specified herein or in the Special Provisions, piping and tubing, required to be insulated, shall be covered with 85% magnesia asbestos sectional or segmental covering with eight-ounce canvas jacket tightly stretched, neatly pasted on, and securely held in place by two (2) metal bands for each three-foot section. Thickness of insulation shall be as specified on the plans or in the Special Provisions. After the insulation has dried thoroughly, it shall be sized, in place, with an approved lagging adhesive, with anti-mold for ratproofing.

Fittings, valve bodies, stub ends and similar parts, except unions and flanges, unless otherwise specified, shall be covered with 85% magnesia asbestos plastic cement built up to the same thickness as the adjacent pipe covering and then covered with eight-ounce canvas jacket securely held in place and lapped to the canvas of the adjacent pipe insulation. The insulation shall be sized, in place, as set forth hereinbefore.

Unless otherwise specified in the Special Provisions, hot water piping and tubing, however, required to be insulated, shall be covered with an approved fiber glass sectional covering, with standard factory attached canvas pasted smoothly over the insulation, and each three-foot section additionally secured with at least two metal bands. Thickness of insulation shall be as specified on the plans or in the Special Provisions. All fittings and other appurtenances, except unions, unless otherwise specified, shall be covered as set forth hereinbefore or with an approved insulating cement equal to the thickness of the adjoining pipe covering and finished with canvas. All canvas shall be additionally finished with one heavy brush coat of an approved lagging adhesive.

Pipe insulation at hanger and support locations shall be fitted with steel protection saddles.

Any existing insulation damaged during the course of the work shall be replaced.

Piping appurtenances shall not be insulated until after installation, inspection, testing and approval. Pipe shall be clean and dry prior to application of insulation.

Piping normally requiring insulation includes, but is not limited to, steam supply lines, exposed condensate return lines within six feet of floors, and hot water lines.

## 502.10 Piping Identification and Color Code

General. - Piping furnished and installed in new buildings and pipe tunnels shall be identified and the direction of flow indicated by means of approved colored, pressure sensitive, self-adhesive markets, as specified herein. Piping furnished and installed in existing buildings and pipe tunnels shall be labeled similarly only when specifically called for on the plans or in the Special Provisions. The markers shall be applied after all cleaning and painting of the piping and insulation is completed.

The identification shall be applied to all piping, except for that piping which is located in furred spaces without access to permit entrance of personnel, and except for that piping which is buried in the ground or in concrete.

Printed legends and flow arrows shall be applied at all valve locations, at all points where piping enters or leaves a wall, partition, bulkhead, cluster of piping, or similar obstruction, and adjacent to under-floor lighting, and at approximately 20-foot intervals on pipe runs elsewhere. Where different equipment is supplied from a common main, the main shall be identified and each respective branch takeoff properly identified.

Practicable variations or changes in location and spacing of piping identification may be made with the specific approval of the Engineer to meet specific conditions.

Wherever two or more pipes run parallel, the printed legend and other markings shall be applied properly grouped and neatly arranged.

The markings shall be located so as to be conspicuous from any reasonable point of vantage.

Legend and flow arrow backgrounds shall be in the colors indicated in the "Pipe Marking Schedule". Letters and flow arrows proper shall be black except that yellow letters and arrows may be used where brown background is called for, to permit better visibility. All markers shall be placed with the legend parallel to the pipe run.

The sizes of printed lettering and flow arrows shall be used as follows:

<u>Outside Diameter Pipe or Covering</u>	<u>Height of Printed Letter</u>	<u>Minimum Length of Flow Arrow</u>
$\frac{5}{8}$ to 1 - $\frac{1}{2}$ inches	$\frac{5}{16}$ to $\frac{1}{2}$ inch	1 - $\frac{1}{2}$ inches
2 to 2 - $\frac{1}{2}$ inches	$\frac{5}{8}$ to 1 inch	1 - $\frac{1}{2}$ inches
3 inches and larger	2 inches	3 inches

The Pipe Marking Schedule shall be as follows:

<u>Legend</u>	<u>Background Color</u>
Air .....	Green
Blow Off Water .....	Yellow
Boiled Feed Water .....	Yellow
City Water .....	Green
Cold Water .....	Green
Compressed Air .....	Green
Condensate .....	Yellow
Condensate Return-Gravity .....	Yellow
Drinking Water .....	Yellow
Fire-Automatic Sprinklers .....	Red
Fire-Dry Stand Pipe .....	Red
Fire Protection Water .....	Red
Fresh Water .....	Green
Heating Return .....	Yellow
Heating Steam .....	Yellow
Heating Supply .....	Yellow
Hi Press Air .....	Yellow
Hi Press Condensate .....	Yellow
Hot Water .....	Yellow
Lo Press Air .....	Green
Lo Press Steam .....	Yellow
Plumbing Vent .....	Brown
Sprinkler Fire .....	Red
Sprinkler Water .....	Red
Steam .....	Yellow
Treated Water .....	Green

High pressure steam is above 10 psig.

Low pressure steam is 15 psig and lower.

Services not listed shall be provided with suitable legends on colored backgrounds in accordance with American National Standards Bulletin A-12.

All piping shall be dry and clean of any dirt, grease or loose surface material before application of markets.

Backing cards shall be removed and installation completed in accordance with the manufacturer's application instructions.

In lieu of applying the pressure sensitive, self-adhesive markers, the Contractor may elect to paint the colored backgrounds on piping and stencil letters and flow arrows thereover in accordance with the color requirements specified hereinbefore.

**Sewage Pumping Stations.** - Piping and valves furnished and installed In sewage pumping stations, and which are exposed, unless otherwise specified, shall be painted in colors to conform to the following schedule. Services not designated shall be painted as specified in the Special Provisions, or as directed by the Engineer.

<u>Service</u>	<u>Piping</u>	<u>Valve Ring</u>	<u>Valve Spokes</u>
Sewerage Influent .....	Brown	Brown	Brown
Sewerage Influent Drain .....	Brown	Brown	Brown
Sewerage Effluent .....	Black	Black	Black
Sewerage Effluent Drain .....	Yellow-Brown	Yellow	Black
Water Supply from Meter Air Gap .....	Aluminum	Aluminum	Aluminum
Domestic Water .....	Blue	Blue	Blue
Domestic Water Drain .....	Yellow-Blue	Yellow	Blue
Seal Water .....	Orange	Orange	Orange
Seal Water Drain .....	Yellow-Orange	Yellow	Orange
Washdown .....	Green	Green	Green
Washdown Drain .....	Yellow-Green	Yellow	Green
High Pressure Oil .....	Purple	Purple	Purple
Fuel Oil .....	Pink	Pink	Pink

## 502.11 Pipe Hangers and Supports

**General.** - All piping furnished and installed in buildings shall be properly and adequately supported and anchored by hangers, brackets, standard clamps, etc., as applicable, as shown on the plans, or, if not shown, as approved by the Engineer. Any lines which sway, crawl or vibrate shall be supported additionally and braced as necessary, or required. Pipe shall not rest on, nor hang from, other pipelines or equipment.

Plumber's tape or similar strap will not be considered an approved method of support.

Horizontal piping shall be supported in harmony with the exposed structure and, unless otherwise specified, at maximum intervals of ten feet with a separate hanger for each branch over six feet long. Vertical Piping, unless otherwise specified, shall be supported by riser clamps at each floor level and at not over ten-foot intervals.

Hangers shall not be attached to the tension side of beams.

**Expansion Shields.** - All fastenings to concrete, other than inserts, shall be made by using Diamond Expansion Bolt Company expansion shields,. Star Expansion double-interlocking expansion shields, or Western Expansion Bolt Company Forway machine bolt expansion shields, or equal; except as otherwise noted on the plans or specified in. the Special Provisions.

Loads designated by the Engineer as minor may be supported with Philips Drill Company, or equal, flush shells.

Unless otherwise allowed, inserts shall be used for new construction.

## 502.12 Escutcheons, Sleeves and Flashing

Chromium plated pressed steel floor and ceiling plates, unless otherwise specified, shall be furnished and set in place on all pipes that pass through finished floors, walls and ceilings in buildings. These plates shall be held securely in place with set screws and set with provision for the movement of the pipes.

**Sleeves.** - All pipes passing through rough holes made in existing concrete floors, walls and ceilings of buildings, unless otherwise specified or shown on the plans, shall be operated by means of pipe sleeves made of galvanized sheet metal of gauge adequate for rigidity, approximately one inch larger in diameter than,

and concrete with, the enclosed pipe and extending the full thickness of the concrete. Where piping is to be insulated, the sleeves shall allow for the full thickness of the insulation, plus one-half inch clearance all around. Pipe sleeves passing through such existing concrete shall have the spaces around the sleeves filled and neatly pointed with an approved cement mortar. Spaces between pipes, or pipes and insulation, and sleeves shall be first packed with oakum and then filled mastic at both ends.

All pipe passing through smooth machine-cored holes made in existing concrete floors, walls, and ceilings of buildings, unless otherwise specified or shown on the plans, shall have the same clearances, packing and mastic as specified hereinbefore.

Pipes shall pass through new building construction, existing concrete walls below grade and concrete floor slabs on ground as detailed on the plans or specified in the Special Provisions.

Flashing. - Flashing for all piping through roofs, unless otherwise specified, shall be made with sheet lead weighing not less than eight pounds per square foot and extending not less than ten inches in all directions from the pipe. A lead pipe collar of the same thickness, and not less than eight inches in height, shall be attached by a wiped joint. This flashing shall then be counter-flashed with a piece of lead pipe of the same thickness as the collar, turned down inside of the pipe and down over the lead flashing four inches.

### 502.13 Contractor to Clean Lines

After final assembly, but before making final connections to equipment, pumps, valves, meters, etc., and before final tests are made, the Contractor shall, unless otherwise specified, flush clean the inside of all lines by blowing with air, washing with water, or by other methods approved by the Engineer.

### 502.14 Testing

Except as otherwise specified or covered by San Francisco Plumbing and Gas Appliance Code, the Contractor shall subject all completed piping and appurtenances furnished and installed under the contract. to a hydrostatic test pressure not less than that specified in the Special Provisions. Gravity drainage systems shall be tested by filling the system with water to the highest point of overflow or by subjecting the system to an equivalent pressure. Gauge pressure readings shall stay constant for one hour unless otherwise specified. If leaks exist, the Contractor shall make proper repairs and replacements and repeat the testing until the piping satisfactorily withstands the test pressure. Caulking of leaking threaded joints will not be permitted.

Upon completion of the hydrostatic tests, the Contractor shall put each portion of the work completed under the contract through an operational test, and shall adjust, correct, or properly repair, as the case may be, all leaks and malfunctions revealed by the test until the piping facilities are leakfree and operate properly, all as determined by, and the the satisfaction of, the Engineer.

The Contractor shall furnish all equipment, apparatus and materials necessary, or required, to properly conduct the tests.

All testing shall be done in the presence of the Engineer, and where applicable, in the presence of the Chief Plumbing Inspector or his authorized representative.

In order to expedite the work, piping facilities may be tested in sections, approved by the Engineer.

Testing of all underground piping shall be done prior to backfilling the pipe trenches.

The Contractor shall, when applicable, furnish at his own expense, a certificate of inspection from the Bureau of Building Inspection, Department of Public Works, City and County of San Francisco, certifying that all plumbing system and gas piping regulations have been carried out fully.

## **503 Ductwork, Appurt. and Access. Mat. and Inst.**

### **503.01 General**

All ductwork and appurtenance and accessories, including, where applicable, ducts, turning vanes, dampers, access doors, registers, grilles, diffusers, isolation joints, flexible connections, hangers, supports, etc., shall be as specified herein, or approved equal. All such ductwork and appurtenances and accessories shall be installed by the Contractor where and as shown on the plans, or where directed by the Engineer. All direct drive blower units and exhaustor units shall comply with the applicable sections of the San Francisco Electrical Code.

### **503.02 Sheet Metal Ducts**

The duct information shown on the plans is correct for design purpose. The Contractor may vary the location and proportions of the ducts as required by field conditions; however, the equivalent cross-sectional area must remain undiminished.

All ducts shall be diagonally creased for stiffness and all ducts located outside buildings shall be made weatherproof.

Changes in direction or elevation shall be made, wherever possible, only by curved sections, except as otherwise shown on the plans. Changes in sizes of ducts shall be made by uniformly tapering sections.

Every effort shall be made to keep the centerline radius ratio of elbows at 1.5 or more.

Metal ventilation ducts, except as otherwise specified, shall be constructed in accordance with the recommendations on construction for regular sheet-metal ducts or on construction for round and flat-oval ducts, as applicable, of the latest revision of the ASHRAE Guide and Data Book, or "Duct Manual and Sheet Metal Construction for Ventilation and Air Conditioning Systems" of SMACNA. Bolted joints shall be made air-tight with approved chromate gasketing, 3/4-inch wide.

All field joints shall be taped for vapor and air-tightness with an approved tape.

Elbows and transition sections shall be formed with Pittsburgh corner seams.

Double compounded elbows and other complicated fittings shall be constructed with double-seam corners.

### **503.03 Turning Vanes**

All elbows having centerline radii of less than 1.5 times the width of the duct in the direction of the turn, including all square-turn elbows, shall be fitted with turning vanes so designed that each elbow loss will not exceed, by 10%, the normal loss in an elbow having a centerline radius 1.5 times the duct width. Turning vanes shall be riveted securely to the sides of ducts at the correct angle.

### **503.04 Splitter Dampers**

Adjustable splitter type deflector dampers, each of length equal to one-half the width of the duct, shall be furnished and installed where shown on the plans for branch ducts or wherever necessary to provide complete control for balancing air flows as called for on the plans. Dampers shall be constructed to conform to Figure "B", Plate No. 28, of SMACNA "Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems" (with all supplements issued) and as shown on the plans. Each damper shall be located so that it will be readily accessible for inspection and adjustment. All metal parts shall be galvanized or treated with rust inhibitor after assembly.

### **503.05 Access Doors**

Access doors shall be provided on ducts at all fire damper locations and wherever access for cleaning and servicing of equipment will be required. Duct access doors shall be constructed to conform to Plates Nos. 30 and 31 of SMACNS "Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems" (with all supplements issued) and as shown on the plans.



### **503.06 Registers, Grilles and Diffusers**

Registers, grilles and diffusers shall be as indicated on the plans or in the Special Provisions and shall be fitted with sponge or foam rubber gaskets under the rims to prevent smudging of adjacent surfaces.

### **503.07 Isolation Joints**

Dielectric isolation strips of an approved chromate gasket Material shall be furnished and installed at all points of connection of aluminum and steel or of aluminum and brass.

### **503.08 Flexible Connections**

Flexible connections, in general, shall be made with neoprene impregnated canvas, or other approved similar type connection material, designated to prevent the transmission of vibrations, and shall be attached securely to fans or blowers and ducts with metal bands and clamps, but not stretched too tightly.

Flexible connections between fans or blowers and ducts for sewage pumping and treatment plant ventilation systems shall be made with approved 32-ounce weight, heavy grade, fiber glass fabric coated with neoprene, which shall be resistant to alkalis, acids, corrosive gases, oils, solvents and grease, and shall withstand high pressures and vacuums. The fabric shall be fastened to fans or blowers and ducts with an approved nonpourable cement, applied in a band 1/8-inch thick by 4 inches wide and bonded securely in place with bolted 2-inch wide straps. The straps shall be tightened to allow a layer of nonpourable cement, 1/8-inch thick, to remain between the duct and the fabric to form a flexible vapor and pressure-tight joint.

### **503.09 Hangers and Supports**

Hangers and supports for ducts shall be furnished and installed to conform with the applicable Plates in the SMACNA "Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems" (with all supplements issued) and as shown on the plans.

All sharp exposed angles and surfaces on hangers over, or adjacent to, walkways shall be rounded.

### **503.10 Location of Ducts**

All ducts shall be run parallel and perpendicular to floors, walls and ceilings, and shall follow the general lines of rooms to make a neat and, where applicable, symmetrical, installation. All ductwork shall be located near the ceiling or shall hug walls in order to give a maximum of headroom and free space.

### **503.11 Protection of Fans in Sewage Pumping and Treatment Plants**

The interior surfaces of ventilating fans, furnished and installed in sewage pumping and treatment plants, shall be painted with "Amercoat", or equal, material, which shall resist corrosion by hydrogen sulfide, ammonia and other common sewage gases and vapors under dry and wet conditions. Coatings and preparation shall be as follows:

Surfaces to be painted shall have all weld splatter removed, rough welds and sharp edges ground smooth, and shall be dry sandblasted to provide a surface free of all millscale, rust, paint or foreign matter. Immediately thereafter one prime coat of "Amercoat" No. 23 Prime Coat, or equal, shall be applied. After priming, two coats of "Amercoat" No. 23 Body Coat, or equal, and three Coats of "Amercoat" No. 33 Seal Coat, or equal, shall be applied. Total film thickness shall be not less than .010 inches (10 mils).

### **503.12 Balancing of Ventilation Systems**

The Contractor shall balance the ventilation systems to provide the air quantities indicated on the plans for each outlet.

Immediately before balancing, all dampers shall be placed in a neutral position, the rotating equipment shall be lubricated and checked for proper rotation, and air filters shall be cleaned thoroughly.

The Contractor shall begin by taking readings across the supply or return fans with a calibrated anemometer, velometer or Pitot tube. Care shall be taken to obtain an average velocity over each face area. All registers, grills and diffusers shall then be read and adjusted to obtain the proper quantity and diffusion of air in each area. After all dampers have been adjusted and the systems are balanced, the Contractor shall submit to the Engineer six copies of a list of all outlets indicating the outlet location, air quantity in cubic feet per minute, and air velocity in feet per minute. In addition, the Contractor shall list the fan speed and motor speed, current and voltage.

The Contractor shall furnish all testing equipment and materials necessary, or required, for balancing of the air systems, all subject to the approval of the Engineer.

END PART 5

## Part 6

# Electric Work

### Table of Contents

---

600	Electrical Work . . . . .	156
601	Rigid Steel Conduit, Galvanized . . . . .	164
602	Electrical Metallic Tubing . . . . .	167
603	Flexible Conduit . . . . .	168
604	Rigid Plastic Conduit . . . . .	169
605	Plastic Coated Rigid Steel Conduit . . . . .	170
606	Electrical Boxes . . . . .	171
607	Materials, Devices and Appurtenances . . . . .	172
608	Wire and Cable . . . . .	173
609	Payment . . . . .	177

---

## **600 Electrical Work**

### **600.01 General Requirements**

The following are standards and codes applicable to electric work. The latest revision at the time of receipt of Bids shall be used.

American National Standards Institute (ANSI)  
American Society for Testing and Materials (ASTM)  
American Wire Gage (AWG)  
California Administrative Code, Title 8, Subchapter 5  
California Administrative Code, Title 24  
Electrical Safety Orders  
General Order 95 of the Public Utilities Commission  
Institute of Electrical and Electronic Engineers (IEEE)  
Institute of Traffic Engineers (ITE)  
Insulated Power Cable Engineers' Association (IPCEA)  
National Electrical Code (NEC)  
National Electrical Manufacturers Association (NEMA)  
National Electrical Safety Code (NESC)  
National Fire Protection Association (NFPA)  
Occupational Safety and Health Act (OSHA)  
Rules for Overhead Electrical Line Construction  
San Francisco Electrical Code (SFEC-84)  
Underwriters' Laboratory (UL)

The Contractor shall obtain, at his own expense, prior to start of any electrical work in buildings and in other locations outside of street areas, all necessary permits from the Department of Public Works for the work covered by the specifications, and shall deliver the certificate of final inspection to the Engineer upon completion of the work. City work is exempt from electrical permit fees.

### **600.02 Adjustment or Relocation of Existing Facilities**

If required to permit the prosecution of the work, the adjustment or relocation, as approved by the Engineer, of existing electrical conduit and contained wires, existing pipes or existing ducts, where such conduit and pipes are 1-1/4 inches or less in nominal diameter and the ducts are one square foot or less in cross-sectional area, shall be considered Incidental Work. The adjustment or relocation of larger sized existing facilities, however, unless specifically indicated for such adjustment or relocation on the plans or in the Special Provisions, if necessary, as determined by the Engineer, shall be done as directed, as Extra Work in accordance with the requirements of Section 112.

### **600.03 Floor, Wall and Ceiling Openings**

The Contractor shall secure the Engineer's approval of the locations for holes and openings in floor, walls and ceilings, necessary for the installation of electrical equipment, conduit, and appurtenances, and shall keep to a practicable minimum the size of such holes and openings. All requirements of Section 500.04 shall apply to the work under this Section, except that the use of any type of impact drill will not be permitted in basement walls or in sidewalks directly above basements.

### **600.04 Uninspected Work not to be Closed In**

The Contractor shall not cover up nor enclose any of his work until it has been tested by him in the presence of the Engineer if testing is required, and until it has been inspected and approved by the Engineer. Should any of the work be enclosed or covered up before such testing and inspection, the Contractor shall, at his own expense, uncover the work and, after it has been tested, inspected and approved, restore such covering and enclosure.

### **600.05 Electric Service**

The City will order the required electric services and pay all costs directly to the Pacific Gas and Electric Company. Any service equipment, materials and connections that are the responsibility of the Contractor shall comply with the current rules of the Pacific Gas and Electric Company.

For service other than for street lighting or traffic signals, the Contractor shall communicate with the Pacific Gas and Electric Company to determine the extent of the work that Company will perform, and the labor and materials the Contractor must furnish.

The Contractor shall make all arrangements with the Pacific Gas and Electric Company for the connection of electric services and, if required, for the installation of meters.

The Pacific Gas and Electric Company will make electric connections in their service handholes and manholes, and will install pole riser conduit and wiring from their service poles to the City pull box adjacent to each such pole.

Conduit and conductors from the work to handholes and manholes for service connections shall be furnished and installed by the Contractor, and will be paid for under the appropriate Bid item when conduits are bid at unit prices.

The Contractor shall be responsible for all materials and services required of him and for all charges by the Pacific Gas and Electric Company for energy used during testing and adjusting of the work, or for energy supplied for construction purposes. He shall do such work, furnish such materials and pay such charges as Incidental Work, payment for which shall be included in the price or prices bid.

### **600.06 Bonding and Grounding**

All steel conduits terminating in manholes, pull boxes, and bases of standards and traffic signal controller shall be effectively bonded, both together and to exposed metallic surfaces of traffic signal controllers, metal standards and other equipment, by means of grounding bushings, bonding jumpers, grounding "studs" and screw-type pressure solderless lugs, as applicable.

Materials and devices used for bonding and grounding shall be in accordance with the requirements of Section 607 and wherever employed in this regard, the machine screws, lock washers and nuts shall be stainless steel.

Conduit bushings with grounding wedges and lock nuts may be substituted for grounding bushings. The Contractor shall furnish and apply an anti-oxidant coating on all exposed junctions of bonding and grounding materials.

### **600.07 Service Interruptions**

Where work under the contract requires connection to existing services and it is necessary to keep the existing facilities in operation, as determined by the City, all service interruptions shall be held to a minimum and shall be scheduled in advance by the Contractor and approved by the Engineer.

Extra shifts of work resulting from the requirement that service cut-over operations be made at other than regular working hours, shall be done at no additional cost to the City.

### **600.08 Safeguarding Fire Alarm Systems**

The Contractor shall not cut into any existing City fire alarm conduit, Shall not disturb, splice or cut any existing City fire alarm wiring, and shall take every precaution necessary, or required, to protect such conduit and wiring.

He shall be responsible for the repair or replacement, as required, to the satisfaction of the General Manager of the Department of Electricity and the Engineer, of any damage to existing fire alarm facilities resulting from his operations.

### **600.09 Work at Utility Facilities**

The Contractor shall conduct his work in manholes, vaults, handholes, and pull boxes of the Pacific Bell Company, the Pacific Gas and Electric Company, the Public Utilities Commission of the City and County of San Francisco, the Department of Electricity, and in all other such facilities not owned by the Department of Public Works, in strict accordance with the requirements of the owners thereof. He shall notify the owners of manholes, vaults, handholes, and pull boxes at least 48 hours before commencing work therein.

The Contractor shall not commence the installation of conduit into any manhole, vault, handhole, or pull box until an authorized representative of the owner thereof has designated the point of entry of the conduit. The Contractor shall install the conduit where designated.

Conduit installed to utility company manholes or handholes shall terminate within the wall thereof at a point 3/4-inch from the inside face of wall. The manhole or handhole wall shall be refinished and rounded off with Class B mortar to conform to the interior surface.

The Contractor shall not connect or disconnect any wire or cable, except that exclusively for traffic signal control, in any such manhole or vault.

All persons entering or leaving manholes or vaults shall do so only by ladders, so as to avoid damage to cables and other facilities. Suitable barricades shall be placed around each open manhole, handhole, or pull box, and a flagman shall be stationed at the manhole during the entire time the manhole cover is off, in accordance with the applicable requirements of Section 110.12.

### **600.10 Nameplates, Signs and Markings**

General. - Unless otherwise specified on the plans or in the Special Provisions, the Contractor shall furnish and install nameplates and signs in accordance with the following provisions:

Nameplates. - The following shall be equipped with nameplates:

- 1) All motors, motor starters, motor control centers, control stations, control panels, and time switches;
- 2) Disconnect switches, fused or unfused; switchboards and panelboards; circuit breakers, contactors, relays, or other control devices in separate enclosures;
- 3) Power receptacles where the nominal voltage between any pair of contacts is greater than 150 volts;
- 4) Wall switches controlling outlets for lighting fixtures or equipment, where the outlets are located not within sight of the controlling switch;
- 5) Telephone, intercom, radio, television and other special electrical systems shall be properly identified at junction and pull boxes, terminal cabinets, and equipment racks;
- 6) Signal outlets, such as antenna, radio, television, microphone, audio-visual, and controls, such as volume controls and channel selectors; and
- 7) High voltage boxes and cabinets (above 600 volts).

In addition, terminal blocks shall be furnished with legend strips, properly inscribed with circuit function or to correspond with notations on pertinent wiring diagrams. Legend strips shall be enclosed in clear plastic sheathings.

Nameplate inscriptions shall adequately describe the function or use of the particular equipment involved, and shall be subject to approval of the Engineer. Where nameplates are detailed on the plans, inscription and size of letters shall be as shown.

Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply; for example: "Panel A. 277/480V, 3ph. 4W".

The name of the machine on the motor nameplates for a particular machine shall be exactly the same as that used on all motor starter, disconnect and control station nameplates for that machine.

Nameplates shall be laminated phenolic plastic, black front and back with white core, with lettering etched through the outer covering. Lettering shall be 3/16-inch high at control stations, thermal overload switches, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4-inch high, unless otherwise detailed on the plans. Nameplates shall be securely fastened to equipment with No. 4 Phillips, round-head, cadmium-plated steel selftapping screws or nickel-plated brass bolts.

Motor nameplates may be of non-ferrous metal not less than 1/16-inch thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable, if approved by the Engineer. Engraved lettering shall be filled with either black or white enamel, as determined by the Engineer.

Warning Signs. - Warning signs shall be furnished and installed in accordance with the following provisions:

- 1) On enclosures containing high voltage equipment, the signs shall read, "DANGER - HIGH VOLTAGE - DO NOT ENTER". Signs shall be 7 inches x 14 inches, with all lettering 1 inch high, except the word "DANGER" which shall have 1-1/2-inch high letters. The aforementioned dimensions are minimum requirements.
- 2) On non-load disconnects and cutouts, the signs shall read "DO NOT OPEN UNDER LOAD". Letters shall be 1 inch high, minimum.

Warning signs shall be of standard manufacture, fabricated of No. 18-gauge steel, or heavier, with a porcelain enamel finish. Letters shall be red on white background.

High Voltage Marking. - All high voltage boxes, cabinets, and conduits in exposed or accessible locations shall be marked with the letters "HIGH VOLTAGE". Markings shall be either by means of stenciling or with approved, pressure sensitive, self-adhesive markers.

The markings shall be located so as to be readily conspicuous at all times from any reasonable vantage point. All surfaces to be identified shall be dry and clean of any dirt, grease or loose surface material before application of markers. Backing cards shall be removed and installation completed in accordance with the manufacturer's instructions.

Letters shall be black on orange background, not less than 1-7/8 inches high. If the dimensions of the surfaces to be marked deem the use of 1-7/8-inch high letters impracticable, then a smaller size lettering shall be used, all as determined by the Engineer. On conduit runs, markings shall be applied at intervals not exceeding 10 feet in any individual area. All markings shall be made after painting of all other work under the contract has been completed. Freehand lettering will not be acceptable.

## 600.11 Wiring Diagrams

Accurate, complete as-built wiring diagrams consisting Of one or more good quality transparencies (sepias are not acceptable) and two sets of prints shall be furnished for each panel, cabinet or enclosure which houses electrical and electronic equipment, communicating equipment, controls and protective devices or which are used as wiring termination panels or cabinets. One set of the prints shall have each print laminated in clear plastic and attached to the inside of the door for single diagrams or enclosed in a clear heavy-duty plastic envelope and placed in a document holder or pocket mounted on the inside of the door for multiple

diagrams. New single print wiring diagrams shall be furnished with brass eyelets, stainless steel screws, nuts, shakeproof washers and brass springs for attachment means.

In addition, the Contractor shall furnish and install a new wiring diagram in existing cabinets to which he has made modifications or circuit changes, or when modifications or circuit changes made by him affect the existing equipment within the cabinets. Existing wiring diagrams shall remain the property of the City, and the Contractor shall deliver them to the Engineer. Each replacement wiring diagram shall be properly dated, and shall make reference to the origin and number of the diagram it supersedes.

### **600.12 Preservation and Cleaning**

After all other work in the area, including sanding and painting has been completed, electrical equipment such as lighting fixtures, panelboards and switchboards shall be cleaned to remove all dust, dirt, grease or other marks, and the work left in a condition satisfactory to the Engineer.

### **600.13 Maintain Existing Electrical Equipment in Service**

General. - Existing electrical equipment or approved temporary replacements shall be kept in operation throughout the life of the contract.

The duration of each shutdown period shall be kept to a minimum by proper planning and preparation, and the provisions of Section 110.08 shall be observed.

Before commencing the work, the Contractor shall submit in writing to the Engineer a description and detailed schedule of his intended operations relative to keeping the electrical equipment in operation as hereinbefore specified. Such schedule shall be part of the Progress Schedule required by Section 107.04.

The Contractor shall furnish and install whatever temporary or permanent conduit, wiring, and equipment is necessary, shall make all connections and shall do all other work necessary to maintain normal operation. At the conclusion of the need therefore the Contractor shall remove all temporary facilities from the site.

The Contractor shall temporarily relocate existing City-owned equipment required to be maintained in service until replaced, where the present location thereof conflicts with an installation under the contract.

The Contractor shall be completely responsible for the maintenance and continuity of operation of any temporary electrical facility installed by him.

Before final acceptance of the work the costs of any emergency work necessary to be performed by City or other forces to repair any facility installed or damaged by the Contractor, including all investigative work relative thereto, shall be borne by the Contractor.

The cost of electrical energy required for any temporary facility will be borne by the City but the Contractor shall bear all costs of any temporary service connections.

**Traffic Signals and Street Lights** - Shut down of traffic signal systems will be allowed during the period from 9:00 A.M. to 4:00 P.M. subject to prior approval by the Engineer. Lighting system shutdowns shall not interfere with the regular lighting schedule unless otherwise permitted by the Engineer.

The Contractor shall notify the Engineer and the Department of Electricity, 901 Rankin Street, Telephone No. (415) 821-5591, at least 24 hours in advance of removing, disconnecting or doing any work on any existing traffic signal equipment, wiring or conduit, or placing in service any traffic signal equipment installed under the contract. Further, in the case of placing in service newly installed signal equipment, he shall similarly notify the Bureau of Traffic Engineering and Operations, Telephone No. (415) 558-3371.

Traffic signal controllers shall be first placed in operation only on Tuesday, Wednesday or Thursday between 9 a.m. and 4 p.m., provided such days do not precede a holiday.

In the event it is foreseen that the Contractor cannot complete the work to restore any existing traffic signal to normal service before 4:00 p.m., he shall install or reinstall temporary wiring at his own expense, to put such equipment in service by that time.

Lamps in traffic signal heads or luminaires installed or relocated by the Contractor that burn out during the life of the contract shall be replaced by him with new, approved equal lamps.

The Contractor shall notify the Engineer and the Bureau of Light, Heat and Power, Tel: 550-6507, 24 hours in advance of the time he will place new street light equipment and circuit in service or request



clearances to work on or interrupt existing high voltage street lighting circuits. Disconnection of any existing or temporary street lights will not be permitted until the new equipment has been tested and properly adjusted.

### 600.14 Underground Work

Removing and Replacing Improvements. - Improvements such as sidewalks, curbs, gutters, portland cement concrete and asphalt concrete pavement, underlying material, lawns and plants, and any other improvements removed, broken or damaged by the Contractor's operations shall be replaced or reconstructed with the same kind of material as found on the work or with materials of equal quality. The new work shall be left in a serviceable condition.

Whenever a part of a square or slab of existing concrete sidewalk, curb, gutter, or driveway is broken or damaged, the entire square, section or slab shall be removed and the concrete reconstructed as above specified.

The outline of all areas to be removed in concrete sidewalks and driveways and in pavement shall be cut to a minimum depth of 0.17-foot with an abrasive type saw prior to removing the sidewalk, driveways and pavement material. Cuts shall be neat and true along score lines, with no shatter outside the removal area.

The excavations required for the installation of conduit, foundations, and other appurtenances shall be performed in such a manner as to avoid any unnecessary damage to streets, sidewalks, landscaping, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appurtenances and foundations. Excavation shall not be performed until immediately before installation of conduit and other appurtenances. The material from the excavation shall be placed in a position that will not cause damage or obstruction to vehicular and pedestrian traffic nor interfere with surface drainage.

Foundations from which electrical equipment has been removed and which are not to be reused in the work, as well as excavated materials not suitable for backfilling of constructing embankment, and all surplus excavated materials, shall be removed from the site by the Contractor as his property within 48 hours and disposed of in a legal manner.

Rock Cutter. - Conduits may be installed under roadway pavement by use of rock cutter in accordance with the following requirements:

Prior to starting trenching operations, the Contractor shall:

- 1) Notify all utility companies and have them mark the locations of their underground facilities on the pavement.
- 2) Use a pipe locator or other means to determine the depth of any pipe or conduit within the proposed trench line and to the depth of the proposed conduit installation.

The Contractor agrees that if any existing underground facilities are damaged due to his trenching operations that he will pay the cost to repair such damaged facilities.

Conduit shall be placed under existing pavement in a trench approximately 2 inches wider than the outside diameter of the conduit to be installed. Trench width shall not exceed 6 inches. The top of the installed conduit shall be a minimum of 9 inches below finish grade.

The outline of all areas of pavement to be removed shall be cut to a minimum depth of 3 inches with an abrasive type saw or with a rock cutting excavator specifically designed for this purpose. Cuts shall be neat and true with no shatter outside the removal area. Dust control shall be provided by using water with the cutting wheel.

The conduit shall be placed in the bottom of the trench and the trench shall be backfilled with commercial quality concrete, containing not less than 564 pounds of cement per cubic yard, to not less than 2-inches below the pavement surface for asphalt-surfaced roadways and 6-inches below the pavement surface for portland-cement concrete-surfaces roadways. This concrete backfill shall be colored red to serve as a warning for future excavations of the location of the installed conduit. The top 2-inches of asphalt surfaced roadways shall be backfilled with asphalt concrete produced from commercial quality paving asphalt and aggregates,

and the top 6-inches of portland cement concrete surfaced roadways shall be backfilled with commercial quality concrete containing not less than 705 pounds of cement per cubic yard and accelerating admixtures or other provisions of high-early strength. Calcium chloride shall not be used in concrete which will be in contact with metal conduit.

Spreading and compacting of asphalt concrete shall be performed by any method which will produce an asphalt concrete surfacing of uniform smoothness, texture, and density.

Spreading and finishing of portland cement concrete surfacing shall be performed by any method which will produce a portland cement concrete surfacing of uniform smoothness, and texture equal to the adjacent surface.

Except in intersection areas the alignment of the trench shall be adjacent to the concrete parking strip or gutter or where directed by the Engineer.

All trenches shall be backfilled with concrete the same day they are cut. The 2-inch asphalt concrete wearing surface shall be restored on these trenches no later than 3 working days after trenching.

All City noise requirements shall be observed in all operations.

## 600.15 Painting

All electrical equipment furnished and installed by the Contractor shall be painted unless it is factory painted. Existing equipment worked on by the Contractor shall be touch up painted. All painting done by the Contractor shall be according to Section 809.

Equipment cabinets, switchboards, and enclosures for which factory paint is available shall be factory painted. Factory paint shall be by electrodiposition process or equal. It shall consist of one prime coat and two coats of finish at the minimum. The finish shall have a dry film thickness of at least 3 mils. The finish outside color shall be ANSI 61 light gray and the finish inside color shall be ANSI 70 off-white.

All exposed conduits shall be painted to blend in with the background.

For street lighting and traffic signal work, all metal surfaces except luminaires and stainless steel screws shall be painted as follows:

### Prime Painting

First Coat: One (1) application of a zinc dust-zinc oxide paint conforming to the requirements of Federal Specification TT-P641, Type II, applied immediately following the completion of all prepainted preparations.

Second Coat: One (1) application of a pre-treatment vinyl wash primer conforming to the requirements of Caltrans Standard Specifications Section 91-2.07. The vinyl wash primer shall be applied by spraying or brushing to produce a uniform wet surface.

City furnished traffic signal standards shall be primed with one (1) coat of the zinc dust-zinc oxide paint specified above.

### Finish Painting

Two (2) separate and complete applications of finish paint shall be applied. Paint for the first application shall be tinted with a compatible coloring agent to slightly contrast with the color of the final application. The paint used for the finish coats shall be one of the following:

- |   |  |
|---|--|
| 1. Stainless Steel Beige Enamel .....           | Federal Spec. TT-E-1593;                     |
| 2. Alkyd Gloss Medium Gray Enamel .....         | Federal Spec. TT-E-489f                      |
| 3. Traffic Signal Dark Olive Green Enamel ..... | Caltrans Standard Spec., Sec. 91-4.02;       |
| 4. White Enamel .....                           | MIL-E-1115A;                                 |
| 5. Aluminum Paint .....                         | Caltrans Standard Spec., Sec. 91-2-2.08; and |
| 6. Stenciling Paint - Federal Spec. ....        | TT-P-98B                                     |

The total thickness of applied paint at all points shall be not less than 5 mils.

## 600.16 Testing

General. Whenever a unit is shipped in more than one piece, it shall be assembled to assure that it fits together and shall be tested as specified with all components assembled by the Contractor.

Factory Testing. - Electrical equipment units in bulk quantities (cables, panels, lighting transformers, etc.) of the same or similar type, rating, class, and characteristics shall receive a full factory performance test on the first unit, or when specified, the first unit of each batch.

Major electrical equipment units (motor control centers, switchgear, power transformers, engine/generator sets, etc.) each shall be fully factory tested per applicable standards.

All factory test results shall be documented, and copies identifying the applicable equipment unit shall be submitted to the Engineer.

Functional Testing. - Prior to start of functional testing, the Contractor shall perform the following tests in the presence of the Engineer.

Continuity - Each circuit shall be checked and tested for continuity.

Ground - Each circuit and equipment with grounding provision shall be checked and tested for grounds.

Circuits to be energized with a line-to-line voltage of 250 volts or more shall receive insulation resistance tests. These tests shall be made after all equipment has been connected. The insulation shall be tested with a 500 volt d.c. insulation resistance tester with a scale reading 100 megaohms. The insulation resistance shall be 30 megaohms or more.

A functional test shall be made by the Contractor, in the presence of the Engineer, in which it is demonstrated that each and every part of the system functions as specified. Each test shall be performed three times.

## 601 Rigid Steel Conduit, Galvanized

### 601.01 General

The Contractor shall furnish and install galvanized rigid steel conduit complete with fittings and appurtenances, where and as shown on the plans or where required, including all excavating, backfilling, restoring pavement, and other Incidental Work necessary or required for a complete, legal and satisfactory installation.

### 601.02 Material

Rigid steel conduit, including couplings, elbows, and nipples, shall be new, first quality, standard weight, wrought steel, galvanized on the exterior and interior surfaces and furnished with plastic thread protectors. Galvanizing shall be by hot-dipping, electroplating, sherardizing, or metallizing process, and shall meet the latest requirements of the National Electric Code. Each length shall bear the label of the Underwriters' Laboratories, Inc., and the name of the manufacturer.

All surfaces of conduit and fittings shall be free of obstructions, projections, roughness, blisters, scale, sharp edges and rust.

All conduit fittings, such as couplings, elbows, outlet boxes, junction boxes, caps and locknuts, shall be threaded fittings, and, together with covers therefor, shall be galvanized ferrous material.

Covers shall be furnished with neoprene gaskets cemented thereto and stainless steel screws. Gasket cement shall be of the type approved for automotive engine application. Non-cemented surfaces of gaskets shall be coated with a lubricant containing silicon and of the type approved for application on rubber-like materials.

Hot dipped galvanized rigid steel conduit shall be used for all installation underground, outdoors above ground, and cast in concrete.

Rigid steel conduit for above ground use in buildings, except conduit buried in concrete, may have sherardized or equivalent coating.

### 601.03 Installation

General. - Rigid steel conduit shall not be cut with pipe cutters but shall in all cases be cut with a hack saw. Both ends of every length and piece of conduit shall be carefully reamed open to the full diameter, and all burrs and sharp edges shall be removed. Threads shall be cut clean and true with sharp dies. No connections shall be made with defective threads. No pipe fittings, except caps, shall be used. Three piece union couplings shall be used at each point of conduit union. All conduit and screwed fittings shall be securely tightened and installation made in a workmanlike manner.

Except for indoor work in dry locations, the external threads only of all steel conduit and fittings, except at grounding bushings, shall be well painted with conductive pipe joint compound before assembly, so that the compound will not be forced into the conduit in tightening the joints. The heating of any metallic conduits for the purpose of bending is prohibited.

All conduit, including existing conduit intended for reuse, damaged on the job, before and during installation, shall not be used in the work, and shall be removed from the job site immediately.

Conduit shall be brought into pull boxes and junction boxes in such a manner that sufficient space is allowed for proper bonding of the conduits. All conduit shall be installed so that the cable or wire will not be damaged in pulling.

After installation, the Contractor shall clean out all new and reused conduits by pulling a mandrel or steel brush, approved by the Engineer, through each run. At all stages of the work, everything possible shall be done to prevent foreign material from entering conduits.

All ends of conduit not immediately connected or used shall be capped. After conductors have been installed, the ends of conduits terminating in pull boxes and control enclosures shall be sealed with an approved type of sealing compound.

Conduit fittings shall be installed with the cover facing the installer, and so that the cover screws are accessible and not obstructed. The Contractor shall furnish and install all necessary fittings for attaching the conduit at its entrance to equipment.

Where metallic conduits enter panel boxes, pull boxes, or outlet boxes, except where entering concrete pull boxes, the conduits shall be secured in place by galvanized locknuts and bushings, one locknut inside and one locknut outside the box, and a bushing on the conduit end, all drawn tight to insure perfect electrical and mechanical contact. The locknuts shall be tightened against the box without deforming the box. Insulating bushings shall be installed as required by code. Insulating bushings shall have the insulating material permanently fastened to the fittings.

The installation of conduit, to facilities of utility companies or to facilities not owned by the Department of Public Works, shall be in accordance with the requirements of Section 600.09.

Where existing conduits are shown on the plans to be reused and any portions thereof are damaged or the ends and terminal elbows thereof are rusted or lack threads, the Contractor shall furnish and install conduit, elbows and nipples to replace the existing conduit. Such conduit replacement will be paid for as Extra Work. Such Extra Work will be approved only if, in the opinion of the Engineer, the Contractor has made every reasonable effort, including the use of compressed air and approved lubricants and solvents, to use the existing conduit; further, the Extra Work will be subject to the limitation that work to the extent specified to be alterations shall be done as Incidental Work.

On Structures. - Where conduit runs are exposed, whether singly or in multiple runs, whenever possible they shall be installed straight and true, parallel with respect to each other and the adjacent construction, or perpendicular thereto.

Neither perforated strapping nor steel wire will be acceptable as conduit supports. Conduit clamps for surface mounted conduits on steel poles shall be attached using stainless steel round head screws.

A minimum separation of 6 inches shall be maintained between conduits and steam or hot water lines.

Except for offsets required to connect conduits to enclosures, all changes in directions of conduit runs installed on walls and structures shall be made with condulets of the approved type.

Holes drilled for conduit through walls and other structural members shall be completely sealed around the conduit with caulking and waterproofing compounds in accordance with recommendations of the manufacturer.

Surface mounted conduit on poles and standards shall be installed on the side opposite the roadway or intersection. The use of an impact rotary type drill for drilling holes through concrete walls is prohibited.

Conduit and conduit clamps installed on structures, and basement and other concrete walls and ceilings, shall be primed with one coat of Subox Incorporated, Subalox No. 111FD, or Dupont No. 67-Y-744, or equal primer, and finish painted with one coat of approved aluminum paint, all in accordance with the requirements of Section 809.

Each conduit run in basements shall be identified with one-inch high letters stenciled in black at intervals not greater than 18 feet.

Underground. - The Contractor shall lay underground conduit in open trench, except that he may install rigid steel conduit in the ground by opening sections of trench and pushing the conduit from one opening to the next without breaking the surface between openings. However, conduit may be jacked only by a machine which does not rotate the conduit and which applies a constant pushing or pulling force, not impact, provided that the conduit is not damaged nor the galvanized coating removed, and provided that existing underground facilities will not be damaged.

In addition, jacking of conduit will be permitted only when the conduit is preceded by a fitting having a diameter twice that of the conduit being installed. Such a fitting may be a section of conduit or pipe with a reducing coupling and square head pipe plug on the lead end, and a reducing coupling of the proper size on the other end.

If jacking of conduit is employed, inspection holes shall be opened, as required, for the Engineer to determine compliance with the requirements for depth and line.

Except as hereinafter specified, conduit shall not be installed at a depth greater than 36 inches below pavement surface, nor 30 inches below ground surface in unpaved areas; and minimum depth of conduit shall be 24 inches in roadway areas and 18 inches in sidewalk and unpaved areas.

If an existing pipe or duct is in the path of, or obstructs, the laying of underground conduit at normal depth, and if such pipe or duct extends to a depth greater than 3 feet, the conduit shall cross over the pipe or duct. If such pipe or duct extends only to a depth of 3 feet or less, the conduit shall cross one foot below

the pipe or duct.

Conduit installed beneath railway track beds shall be installed one foot below the bottom of the ballast bed.

Where parallel runs of conduits are installed in a common trench, such conduits shall have a minimum separation of two inches.

Conduit holes through any underground walls shall be filled as specified for bridge abutment walls.

Where basements exist under sidewalks in the path of conduit runs, the Contractor shall notify the owners of the affected buildings and arrange for installing the conduit in each such basement. Conduit placed in basements under sidewalk shall be attached to the street retaining wall of the basement or shall be supported from the sidewalk structure immediately adjacent to the retaining wall as determined by the Engineer.

Where underground conduit changes direction, long radius sweeps shall be used instead of short bends, and in no case, except at foundations or where otherwise specified, shall a bend radius of less than 30 inches be used. Bends at foundations or other underground structures shall be of maximum possible radius, in no case less than 12 times the internal diameter of the conduit. Conduit shall not be flattened in bending, and shall be free of kinks and indentations. In addition, unless otherwise directed, the maximum number of bends in any conduit run shall be as follows:

a run of conduit between the bases of standards and controller pedestals shall not contain more than the equivalent of two 90° and one 45° bends;

a run of conduit between pull or junction boxes shall not contain more than the equivalent of three 45° bends;

a run of conduit between the base of a standard or controller pedestal and pull or junction box shall not contain more than the equivalent of one 90° and one 45° bend.

#### **601.04 Payment**

Rigid steel conduit, galvanized, of each size, if the Proposal does not contain a Bid Item therefor, shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.

If the Proposal contains a Bid Item or Bid Items for rigid steel conduit, galvanized, each size thereof for which there is a Bid Item, satisfactorily furnished and installed, complete in place, as specified, will be paid for at the price bid per linear foot.

The quantity to be paid for will be the aggregate length of conduit measured along the actual longitudinal centerline, thereof in place, including all fittings, bends, elbows and bushings in the conduit runs. The length of any fitting connecting sections of conduit of different sizes will be included in the length of the larger size conduit.

If the Proposal includes a Bid Item or Bid Items, other than for conduit, specifically for or specifically including appurtenances such as pull boxes and junction boxes, no deduction will be made from the aggregate length of conduit because of such appurtenances in the conduit run.

## **602 Electrical Metallic Tubing**

### **602.01 General**

The Contractor shall furnish and install electrical metallic tubing complete with fittings and appurtenances, where and as shown on the plans or where required, including all Incidental Work necessary or required for a complete, legal, and satisfactory installation.

All applicable requirements for rigid steel conduit and fittings and the installation thereof shall apply equally to electrical metallic tubing and fittings.

### **602.02 Material**

Electrical metallic tubing shall be cold rolled steel tubing with a zinc coating on the outside and a protective enamel coating on the inside.

Fittings shall meet the same requirements for finish and materials as electrical metal tubing.

### **602.03 Installation**

Electrical metallic tubing may be used at the following locations only:

- 1) In furred spaces;
- 2) In partitions other than concrete or solid masonry;
- 3) For exposed work above switch height indoors, except on boiler structures or in refrigerated rooms;
- 4) In hollow concrete block walls, in the vertical cells or horizontal courses not containing steel;

### **602.04 Payment**

Electrical metallic tubing shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.

## **603 Flexible Conduit**

### **603.01 General**

The Contractor shall furnish and install flexible conduit, complete with fittings and appurtenances, where and as shown on the plans or where required, including all Incidental work necessary or required for a complete, legal, and satisfactory installation.

All applicable requirements for rigid steel conduit and fittings and the installation thereof shall apply equally to flexible conduit and fittings except that flexible conduit shall not be installed buried in the ground or embedded in concrete.

### **603.02 Material**

Flexible conduit shall be spirally wound continuous length steel strip with a continuous zinc coating. Fittings shall be of an approved type which clamp the flexible conduit securely to the fitting.

Liquid-tight flexible conduit shall be hot-dip galvanized, spirally wound continuous length steel strip, with continuous extruded polyvinyl covering and watertight connectors.

### **603.03 Installation**

The installation of flexible conduit shall be in accordance with the following requirements:

- 1) All flexible conduit installed in outdoor or damp locations and inside refrigerated rooms shall be liquid-tight type.
- 2) Flexible conduit shall be used for connection of all motor terminal boxes to conduit stubs, outlets or junction boxes. Flexible conduit connecting to splash-proof or totally-enclosed motors shall be liquid-tight type, regardless of location. Where motors are mounted on sliding bases, the flexible connection shall be of sufficient length to allow full travel of motor on base.
- 3) Continuity of equipment ground shall be obtained by installing inside the conduit a bonding wire, each end of which shall be attached to an outlet or junction box by separate lugs for each wire.

### **603.04 Payment**

Flexible conduit shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.



## **604 Rigid Plastic Conduit**

### **604.01 General**

The Contractor shall furnish and install rigid plastic conduit, complete with fittings and appurtenances, where and as shown on the plans or where required, including all Incidental Work necessary or required for a complete, legal, and satisfactory installation.

All applicable requirements for rigid steel conduit and fittings and the installation thereof shall apply equally to rigid plastic conduit and fittings.

Rigid plastic conduit and fittings shall be impervious to soil or environmental chemicals, and that for use underground shall be designed for direct burial and shall have a minimum wall thickness of 1/8 inch. Only virgin materials shall be used in the manufacture of rigid plastic conduit. Such conduit containing reclaimed materials will be rejected.

Rigid plastic conduit and fittings shall be designed for solvent-weld joining.

### **604.02 Installation**

Cover for rigid plastic conduit shall be as specified in Section 601.03 except that, if not encased in concrete, the minimum cover shall be 30 inches measured from the finished ground or pavement grade, as the case may be.

Connections shall be made in accordance with the manufacturer's recommendations, a copy of which the Contractor shall give to the Engineer in the field. All joints shall be made watertight and vapor-proof. All conduit shall be kept clean during construction.

After the conduit has been aligned, proper fill material shall be placed and carefully and firmly tamped under, around and over the conduit with hand tampers, in accordance with the requirements of Section 703.

### **604.03 Payment**

Rigid plastic conduit, of each size, if the Proposal does not contain a Bid Item therefor, shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.

If the proposal contains a Bid Item or Bid Items for rigid plastic conduit, each size thereof, for which there is a Bid Item, satisfactorily furnished and installed, complete in place, as specified, will be paid for at the price bid per linear foot.

The quantity to be paid for will be as specified in Section 601.04.

## **605 Plastic Coated Rigid Steel Conduit**

### **605.01 General**

The Contractor shall furnish and install plastic coated rigid steel conduit, complete with fittings and appurtenances, where and as shown on the plans or where required, including all Incidental Work necessary or required for a complete, legal and satisfactory installation.

All applicable requirements for rigid steel conduit and fittings and the installation thereof shall apply equally to plastic coated rigid steel conduit and fittings except as otherwise specified herein.

### **605.02 Material**

Conduit shall be as specified for rigid steel conduit, galvanized. Conduit shall be coated with polyvinyl chloride or polyethylene. The exterior thermoplastic coating shall have a minimum thickness of 35 mils.

### **605.03 Installation**

Plastic coated conduit shall be cut only with pipe cutters. Hack saws shall not be used to cut plastic coated conduit. Coated conduit shall be threaded with standard conduit threading dies. Coating shall not be removed prior to the threading, but shall be removed by threading die only. Conduit shall be tightened into couplings or fittings using strap wrenches or approved groove joint pliers.

Plastic coated conduit couplings and conduit damaged by wrenches, groove joint pliers, threading machine chucks or otherwise shall be wrapped with at least one layer of 2-inch wide, 20-mil, minimum thickness, polyvinyl chloride tape, conforming to ASTM "Standard Methods of Testing Pressure-Sensitive Adhesive Coated Tapes Used for Electrical Insulation", Designation D 1000, with a minimum tape overlap of 1/2 inch. Before applying the tape, conduit and fittings shall be cleaned and painted with one coat of rubber resin based adhesive as recommended by the tape manufacturer. Damaged spots in the plastic coating may be repaired by painting over with a brushing type compound as supplied by the conduit manufacturer, in lieu of the tape wrap.

Plastic coated conduit shall be bent with a standard bending tool designed for use on plastic coated conduit, and shall be free of burrs and pits.

### **605.04 Payment**

Plastic coated rigid steel conduit, of each size, if the proposal does not contain a Bid Item therefor, shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.

If the proposal contains a Bid Item or Bid Items for plastic coated rigid steel conduit, each size thereof, for which there is a Bid Item, satisfactorily furnished and installed, complete in place, as specified, will be paid for at the price bid per linear foot. The quantity to be paid for will be as specified in Section 601.04.

## 606 Electrical Boxes

### 606.01 General

Boxes shall be installed in concealed locations flush with finished surfaces. Boxes shall be installed in a rigid and satisfactory manner. Wall-mounted boxes shall be supported independently of conduit by bar hangers in frame construction or fastened directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork. Threaded studs driven . by a powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields. Where boxes are concealed in walls, if not embedded in concrete, the hole shall be no larger than required to receive the box. Free standing boxes shall be secured to concrete floors or slabs with anchors or other approved means. Locations indicated on the plans are approximate.

Boxes shall be furnished with screw-fastened covers. All boxes shall be readily accessible and shall not be installed in finished areas. Pull boxes shall be provided not more than 150 feet apart in long runs, unless otherwise approved by the Engineer.

Where indicated or required, specified boxes shall be installed below grade with cover flush with finished grade in locations outside of paved areas or walkways. If adjacent structure is available, NEMA 3R box may be mounted on structure surface just above finished grade in unobtrusive location.

Exterior boxes in ground and pavement shall be precast concrete complete with concrete or steel cover, drain rock and fittings such as pulling irons, cable racks and ground rods where specifically required.

A concrete slab, 3 feet x 3 feet x 3-1/2 inches, shall be furnished and installed around each pull and junction box installed in unpaved, rock and asphalt concrete sidewalk areas unless otherwise noted.

In addition to cover legends shown on the plans, additional cover legends may be used as applicable. Cover legends shall be confirmed in the shop drawing review process.

Boxes for embedment in structure concrete shall be of code gauge sheet steel of the size as shown on the plans. Boxes shall have gaskets and drains. Each box shall have a grounding lug. Boxes shall have a factory or shop applied final paint finish except where installed in a wet location. At wet locations the boxes shall be hot-dip galvanized. All boxes mounted on concrete walls shall have concrete contact surfaces coated with polyethylene tape or coal tar mastic.

Boxes shall be gasketed cast metal type having threaded hubs in outdoor locations, and shall be flush or surface mounted on exterior surfaces.

Boxes in other areas shall be of the cadmium-plated or zinc-coated sheet metal type. Boxes shall be not less than 1-1/2-inches deep. Ceiling and bracket outlet boxes shall be not less than 4-inches octagonal. Switch and receptacle boxes shall be 2-inches by 4-inches minimum.

Junction boxes for conduits below grade shall be of the watertight, cast metal type. The minimum size shall be 8 inches by 8 inches by 4-inches.

### 606.02 Payment

Electrical Boxes, if the Proposal does not contain a Bid Item therefor, shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.

If the Proposal contains a Bid Item or Bid Items for Electrical Boxes, each type of box for which there is a Bid Item, satisfactorily constructed or furnished and installed, as the case may be, complete in place, as specified, will be paid at the unit price bid therefor.

## **607 Materials, Devices and Appurtenances**

### **607.01 General**

The Contractor shall furnish, and place or install, as the case may be, all materials, devices, and appurtenances necessary for the satisfactory construction of complete legally operable electrical facilities, where and as shown on the plans or where required, and including all other necessary or required Incidental Work.

### **607.02 Payment**

Materials, devices, and appurtenances used in the construction of electrical facilities shall be furnished, and placed or installed, as Incidental Work, and payment therefor shall be included in the price or prices bid.

## 608 Wire and Cable

### 608.01 General

The Contractor shall furnish, install, connect, test and label, where required, all wire, cable and appurtenances, where and as shown on the plans, as required by the specifications and where required for a satisfactory, safe and legally operable installation, including doing all other necessary or required Incidental Work.

### 608.02 Material

Conductors 600 Volts and Below. - Conductors shall be copper with the type of insulation specified. Conductors, including insulation, cabling, jacket, filler, shielding, covering, and testing, shall meet all applicable requirements of IPCEA S-19-81 and S61-402. Conductor sizes shall be not less than those shown.

Conductors No. 8 AWG or larger shall be stranded and have THW insulation. Conductors No. 10 AWG or smaller shall be solid and have THWN insulation. Conductors shall be factory color-coded with a separate color for each phase used consistently throughout system.

Fixture wire shall be furnished and installed in fixtures and at equipment where the specified power and control wire does not have the required temperature rating. Fixture wire shall be 600-volt, silicone rubber insulated, 200°C, type SF-2 fixture wire with stranded copper conductors.

All traffic signal conductors shall be Type UF.

Conductors Above 600 Volts. - High-voltage conductors shall be stranded copper with cross-linked polyethylene (XLP) insulation, extruded semi-conducting strand and insulation shields, copper drain wires and a polyvinyl chloride jacket. The conductors shall be single-conductor, shielded, 5 KV, 133% insulation level, UL Type RHH/RHW, or shielded, 15 KV, 133% insulation level as indicated and shall meet applicable portions of IPCEA S-66-524, NEMA WC7-1971 and AEIC Ionization Level Requirements. Cable shall be UL listed Type Mv-90. All high-voltage conductor splices and terminations shall be made with approved splice and termination kits rated for application to 25 KV system and suitable for the type and size cable furnished. Slip-on type terminators, shall be used suitable for single-conductor, cross-linked polyethylene insulated cable of the size indicated. Terminators rated in accordance with IEEE No. 48, pothead Standards shall be provided.

Equipment Grounding Conductors. - Conductors for equipment grounding shall be stranded copper. Conductors shall have green Type THWN insulation.

Control Cable. - Control cable shall be stranded multiconductor, color-coded, industrial control cable. Cable shall be insulated in accordance with IPCEA S-66-524.

Single conductors (Type 1) shall be nineteen-strand, No. 14 AWG minimum copper conductors, 600-volt, individually insulated with color-coded (IPCEA Method 1) cross-linked polyethylene, conductor up covered with polyester-film tape. Conductors shall have overall PVC jacket.

One twisted and shielded pair (Type 2) shall be seven-strand, No. 18 AWG minimum tinned-copper conductors, 300-volt, individually insulated with polyvinyl chloride. Insulated conductors shall be twisted into a pair. Paired assembly shall be covered with aluminum-polyester cable tape, 12.5% overlap, and tinned-copper drain wire. Conductors shall have overall PVC jacket.

Multi-twisted and shielded pairs with a common overall shield (Type 3) shall be seven-strand, No. 20 AWG minimum, tinned-copper conductors, 300-volt, individually insulated with numeric printed coded polyvinyl chloride. Insulated conductors shall be twisted into pairs. Paired assembly shall be covered with aluminum-polyester cable tape, 12.5% overlap, and tinned-copper drain wire. Conductors shall have overall PVC jacket.

Traffic Signal Multiconductor Cable. - Traffic signal multiconductor cable shall be jacketed with twelve (12) 600-volt insulated, No. 14 AWG, solid, copper conductors. Cable shall meet the requirements of International Municipal Signal Association, Inc., Specification No. 19-1 1983 (or current later date). The function of each conductor and corresponding insulation color code shall be as follows:

<u>Insulation Color</u>	<u>Function</u>
Black .....	Dial 2
Black with white stripe .....	Spare
White .....	Common
White with black stripe .....	Spare
Red .....	Spare
Red with black stripe .....	Spare
Orange .....	Spare
Orange with black stripe .....	Flash
Green .....	Offset 1
Green with black stripe .....	Offset 3

Traffic Signal Inductive Detection Loop Cable. - The cable shall consist of a continuous, unspliced, No. 14 AWG, stranded, copper conductor with 600-volt, type THHN or THWN insulation loosely encased in a flexible polyvinyl chloride (PVC) tube. Tubing shall be rated 105°C and shall have wall thickness of 1/32-inch, inner diameter of 0.182-inch (Min.) - 0.198 (Max.), dielectric strength approximately 900 v/mc, moisture absorption.

### 608.03 Installation

Installation. - Wire and cable shall not be pulled into conduits until conduits have been cleaned. The installation of any wiring in conduits shall not take place until the Contractor has demonstrated to the Engineer's satisfaction and approval that the Contractor has employed all means necessary, or required, to clean and prepare the conduits for the installation of wiring therein.

Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the cable insulation.

Soapstone, tale or UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Raceway construction shall be complete and protected from the weather before cable is placed.

All wires or cables shall be pulled into or out of a conduit at the same time. If new wiring is to be added in a conduit containing existing wiring, the existing wiring shall first be withdrawn. Both the new and the withdrawn existing wiring shall be attached to a common pulling device and drawn into the conduit simultaneously.

No wire or cable shall be pulled by an automobile or truck, but mechanical devices with quick-release mechanisms may be used if such devices are specifically approved by the Engineer. Cable shall be pulled by means of approved cable grips of "wire baskets".

Splices shall not be made on conductors except at pullboxes, manholes, boxes, outlets, devices supplied with pigtails, cabinets or panels. Splices shall not be permitted in conduit bodies. Wire connectors of insulating material or solderless pressure connectors properly taped for all splices shall be used. Soldered mechanical joints insulated with tape will not be acceptable. Vinyl plastic tape of suitable quality is acceptable in lieu of rubber and friction tapes. Connectors shall be approved for the type of conductor material used. Solid conductors shall be spliced with electrical spring connectors. Conductor and cable markers shall be provided at splice points.

Connectors shall be tool applied compression type. Connectors shall be tin-plated high-conductivity copper. Connectors for wire sizes No. 10 AWG and smaller shall be nylon self-insulated locking-spade terminals. Connectors for wire sizes No. 8 AWG and larger shall be NEMA one-hole lugs up to size No. 3/0 AWG, and NEMA two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable.

Terminations at devices with 120-Volt pigtail leads shall be made using self-insulating tubular compression connectors. Compression lugs and connectors shall be installed using manufacturer's recommended tools.

Conductors No. 6 AWG and smaller in panels and electrical equipment, shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Lacing is not necessary in plastic panel wiring ducts. Conductors

crossing hinges shall be bundled into groups not exceeding 12 and shall be so arranged that they will be protected from chafing when the hinged member is moved.

If existing strapping or lacing of wiring is disturbed in the course of the work, the Contractor shall replace or restrap it as applicable.

All wires terminating in a metallic enclosure or any designated termination enclosure shall terminate on a terminal board equipped with screw-type or box-type numbered terminals fabricated from copper or copper-alloy material. Wiring terminating on screw type terminations shall be equipped with self-insulated self-locking, spade-type terminals. Each power and control conductor shall be identified by an approved marking system and means at each terminal to which it is connected. All power and control cables shall have clear, distinctive and permanent marking on the outer surface throughout the entire length showing manufacturer's name or trademark, insulation type letter designation, conductor size, voltage rating, and number of conductors.

All wires and cables shall be of sufficient length to provide for slack loops and routing along the walls in all pull boxes, condulets, switch enclosures, manholes, and handholes. Slack loops shall not be less than 3 feet long in handholes and shall not be less than 6 feet long in sidewalk pull boxes, junction boxes, and manholes.

For traffic signal work all wiring shall be tagged as to origin or destination (such as "SE CORNER") in accordance with the plans and wiring diagrams. Tags shall be made of sheet aluminum or brass and shall be stamped with the appropriate marking, subject to the approval of the Engineer. Tags shall be fastened to the conductors in all pull boxes, manholes, bases of standards, and other enclosures. Additional tagging requirements for traffic signal wiring are set forth hereinbefore.

Control Cable. - No splices shall be made without permission of the Engineer. Splices shall be located where necessary, only in readily accessible cabinets or junction boxes using terminal strips.

Maintaining the integrity of shielding of control cables is essential. Special care shall be taken in cable installation to insure that grounds do not occur because of damage to the jacket over the shield.

After installation and conductor termination the Contractor shall perform tests witnessed by the Engineer to insure that control cable shields are isolated from ground, except at the grounding point. All improper grounds shall be removed at no additional cost to the City.

Conductors Above 600 Volts. - Splices will not be permitted unless specifically indicated or approved by the Engineer. Terminators shall be provided at the high voltage switchgear, unit substation high-voltage switches, and at other locations shown on the plans.

All splices and terminations shall be made in strict accordance with the cable manufacturer's instructions. These instructions shall be submitted to the Engineer for approval before any splices or terminations are made. Splices and terminations shall be made by craftsmen experienced in this work. Once started, any splice or termination shall be completed as a continuous operation.

Two working days' notice shall be given to the Engineer prior to making the splices or terminations to allow the Engineer to witness the actual work if he elects to do so. The ducts, raceways, manholes, pull boxes, etc., required for the high-voltage cables shall be arranged so that the installed minimum bending radii of these cables is 12 times the overall cable diameter.

Testing. - High voltage cable shall be tested after installation in the presence of the Engineer. Each length of each phase cable in the system shall be tested with splices and terminations in place but disconnected from equipment. Necessary test equipment, experienced testing personnel, and necessary electric power shall be furnished.

High-potential tests shall be performed in strict accordance with IPCEA S-660524, Voltage Tests After Installation. Use dc test voltage of 65 KV for 15 KV (133% insulation) cable and 25 KV for 5 KV (133% insulation) cable applied for 15 minutes. Current and voltage shall be recorded as a function of time throughout each test. Test results shall be included in operations and maintenance manuals. Cables not passing tests shall be replaced or tests repeated. Repaired cables must pass the same test.

WARNING: Following these tests, hazardous voltages may exist on the cable. Immediately following tests, cable tested shall be grounded to permit any charge to drain to earth.

**608.04 Payment**

Wire and cable, if the Proposal does not contain a Bid Item therefor, shall be furnished and installed and Incidental Work and payment therefor shall be included in the price or prices bid.

If the Proposal contains a Bid Item or Bid Items for wire or cable, each for which there is a Bid Item, satisfactorily furnished and installed, complete in place, as specified, will be paid for at the lump sum price bid therefor, or at the price bid per linear foot, as the case may be.



## **609 Payment**

Electrical work, satisfactorily constructed or furnished and installed, complete, in place, as specified, will be paid for at the lump sum price bid therefor, except that if electrical work is not shown on the Proposal, it shall be done as Incidental Work, and payment therefor included in the price or prices bid for the improvement of which it is a part.

END PART 6

---

**Part 7****Excavation, Backfill and Embankment****Table of Contents**

---

700	Excavation - General Requirements . . . . .	179
701	Pavement Excavation . . . . .	185
702	Trench Excavation . . . . .	188
703	Trench Backfill . . . . .	189
704	Clearing, Grubbing and Site Preparation . . . . .	191
705	Common Excavation . . . . .	192
706	Embankment . . . . .	194
707	Compaction . . . . .	197
708	Structural Excavation . . . . .	199
709	Structural Backfill . . . . .	200
710	Pervious Backfill Material . . . . .	202
711	Filter Material . . . . .	203
712	Crushed Rock Layer . . . . .	204
713	Riprap . . . . .	205
714	Imported Fill Material . . . . .	206

---

## **700 Excavation - General Requirements**

### **700.01 General**

The Contractor shall do all excavating, backfilling, and restoring of pavement necessary or required to properly construct and install the required work and equipment, including the required removal of existing sewers, City-owned or abandoned structures, foundations, pipes and other improvements and equipment. He shall conduct all excavating operations in accordance with the requirements of the applicable Sections of this 7. Payment therefor shall be as specified in such Sections subject to the provisions of Section 220.

The requirement that the Contractor obtain a street opening permit is waived for Department of Public Works contracts.

Trenches and other excavations shall be made safe and passable by the use of barricades, bridges, and other improved means.

Traffic routing shall be done in accordance with Section 110.

In accordance with Section 373 of the San Francisco Public Works Code there shall be no limitation on the use of labor-saving devices except at the locations specified in Sections 104.04 and 701.06.

Trenches and other excavations shall be sufficiently wide to allow for the proper construction, installation and inspection of the work, but shall not exceed such necessary width.

Tunneling or jacking shall not be used unless specified or approved in writing by the Engineer.

Where the existing finished pavement surface is concrete, including concrete parking strip, concrete gutter, and concrete sidewalk, all cuts therein between pavements to be removed and those to remain in place shall be made in accordance with the applicable requirements of Section 701.03.

### **700.02 Safety Requirements**

All excavating and other earthwork shall be done in conformance with the rules and regulations pertaining to safety established by the California Department of Industrial Relations, Division of Occupational Safety and Health (CAL-OSHA).

The rules and regulations establish minimum standards and prescribe measures to be taken for securing safety in places of employment. The measures shall include the adoption of a Code of Safe Practices for the work, the inauguration and maintenance of an accident prevention program which shall include the inspections, corrective measures, safety meetings, instructions, precautions, illumination, and protective and traffic control measures prescribed by the hereinafter specified rules and regulations.

The Contractor shall do whatever additional work he considers necessary to assure the safety of all persons employed on the work, and of the general public.

Trenches and other excavations shall be guarded against hazard by means of shoring, lagging and bracing in conformance with the applicable Safety Orders issued by CAL-OSHA and the therein prescribed procedures for the installation thereof.

During construction, the Contractor shall construct and maintain satisfactory, substantial, and appropriate barricades and steel plates at all excavations, at locations where materials are stored, and at other hazards. All such enclosures shall have warning lights adequate for public safety.

High rise warning flag units, to provide advance warning for traffic approaching excavations, will be required in all cases where motorists' visibility of the work is limited or obscured. Where required, the Contractor shall provide and maintain safe and adequate passage for vehicular and pedestrian traffic over and adjacent to trenches and other excavations by the use of barricades, bridges and other approved means. Additional traffic safety requirements are included in Section 110.

The Contractor's attention is drawn to the restrictions specified in Section 110.02 on his operations during the Christmas holiday season.

Estimated dates of starting and finishing the various excavations shall show a reasonable and orderly work sequence precluding excessive time for completion of the work at any excavation, and shall be compatible with material and equipment delivery dates.

Excavating shall not be done significantly ahead of the time required for expeditious prosecution of the subsequent work. The Contractor's operations at excavations, and the work necessitating excavation, shall be prosecuted as continuously as practicable, in order that his operations will be in compliance with the requirements of Sections 107.04, 110.02 and 110.05.

The Contractor shall take adequate measures, commensurate with the danger involved, to prevent unauthorized entry by children or others upon the area of excavation operations. The measures shall include the provision of proper and adequate guard railing, solid or chain link fence, and the placement of a difficult to remove weighted cover on each deep shaft excavation.

If the Contractor encounters material in trench or other excavation which he has reason to believe may be hazardous waste, as defined by Section 25117 of the Health and Safety Code of the State of California, he shall immediately so notify the Engineer in writing. If authorized by the Engineer, excavation in the immediate area of the suspected hazardous material shall be suspended until the Engineer authorizes it to be resumed. If such suspension delays the current controlling operation, the Contractor will be granted an extension of time as provided in Section 107.10. The City reserves the right to use other forces for exploratory work to identify and determine the extent of the hazardous material and for removing such material from the site.

### **700.03 Excavations to Have Vertical Sides**

Unless specific provisions in the contract provide otherwise, all trenches and other excavations shall have vertical sides, and shall be no wider at the top than at the bottom, except as required to accommodate successive lifts of lagging. In all cases trenches and other excavations shall be constructed in accordance with CAL-OSHA rules and regulations.

### **700.04 Sheet Piling, Lagging, Bracing and Cofferdams**

General. - The Contractor shall furnish, install and maintain such sheet piling, bulkheading, cribbing, timbering, lagging, underpinning, shoring, bracing, cofferdams, and other temporary construction as necessary to safely support the sides of excavations and any adjacent structures, and to prevent any movement of adjacent ground, pavement or improvements, or danger to life or property, and such construction shall be carried to adequate depths and heights and made as tight as necessary for the proper performance of work.

The manner of bracing excavations shall be in accordance with the rules, orders and regulations of CAL-OSHA.

The use of vibratory hammers and other vibratory equipment will be subject to the approval of the Engineer. However, such approval does not relieve the Contractor of the responsibility for any damages or injuries resulting from the use thereof.

The use of high frequency vibrating equipment, or sonic equipment, for the driving or withdrawal of sheet piling, is prohibited. Unless otherwise specifically approved for each particular location by the Engineer, struts, braces and other temporary construction shall be so constructed as not to pass through volumes to be occupied by concrete structures leaving openings in the concrete which must be subsequently filled.

In excavations where sand or other non-cohesive material is encountered, placing of the necessary lagging or sheet piling shall commence before a depth of 5 feet is attained, and thereafter such lagging shall be driven or lowered progressively with the excavating in a manner such that the sides of the excavation will be completely covered and adequately supported.

Should any sheet piling, lagging, or bracing which has been installed be in any way insufficient for its purpose, the Contractor shall at once provide additional and adequate materials. The provision of any additional supports ordered by the Engineer shall in no way relieve the Contractor of his responsibility for the sufficiency of his precautions.

Excavation safety plans shall be submitted and permits obtained, in accordance with the requirements of Section 106.09. The approval of such plans by the Engineer shall in no way relieve the Contractor of any responsibility or liability, including that for structural adequacy, under the contract, and he shall take all precautions he considers proper for the protection of the public and the work.

Any voids that exist between the outside surface of the lagging and the adjacent side of the excavation shall be immediately backfilled in accordance with Section 703.

Lagging shall not be used as a surface against which concrete is placed unless permitted in the Special Provisions. Adequate space shall be provided within the limits of the excavation, sheet piling, lagging, or bracing, as the case may be, to allow for proper construction of the structure to the alignment and cross sections shown on the plans. If lagging is used for the outside form, the concrete shall be separated from the

lagging by a waterproof membrane, or by other means approved by the Engineer, and any excess width of trench caused by misalignment of the lagging shall be offset by increasing the structure wall thickness. No deviation in the interior alignment or dimensions will be permitted.

Unless otherwise specified or approved, sheet piling, lagging, and bracing shall be removed during backfilling. Vacancies left by such removal shall be immediately backfilled with acceptable material compacted into place. Sheet piling and lagging which during withdrawal fails or breaks, or in the opinion of the Engineer is otherwise incapable of being withdrawn, shall be cut off at least 3 feet below pavement subgrade and the upper part removed. Payment. - When a bid item exists for trench support or excavation support, such work satisfactorily completed shall be paid for in accordance with the Contractor's bid price. When no bid item exists for trench support or excavation support work, such work shall be constructed as Incidental Work.

### **700.05 Excavation Adjacent to Existing Structures - Hazardous Excavation**

The Contractor shall engage the services of a registered engineer to determine the methods and construction sequence to be employed, and the precautions to be taken, to prevent earth slippage or damage to, or displacement of, any improvement or facility, and to design the required temporary supports and construction when it is necessary to excavate:

- 1) adjacent to and below the foundations of existing structures to remain;
- 2) slopes steeper than 1 horizontal: 2 vertical;
- 3) where unstable or unsound soil or a potential slide requires that sheet piling or otherwise temporary construction be used to support earth or slopes and safeguard the work, adjacent property or street pavements;
- 4) or in the area of any existing facility or improvement within or over the required excavation, and specified to be supported, worked around, and protected by the Contractor, other than pipes, mains and ducts the support for which is specified in Section 104.

The Contractor shall submit for review, in accordance with the requirements of Section 106.08, 6 copies of the description or detailed drawings of the proposed methods, construction sequence, and precautionary measures.

The description or drawings shall be signed by a Civil Engineer specializing in soils and foundations, or a Structural Engineer, as applicable, properly licensed by the State of California. Submittal to the City will constitute evidence only that there has been review by a qualified person of the temporary support design, and will in no way relieve the Contractor of any responsibility or liability under the contract. The Contractor shall take all precautions he considers proper for the protection of the public and the work.

The sequence and scheduling of all construction activities shall be included in the Progress Schedule.

### **700.06 Protection of Fill Material**

The Contractor shall protect fill material during stockpiling by plastic sheeting or other acceptable means, to prevent the entry of water during rains. If the material becomes permeated with water and the required compaction cannot be obtained by the Contractor after drying the material, he shall remove such material from the site and replace it with acceptable material, in accordance with Section 706.02, at no cost to the City.

### **700.07 Storage of Excavated Materials**

The Contractor shall store excavated materials at the site only at locations and in a manner that will ensure compliance with the requirements of the specifications. The Standard Specification requirements with respect to public safety, site maintenance, and material protection are in Sections 108.13, 108.17 and 700.06, respectively.

The Contractor's attention is particular drawn to the requirements of Section 110.02 with respect to vehicular and pedestrian movements and access to properties, and access by emergency vehicles and to fire hydrants.

### 700.08 Excavations to be Kept Dry - Dewatering and Disposal of Water

General - The Contractor shall conduct his operations with respect to the handling and disposal of water and sewage in accordance with the requirements of Sections 108.06, 301, 321 and 712.

He shall protect the work from water damage, keep excavations dry and, by proper diversion and pumping, remove therefrom and dispose of all water and sewage that enter upon the work. He shall provide, maintain and operate all pumping equipment required for such purpose during the time concrete or other work is being placed and thereafter as required for the protection of the work. The aforesaid requirements shall be observed as necessary or required prior to the completion of drainage facilities specified or ordered to be constructed under the contract.

Dewatering and the rate and manner of lowering the water table shall be such as to minimize any settlement that might be caused thereby.

Pumping operations for excavations shall be continuous and satisfactory from the time drawdown is first accomplished until all the concrete has been placed. The Contractor shall not allow his pumping operations to be interrupted; shall take adequate precautions to such end; and shall assume full responsibility for any damage that occurs due to fluctuating water table in the area influenced by the dewatering.

Pumping from the interior of the excavation shall be done in such a manner that there will be no movement of water through any fresh concrete, and for a period of 24 hours after a pour shall be done from a suitable sump separated from the concrete work by a watertight wall or by other effective means.

The Contractor shall at all times, by the institution of proper precautions, prevent hydrostatic uplift and flotation of the work.

Drains. - When specified, shown on the plans, or required by field conditions, the Contractor shall construct permanent or temporary drains and appurtenances adequate to keep excavations and subgrades sufficiently dry to permit proper conduct of his operations. Unless otherwise specified, pipe to carry such drainage shall be perforated bell and spigot vitrified clay pipe, not less than 6 inches in diameter, and shall be placed with the perforations facing down. The drains shall be placed in filter material in accordance with Section 711, extending at least 6 inches laterally from each side of the pipe and 12 inches vertically above the top of the pipe, with an approved waterproof membrane thereover and acceptable backfill over the membrane.

The Contractor shall not allow water originating on or due to his work, or which he is obliged to handle and dispose of, to discharge upon the work or into the trenches of another contractor.

### 700.09 Removal of Subsurface Obstacles - Differing Subsurface Conditions

General. - Subsurface obstacles are defined as foreign, man-made, or man-deposited materials and objects required to be removed in order to construct the contracted for facilities, and are included in one or more of the following categories:

- 1) building and other debris, and rubble, used as fill material;
- 2) boulders obviously not native material;
- 3) abandoned sewers and sewer structures not shown on the plans or specified to be removed;
- 4) iron and steel, including rails and auto bodies;
- 5) wood, steel or concrete, including
  - a) structures;
  - b) walls, foundations and slabs;
  - c) abandoned utility facilities, not shown on the plans or specified to be removed;
- 6) pavement materials;
- 7) cable care yokes;

- 8) piles, separate from attached material, (not subject to the hereinafter specified initial one cubic yard exclusion);

Subsurface obstacles, regardless of size, shape or type of material, encountered within the limits of the excavation necessary for the work, shall be removed by the Contractor to the extent required and the resulting void backfilled.

Subsurface obstacles shall be removed to not less than 3 feet below subgrade for street pavement, curb and sidewalk.

Within areas where the required subgrade is that for a structure, pipe, or like facility, or where excavation is to graded ground upon which no construction is called for under the contract, removal of subsurface obstacles shall be to not less than one foot below such subgrade or ground surface.

Where the surface serves as subgrade for footings or foundations, the voids left by the removal of subsurface obstacles shall be backfilled with Class 4-2000-13 concrete.

The City assumes responsibility for the correctness of the information shown on the Log of Test Borings plans only at the location of each test boring.

The City assumes no responsibility for the soils investigations or reports, or for any interpretation, deduction or conclusion given therein, or any soil or rock profiles, estimated quantities of rock excavation, etc. which the City or its consultants may have made.

Bidders must make their own deductions and conclusions as to the nature and difficulty of excavation of all natural materials.

Conditions for Payment. - The removal of subsurface obstacles and the subsequent backfill of the resulting voids shall be done as Incidental Work except under the following conditions:

- 1) the subsurface obstacles is not shown on the plans, other than the Log of Test Borings;
- 2) the subsurface obstacle is not mentioned in the Special Provisions;
- 3) the subsurface obstacle, except for piles, exceeds one cubic yard in volume; and
- 4) the removal of the subsurface obstacle involves additional cost.

In the event the above conditions are met, the removal of subsurface obstacles shall be done as Extra Work. Payment for the removal of subsurface obstacles will be made even if the Log of Test Borings in the plans, or the soils report, indicates the probability of encountering subsurface obstacles.

Obstacles connected to, or enmeshed with, each other such that work additional to the excavation thereof is required to separate them will be considered a single obstacle.

Each initial cubic yard, except as specified for piles, shall be removed as Incidental Work. The negotiated Extra Work payment for the excavation or removal of, and, if required, backfill for, each subsurface obstacle shall be for 100% of all allowable costs therefor, over and above the cost of normal excavation at the location of the subsurface obstacle.

The City will use the soils investigation as a general indication of the types of materials expected to exist in the excavation. Normal excavation cost will be based on the Contractor's observed performance in each such type of material. This cost will be used as a base for payment as Extra Work of the herein allowable additional cost of excavating each qualifying subsurface obstacle volume.

Where excavation is designated to be paid for under a Bid Item, no reduction in the pay quantity thereof will be made on account of the presence of any subsurface obstacle. The Contractor shall give written notice of each claim for subsurface obstacle Extra Work.

## **700.10 Excavation of Unsound Subgrade Material**

The Contractor, where and as shown on the plans, and where and to the extent directed, shall excavate, as common excavation, all existing topsoil, loam, wet clay, and any other materials determined by the Engineer to be unsound and inferior, encountered at any required subgrade. In place of the unsound materials he shall construct satisfactorily compacted backfill in accordance with Section 707. Payment therefor shall be in accordance with the provisions of Section 714.03. This provision shall apply to subgrade for embankment as well as to subgrade for any other construction.

If the proposal does not contain a Bid Item for common excavation or excavation, the excavation and disposal of unsound subgrade materials shall be done only where directed by the Engineer.

Such excavation to a depth of 12 inches below the existing or required subgrade, whichever is lower, will, together with the disposal of the material so excavated and the required backfilling, be paid for as Extra Work as set forth in Section 112.01 of the Standard Specifications, to the extent that the excavation of unsound material exceeds 5% of the total area of the work requiring any excavation, grading or filling. The initial 5% shall be done as Incidental Work.

All excavation of unsound subgrade materials below such 12 inch depth, together with the disposal of the materials so excavated and the required backfilling, will be paid for as "Extra Work".

Construction of required backfill shall be done in accordance with the requirements of Sections 703 or 709 as the case may be, and except as hereinafter specified shall be done as Incidental Work.

### **700.11 Disposal of Excavated Materials**

All excavated materials not in accordance with or in excess of requirements for the construction of backfill, fill and embankment, and, except as otherwise specified, all trees and other vegetation complete with their entire root structures, and all humus-containing topsoil, shall be removed from the site. by the Contractor as his property, as Incidental Work.

Such material shall also include excavated pavement, concrete and masonry, including foundations, slabs, and cable car conduit and yokes, all rails except those specified to be salvaged, all ties, track fittings and appurtenances, and all rubbish and other construction debris.

The Contractor shall not allow any portion of any excavated material or refuse to be disposed of upon paved streets, into catchbasins, or otherwise into the City Sewer System. No materials shall be placed on private or public property without proper authority.

Quantities of surplus material shown on the plans or specified in the Special Provisions, are approximate only. The Contractor shall satisfy himself that there is sufficient material available for the completion of all embankment before disposing of any indicated surplus material. Any shortage of material, caused by premature disposal of material by the Contractor, shall be replaced by him at no additional cost to the City.

Disposal of excavated and other materials shall be in accordance with the requirements of Section 108.10.



## **701 Pavement Excavation**

### **701.01 General**

The Contractor shall excavate, remove, and conduct his operations in all respects in accordance with the requirements of Section 700; shall excavate, remove and dispose of, existing concrete curb, sidewalk, pavement and base, stone curb, asphalt concrete base and wearing surface, including the latter at conform points, cement treated rock base, and plain and reinforced concrete and masonry, walls, foundations, coping, sections of manholes, catchbasins and other structures, all where, as, and from within the limits shown or indicated on the plans for pavement excavation, and elsewhere where directed; shall construct compacted embankment in the areas from which, as necessary to obtain the required subgrade, the hereinafter specified materials have been removed; and shall do all other necessary or required Incidental Work.

Payment under a pavement excavation Bid Item will be made based on calculations of the actual volumes of pavement removed within the limits shown on the plans.

In the absence of cross sections, information on the plans or specific limits set forth in the Special Provisions defining lateral limits of excavation, pay quantities shall include only those volumes lying between existing street property lines.

Excavating that shall not be done under a Bid Item for pavement excavating is that:

- 1) of earth, untreated rock and macadam bases, asphalt paths, basalt block gutters, and cable car conduit and yoke structure;
- 2) within the limits defined for a Bid Item for excavation in a specified width of existing street railway track area;
- 3) outside of or beyond, including overbreak, the limits shown on the plans or specified to be done under a Bid Item for pavement excavating.

Materials excavated beyond the shown or specified limits, and overbreak, shall be satisfactorily replaced by the Contractor, at no cost to the City.

Pavement excavation not within the limits shown or specified therefor, including that, as specified in Section 220, necessitated by other work under the contract shall be done as Incidental Work.

Existing concrete, masonry, and pavement necessary to be removed to obtain the required subgrade shall be excavated to 3 feet below such subgrade and the resulting voids created below subgrade shall be backfilled. In areas where no improvement is to be constructed, such concrete, masonry and pavement shall be excavated to a depth of one foot, measured normal to the slope, beneath the face of the slope.

Abandoned pits, vaults, and basements under pavement or sidewalk areas, to the extent that the walls and slabs thereof are to remain in place, after having been broken or penetrated as required to allow normal water filtration and drainage, shall be backfilled with sand compacted to maximum density.

### **701.02 Removal of Asphalt and Topped Pavement**

Where existing pavement surface is asphalt concrete, cuts therein, as for trenches, etc., shall be made vertical and to neat regular lines.

### **701.03 Rem. of C. Pavement, Sidewalk and P. Strip - Conc. S. Cutting Req.**

Where the existing finished pavement surface is concrete, including concrete parking strip, concrete gutter and concrete sidewalk, cuts therein between pavements to be removed and those to remain in place shall be made by an approved pavement cutting saw before any pavement is jackhammered or broken, and in sidewalk and traffic island pavement shall be to neat flag lines. Similarly, concrete saw cuts shall be made for the full length of the juncture of the portion of existing concrete structure or footing to remain with that to be removed.

Saw cuts shall be 2 inches deep, neat, regular and vertical. The Contractor shall exercise extreme care not to damage the cut edges of the surface. Damaged edges shall be recut to acceptable alignment and vertical surface.

Where the edge of excavation closest to the curb in concrete parking strip or pavement is less than four feet from the curb, the pavement in the area of the cut shall be removed to the curb; if the parking strip in this case is monolithic with curb, removal shall be to within 6 inches of the curb.

When an edge of excavation is less than 4 feet from a construction joint in parking strip or pavement, that portion thereof between the construction joint and the excavation shall be removed.

Cuts to the curb in concrete pavement not monolithic with adjacent curb shall be saw cut to as close to the curb as possible, and extended neatly and regularly thereto by means other than saw cutting.

Saw cuts to the curb in monolithic curb and parking strip shall be terminated as close to the curb as possible, and in the case of trench, with a saw cut parallel thereto, and the work completed by tunneling. If the cut is not for trench, extension thereof shall be as hereinbefore specified for pavement not monolithic with curb.

#### **701.04 Rem. of Pavement and Rails within Street Railway Track Area**

Pavement excavation in a specified width of existing street railway track area shall include:

- 1) the excavation, by means of hand tools and hand operated pneumatic tools, of pavement materials and header blocks to the full depth of the rails in preparation for the removal and salvage, under a separate Bid Item, of street railway rails without damage thereto; and after such removal and salvage,
- 2) the excavation of all rails and railway track materials not to be salvaged, and all pavement materials, ballast, ties and other materials, including concrete rail stringers, if any,

all from within the limits of the specified width of track area shown on the plans, and lying within the depth specified or shown on the plans or cross sections, from, and measured normal to the surface of the existing pavement.

#### **701.05 Removal of Cable Car Conduit and Yoke Structure**

The Contractor shall excavate, remove from the site, dispose of, and construct compacted backfill in place of, all abandoned cable car conduit and yoke structures and elements and appurtenances thereof within the limits of the work, where and as shown on the plans, or where directed by the Engineer.

#### **701.06 City May Limit Use of Pavement Breaker**

In accordance with the requirement of Section of the Public Works Code there shall be no limitation on the use of labor-saving devices except at the locations, if any, specified in Section 104.04 or in the Special Provisions, provided, however, that when, during construction operations, an additional location is revealed where, in the judgment of the Engineer, such limitation is necessary to avoid public nuisance or protect public health, safety or facilities, then the limitation shall apply to such additional location and the expense caused to the Contractor by the limitation on his operations in such additional location shall be estimated and paid for as Extra Work in accordance with the requirements of Section 112.

#### **701.07 Payment**

General. - Pavement excavation satisfactorily done, as specified, will be paid for at the price bid per cubic yard measured in place as the aggregate net volume of pavement materials excavated from within the limits shown, specified, or directed, but not including specified exclusions.

The removal of asphalt concrete wearing surface in conform areas, if the Proposal contains a Bid Item therefor, will be paid for at the price bid per cubic yard, or if a specific Bid Item therefor does not exist, the volume of wearing surface removed from conform area will be included for payment as pavement excavation.

Pavement excavation, if there is no Bid Item therefor, will be included for payment as common excavation or excavation. If the Proposal does not contain a Bid Item for any such work, it shall be done as Incidental Work as set forth under Section 108.

In Specified Width of Track Area. - Pavement excavation within a specified width of track area and

depth will be paid for at the price bid per linear foot of such track area satisfactorily excavated, measured horizontally along the centerline of the tracks.

Removal of Cable Car Conduit and Yoke Structure. - Removal of cable car conduit and structure will be paid for at the price bid per linear foot of conduit and structure, satisfactorily excavated, measured horizontally along the longitudinal centerline thereof.

If the Proposal does not contain a Bid Item for such work, it shall be removed as a "Subsurface Obstacle" as set forth under Section 108.05.

## **702 Trench Excavation**

### **702.01 General**

The Contractor shall conduct his operations in all respects in accordance with the requirements of Section 700 and shall do all trenching and excavating, as to the depths necessary, or required, for the proper construction of the work and installation of equipment.

Tunneling or jacking shall not be used unless specified, or approved in writing by the Engineer, except that the Contractor may tunnel under concrete curb and combined concrete curb and gutter. If it required, or if the Contractor elects to remove a portion of the curb or of combined curb and gutter, he shall remove an entire section between construction joints.

### **702.02 Minimum and Maximum Length of Trench**

The Contractor shall prepare trench subgrade for sewers and pipes not less than 30 linear feet in advance of such sewer and other pipe construction.

The Contractor shall not have more than 500 linear feet of trench, other than side sewer or culvert trench, open at any one time, subject however, to possible further limitations because of traffic routing restrictions. Such maximum footage of open trench shall include backfilled but unpaved trench, partially or completely excavated trench, and area from which pavement has been removed for anticipated trench excavation.

### **702.03 Payment**

Trench excavation, including saw cutting of concrete pavement and disposal of materials, shall be paid for in accordance with the Schedule of Bid Prices. If no bid item exists for trench excavation, it shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **703 Trench Backfill**

### **703.01 General**

The Contractor shall do all backfilling and restoring of pavement necessary, or required, to satisfactorily complete the work, and he shall backfill all excavations to the elevations of the required subgrade or adjacent ground, as the case may be.

Backfilling shall not commence until after sewers, culverts, drains, sewerage and drainage structures, pipe, conduit, and other equipment and appurtenances placed in trench or similar excavations have been properly constructed, or installed as applicable, inspected, and if required, tested.

Backfill shall be placed in a manner not to disturb, damage, nor subject such facilities to unbalanced loads or forces. Restoring of pavement shall be done in accordance with Section 109.

### **703.02 Concrete Strength before Backfilling**

Backfilling over and against sewerage and drainage facilities shall not commence until concrete has attained a compressive strength of at least 2,500 pounds per square inch based on field cured cylinders, nor until all mortar joints are set sufficiently to prevent damage.

### **703.03 Sand Bed for Pipe Sewers and Culverts**

All pipe sewers, and all cast or ductile iron pipe culverts, shall be constructed on a prepared or natural sand bed the width of which shall be at least the full width of the pipe, and not less than 4 inches thick below the line of the bells of the pipe after installation; however, a sand bed will not be required for pipe sewers on concrete foundations, in encasements, or on crushed rock bedding.

### **703.04 Subgrade Surfaces for Pile-Supported Concrete**

Subgrade surfaces on which pile-supported concrete is placed shall be adequately prepared to assure proper support for the placed concrete until such concrete has sufficient strength to span and be supported solely by the piles.

### **703.05 Crushed Rock Layer in Trench**

Crushed rock shall be furnished and placed where necessary to maintain an appropriately dry trench in accordance with Section 712.

### **703.06 Required Sand Backfill**

Backfill around all sewers, culverts, sewerage and drainage structures, and all cast or ductile iron pipe, from the bottom of the trench to a height 6 inches above the top of such facilities for the full width of the trench shall be sand only.

Backfill around manholes and catchbasins shall be sand to a level 6 inches above the supporting structure or adjacent sewer or culvert.

### **703.07 Backfill Above Required Sand**

Backfill material above the required sand shall be in accordance with the provisions of Section 706.02.

### **703.08 Backfill Layers**

Each layer of backfill shall be compacted both during placement and following the withdrawal of sheet piling and lagging to the top of the layer being compacted. Withdrawal of sheet piles or other trench support systems shall be done such that voids are not created from loose material under the adjacent pavement entering the trench. After the placing of backfill has been started, the Contractor shall proceed as soon

as practicable with densification. All sand backfill to be densified by water shall be jetted, unless flooding is specified or otherwise authorized by the Engineer. Flooding of sand will be prohibited where sewers or structures might be damaged, or adjacent materials softened, by the applied water. The Contractor shall make his own determination that flooding or jetting will not result in damage. Any resulting damage shall be repaired at the Contractor's expense. Sand backfill jetted, flooded, or compacted by other approved means, shall be done in horizontal layers not more than five feet thick.

Jetting of backfill shall be done in accordance with the following requirements:

- 1) The jet pipe shall consist of a minimum one inch diameter pipe to which a minimum 1-1/2 inch diameter hose is attached at the upper end. The jet shall be of sufficient length to project to within one foot of the bottom of the lift being densified.
- 2) The Contractor shall jet to within one foot of the bottom of the lift and apply water in a manner, quantity and at a rate sufficient to thoroughly saturate the thickness of the lift. being densified. The jet pipe shall not be moved until the backfill has collapsed and the water has been forced to the surface.
- 3) Voids left by the removal of sheeting, piles and similar sheeting supports shall be immediately backfilled with clean sand which shall be jetted into place to ensure dense and complete filling of the voids.

All backfill other than sand shall be placed in horizontal layers not more than 8 inches thick before compaction, and each layer shall be satisfactorily compacted by mechanical means. Flooding or jetting, in this case, will not be allowed. In all cases, each layer of backfill material shall be satisfactorily compacted before placing the next layer thereon. Compaction shall be in accordance with the applicable requirements of Section 707.

### **703.09 Payment**

Trench backfilling shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **704 Clearing, Grubbing and Site Preparation**

### **704.01 General**

The Contractor shall clear and remove from the site of the work all trees, stumps, roots, brush, grass, rubbish, debris, fences, street improvements, structures, and obstructions of any kind, natural or artificial which, if left in place, would interfere with the construction of the work.

All cleared areas shall be grubbed. Grubbing shall consist of the complete removal of stumps, tap and lateral roots 1-1/2 inches or more in diameter, buried logs, and similar objectionable material, if encountered, to a depth of 3 feet below required subgrade, final ground line, or existing ground surface in an area to receive embankment, as the case may be.

The Contractor shall backfill with acceptable material, as specified in Section 706.02, to the elevation of the ground line as it existed prior to the start of the contract or to new subgrade, as the case may be, the voids being created by the hereinafter specified removals. Such backfilling shall be done as Incidental Work and shall be compacted to 95% relative compaction.

The Contractor shall not disturb the existing trees designated to remain. The City reserves the right to remove any trees or plants prior to the clearing and grubbing. Existing improvements, facilities, trees, and shrubbery that are not required to be removed shall be protected from destruction or damage by the Contractor's operations. If required, sod and loam which is removed shall be properly preserved and stored for use.

All existing abandoned concrete or masonry building walls, footings, copings, stairs, slabs and pavement shall be removed to a depth of 3 feet below required subgrade or final ground line, as applicable. The Contractor shall break up or penetrate, as required, existing slabs and walls which are to remain in place in order to allow normal water filtration and drainage.

The Contractor shall give reasonable notice to occupants of buildings or property adjacent to the work to permit such occupants to salvage or relocate plants, trees, fences, sprinkler systems, or other improvements which they have placed within the limits of the work and which might be destroyed or damaged by the Contractor's operations. Portions of fence, water lines, etc., remaining after site is cleared shall be properly terminated.

Materials, specified on the plans or in the Special Provisions to be salvaged, shall be carefully removed and delivered by the Contractor to the City yard designated on the plans, where a receipt will be issued in duplicate. The Contractor shall furnish one copy of this receipt to the Engineer.

The disposal of all cleared, grubbed and razed materials shall be in accordance with the requirements for excavated materials set forth in Section 108.10.

### **704.02 Payment**

Clearing, grubbing, site preparation and related backfilling shall be done as Incidental Work. However, if there is a contract Bid Item for "Pavement Excavation", pavement excavation within the street area, i.e., within the existing street property lines, will be paid for at the price bid therefor in accordance with the provisions of Section 701.

If embankment is to be placed in cleared and grubbed areas, the quantity to be paid for will be measured from the original ground line and not the cleared ground line.

## 705 Common Excavation

### 705.01 General

The Contractor shall conduct his operations in all respects in accordance with the requirements of Section 700 and shall excavate to bring the existing subgrade or ground surface, as the case may be, to the required subgrades and elevations, where shown on the plans or where directed. The work shall include:

- 1) excavating waterbound macadam, untreated rock base, asphalt paths and basalt block gutters;
- 2) stripping and grading existing slopes;
- 3) removing and disposing of obstructions;
- 4) excavating all concrete and masonry walls, slabs, structures, and pavement materials not specified to be removed under Bid Items, all rubble and debris within the volume specified to be excavated as common excavation, and all material contained by structures and parts thereof which are to be removed as other than common excavation;
- 5) breaking up or penetrating, as required, to allow normal water filtration and drainage, exposed or encountered existing slabs and walls which are to remain in place, and;
- 6) the constructing of drainage ditches necessary or required for the protection of the work.

If the proposal does not include a separate Bid Item for pavement excavation, no differentiation will be made between pavement material and other material excavated, and pavement excavation shall be included under whatever Bid Item, such as excavation, common excavation or embankment, is included in the Proposal.

In the absence of cross sections, information on the plans, or specific limits set forth in the Special Provisions defining lateral limits of excavation and embankment, pay quantities shall include only those volumes lying between street property lines.

Excavating shall not unnecessarily disturb the material below subgrade. Materials excavated beyond the shown or specified limits, and overbreak, shall be backfilled at no cost to the City.

All excavating such as trench and footing excavation, below the required subgrade or final graded ground line, shall be done as Incidental Work.

Not included in this work will be that shown or specified to be done under other Bid Items or as Incidental Work, such as the excavating and removal of grass, shrubs, trees, stumps, roots and other vegetation and fencing. No reduction, however, will be made in the pay quantity of a Bid Item for common excavation or excavation on account of excavating specified to be done under another Bid Item, such as that of those portions of concrete and masonry foundation, walls, slabs, stairs and appurtenances, and cable car conduit and yoke structures, that intrudes into, or occurs within, the volumes specified to be excavated as common excavation or excavation.

Excavation for the purpose of obtaining borrow material shall be done as Incidental Work and payment therefor shall be included in the price or prices bid. If the proposal contains a Bid Item for earthwork, it will contain a Bid Item for either excavation or embankment, whichever is estimated to exceed in quantity, and other earthwork shall be done as Incidental Work.

If the proposal does not contain a Bid Item or Items for other work required to be done in connection with excavating, all such work shall be done as Incidental Work and payment therefor included in the price or prices bid. Such work includes, but is not limited to, the following:

- 1) Placing and compacting approved material to construct required embankment, or to fill or backfill holes, pits, depressions, and excavations resulting from the removal of subsurface obstacles, structures and other facilities, all to the elevations required to obtain the pavement subgrade or ground surface shown on the plans or cross sections. Such work done with site excavated materials shall include all loading and hauling thereof; if specified or required to be done with imported fill or designated borrow material, or crushed rock, the furnishing of the required material at the proper site location, if the Proposal contains a Bid Item therefor, will be included for payment thereunder.



- 2) All required benching, scarifying, watering or drying of materials to the required moisture content, shaping and finishing constructed subgrade as specified in Section 200, constructing and maintaining the slopes and ditches and stockpiling and replacing topsoil.

If required in order to comply with the traffic routing or other provisions of the specifications or because of the danger of overburdening an existing or potential slide area, materials shall not be stored on the site, nor, in the latter case, on the slopes above or below the site.

The Contractor, at his sole expense, shall remove materials that, on account of the nature or performance of the work, slide into, or slip from, a constructed slope or subgrade, and shall refinish and maintain during the contract period, such slopes and subgrades to the lines and grades shown on the plans and cross sections.

Tops of slopes shall be rounded as shown on the plans. Material removed in rounding excavated slopes will be measured for payment as specified for the material removed. No payment other than the contract unit price governing the applicable earthwork will be made by reason of field modification of slopes.

The Contractor, in accordance with the requirements of Section 108.17, shall wet down any area whenever necessary to prevent dust nuisance.

The Contractor shall not remove from the work, nor waste, any site excavated material that is in accordance with the specified requirements for backfill, and embankment, except that quantity thereof, if any, that may be in excess of the total quantity required to complete all backfilling and embankment as specified in Section 700.11.

## **705.02 Payment**

Common excavation or excavation, satisfactorily done as specified, will be paid for at the price per cubic yard measured in place within the limits shown, specified, or directed, and computed from cross sections between the existing ground surface, or the lower limit of pavement excavation if the Proposal contains a Bid Item therefor, and the final graded ground surface or constructed subgrade, as applicable, but not including trench, structure, or other excavating below or outside of that required for subgrade for street work.

If the Proposal does not contain a Bid Item for such work, it shall be done as Incidental Work set forth under Section 108.

## **706 Embankment**

### **706.01 General**

The Contractor shall prepare the subgrade for, and construct, compacted embankment and fill from earth, concrete pavement, other site excavated concrete materials, borrow materials from designated on-site areas, and from imported fill material if required, all as necessary to complete the work.

The work shall include all common excavation, the furnishing of imported fill materials except as the provisions of a Bid Item for such furnishing otherwise state; all loading, hauling, stockpiling, depositing, watering, aerating, vibrating, tamping and rolling of the embankment and fill material. The work shall further consist of constructing embankment to bring all surfaces, including those of areas where pavements or unsound subgrade materials have been excavated, to the lines, grades and cross sections required for final graded ground surfaces and subgrades, all where and as shown on the plans and cross sections, including all Incidental Work.

Required topsoil or loam placed on areas of embankment will be paid for as embankment if the Proposal does not contain a Bid Item for loam.

All required benching, scarifying, watering or drying of materials to the required moisture content, shaping and finishing constructed subgrade as specified in Section 200, and constructing and maintaining the required slopes and ditches, shall be done as Incidental Work.

Backfilling of voids, below subgrade, left by the removal of subsurface obstacles, or by the specified removal of facilities, will not be paid for as embankment.

Materials excavated beyond or below the specified limits shall be satisfactorily replaced by the Contractor at no cost to the City.

The construction of embankment and fill not within the limits shown on the plans or cross sections, or specified to be paid for under a Bid Item, shall be done as Incidental Work.

If the Proposal contains a Bid Item for earthwork, it will contain a Bid Item for either excavation or embankment, whichever is estimated to exceed in quantity, and the other class of earthwork shall be done as Incidental Work.

### **706.02 Acceptable Materials**

Acceptable embankment, fill and backfill materials, are materials which meet the compaction requirements of Section 707 and are free of debris, wood, other organic or deleterious matter, and from materials that would prevent or adversely affect permanent compaction and stability. The compaction and acceptability of the material will be determined by the City's Materials Testing Laboratory, based on the results of the tests specified in Section 707.01.

Lumps, ballast, rocks and broken concrete measuring 3 inches or less in greatest dimension may be incorporated into backfill and embankment, and if satisfactorily distributed in earth or other fine materials, pieces not greater than 6 inches in greatest dimension may be so incorporated, provided that such latter pieces be not placed within 3 feet of finished grade or subgrade. Rocks, concrete, or hard lumps of earth larger than allowed shall be broken up before compacting.

Rocks, broken concrete or other solid materials, larger than 4 inches in greatest dimension, shall not be placed in embankment areas where piles are to be placed or driven.

### **706.03 Procedures**

Existing material to remain will be subject to approval and shall be compacted as specified in Section 707.03.

Except in contained volumes, the compacted material upon which embankment is to be constructed shall be scarified to a depth of 6 inches, and in no case shall backfill, fill, or embankment be constructed upon topsoil or other unsound material.

Excavated untreated rock base shall be used prior to the use of any other material for constructing compacted fill and embankment.

Embankment and fill material shall be spread with a bulldozer or other equipment upon which the blade precedes the wheels or tracks. If such material is deposited against an existing slope, the depositing shall be in accordance with the requirements of Section 706.05.

The materials for, and placement of, backfill, fill and embankment above and against structures, sewers and the like shall be as specified in the applicable portions of Sections 703 and 709. The Contractor's attention is directed to the possibility of excessive lateral pressure on, and resultant damage to, retaining walls; he shall, therefore, exercise care in properly placing backfill, fill and embankment behind such walls.

At the time of compaction, materials to be incorporated in backfill, fill, and embankment, shall have the proper uniform moisture content required to obtain the specified relative compaction. The Contractor shall water, or do whatever spreading, mixing and stockpiling is necessary to dry such materials, as the case may be, in order to obtain such proper moisture content.

Fill material that is segregated such that the maximum density of samples thereof varies by more than 5 pounds per cubic foot shall be thoroughly mixed by mechanical means before placement, or shall be compacted in alternate layers of each material, or shall be removed from the site and replaced with acceptable material, in accordance with Section 706.02, at no cost to the City.

Material deposited within two feet of final graded ground surface and of side slopes, the latter measured at right angles to the face of the slope, shall contain clay or other acceptable binder material in a proportion adequate to minimize erosion by wind and rain.

If there are insufficient excavated earth materials for completion of all required backfilling and embankment, the balance of fill material needed to bring the grades to the elevations shown on the plans shall be obtained, at no charge to the Contractor, from a specified on-site "borrow area" If there is no such borrow area, the Contractor shall, as approved by the Engineer, furnish at the site, where and in the quantities required to correct the deficiency, "Imported Fill Material" in accordance with the requirements therefor of Section 714.

Slopes shall be maintained to the grade and cross sections shown on the plans until the acceptance of the contract.

#### **706.04 Embankment and Fill Layers**

All embankment and fill, other than sand, shall be placed in horizontal layers not more than 8 inches thick before compaction, and each layer shall be satisfactorily compacted as and to the degree specified in Section 707.02 by means of suitable mechanical equipment. Flooding or jetting, in this case, will not be allowed.

Section 707.02 specifies methods of compaction where the material is sand or too sandy to be satisfactorily compacted by the usual tamping and rolling. In the case of compaction of such material by vibratory rollers the maximum thickness of layer may be increased to 3 feet.

In all cases, each. layer material shall be satisfactorily compacted before placing the next layer thereon.

#### **706.05 Placing Material Against Slopes**

Slopes and slide areas upon which embankment or fill is to be placed shall have all loose material removed therefrom, and shall be benched in level terraces separated by vertical or nearly vertical slopes. Such stepped benches shall each be cut 4 feet horizontally into the slope, and may be cut progressively with the construction of embankment. Final cutting of each bench shall be with hand tools to undisturbed, compact, and stable materials. The material so removed may be incorporated in the Embankment, provided such material is in accordance with the requirements of Section 706.02.

#### **706.06 Payment**

Embankment will be paid for at the price bid per cubic yard of compacted embankment satisfactorily constructed, in place, within the limits shown or specified, or where directed, computed from cross sections between the ground surface existing at the start of the contract and the final graded ground surface, or prepared subgrade for the subbase, base, curb, sidewalk, or other construction for which the embankment is required, but not including backfilling specified to be done as Incidental Work.

If the Proposal does not contain a Bid Item for embankment, it shall be done as Incidental Work as set forth under Section 108.

Embankment to bring cleared ground back to the elevations of original ground shall be furnished and placed as Incidental Work.

## **707 Compaction**

### **707.01 General**

The Contractor shall do the work necessary to obtain the required compaction of subgrade, embankment, fill, and backfill materials. Compaction shall be obtained in accordance with the restrictions imposed by the applicable provisions of Sections 703, 706 and 709.

Tests of relative compaction, including determination of optimum moisture content and maximum density of backfill, fill, and embankment materials, will be made in accordance with Method "C" of ASTM "Standard Methods of Test for Moisture-Density Relations of Soils, Using 10-lb. Rammer and 18-in. Drop", Designation D 1557, ASTM "Standard Method of Test for Density of Soil in Place by the Sand Cone Method", Designation D 1556, and Methods "A" and/or "B" of ASTM "Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)", Designation D 2922. As stated therein, the term "relative compaction", used hereinafter regarding compaction of backfill or embankment, means the percentage ratio of the field-compacted dry density to the maximum dry density obtainable by compaction at optimum moisture content.

Density and compaction tests of in place compacted backfill, fill, or embankment, as the case may be, and of the materials used, required by the Engineer as the work progresses, will be conducted and evaluated by the City at no cost to the Contractor.

### **707.02 Backfill, Fill and Embankment Areas**

The Contractor shall obtain a relative compaction of not less than 95% throughout each layer of all backfill, fill, and embankment constructed within 3 feet of pavement subgrade, or adjacent ground, as the case may be. Below the top 3 feet of backfill, fill, and embankment constructed, the relative compaction shall not be less than 90%.

Compaction of material too sandy to be satisfactorily compacted by the usual rolling and tamping shall be effected by watering to the point that the required compaction is obtained by rolling and tamping, or by the use of vibrating rollers or compactors.

### **707.03 Cleared or Excavated Areas**

The Contractor shall obtain a relative compaction of not less than 95% for the 6-inch layer of undisturbed material underlying all areas cleared, or from which existing pavement or excavated material has been removed, and which serve as subgrade for backfill, embankment, pavement subbase or base, curb, or pavement, as the case may be. Such compaction shall extend for a lateral distance of not less than 3 feet beyond the neat lines of such areas except where confined to a lesser lateral distance by lagging, or by existing construction to remain.

### **707.04 Backfill in Areas of Excessive Excavation and Areas of Removed Unsound Material**

Except as required by Section 708.01, 95% relative compaction shall be obtained in backfilling excavation in excess of that shown on the plans, including overbreak and that from which unsound subgrade materials have been removed.

### **707.05 Filler Material**

When combined aggregate filter material in accordance with the requirements of Section 711 is placed as a layer in backfill, fill or embankment, such material, and the first 12-inch layer of backfill or embankment directly above it, shall be compacted by use of a vibratory compactor.

**707.06 Equipment**

Unless otherwise specified, all compacting equipment shall be power equipment, and shall be capable of obtaining the specified compaction.

If, however, compaction is not sufficiently uniform, or tests show it to be inadequate, the Engineer may require placement in thinner layers or the use of other or additional equipment. Selection of such equipment shall be by the Contractor, and it shall be solely his responsibility to obtain the specified compactions throughout the required volume.

The use of heavy compacting equipment in areas immediately behind retaining walls will not be permitted, and in general only hand-portable power tampers or vibratory compactors will be approved for such compaction.

If small or hand-portable equipment is used, as for compacting narrow berm, confined areas, or behind retaining walls, the thickness of layers and other conditions shall be adjusted as required to obtain the specified compaction.

**707.07 Payment**

Compaction shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **708 Structural Excavation**

### **708.01 General**

The Contractor shall do all excavating necessary to obtain the subgrade required for the foundations, footings, slabs or other structural components of the contract work, including constructing related drainage facilities and doing other Incidental Work, all where and as shown on the plans and in accordance with the requirements set forth herein.

Excavation for the footing or foundation of any structure shall extend to undisturbed material. The last three inches of material excavated for footings and foundations shall be loosened and removed with hand tools to leave an undisturbed bed.

Where the slope of the bottom of the required excavation for footings or foundations is greater than 10 horizontal: 1 vertical, the Contractor, at no additional cost to the City, shall excavate "step footings" having a 4'- 0" minimum length of step and 2'- 6" maximum depth.

Excavations below the subgrade for footings and foundations shall be backfilled to the required subgrade by the Contractor at his own expense. Such backfilling shall be with Class 4-2000-1-1/2 concrete.

### **708.02 Preparation of Subgrade**

Subgrade shall be prepared to provide a satisfactory, uniform and compacted bearing surface for the construction. Subgrade surfaces on which pile-supported concrete is placed shall be adequately prepared to assure proper support for the placed concrete until such concrete has sufficient strength to span and be supported solely by the piles.

### **708.03 Payment**

Structural excavation shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## 709 Structural Backfill

### 709.01 General

The Contractor shall furnish, place and compact backfill from site excavated or other earth and concrete materials, all as required to bring all surfaces to the lines, grades and cross sections shown on the plans and cross sections, or that of the adjacent existing ground surface, as the case may be, including loading, hauling, stockpiling, depositing, watering and compaction, and all other Incidental Work, all in accordance with the requirements set forth herein.

### 709.02 Structural Backfill Materials

Structural backfill shall consist of approved material, free from debris, wood, and other organic, unsound or deleterious matter, and from all other materials that will prevent or adversely affect thorough and permanent compaction and stability.

Materials, including those excavated at the site, yielding a maximum dry density of less than 112 pounds per cubic foot, when tested in the laboratory in accordance with the compaction test described in Section 707 shall not be used as structural backfill or fill.

The material used for structural backfill behind or around structures and appurtenant facilities shall have a sand equivalent value of not less than 30. The percentage composition by weight shall conform to the following grading:

<u>Sieve Size</u>	<u>Percentage Passing</u>
3-inch	100
No. 4	35-100

Lumps, rocks and concrete pieces measuring 3 inches or less in greatest dimension may be incorporated into backfill; and, if contained in backfill more than 4 feet deep, and satisfactorily distributed in earth or other fine materials, pieces not greater than 6 inches in greatest dimension may be so incorporated, provided that such latter pieces be not placed within 3 feet of finished grade or subgrade, nor in areas where piles are to be driven or drilled.

Rocks, concrete, or hard lumps of earth larger than allowed shall be broken up before compacting.

### 709.03 Procedures

All sand backfill, except that behind abutments and except pervious material and backfill behind retaining walls, shall be flooded or jetted, or compacted by other approved means, in horizontal layers not more than 3 feet thick. Flooding shall be such that, after 5 minutes, water will show on the surface.

Backfilling for facilities in street areas such as sewers, sewer structures, and the like, shall be as specified in Sections 703 and 707.

Flooding or jetting of sand will be prohibited where facilities or structures might be damaged, or adjacent materials softened, by the applied water.

All backfill, other than sand, shall be placed in horizontal layers not more than 8 inches thick before compaction, and each layer shall be satisfactorily compacted as and to the degree specified in Section 707.02, by means of suitable mechanical equipment. Flooding or jetting, in this case, will not be allowed.

Pervious material, sand, and filter material in accordance with Section 711, behind retaining walls and abutments shall not be flooded or jetted but shall be deposited in 8-inch layers and compacted with mechanical vibrators.

Compaction of sand and of pervious backfill shall be to the degree specified in Section 707.02.

In all cases, each layer of material shall be satisfactorily compacted before placing the next layer thereon.

Backfilling above or against any facilities to be constructed under the contract shall not commence until after such facilities have been properly constructed and inspected. Further, backfilling above or against poured-in-place reinforced concrete structures shall not commence until the concrete has attained a compressive strength of at least 2,500 pounds per square inch based on field cured cylinders. Backfill shall be



placed in a manner not to disturb or damage such facilities of structures, nor subject them to unbalanced loads or forces.

Furthermore, structural members shall not be subjected to any live loads until the concrete has attained its 28 day compressive strength.

Backfill in front of a retaining wall shall be placed and compacted prior to backfilling behind such wall. Backfilling behind the retaining walls shall not commence until a minimum of fourteen days have elapsed after construction of the wall.

At the time of compaction, materials to be incorporated in backfill, except sand, shall have the proper uniform moisture content required to obtain the specified relative compaction. The Contractor shall water, or do whatever spreading, mixing and stockpiling is necessary to dry such materials, as the case may be, in order to obtain such proper moisture content.

The Contractor's attention is directed to the possibility of excessive lateral pressure on, and resultant damage to, retaining walls; he shall, therefore, exercise care in properly placing the backfill behind such walls. The use of heavy compacting equipment in areas immediately behind retaining walls will not be allowed, and all such compaction shall be done with portable equipment.

#### **709.04 Payment**

Structural backfilling shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## 710 Pervious Backfill Material

### 710.01 General

Pervious backfill material shall be furnished and placed where specified or shown on the plans and in accordance with the following requirements.

Pervious backfill material shall consist of gravel, crushed gravel, crushed rock, natural sands, manufactured sand, or combinations thereof. Pervious backfill material shall conform to the following grading requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
2" .....	100
No. 50 .....	0-100
No. 100 ....	0-8
No. 200 ....	0-4

That portion of pervious backfill material passing the No. 4 sieve shall have a Sand Equivalent of not less than 60.

Pervious backfill material shall be placed in horizontal layers along with and by the same methods specified for structural backfill. Pervious backfill material at any one location shall be of approximately the same grading, and at locations where the material would otherwise be exposed to erosion shall be covered with at least a one foot layer of earthy material approved by the Engineer.

### 710.02 Payment

Pervious backfill material shall be furnished and placed as Incidental Work and payment therefor shall be included in the price or prices bid.

## **711 Filter Material**

### **711.01 General**

The Contractor shall furnish and place filter material, consisting of 3/4-inch combined aggregate in accordance with Section 800.06, where and as shown on the plans or specified, including doing all Incidental Work necessary or required.

Where specified or shown on the plans, the Contractor shall construct subdrainage facilities within or below volumes of backfill, fill or embankment. He shall furnish and place, in accordance with the requirements of Section 700.08, the required perforated drain pipe with the perforations down, filter material bed, layer of approved impervious material, and riprap drain troughs.

### **711.02 Behind Retaining Walls**

The Contractor shall furnish and place filter material behind retaining walls, for drains and otherwise, where and as shown on the plans or specified.

### **711.03 Payment**

Filter material shall be furnished and placed as Incidental Work and payment therefor shall be included in the price or prices bid.

Filter material, if the Proposal includes a Bid Item therefor, satisfactorily furnished and placed, as specified, and where specified or directed, will be paid for at the price bid per ton, and shall be furnished saturated surface dry, the weight thereof subject to the deduction specified in Section 111.02.

## **712 Crushed Rock Layer**

### **712.01 General**

The Contractor shall furnish and install an 8-inch minimum thickness crushed rock layer including all necessary or required Incidental Work.

When a Bid Item for crushed rock is included in the Proposal, the Engineer will, under such a Bid Item, order crushed rock where necessary, in his opinion, to maintain an appropriately dry subgrade. Sanitary and storm water flow shall be handled and disposed of in accordance with the requirements of Section 301.

Crushed rock shall be uniformly graded from No. 4 to 3/4-inch sieve size.

The crushed rock layer shall be placed within the longitudinal limits and widths ordered by the Engineer. Such ordered widths will not exceed the outside width of the sewer, structure, or manhole base, as the case may be, plus two feet. Crushed rock placed in excess of the required minimum thickness, or outside the limits ordered by the Engineer, shall be at the Contractor's sole expense, and no direct or additional payment will be made therefor.

### **712.02 Payment**

Crushed rock layer satisfactorily furnished and installed, in place, as specified, will be paid for at the price bid per square foot, measured horizontally within the limits ordered by the Engineer.

When subdrains are used in conjunction with a crushed rock layer, no reduction in the quantity of crushed rock will be made because of the construction of subdrains and related appurtenances within the layer.

## 713 Riprap

### 713.01 General

The Contractor shall furnish and place riprap to the lines, grades and depths shown on the plans, or where specifically ordered by the Engineer.

### 713.02 Rock

Rock for riprap will be hard, durable and not subject to disintegration by the action of air or water. When tested for soundness by the sodium sulphate test in accordance with the requirements of ASTM "Standard Method of- Test for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate", Designation C 88, not more than 7% of the rocks tested after 5 cycles of immersion and drying shall show any of the following types of deterioration : (1) Disintegration; (2) Splitting; (3) Crumbling; (4) Cracking; (5) Flaking. Sound metamorphic sandstone and basalt will pass this test; shale, weathered sandstone and igneous rock subject to splitting in seams will not pass the test.

Percentage by weight of the various individual rock weights shall be as follows:

<u>Percentage of Total Weight</u>	<u>Approximate Limits of Rock Weights</u>
40%	400 lbs to 200 lbs
35%	200 lbs to 50 lbs
25%	50 lbs to 2 lbs

No stone shall be less than 2 inches in diameter.

When required by the Engineer, samples of the rock shall be furnished by the Contractor and tested by the City at no cost to the Contractor.

### 713.03 Placing

Rock shall be well graded and placed to form a practicable minimum of voids. In general, the larger rocks shall be dumped first and the smaller rocks shall be dumped and distributed to fill the voids.

### 713.04 Payment

Riprap, satisfactorily furnished and placed as specified, will be paid for at the price bid per ton.

## 714 Imported Fill Material

### 714.01 General

The Contractor shall furnish imported fill material at the site to supplement site-excavated materials required for embankment, fill, or backfill, including that required for backfilling voids left by the removal or abandonment of subsurface obstacles and by the specified removal of facilities and materials from below the required subgrade. The borrow site for imported fill material may be designated by the City.

The work, as applicable, shall include:

- 1) loading and disposing of by the Contractor as his property, a quantity or site-excavated material suitable for use as embankment or fill, equal in volume to the quantity of imported fill material furnished;
- 2) excavating and disposing of unsuitable material as necessary, in order to excavate from the borrow area, the material required for embankment of fill; and
- 3) all other necessary or required Incidental Work.

Imported fill material is defined as material to be used for embankment or fill, obtained by the Contractor elsewhere than from the site of the work, and shall be in accordance with the requirements of Section 706.

Before importing any fill material the Contractor shall incorporate into embankment and fill all site-excavated materials that meet the requirements for embankment.

Any satisfactory material required for embankment and removed from the site by the Contractor, or wasted as a result of his operations, shall be satisfactorily replaced at the site by him at his sole expense.

Imported fill material shall not be delivered to the work until the source has been approved and the material tested and approved as hereinafter specified.

Removal from a borrow area shall be in a manner to obtain thereon the grades shown on the plans.

### 714.02 Testing

The Contractor shall notify the Engineer, in writing, 30 days in advance of hauling imported fill material to the site of the work, of the location of the area and the exact portion thereof from which he will obtain imported fill material.

The Contractor, as Incidental Work, shall excavate test pits in the aforementioned area at least 4 feet square and extending 4 feet below the unacceptable overburden, to expose representative samples of the material.

The City, at no cost to the Contractor, will conduct and evaluate tests of samples from the test pits in its laboratory to determine the acceptability of such material.

Material which is not as specified will be rejected.

### 714.03 Payment

- 1) If the Proposal does not contain a Bid Item for imported fill material, or if the contract is on a lump sum basis, the furnishing, placing, and compacting of the quantity of imported fill material specified, or indicated on the plans, shall be done as Incidental Work and included in the price or prices bid.
- 2) If imported fill material is to be furnished, placed and compacted as Incidental Work, as in 1) above, and more is required than contemplated in the plans and Special Provisions, the furnishing, placing, and compacting of such excess will be paid for as Extra Work in accordance with the provisions of Section 112.
- 3) If the Proposal contains a Bid Item for imported fill material, such material satisfactorily furnished, placed and compacted where directed will be paid for at the price bid per cubic yard. Measurement for payment will be as set forth in the Special Provisions, and will be one of the following:
  - 1) The aggregate volume, in place, of material satisfactorily furnished, computed from the cross sections between the ground surface existing at the start of the contract or the lower limit of pavement excavation, and the final graded ground surface or subgrade, as the cases may be.

- 2) The original volume, in place, of satisfactory material excavated from the borrow area and placed where required, computed by the average end area, or borrow pit, method.
- 3) Truck measurement, in accordance with the provisions of Section 111.03.
- 4) If a Bid Item for imported fill material occurs in a contract containing a Bid Item for embankment, the furnishing only of imported fill material to make up the deficiency of proper site excavated material will be paid for by truck measurement. All work to incorporate and compact imported fill material to the lines and grades of originally contemplated embankment or fill, shall be done as Incidental Work.

END PART 7

**Part 8****Concrete, Metalwork, Painting and Misc.****Table of Contents**

---

800	Portland Cement Conc. and Rel. Work . . . . .	209
801	Metal Castings . . . . .	228
802	Misc. Steel, Iron and Hardware . . . . .	230
803	Chain Link Fence . . . . .	231
804	Pipe Handrailing . . . . .	235
805	Bridge Railing . . . . .	236
806	Welding . . . . .	238
807	Galvanizing . . . . .	240
808	Blast Cleaning of Steel . . . . .	242
809	Painting . . . . .	246
810	Engineering Fabrics . . . . .	251

---



## 800 Portland Cement Conc. and Rel. Work

### 800.01 General

Portland cement concrete, component materials therefor, mortar, grout, lime, additives for concrete, and certain concrete construction requirements, shall be as specified herein, except as otherwise stipulated on the plans or by the Special Provisions.

Reinforced and prestressed concrete construction shall be in accordance with Sections 411 and 412, respectively.

Concrete designated by compressive strength shall be proportioned such that the concrete will conform to the strength shown on the plans or specified in the Special Provisions.

Before using concrete for which the mix proportions have been determined by the Contractor, or in advance of revising such mix proportions, the Contractor shall submit in writing to the Engineer a copy of the mix design.

Compliance with cement content requirements will be verified in accordance with procedures described in California Test 518. Batch proportions shall be adjusted as necessary to produce concrete having the specified cement content. All concrete for which the mix proportions are determined either by the Contractor or the Engineer shall conform to the requirements of this Section.

### 800.02 Portland Cement

General. - Unless otherwise specified, Portland cement shall be either “Type IP (MS) Modified” or “Type II Modified”. Type IP (MS) Modified” cement shall conform to the specifications for Type IP (MS) cement in ASTM “Standard Specification for Blended Hydraulic Cements”, Designation C 595 and shall be comprised of an intimate mixture of “Type II Modified” cement and not more than 20% of a pozzolanic material. “Type II Modified” cement shall conform to the specifications for Type II cement in ASTM “Standard Specifications For Portland Cement”, Designation C 150. In addition, “Type IP (MS) Modified” and “Type II Modified” cement shall conform to the following requirements:

- 1) The cement shall not contain more than 0.60% by weight of alkalis, calculated as the percentage of Na<sub>2</sub>O plus 0.658 times the percentage of K<sub>2</sub>O, when determined by either direct intensity flame photometry or by the atomic absorption method. The instrument and procedure used shall be qualified as to precision and accuracy in accordance with the requirements of ASTM “Standard Method for Chemical Analysis of Hydraulic Cement”, Designation C 114.
- 2) The autoclave expansion shall not exceed 0.50%.
- 3) Mortar, containing the Portland cement to be used and Ottawa sand, when tested in accordance with California Test 527, shall not expand in water more than 0.010% and shall not contract in air more than 0.048% except that when Portland cement is to be used for precast prestressed concrete piling, precast prestressed concrete members or steam cured concrete products, the mortar shall not contract in air more than 0.053%.

Type III and Type V Portland cements shall conform to the specifications in ASTM Designation C 150, and the modifications listed above for Type II Modified cement except that when tested in accordance with California Test 527, mortar containing Type III Portland cement shall not contract in air more than 0.075%.

Mineral admixtures may be used to replace a portion of the required Portland cement in accordance with the provisions in Section 800.08.

To accelerate the gain in strength of concrete, the Contractor may, at his expense, substitute, in identical required quantities, Type III Portland cement in lieu of Type I or Type II Portland cement, except when Type II Portland cement is specifically required. As an alternative to using Type III Portland cement, the Contractor may include an additional one-half sack of Type I or Type II Portland cement, as applicable, per cubic yard of concrete.

The use of Type III Portland cement in concrete for prestressed or precast construction will not be allowed.

All cement used in the manufacture of cast-in-place concrete for exposed surfaces of like elements of a structure shall be from the same cement mill.

Cement shall be protected from exposure to moisture until used. Sacked cement shall be piled to permit access for tally, inspection, and identification of each shipment.

Adequate facilities shall be provided to assure that cement meeting the requirements specified in this Section 800.02 will be kept separate from other cement in order to prevent any but the specified cement from entering the work. Safe and suitable facilities for sampling cement shall be provided at the weigh hopper, or in the feed line immediately in advance of the hopper.

All cement shall be delivered at the work in the original package, with the brand and the name of the manufacturer plainly marked thereon, unless shipped in bulk, in which case this information shall be contained in the shipping invoices accompanying the shipment.

Tests. - The Contractor shall give the Engineer 24 hours notice prior to placing Portland cement concrete. The Contractor, when requested, shall deliver to the Engineer not less than 5 samples of 4 pounds each of cement from the manufacturer's bin for testing by the City. Additional samples may be required commensurate with quantities of cement used and test results. He shall also, when requested, furnish the manufacturer's certificate of analysis and test, of any shipment of cement.

The Engineer may test samples taken either at the mill or at the work, or both. Shipments covered by satisfactory manufacturer's certificates will, after sampling, be released by the Engineer for immediate use. When the cement is of a brand not previously tested, or of a brand of which previous samples have not complied with the specifications, the Engineer may require any shipment to be held in storage until the completion of 3-day or 7-day tests.

All cement, the samples of which do not pass the specifications, and all cement which may have become damaged by exposure to moisture, shall be immediately and permanently removed from the work.

If it is found, by subsequent tests, that the cement used in any part of the work was not in accordance with the requirements of the specifications, then the Engineer may order the reconstruction of such part of the work. The Contractor shall perform such reconstruction at his own expense.

### 800.03 Aggregates

Aggregates shall be free from deleterious coatings, clay balls, roots, bark, sticks, rags and other extraneous material.

All natural aggregates shall be thoroughly and uniformly washed before use.

The Contractor, at his expense, shall provide safe and suitable facilities, including necessary splitting devices for obtaining samples of aggregates. Aggregates shall have not more than 10% loss when tested for soundness in accordance with California Test 214. The soundness requirement for fine aggregate will be waived, provided that the durability index,  $D_f$  of the fine aggregate is 60 or greater.

### 800.04 Course Aggregate

General. - Coarse aggregate shall consist of gravel, crushed gravel, crushed rock, crushed air-cooled iron blast furnace slag, or combinations thereof. Crushed air-cooled iron blast furnace slag shall not be used in any reinforced or prestressed concrete.

Coarse aggregate shall conform to the following quality requirements:

<u>Tests</u>	<u>California Test</u>	<u>Requirements</u>
Loss in Los Angeles Rattler (after 500 revolutions) . . . . .	211	45% Max
Cleanness Value . . . . .	227	76 Min

If the result of a single test, of the "Cleanness Value", falls below 76 but not below 71, two additional samples representative of material entering the work shall be taken immediately for testing. The average of the three test results shall be a minimum of 76. The minimum acceptable result for any single test shall be 71.

Aggregate containing more than 10% of inferior materials, flat or elongated particles, cracked or laminated rock, or rock which can readily be broken after immersion in water for one hour, will be rejected. When shaken or washed in water, the volume of silt settling in one hour shall not exceed 3% of the volume of the sample.

Coarse aggregate for Portland cement concrete shall be in accordance with the applicable requirements of ASTM "Standard Specifications for Concrete Aggregates", Designation C 33, and shall be composed of and properly graded from aggregates segregated into the following two primary size groups which shall be identified by the maximum nominal size in each:

<u>Sieve Sizes</u>	<u>Percentage by Weight Passing</u>	
	<u>Primary Aggregate Nominal Sizes</u>	
	<u>1 1/2" x 3/4"</u>	<u>3/4" x No. 4</u>
2" .....	100	...
1 1/2" .....	85 - 100	...
1" .....	0 - 66	100
3/4" .....	0 - 20	85 - 100
3/8" .....	0 - 9	0 - 66
No. 4 .....	...	0 - 20
No. 8 .....	...	0 - 9

The gradation of the primary aggregate nominal sizes as furnished for the work shall be of such uniformity that:

of the material for the 13-inch nominal size the maximum variation from an approved gradation of the percentage -of material passing the 1-inch sieve shall be +18;

and of the material for the 3/4-inch nominal size the maximum variation from an approved gradation of the percentage of material passing the 3/8-inch sieve shall be +18.

Such variation is the maximum allowable and will be reduced by the amount necessary to meet the grading requirements set forth in the preceding table.

Except in the case of nominal 3/4-inch x No. 4 aggregate, coarse aggregate shall be furnished from both of the primary size groups listed in the foregoing table. Aggregate of each size group shall be handled separately and combined with the other size when the aggregates are proportioned for each batch of concrete. Each primary aggregate nominal size may be separated into 2 sizes and stored separately provided that if the materials were combined they would conform to the grading requirements for the particular primary aggregate nominal size being separated.

**Lightweight Aggregate.** - Coarse aggregate, when lightweight aggregates are specified, shall be in accordance with the requirements of ASTM Specifications for Lightweight Aggregates, Designations C 330, C 331 and C 332, as applicable.

## 800.05 Fine Aggregate

**General.** - Fine aggregate shall be natural sand or a combination of natural and manufactured sand, consisting of material of siliceous, granitic or igneous origin, and shall be hard and durable. It shall be free from oil and injurious amounts of clay, shale, mica or other objectionable materials.

Fine aggregate shall conform to the following quality requirements:

<u>Tests</u>	<u>California Test</u>	
	<u>Method No.</u>	<u>Requirements</u>
Organic Impurities .....	213	Satisfactory
Mortar Strengths Relative to Ottawa Sand .....	515	95% Min.
Sand Equivalent .....	217	76 Min.

Fine aggregate developing a color darker than the reference standard color solution may be accepted if it is determined by the Engineer, from mortar strength tests, that a darker color is acceptable.

If the results of a single "Sand Equivalent" test falls below 76, not below 71, two additional samples representative of material entering the work shall be taken immediately for testing. The average of the three test results shall be a minimum of 76. The minimum acceptable result for any single test shall be 71.

The dry sand or fine mineral aggregate shall have a particle size distribution such that the percentage composition by weight, determined by test using standard sieves of square mesh wire construction, will conform to the following grading requirements:

<u>Sieve Sizes</u>	<u>% Passing by Weight</u>
3/8" .....	100
No. 4 .....	93 - 100
No. 8 .....	61 - 99
No. 16 .....	42 - 88
No. 30 .....	22 - 58
No. 50 .....	7 - 38
No. 100 .....	2 - 10
No. 200 .....	0 - 5

In addition to the required grading analysis set forth hereinbefore, the distribution of the fine aggregate sizes shall be such that the difference between the total percentage passing the No. 16 sieve and the total percentage passing the No. 30 sieve shall be between 10 and 40%; and the difference between the percentage passing the No. 30 and No. 50 sieves shall be between 10 and 40%.

The gradation of the fine aggregate furnished for the work shall be of such uniformity that the material passing the Nos. 16, 30, and 50 sieves will not vary from. an approved gradation by more than the following:

Max. variation of percentage of material passing the No. 16 sieve ...	±10
Max. variation of percentage of material passing the No. 30 sieve ...	±9
Max. variation of percentage of material passing the No. 50 sieve ...	±6

The variations shown immediately hereinbefore are the maximum allowable and will be reduced by the amount necessary to meet the grading requirements set forth in the preceding table.

Fine aggregate may be separated into 2 or more sizes and stored separately, provided that when the materials are combined they will conform to the grading requirements specified in this Section 800.05.

Lightweight Aggregate. - Fine aggregate, when lightweight aggregates are specified, shall be in accordance with the requirements of ASTM Specifications for Lightweight Aggregates, Designations C 330, C 331, and C 332, as applicable.

## 800.06 Combined Aggregate Gradings

General. - Fine aggregate, and coarse aggregate of the primary aggregate nominal sizes, in each batch of concrete shall be combined in proportions that will produce a mixture within the grading limits for combined aggregates specified immediately hereinafter unless otherwise specified; however, within these limitations, the exact proportions of aggregate sizes used in the concrete mix shall be as designated by the Engineer.

<u>Sieve Sizes</u>	<u>% Passing by Weight</u>	
	<u>1 1/2" Max.</u>	<u>3/4" Max.</u>
2" .....	100	...
1 1/2 .....	90 - 100	...
1" .....	50 - 86	100
3/4" .....	45 - 75	90 - 100
3/8" .....	38 - 55	60 - 80
No. 4 .....	30 - 45	40 - 60
No. 8 .....	23 - 38	30 - 45
No. 16 .....	17 - 33	20 - 35
No. 30 .....	10 - 22	13 - 23
No. 50 .....	4 - 10	5 - 15
No. 100 .....	1 - 3	1 - 5
No. 200 .....	0 - 2	0 - 2

Lightweight Aggregates. - Fine and coarse lightweight aggregates in each batch a concrete Shall be combined in proportions that will produce a mixture within the grading limits for combined aggregates as set forth in ASTM Specifications for Lightweight Aggregates, Designations C 330, C 331 and C 332, as applicable, unless otherwise specified.

### 800.07 Water

In conventionally reinforced concrete work, the water for curing, for washing aggregates, and for mixing shall be free from oil and shall not contain more than 1,000 parts per million of chlorides as  $Cl$ , nor more than 1,300 parts per million of sulfates as so In prestressed concrete work, the water for curing, for washing aggregates, and for mixing shall be free from oil and shall not contain more than 650 parts per million of chlorides as  $Cl$ , nor more than 1,300 parts per million of sulfates as  $SO_4$ . In no case shall the water contain an amount of impurities that will cause a change in the setting time of Portland cement of more than . 25% nor a reduction in the compressive strength of mortar at 14 days of more than 5% when compared to the results obtained with distilled water.

In non-reinforced concrete work, the water for curing, for washing aggregates, and for mixing shall be free from oil and shall not contain more than 2,000 parts per million of chlorides as  $Cl$ , nor more than 1,500 parts per million of sulfates as  $SO_4$ .

In addition to the above requirements, water for curing concrete shall not contain any impurities in a sufficient amount to cause discoloration of the concrete or produce etching of the surface.

Water reclaimed from mixer wash-out operations may be used in mixing concrete provided it is made up from a dilution type process rather than a concentration type process. A dilution type process is one in which the reclaimed water is extensively diluted and continuously agitated to keep solids in a state of suspension. In addition to the foregoing requirements of this section, such water shall not contain coloring agents or more than 300 parts per million of alkalies ( $Na_2O + 0.658K_2O$ ) as determined on the filtrate. The specific gravity of such water mixture shall not exceed 1.03 and shall not vary more than  $\pm 0.010$  during any day's operations.

### 800.08 Admixtures

General. - Admixtures used in Portland cement concrete shall conform to and be used in accordance with the requirements in this Section and the Special Provisions. Admixtures shall be used when specified or ordered by the Engineer and may be used at the Contractor's option as provided herein.

Chemical admixtures and air-entraining admixtures containing chlorides as  $Cl$  in excess of 1% by weight of admixture, as determined by California Test 415, shall not be used in prestressed or reinforced concrete.

Calcium chloride shall not be used in any concrete containing steel reinforcement or other embedded metals unless otherwise specified.

Admixtures shall be uniform in properties throughout their use in the work. Should it be found that an admixture as furnished is not uniform in properties, its use shall be discontinued.

If more than one admixture is used, said admixtures shall be compatible with each other so that the desirable effects of all admixtures used will be realized.

Materials. - Admixtures shall conform to the requirements of the ASTM Designations shown below:

Chemical Admixtures .....	ASTM Designation C 494
Air-entraining Admixtures .....	ASTM Designation C 260
Calcium Chloride .....	ASTM Designation D 98
Mineral Admixtures .....	ASTM Designation C 618*

\*Except that the loss on ignition shall not exceed 4%.

Required Use of Chemical Admixtures and Calcium Chloride. - When the “use of a chemical admixture or calcium chloride is specified or ordered by the Engineer, the admixture shall be used at the dosage specified or ordered, except that if no dosage is specified or ordered, the admixture shall be used at the dosage normally recommended by the manufacturer of the admixture.

Optional Use of Chemical Admixtures. - The Contractor will be permitted to use Type or F, water-reducing; Type B, retarding; or Type D or G, water-reducing and retarding admixtures as described in ASTM “Standard Specification for Chemical Admixtures for Concrete”, Designation C 494, to conserve cement or to facilitate any concrete construction application subject to the following conditions:

When concrete is designated by compressive strength, no reduction in minimum cement content will be allowed.

When concrete is not designated by compressive strength and a water-reducing admixture or a water-reducing and retarding admixture is used, the cement content specified or ordered may be reduced by a maximum of 5% by weight except that the resultant cement content shall be not less than 470 pounds per cubic yard.

When a reduction in cement content is made, the dosage of admixture used shall be the dosage used in determining approval of the admixture.

Required Use of Air-entraining Admixtures. - When air-entrainment is specified or ordered by the Engineer, the air-entraining admixture shall be used in amounts to produce a concrete having the specified air content as determined by California Test 504.

Optional Use of Air-entraining Admixtures. - When air-entrainment has not been specified or ordered by the Engineer, the Contractor will be permitted to use an air-entraining admixture to facilitate the use of any construction procedure or equipment provided that the average air content of 3 successive tests shall not exceed 4% and no single test value shall exceed 53%.

Required Use of Mineral Admixtures. - When the use of concrete containing mineral admixtures is required by the Special Provisions or is ordered by the Engineer, the minimum amount of mineral admixture per cubic yard of concrete and the type and minimum amount of Portland cement per cubic yard of concrete shall be as specified or ordered by the Engineer.

Optional Use of Mineral Admixtures. - The Contractor will be permitted to replace up to 15% of the required Portland cement, other than Type IP (MS) Modified or Type III cements, with a mineral admixture in all concrete except where high early strength has been specified or where the use of mineral admixture is otherwise specified or prohibited. The weight of mineral admixture used shall be equal to or greater than the weight of Portland cement replaced.

Proportioning and Dispensing Liquid Admixtures. - Chemical admixtures, air-entraining admixtures and calcium chloride shall be dispensed in liquid form. Unless otherwise permitted by the Engineer, such liquid admixtures shall be dispensed by automatic dispensing equipment. Dispensers for liquid admixtures

shall have sufficient capacity to measure at one time the prescribed quantity required for each batch of concrete. Each dispenser shall include a graduate measuring unit into which liquid admixtures are measured to within +5% of the prescribed quantity for each batch. Dispensers shall be located and maintained so that the graduations can be accurately read from the point at which proportioning operations are controlled to permit a visual check of batch accuracy prior to discharge. Each measuring unit shall be clearly marked for the type and quantity of admixture.

Each liquid admixture dispensing system shall be equipped with a sampling device consisting of a valve located in a safe and readily accessible position such that a sample of the admixture may be withdrawn slowly by the Engineer.

If more than one liquid admixture is used in the concrete mix, a separate measuring unit shall be provided for each liquid admixture, and dispensing shall be accomplished by injecting equipment located in such a manner that the admixtures are not mixed at high concentrations and do not interfere with the effectiveness of each other. When air-entraining admixtures are used in conjunction with other liquid admixtures, the air-entraining admixture shall be the first to be incorporated into the mix. When liquid admixtures are used in concrete which is completely mixed in paving or tilt-drum stationary mixers, dispensers shall operate automatically with the batching control equipment. Such dispensers shall be equipped with an automatic warning system in good operation condition which will provide a visible or audible signal at the point at which proportioning operations are controlled when the quantity of admixture measured for each batch of concrete varies from the preselected dosage by more than 5% or when the entire contents of the measuring unit are not emptied from the dispenser into each batch of concrete.

Unless liquid admixtures are added to premeasured water for the batch, their discharge into the batch shall be arranged to flow into the stream of water so that the admixtures are well dispersed throughout the batch, except that air-entraining admixtures may be dispensed directly into moist sand in the batching bins provided that adequate control of the air content of the concrete can be maintained.

Liquid admixtures requiring dosages greater than one-half gallon per cubic yard shall be considered to be water when determining the total amount of free water per cubic yard.

Special admixtures, such as "high range" water reducers requiring dosages greater than the capacity of conventional dispensing equipment and which may contribute to a high rate of slump loss, shall be measured and dispensed as recommended by the admixture manufacturer and as approved by the Engineer.

Storage, Proportioning, and Dispensing of Mineral Admixtures. - Mineral admixtures shall be protected from exposure to moisture until used. Sacked material shall be piled to permit access for tally, inspection and identification for each shipment.

Adequate facilities shall be provided to assure that mineral admixtures meeting the specified requirements shall be kept separate from other mineral admixtures in order to prevent any but the specified mineral admixtures from entering the work. Safe and suitable facilities for sampling mineral admixtures shall be provided at the weigh hopper or in the feed line immediately in advance of the hopper.

Mineral admixtures shall be incorporated into concrete using equipment conforming to the requirements for Portland cement weigh hoppers, and charging and discharging mechanisms in ASTM "Standard Specification for Ready-Mixed Concrete", Designation C 94, in Section 800.12, under "Proportioning", and in this Section 800.08.

When concrete is completely mixed in paving or tilt-drum stationary mixers, the mineral admixture shall be weighed in a separate weigh hopper conforming to the requirements for cement weigh hoppers and charging and discharging mechanisms in Section 800.12, under "Proportioning for Pavement", and the mineral admixture and cement shall be introduced simultaneously into the mixer proportionately with the aggregate.

In determining the maximum amount of free water that may be used in the concrete, mineral admixture shall be considered to be cement.

Mineral admixture used in concrete for exposed surfaces of like elements of a structure shall be of the same brand and of the same percentage.

## 800.09 Mortar and Grout

Mortar shall be Portland cement mortar in accordance with the following table:

<u>Class of Mortar</u>	<u>Examples of Uses</u>	<u>Sacks of Cement</u>	<u>Cubic Feet of Sand</u>
A	Finish mortar for curbs and steps; Calking for pipe joints .....	1	1½
B	Mortar for brick manhole exteriors and brick bulkhead walls in sewers and sewer structures .....	1	2
C	Mortar for brickwork exposed to concentrated sewage, manhole invert brick, and sewer invert brick .....	1	1

Grout shall be composed of Class "C" mortar diluted with water to required consistency.

Sand for mortar for use in pipe joints or brickwork need not pass the grading requirements of Section 800.05, provided it is in accordance with the following grading requirements:

	<u>% Passing by Weight</u>
No. 10 Sieve .....	100
No. 50 Sieve, not over .....	85
No. 80 Sieve, not over .....	15

Mortar may be mixed in either a mixing machine or in a watertight box. In either method, the materials shall be accurately measured. If a machine is used to mix the mortar, all the materials, including any coloring matter, and sufficient water, shall be put in the mixer and allowed to mix at least one minute.

If the mortar is mixed by hand, the materials, including any coloring matter, shall be measured in a watertight box and turned at least three times with a hoe or shovel. Sufficient water shall then be added, and the mixing continued until the batch is uniform in color and consistency. All mortar must be used immediately after mixing, and retempered mortar shall not, in any case, be used.

### 800.10 Hydrated Lime

. - Hydrated lime shall be in accordance with the requirements of ASTM "Standard Specifications for Normal Finishing Hydrated Lime", Designation C 6.

Hydrated lime shall be used only when specified. It shall be used in the proportion directed, but such proportion shall not exceed 8 pounds of hydrated lime per sack of cement.

### 800.11 Classes of Concrete

Portland cement concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, admixtures if used, and water, proportioned and mixed as specified, and the various classes of concrete shall conform to the following limiting requirements:

<u>Class</u>	<u>Min. No. of Sacks of Cement per CY of Concrete</u>	<u>(<math>f'_c</math>) Min 28-Day Strength (PSI)</u>	<u>Max. Size of Course Aggregate (Inch)</u>	<u>Max. Slump (Inch)</u>
7 - 4000 - 1½	7	4000	1½	4
7 - 4000 - ¾	7	4000	¾	4
6.5 - 3500 - ¾	6.5	3500	¾	4
6 - 3500 - 1½	6	3500	1½	4
6 - 3000 - ¾	6	3000	¾	4
5.5 - 3000 - 1½	5.5	3000	1½	3
5.5 - 2500 - ¾	5.5	2500	¾	4
5 - 2500 - 1½	5	2500	1½	4
4 - 2000 - 1½	4	2000	1½	4



The class of concrete used shall be as specified. If the concrete class is not specified, Class 6 – 3000 – 3/4 shall be used.

Where concrete containing 1 1/2-inch maximum size aggregate is specified, but reinforcement clearances or structural dimensions will not permit the use of 1 1/2-inch aggregate, the Contractor, with the approval of the Engineer, may substitute concrete of like strength with 3/4-inch maximum size aggregate. Any additional cost therefor will be paid for by the City as Extra Work.

The weighmaster's certificate, delivered to the Engineer with each load of concrete, shall state the number of sacks of cement per cubic yard of concrete.

Should the quantities of ingredients designed to produce a cubic yard of concrete result in a volume (yield) greater or less than one cubic yard, the amounts of fine and coarse aggregate shall be changed as necessary to maintain the required quantity of Portland cement in each cubic yard of concrete.

The slump of concrete shall be determined in accordance with the requirements of the ASTM "Standard Method of Test for Slump of Portland Cement Concrete", Designation C 143, which is a slump cone test, or by the "Kelly Ball" method of test. For any batch of concrete, the results of the "Kelly Ball" method of test will be approved equivalent of the required slump. Any concrete not meeting the slump requirements tabulated in the table set forth hereinbefore shall be immediately removed from the site of the work.

## 800.12 Proportioning and Storing Concrete Aggregates and Cement

Storage of Aggregates and Cement. - Aggregates shall be stored or stockpiled in such manner that separation of coarse and fine particles of each size will be avoided and also that the various sizes will not become intermixed before proportioning.

Aggregates shall be stored or stockpiled and handled in a manner that will prevent contamination by foreign materials. In addition, storage of aggregates at batching or mixing facilities which are erected subsequent to the award of the contract and which furnish concrete to the project shall conform to the following:

Intermingling of the different sizes of aggregates shall be positively prevented. The Contractor shall take the necessary measures to prevent such intermingling. Such preventive measures may include, but are not necessarily limited to, physical separation of stockpiles or construction of bulkheads of adequate length and height.

Contamination of aggregates by contact with the ground shall be positively prevented. The Contractor shall take the necessary measures to prevent such contamination. Such preventive measures shall include, but are not necessarily limited to, placing aggregates on wooden platforms or on hardened surfaces consisting of Portland cement concrete, asphalt concrete, or cement treated material.

In placing aggregates in storage or in moving them from storage to the weigh hopper of the batching plant, any method which may cause the segregation, degradation, or the combining of materials of different gradings which will result in any size of aggregate at the weigh hopper failing to meet the grading requirements shall be discontinued. Any method of handling aggregates which results in excessive breakage of particles shall be discontinued. The use of suitable devices to reduce impact of falling aggregates may be required by the Engineer.

Proportioning Devices. - Fine aggregate, coarse aggregate and bulk cement shall be measured by weighing in approved weighing devices. The correctness of all such weighing devices shall be certified by:

A County Sealer of Weights and Measures

A Scale Service Agency

A Division of Measurement Standards Official

Each weighing unit shall include a visible and easily read springless dial type scale which will indicate the scale load at all stages of the weighing operation from zero to full capacity, or an over-and-under indicator which will show the scale in balance with no load and when loaded at any desired beam setting.

Proportioning devices shall be tested at the expense of the Contractor as frequently as the Engineer may deem necessary to insure their accuracy.

Proportioning. - Proportioning shall consist of dividing the aggregates into the specified sizes, each stored in a separate bin, and combining them with cement and water as provided in these specifications. Aggregates shall be proportioned by weight.

At the time of batching, all aggregates shall have been dried or drained sufficiently to result in a stable moisture content such that no visible separation of water from aggregate will take place during transportation from the proportioning plant to the point of mixing. In no event shall the free moisture content of the fine aggregate at the time of batching exceed 8% of its saturated, surface-dry weight.

Should separate supplies of aggregate material of the same size group, but of different moisture content or specific gravity or surface characteristics affecting workability, be available at the proportioning plant, withdrawals shall be made from one supply exclusively and the materials therein completely exhausted before starting upon another.

Bulk cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the ingredients are released for discharge. Except as otherwise provided in this Section 800.12, under "Proportioning for Pavement", and "Proportioning for Structures", the cement hopper may be attached to a separate scale for individual weighing or may be attached to the aggregate scale for cumulative weighing. If the cement is weighed cumulatively, the cement shall be weighed before the other ingredients.

The Engineer shall be allowed sufficient time to adjust the mix when the source of any aggregate is changed, and such aggregates shall not be used until necessary adjustments are made.

For all batches with a volume of one cubic yard or more, the batching equipment shall conform to one of the following combinations:

- 1) Separate boxes and separate dial or beam scales for weighing each size of aggregate.
- 2) Single box and dial or multiple beam type scales for all aggregates.
- 3) Single box or separate boxes and automatic weighing mechanism for all aggregates.

In order to check the accuracy of batch weights, the gross weight and tare weight of batch trucks, truck mixers, truck agitators, and non-agitating hauling equipment shall be determined when ordered by the Engineer. The equipment shall be weighed at the Contractor's expense on scales designated by the Engineer.

Vehicles that contain more than one compartment, when used for hauling batched aggregates, shall be constructed so that materials do not shift from one compartment to another during haul or discharge.

Proportioning for Pavement. - Aggregates and bulk cement for use in pavement shall be proportioned by weight by means of automatic proportioning devices of approved type conforming to the requirements specified hereinafter, except that when the estimated contract quantity of concrete is 2,500 cubic yards or less, or when the quantity of concrete to be placed for single required construction stage of the contract work is 10,000 square yards or less or when short lengths of pavement are to be placed at structure approaches separately from the normal pavement construction, the aggregates may be proportioned by any one of the weight methods specified in this Section 800.12, under "Proportioning".

The Contractor shall install and maintain in operating condition an electrically actuated moisture meter that will indicate, on a readily visible scale, changes in the moisture content of the fine aggregate as it is batched within a sensitivity of 0.5% by weight of the fine aggregate.

The scale and weigh hopper for bulk cement shall be separate and distinct from the aggregate weighing equipment.

Except as provided below for separate proportioning of aggregates for pavement concrete, batching of cement and aggregate shall be interlocked so that a new batch cannot be started until all weigh hoppers are empty, the proportioning devices are within zero tolerance, and the discharge gates are closed.

The discharge gate on the cement hopper shall be designed to permit regulating the flow of cement into the aggregate as directed by the Engineer.

When separate weigh boxes are used for each size of aggregate, the discharge gates shall permit regulating the flow of each size of aggregate as directed by the Engineer.

Material discharged from the several bins shall be controlled by gates or by mechanical conveyors. The means of withdrawal from the several bins, and of discharge from the weigh box, shall be interlocked so that not more than one bin can discharge at a time, and that the weigh box cannot be tripped until the required quantity from each of the several bins has been deposited therein. Should a separate weigh box be used for each size of aggregate, all may be operated and discharged simultaneously.

When the discharge from the several bins is controlled by gates, each gate shall be actuated automatically so that the required weight is discharged into the weigh box, after which the gate shall automatically close and lock.

The automatic weighing system shall be designed so that all proportions required may be set on the weighing controller at the same time.

Except as provided below for separate proportioning of aggregates for pavement concrete, the proportioning devices shall be automatic to the extent that the only manual operation required for proportioning the aggregates and cement for one batch of concrete shall be a single operation of a switch or a starter.

Aggregate for pavement concrete may be proportioned separately from cement and water. When the separate proportioning method is used, the following requirements shall apply:

Aggregate proportioning equipment shall be interlocked so that a new aggregate batching sequence cannot be started until all aggregate weigh hoppers are empty, the proportioning devices are within zero tolerance, and the discharge gates are closed.

Batches of aggregate shall be transported in a manner that will prevent loss or contamination. Each batch of aggregate shall be kept separate from all other batches.

Cement proportioning equipment shall be interlocked so that a new cement batching sequence cannot be started until the cement weigh hopper is empty, the proportioning device is within zero tolerance, and the discharge gates are closed.

Proportioning for Structures. - When bulk cement is used, the scale and weigh hopper for Portland cement shall be separate and distinct from the aggregate weighing equipment. The charging mechanism of the cement weigh hopper shall be interlocked to be inoperative until the cement weighing device is within zero tolerance and the discharge gate is closed.

### 800.13 Mixing and Transporting Concrete

General. - All concrete shall be mixed in mechanically operated mixers, except that when permitted by the Engineer, batches not exceeding 1/3 cubic yard may be mixed by hand methods in accordance with the provisions in this Section 800.13, under "Hand-Mixing".

Equipment having components made of aluminum or magnesium alloys, which would have contact with plastic concrete during mixing, transporting or pumping of Portland cement concrete, shall not be used.

All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of undispersed cement.

Uniformity of concrete mixtures will be determined by differences in penetration as determined by California Test 533 and by variations in the proportion of coarse aggregate as determined By California Test 529.

The difference in penetration, determined by comparing penetration tests on 2 samples of mixed concrete from the same batch or truck mixer load, shall not exceed 1/2 inch. Variation in the proportion of coarse aggregate will be determined from the results of tests of 2 samples of mixed concrete from the same batch or truck mixer load and the difference between the 2 results shall not exceed 6 pounds per cubic foot.

The Contractor, at his expense, shall furnish samples of the freshly mixed concrete and provide satisfactory facilities for obtaining the samples.

Machine Mixing. - Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer. Mixers and agitators which have an accumulation of hard concrete or mortar shall not be used.

The temperature of mixed concrete, immediately before placing, shall be not less than 50°F. nor more than 90°F. Aggregates and water shall be heated or cooled as necessary to produce concrete within these

temperature limits. Neither aggregates nor mixing water shall be heated to exceed 150°F. If ice is used to cool the concrete, discharge of the mixer will not be permitted until all ice is melted.

The batch shall be so charged into the mixer that some water will enter in advance of cement and aggregates. All water shall be in the drum by the end of the first 1/4 of the specified mixing time.

Cement shall be batched and charged into the mixer by means that will not result either in loss of cement due to the effect of wind, or in accumulation of cement on surfaces of conveyors or hoppers, or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

Paving and stationary mixers shall be operated with an automatic timing device that can be locked by the Engineer. The timing device and discharge mechanism shall be so interlocked that during normal operation no part of the batch will be discharged until the specified mixing time has elapsed.

The total elapsed time between the intermingling of damp aggregates and cement and the start of mixing shall not exceed 30 minutes.

The size of batch shall not exceed the manufacturer's guaranteed capacity or the rated capacity as determined by the standard requirements of the Associated General Contractors of America.

When producing concrete for pavement or base, suitable batch counters shall be installed and maintained in good operating condition at jobsite batching plants and stationary mixers. The batch counters shall indicate the exact number of batches proportioned and mixed.

Concrete shall be mixed and delivered to the site of the work by means of one of the following combinations of operations:

- 1) Mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in truck agitators or in nonagitating hauling equipment (Known as central-mixed concrete).
- 2) Mixed partially in a stationary mixer, and the mixing completed in a truck mixer (Known as shrink-mixed concrete).
- 3) Mixed completely in a truck mixer (Known as transit-mixed concrete).
- 4) Mixed completely in a paving mixer.

Agitators may be truck mixers operating at agitating speed or truck agitators. Each mixer and agitator shall have attached thereto in a prominent place a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the manufacturer's guaranteed capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades.

Truck mixers shall be equipped with electrically or mechanically actuated revolution counters by which the number of revolutions of the drum or blades may readily be verified. The counters shall be of the continuous registering type, which accurately register the number of revolutions and shall be mounted on the truck mixer so that the Engineer may safely and conveniently inspect them from alongside the truck.

When shrink-mixed concrete is furnished, concrete that has been partially mixed at a central plant shall be transferred to a truck mixer and all requirements for transit-mixed concrete shall apply. No credit in the number of revolutions at mixing speed shall be allowed for partial mixing in a central plant.

Transporting Mixed Concrete. - Mixed concrete may be transported to the delivery point in truck agitators or truck mixers operating at the speed designated by the manufacturer of the equipment as agitating speed, or in non-agitating hauling equipment, provided the consistency and workability of the mixed concrete upon discharge at the delivery point is suitable for adequate placement and consolidation in place, and provided the mixed concrete after hauling to the delivery point conforms to the requirements in this Section 800.13, under "General".

Truck agitators shall be loaded not to exceed the manufacturer's guaranteed capacity. They shall maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling.

Bodies of non-agitating hauling equipment shall be so constructed that leakage of the concrete mix, or any part thereof, will not occur at any time, and they shall be self-cleaning during discharge.

Concrete hauled in open-top vehicles shall be protected during hauling against access of rain, or exposure to the sun for more than 20 minutes when the ambient temperature exceeds 75°F.

No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point, unless authorized by the Engineer. If the Engineer authorizes additional water to be

incorporated into the concrete, the drum shall be revolved not less than 30 revolutions at mixing speed after the water is added and before discharge is commenced.

The rate of discharge of mixed concrete from truck mixer-agitators shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

When a truck mixer or agitator is used for transporting concrete to the delivery point, discharge shall be completed within 1½ hours, or before 250 revolutions of the drum or blades, whichever comes first, after the introduction of the cement to the aggregates. Under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85°F, or above, a time less than 1½ hours may be required.

When non-agitating hauling equipment is used for transporting concrete to the delivery point, discharge shall be completed within one hour after the addition of the cement to the aggregates. Under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85°F, or above, the time between the introduction of cement to the aggregates and discharge shall not exceed 45 minutes.

Each load of ready-mixed concrete delivered at the jobsite, except loads to be used for pavement, shall be accompanied by a ticket showing volume of concrete, the weight of cement in pounds and the total weight of all ingredients in pounds, unless otherwise directed by the Engineer. The ticket shall also show the time of day at which the materials were batched and for transit-mixed concrete, the reading of the revolution counter at the time the truck mixer is charged.

Each load of ready-mixed concrete used for paving shall be accompanied by a ticket which shall be delivered to the Engineer at the discharge location of the concrete, unless otherwise directed by the Engineer. The ticket shall be stamped with the date and the time of day when the load left the batching plant and, if hauled in truck mixers or agitators, the time the mixing cycle started.

Time or Amount of Mixing. - Mixing of concrete in paving or stationary mixers shall continue for the required mixing time after all ingredients, except water and admixture if added with the water, are in the mixing compartment of the mixer before any part of the batch is released. Transfer time in multiple drum mixers shall be counted as part of the required mixing time.

The required mixing time, in paving or stationary mixers, of concrete used for concrete structures, except minor structures, shall be not less than 90 seconds nor more than 5 minutes, except that when directed by the Engineer in writing, the requirements of the following paragraph shall apply.

The required mixing time, in paving or stationary mixers, except as provided in the preceding paragraph, shall be not less than 50 seconds nor more than 5 minutes.

The minimum required revolutions at the mixing speed for transit mixed concrete shall not be less than that recommended by the mixer manufacturer, but in no case shall the number of revolutions be less than that required to consistently produce concrete which conforms to the uniformity requirements in this Section 800.13, under "General".

Hand-Mixing. - Hand-mixed concrete shall be made in batches not more than 1/3 cubic yard and shall be mixed on a watertight, level platform. The proper amount of coarse aggregate shall be measured in measuring boxes and spread on the platform and the fine aggregate shall be spread on this layer, the 2 layers being not more than one foot in total depth. On this mixture shall be spread the dry cement and the whole mass turned not less than 2 times dry; then sufficient clean water shall be added, evenly distributed, and the whole mass again turned not less than 3 times, not including placing in the carriers or forms.

## 800.14 Placing Concrete

Before placing concrete, all debris, chips, loose dirt and water shall be removed from within the forms, all temporary bracing and cleats taken out, all openings for pipes properly boxed, all forms properly secured in their correct positions and made tight, and all reinforcements cleaned and secured in their proper place.

The Contractor shall give the Engineer 24 hours notice prior to placing Portland cement concrete. Concrete shall not be placed in any form until that form, and the reinforcement therein, has been inspected and approved for the placing of concrete.

Concrete shall not be placed during freezing or other adverse weather conditions unless approved protective measures are taken.

All forms, while concrete is being poured therein, shall be completely detached from runways and mixer supports so that concrete in the process of setting will be entirely free from any vibration whatever. The use of aluminum equipment, such as conduits and chutes, in contact with concrete being poured or placed will not be allowed.

Any concrete which may be on the forms or reinforcement, and is set and dry in advance of the depositing of fresh concrete, shall be cleaned off and removed, and forms and reinforcing steel washed clean. In structures, and where waterproofing is necessary, a layer of neat cement mortar shall be placed between set concrete and wet concrete.

Forms and subgrade shall be thoroughly moistened with water immediately before placing concrete.

Good runways, where necessary for concrete buggies, shall be provided to convey the concrete to place, in order not to displace the forms or reinforcement. Running buggies directly across reinforcing bars will not be permitted, nor will wheeling buggies or walking on concrete within twelve hours after it has been deposited.

Concrete shall be conveyed in such manner that there will be no separation of the ingredients, and in cases where such separation occurs or there has been a delay in placing, the concrete may be rejected unless, in the opinion of the Engineer and with his specific approval, it can be satisfactorily remixed before placing. In any event, concrete which has attained initial set, and that for which more than one hour has elapsed since the initial introduction of water thereto, shall not be incorporated into the work.

Concrete shall not be dropped through the reinforcing steel in such a manner as to cause segregation of the aggregates. In no case, within the formwork or otherwise, shall concrete be permitted to fall from a height greater than 6 feet except through approved adjustable-length pipes or "elephant trunks".

Concrete for horizontal members or sections shall not be placed until the concrete in the supporting vertical members or sections has been consolidated and settlement due to bleeding has occurred.

Reinforcement, anchor bolts or other fixtures that are to be embedded in the concrete shall not be displaced.

Concrete shall be thoroughly compacted by vibration during and immediately after placing. The Contractor shall provide a sufficient number of approved electrical, pneumatic or other mechanical internal vibrators, operators therefor, and helpers, to so compact each batch of concrete.

Each vibrator shall be inserted directly in the concrete at each location for a period from twenty to thirty seconds, depending on the consistency of the concrete, at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. No vibrator shall be attached to either the reinforcing steel or the forms, unless the Special Provisions allow external vibration on forms. Vibration shall be of sufficient duration to thoroughly compact the concrete and work it around the reinforcement and embedded fixtures and into the corners and angles of forms, but shall not be continued so long as to cause segregation of the concrete.

Vibration shall be supplemented by such spading along form surfaces, in corners and in locations inaccessible to vibrators, as is necessary to insure smooth and dense concrete, free from air pockets, rock pockets and honeycombed areas.

The concrete shall be placed in layers about 12 inches in thickness and, insofar as practicable, the work on each part of the structure shall be prosecuted in a manner such that the concrete in each layer is placed before the concrete immediately under it has initially set.

The placing of fresh concrete against old or set concrete shall be done as specified in Section 800.15.

Subgrade surfaces on which pile-supported concrete is placed shall be adequately prepared to assure proper support for the placed concrete until such concrete has sufficient strength to span, and be supported solely by the piles.

During construction of pavement, the method of placing concrete shall be such as to prevent segregation of the concrete materials and avoid damage to the subgrade, and not require more than a minimum of rehandling of the concrete. Each batch shall be conveyed over the subgrade by means of a boom and bucket, or other approved device, and deposited within the area to be covered by that batch. The use of a chute will not be allowed in pavement construction, unless otherwise specified in the Special Provisions, or permitted by the Engineer.

### 800.15 Construction Joints

For Structures. - Construction joints for structures shall be located, in lieu of specific instructions to the contrary, at points of minimum shear, and shall be formed so as not to impair the strength or appearance of the concrete structure.

Before starting any concreting operation, the unit of concrete placement between construction joints shall be approved by the Engineer.

The entire predetermined unit shall be completed in a single placement operation.

The entire contact surface of old or set concrete against which fresh concrete is to be placed shall be cleared of laitance, thoroughly cleaned, washed with clean water in such manner that free water does not remain on the surface, and then covered with a layer of neat cement mortar of creamy consistency. The fresh concrete shall be thoroughly worked against mortar-covered surface.

All concrete in vertical members, such as columns and walls, shall be in place not less than four hours before any concrete is placed in girders, beams or slabs directly over, and connected to, such vertical members. All excess water and laitance that rises to the top of such vertical members shall be removed, and the concrete cut away as necessary to insure full strength of the concrete at the joint with girders, beams and slabs.

For Curbs and Pavements. - Construction joints for curbs, combined curb and gutter, concrete pavement base, and concrete pavement, shall be in accordance with the respective requirements therefor in Part 2 of these Standard Specifications.

### 800.16 Protecting and Curing Concrete

General. - All fresh concrete, including gunite, shall be adequately protected from weather, sun, rain, and mechanical injury, until thoroughly set and the strength thereof is sufficient to prevent damage, and shall be cured as specified hereinafter or in the Special Provisions.

All newly placed concrete shall be cured in accordance with the provisions in this Section 800.16. The method or methods of curing to be used shall be as specified in these specifications and the Special Provisions.

Water Method. - The concrete shall be kept continuously wet by the application of water for a minimum of 7 days after the concrete has been placed.

Cotton mats, rugs, carpets, or earth or sand blankets may be used as a curing medium to retain the moisture during the curing period.

When cotton mats, rugs, carpets, or earth or sand blankets are to be kept damp by applying water with a nozzle that so atomizes the flow that a mist and not a spray is formed, until the surface of the concrete is covered with the curing medium. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface. At the expiration of the curing period, the concrete surfaces shall be cleared of all curing mediums.

When concrete bridge decks and flat slabs are to be cured without the use of a moisture retaining medium, the entire surface of the bridge deck or slab shall be kept damp by the application of water with an atomizing nozzle as specified in the preceding paragraph, until the concrete has set, after which the entire surface of the concrete shall be sprinkled continuously with water for a period of not less than 7 days.

Curing Compound Method. - Surfaces of the concrete which are exposed to the air shall be sprayed uniformly with a curing compound. The curing compound shall comply with one of the following descriptions and shall be applied at the nominal rates indicated:

- 1) Pigmented Curing Compound-Petroleum Hydrocarbon Resin Base (State Specification 8030-71D-03), one gallon per 200 square feet.
- 2) Pigmented Curing Compound-Chlorinated Rubber Base (State Specification 8030-71D-04), one gallon per 200 square feet.
- 3) Pigmented Curing Compound-Chlorinated Rubber Base - White or Tinted (State Specification 8030-71D-05), one gallon per 200 square feet.

- 4) Non-pigmented Curing Compound-Chlorinated Rubber Base Clear (State Specification 8030-71D-06), one gallon per 250 square feet.

At any point, the application rate shall be within +50 square feet per gallon of the nominal rates shown above and the average application rate shall be within +25 square feet per gallon of the nominal rates shown above when tested in accordance with California Test 535. Runs, sags, thin areas, skips, or holidays in the applied curing compound shall be evidence that the application is not satisfactory.

The compound to be used shall be of the type specified in these specifications or the Special Provisions for various items of work. In the event no specific type is called for, 1, 2, or 3 as listed above may be used at the option of the Contractor.

Curing compounds shall be applied using power operated atomizing spray equipment. The power operated spraying equipment shall be equipped with an operational pressure gauge and a means of controlling the pressure.

The curing compound shall be applied to the concrete following the surface finishing operation immediately before the moisture sheen disappears from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any drying or cracking of the surface, application of water with an atomizing nozzle as specified in this Section 800.16, under "Water Method", shall be started immediately and shall be continued until application of the compound is resumed or started; however, the compound shall not be applied over any resulting free standing water. Should the film of compound be damaged from any cause before the expiration of 7 days after the concrete is placed in the case of structures and 72 hours in the case of pavement, the damaged portion shall be repaired immediately with additional compound.

At the time of use, compounds containing pigments shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. A paddle shall be used to loosen all settled pigment from the bottom of the container, and a power driven agitator shall be used to disperse the pigment uniformly throughout the vehicle.

The manufacturer shall include in the curing compound the necessary additives for control of sagging, pigment settling, leveling, or other requisite qualities of a satisfactory working material. Pigmented curing compounds shall be manufactured so that the pigment does not settle badly, does not cake or thicken in the container, and does not become granular or curdled. Any settlement of pigment shall be a thoroughly wetted, soft, mushy mass permitting the complete and easy vertical penetration of a paddle. Settled pigment shall be easily redispersed, with a minimum resistance to the sidewise manual motion of the paddle across the bottom of the container, to form a smooth uniform product of the proper consistency.

All curing compounds shall remain sprayable at temperatures above 40°F. They shall not be diluted or altered in any manner after manufacture.

Curing compounds shall conform to the requirements of air pollution rules, regulations, ordinances and statutes, specified in Section 11017 of the Government Code of the State of California.

Waterproof Membrane Method. - The exposed finished surfaces of concrete shall be sprayed with water, using a nozzle that so atomizes the flow that a mist and not a spray is formed, until the concrete has set, after which the curing membrane shall be placed. The curing membrane shall remain in place for a period of not less than 72 hours.

Sheeting material for curing concrete shall conform to the specifications of AASHTO Designation M 171 for white reflective materials.

The sheeting material shall be fabricated into sheets of such width as to provide a complete cover for the entire concrete surface. All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint. The joint seams shall have a minimum lap of 0.33-foot.

The sheets shall be securely weighted down by placing a bank of earth on the edges of the sheets or by other means satisfactory to the Engineer.

Should any portion of the sheets be broken or damaged before the expiration of 72 hours after being placed, the broken or damaged portions shall be immediately repaired with new sheets properly cemented into place.

Sections of membrane which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing the concrete shall not be used.

Forms-In-Place Method. - Formed surfaces of concrete may be cured by retaining the forms in place.



The forms shall remain in place for a minimum period of 7 days after the concrete has been placed, except that for members over 20 inches in least dimension the forms shall remain in place for a minimum period of 5 days.

All joints in the forms and the joints between the end of forms and concrete shall be kept moisture tight during the curing period. Cracks in the forms and cracks between the forms and the concrete shall be resealed by methods subject to the approval of the Engineer.

Curing Pavement - The entire exposed area of the pavement, including edges, shall be cured by the waterproof membrane method, or curing compound method using a pigmented curing compound as the Contractor may elect. Should the side forms be removed before the expiration of 72 hours following the start of curing, the exposed pavement edges shall also be cured. If the pavement is cured by means of the curing compound method, the sawcut and all portions of the curing compound which have been disturbed by sawing operations shall be restored by spraying with additional curing compound.

Curing shall commence as soon as the finishing process provided in Section 210.06 has been completed. The method selected shall conform to the requirements specified hereinbefore, except that when curing compound is used, the nominal rate of application shall be one gallon per 150 square feet.

When the curing compound method is used, the compound shall be applied to the entire pavement surface by mechanical sprayers. Spraying equipment shall be of the fully atomizing type equipped with a tank agitator which provides for continual agitation of the curing compound during the time of application. The spray shall be adequately protected against wind and the nozzles shall be so oriented or moved mechanically transversely as to result in the minimum specified rate of coverage uniformly on all exposed faces. Hand spraying of small and irregular areas and areas inaccessible to mechanical spraying equipment, in the opinion of the Engineer, will be permitted. When the ambient temperature is above 60°F, the Contractor shall fog the surface of the concrete with a fine spray of water as specified in this Section 800.16, under "Water Method". The surface of the pavement shall be kept moist between the hours of 10:00 a.m. and 4:30 p.m. on the day the concrete is placed; however, the fogging done after the curing compound has been applied shall not begin until the compound has set sufficiently to prevent displacement. Fogging shall be discontinued if ordered in writing by the Engineer.

Curing Structures. - All newly placed concrete for cast-in-place structures, other than highway bridge decks, shall be cured by the water method, the forms-in-place method, or as permitted herein, by the curing compound method, all in accordance with the specified requirements.

The curing compound method using a pigmented curing compound may be used on concrete surfaces of construction joints, surfaces which are to be buried underground, and surfaces where only Ordinary Surface Finish is to be applied and on which a uniform color is not required and which will not be visible from any public traveled way. If the Contractor elects to use the curing compound method on the bottom slab of box girder spans, the curing compound shall be the white pigmented chlorinated rubber base type. When deemed necessary by the Engineer during periods of hot weather, water shall be applied to concrete surfaces being cured by the curing compound method or by the forms-in-place method, until the Engineer determines that a cooling effect is no longer required. Such application of water will be paid by the City as extra work.

Curing Precast Concrete Members. - Precast concrete members shall be cured or not less than 7 days by the water method in conformance with requirements in this Section 800.16, under "Water Method", or by steam curing, at the option of the Contractor. Steam curing for precast members shall conform to the following provisions:

- 1) After placement of the concrete, members shall be held for minimum 4-hour presteaming period. If the ambient air temperature is below 50°F, steam shall be applied during the presteaming period to hold the air surrounding the member at a temperature between 50°F and 90°F.
- 2) To prevent moisture loss on exposed surfaces during the presteaming period, members shall be covered as soon as possible after casting or the exposed surfaces shall be kept wet by fog spray or wet blankets.
- 3) Enclosures for steam curing shall allow free circulation of steam about the member and shall be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted provided they are kept in good repair and secured in such a manner to prevent the loss of steam and moisture.

- 4) Steam at the jets shall be low pressure and in a saturated condition. Steam jets shall not impinge directly on the concrete, test cylinders, or forms. During application of the steam the temperature rise within the enclosure shall not exceed 40°F per hour. The curing temperature throughout the enclosure shall not exceed 150°F and shall be maintained at a constant level for a sufficient time necessary to develop the required transfer strength. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature is representative of the average temperature of the enclosure.
- 5) Temperature recording devices that will provide an accurate continuous permanent record of the curing temperature shall be provided. A minimum of one temperature recording device per 200 feet of continuous bed length will be required for checking temperature.
- 6) Members in pretension beds shall be detensioned immediately after the termination of steam curing while the concrete and forms are still warm or the temperature under the enclosure shall be maintained about 60°F. until the stress is transferred to the concrete.
- 7) Curing of precast concrete will be considered completed after termination of the steam curing cycle.

Curing Concrete Piles. - All newly placed concrete for precast concrete piles, both conventionally reinforced and prestressed, shall be cured by the method specified in this Section 800.16, under “Curing Precast Concrete Members”, except that the following method shall be used for piles which have been specified as “Corrosion Resistant”, on the plans or in the Special Provisions.

Piles shall be either steam cured or water cured. If water curing is used, the piles shall be kept continuously wet by the application of water in accordance with the provisions in this Section 800.16, under “Water Method”, except that the minimum curing period shall be 14 days.

If steam curing is used, the steam curing provisions in “Curing Precast Concrete Members”, shall apply except that the piles shall be kept continuously wet for their entire length for a period of not less than 7 days including the holding and steam curing periods.

Curing Miscellaneous Concrete Work. - Exposed surfaces of curbs shall be cured by pigmented curing compounds as provided in this Section 800.16 under “Curing Compound Method”.

Concrete sidewalks, gutter depressions, island paving, handicap ramps, driveways, and other miscellaneous concrete areas shall be cured in accordance with any of the methods specified in this Section 800.16.

Air-blown mortar shall be cured for at least 72 hours by spraying with water, or by a moist earth blanket, or by any of the methods provided in this Section 800.16.

Mortar and grout shall be cured by keeping the surface damp for 3 days.

After placing, the exposed surfaces of sign structure foundations, including pedestal portions, if constructed, shall be cured for at least 72 hours by spraying with water, or by a moist earth blanket, or by any of the methods provided in this Section 800.16.

## 800.17 Required Concrete Strengths

The Contractor shall observe the various minimum compressive strengths for concrete that must be obtained:

- 1) before removal of falsework or forms;
- 2) before backfilling;
- 3) before application of construction or other loads;
- 4) at age 28 days.

Such strengths shall be as specified, or shown on the plans.

The compressive strength of concrete will be determined from test cylinders which have been fabricated from concrete sampled, cured, and tested in accordance with the applicable ASTM procedures. The Contractor shall provide all necessary labor and equipment to obtain and protect samples.

Twenty-eight day concrete strengths will be considered acceptable when the average strength of two 28-day field molded laboratory cured compressive test specimens exceeds the required minimum strength shown in the Table in Section 800.11.

When concrete compressive strength is specified as a prerequisite to form. removal or the application of loads or stresses to a concrete structure or member, test cylinders will be cured under conditions similar to those at the casting site. The compressive strength of concrete determined for such purposes will be evaluated on the basis of individual tests.

### **800.18 Repairing Imperfect Concrete**

Voids or stone pockets discovered when the forms are removed shall not be repaired until inspected by the Engineer.

After removal of the forms, all concrete found to be out of line or level, shall be removed and repaired or replaced as required by the Engineer.

Where required, pockets containing either rocks or voids shall be cleaned out to sound concrete, the edges of which at the surface of the structure shall be cut normal to such surface. The so exposed sound concrete shall be generously brushed with neat cement mortar, and proper repair made with concrete, or cement mortar, as directed, held in place with forms if necessary. The brand and type of cement shall be that used for the structure, and the color of the concrete or mortar shall be otherwise controlled so that the patched area will match the contiguous concrete.

Concrete placed, tests of which do not meet the specified strength requirements, shall be removed by a method approved by the Engineer, and each section removed shall be reformed and the concrete replaced, all at the Contractor's sole expense. All costs of additional testing performed by the City, including corings, and Schmidt hammer readings, required as a result of inferior concrete, shall be borne by the Contractor and will be deducted from payment due him.

### **800.19 Preparing Concrete for Painting**

If the Special Provisions require the painting of concrete, all concrete surfaces to be painted shall be prepared in accordance with requirements of Section 809.03.

### **800.20 Payment**

Portland cement concrete and related materials and work shall be furnished and incorporated in the construction as Incidental Work and payment therefor shall be included in the price or prices bid.

## 801 Metal Castings

### 801.01 Cast Iron

General. - Gray iron for cast iron castings shall be such as to make a casting that will be tough, sound, of even grain, and in accordance with the applicable requirements of ASTM “Standard Specifications for Gray Iron Castings”, Designation A 48, Class 30. The tensile strength shall be considered the primary test for qualification under these specifications. In certain cases a transverse bending test may be required by the Special Provisions to a minimum test value specified therein; in such event, the bending test will be conducted in accordance with the requirements of ASTM “Standard Method for Transverse Test of Gray Iron”, Designation A 438.

Test Bars. - The Contractor shall, at his own expense, cast, machine, and provide bars for tensile strength tests, and when applicable, also for transverse bending tests, in accordance with the applicable requirements of the ASTM Specifications referred to hereinbefore. The actual tests will be made by the City at no expense to the Contractor. At least 2 bars representing each lot of castings shall be submitted to the Engineer for testing. Bars shall be poured, and shall represent true samples of the metal used in the castings.

Rejection of Materials. - Should the results of testing fail to meet all the requirements herein specified, all castings made from the lot which the specimens represent will be rejected.

Cleaning and Inspection. - All castings which have passed the required tests shall be thoroughly cleaned, inside and out, without the aid of acid or other liquid, and shall be subjected to careful inspection and hammer tests. The castings shall be of the dimensions shown on the plans, and shall be free from sand or blow holes and cold shuts. No plugging or stopping of holes will be allowed. Casting lines and excess materials shall be ground smooth.

After the castings have been tested and cleaned, as described hereinbefore, they shall be weighed and the weight shall not vary more than 8% of that indicated on the plans for any particular casting, and not more than 4% on the whole lot of castings. The weight of each casting shall be painted with white paint on the outside of the casting. Unless otherwise specified, no casting will be accepted on the work unless the weight is plainly marked thereon.

Patterns. - The Contractor shall assume full responsibility for the correctness and condition of all patterns, whether furnished by him or borrowed from the City.

Marking. - Each casting shall have distinctly cast on the outside thereof such letters and numbers as the Engineer may direct. The letters and numbers shall be not less than 1 – 1/2 inches in length and 1/8 inch in relief, unless otherwise specified.

### 801.02 Cast Steel

General. - Steel castings shall be in accordance with the applicable requirements of ASTM “Standard Specifications for Mild- to Medium-Strength Carbon-Steel Castings for General Application”, Designation A 27, Grade 65-35.

Test Specimens. - The Contractor shall at his own expense, provide and finish all test pieces in accordance with the applicable requirements of the ASTM Specifications referred to hereinbefore. The actual tests will be made by the City at no expense to the Contractor. At least one specimen representing each lot of castings, or heat in the case of chemical analysis, shall be submitted to the Engineer for testing. Each test piece shall be cut cold from coupons attached to some portion of one of the castings where practicable, or cut cold from coupons attached to separate cast blocks, and shall receive the same treatment as the casting or cast block before the specimen is cut out and before the coupon is removed from the casting or cast block.

Rejection of Materials. - Should the results of testing fail to meet all the requirements herein specified, all castings made from the lot, or heat in the case of chemical analysis, which the specimens represent, will

be rejected.

Cleaning and Inspection. - All castings which have passed the required tests shall be thoroughly cleaned, inside and out, without the aid of acid or other liquid, and shall be subjected to careful inspection and hammer tests. The castings shall be of the dimensions shown on the plans, sound and free from all defects or imperfections which may render them unfit for use. Casting lines and excess materials shall be ground smooth.

After the castings have been tested and cleaned, as described hereinbefore, they shall be weighed and the weight shall vary not more than 5% of that indicated on the plans for any particular casting, and not more than 3% on the whole lot of castings. The weight of each casting shall be painted with white paint on the outside of the casting. Unless otherwise specified, no casting will be accepted on the work unless the weight is plainly marked thereon.

Patterns. - The Contractor shall assume full responsibility for the correctness and condition of all patterns, whether furnished by him or borrowed from the City.

Marking. - Each casting shall have distinctly cast on the outside thereof such letters and numbers as the Engineer may direct. The letters and numbers shall be not less than 1<sup>1</sup>/<sub>2</sub> inches in length and 1/8 inch in relief, unless otherwise specified.

### **801.03 Payment**

Metal castings shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.

## **802 Misc. Steel, Iron and Hardware**

### **802.01 Steel**

Steel, except steel for structures, as covered in Section 413 and reinforcing steel as covered in Section 411.05, shall be fabricated and installed in accordance with the requirements set forth on the plans or in the Special Provisions. In the absence of such coverage, steel shall conform to the requirements of ASTM “Standard Specifications for Structural Steel”, Designation A 36.

### **802.02 Bolts, Nuts, Washers, Etc.**

General. - All bolts and nuts, except as otherwise specified, shall conform to the requirements of ASTM “Standard Specification for Low Carbon Steel Externally and Internally Threaded Standard Fasteners”, Designation A 307. Bolts shall have heavy hexagon heads and nuts shall be of the hexagon heavy series. All bolts, washers, nuts, anchor bolts, screws and other hardware shall be galvanized, except as otherwise specified, and all galvanized nuts shall have a free running fit. Bolts shall be of ample size and strength for the purpose intended.

No existing bolts, nuts, washers, etc., shall be reused in contract work, unless specifically indicated for such reuse on the plans or in the Special Provisions.

High Strength Steel Bolts. - High strength steel bolts, together with their nuts and washers, except as otherwise specified, shall conform to the requirements of ASTM “Standard Specification for High Strength Bolts for Structural Steel Joints, Including Suitable Nuts and plain Hardened Washers”, Designation A 325. High strength steel bolts, nuts, and washers shall not be galvanized, unless so specified on the plans or in the Special Provisions.

The methods of installation, including required bolt lengths, of high strength steel bolts, nuts and washers for structural type work shall be in accordance with the latest revision of the “Specifications for Structural Joints Using ASTM A 325 Bolts”, of the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation. The installation of high strength steel bolts, nuts and washers for work other than structural type work shall be in accordance with the recommendations of the manufacturers of the bolts, nuts and washers and as specified for the purpose intended.

### **802.03 Payment**

Miscellaneous steel, iron and hardware shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.

## 803 Chain Link Fence

### 803.01 General

The Contractor shall construct chain link fence of galvanized chain link fabric secured to metal posts, top rails, or top tension cables, as applicable, and bottom tension wires, complete, in place, with all necessary stretcher bars and bands, fabric ties, hardware, appurtenances, concrete footings for posts, and when required, compression and tension braces, extension arms and wire, and gates. Imperfectly galvanized material shall not be used.

The height of the fabric, the fence type, the use of extension arms and wire, the use of gates, and other special requirements, shall be as indicated on the plans or specified in the Special Provisions. The height of fabric shall be the nominal height of the fence.

Attention is directed to Section 105.03 "Damage to Work or Property". Fences that are to remain in place and which have been damaged by the Contractor shall be replaced by him at his expense. All earth, trees, brush, and other obstructions which interfere with the proper construction of fences shall be removed and disposed of, in a legal manner, unless the Engineer orders certain trees to remain in place. Such work will be considered as part of fence construction and no measurement nor payment will be made for this work. Existing cross fences shall be connected to the new fences. Corner posts with braces for every direction of strain shall be placed at the junction with existing fences. The wire in the new and existing fences shall be fastened to the posts.

### 803.02 Fence Types

Type "A" fence shall be 3 feet, 3 feet 6 inches, 4 feet, or 5 feet in height, as specified, and shall include top rails and bottom tension wires.

Type "B" fence shall be 4 feet, 5 feet, or 6 feet in height, as specified, and shall include top tension cables and bottom tension wires. Terminal posts for Type "B" fence shall be braced with diagonal compression and diagonal tension braces.

Type "C" fence shall be 6 feet, 7 feet, 8 feet, or 9 feet in height, as specified, and shall include top rails and bottom tension wires. Terminal posts for Type "C" fence shall be braced with horizontal compression braces and diagonal tension braces.

### 803.03 Posts and Footings

Fence Posts. - Fence posts shall be in accordance with the following requirements:

<u>Fence Type</u>	<u>Corner, End, and Pull Posts</u>	<u>Line Posts</u>
"A"	2.375" OD Steel Pipe at 3.65 LBS/LF or 2" Steel Square Section at 3.65 LBS/LF	1.900" OD Steel Pipe at 2.72 LBS/LF or 1.875" Steel "H" Section at 2.75 LBS/LF
"B"	2.875" OD Steel Pipe at 5.79 LBS/LF or 2 1/2" Steel Square Section at 5.79 LBS/LF	2.375" OD Steel Pipe at 3.65 LBS/LF or 2 1/4" Steel "H" Section at 4.1 LBS/LF
"C"	2.875" OD Steel Pipe at 5.79 LBS/LF or 2 1/2" Steel Square Section at 5.79 LBS/LF	2.375" OD Steel Pipe at 3.65 LBS/LF or 2 1/4" Steel "H" Section at 4.1 LBS/LF

Note: 1 1/2" nominal size pipe has a 1.900" outside diameter (OD)  
 2" nominal size pipe has a 2.375" outside diameter (OD)  
 2 1/2" nominal size pipe has a 2.875" outside diameter (OD)

Gate Posts. - Gate posts shall be pipe of the following sizes for single swing gates or one leaf of double swing gates:

<u>Width of Each Gate Unit</u>	<u>Nominal Post Size</u>	<u>Nominal Post Weight (LBS/LF)</u>
Up to and including 6' .....	1 1/2" (2.875" OD)	5.79
Over 6' to 13' incl. ....	3 1/2" (4.000" OD)	9.11
Over 13' to 18' incl. ....	6" (6.625" OD)	18.97
Over 18' .....	8" (8.625" OD)	24.70

Terminal Posts. - Terminal posts are defined as all posts to which ends of the fabric are secured and shall include corner, end, pull and gate posts.

Footings. - All posts shall be set in cast-in-place Class 6-3000-3/4 concrete footings, crowned to shed water. Each post shall be of sufficient length to provide a 36-inch setting in each concrete footing, except that each line post for Type "A" fence heights of 4 feet and shorter shall be of sufficient length to provide a 30-inch setting in each concrete footing.

Concrete footings for all posts shall extend a minimum of 3 inches below the post pipe. The minimum cross sectional dimension of concrete footings shall not be less than 8 inches, and terminal posts for Types "B" and "C" fence shall have footings with a minimum cross sectional dimension of 9 inches. In the event of adverse ground conditions or in locations subject to extreme wind, the size of the concrete footings shall be increased as shown on the plans or specified in the Special Provisions.

The tops of all new concrete footings shall be approximately 1-inch above the adjacent surfaces and trowelled in such a manner that water will readily drain from the surfaces and away from the post.

On concrete walls, the post pipes shall be set in 3-inch diameter nominal size pipe sleeves embedded a minimum of 18 inches into the wall. The post pipe shall clear the bottom of the sleeved hole by 1/2-inch. The annular space between each post pipe and sleeve shall be filled with a dry-packed expansive mortar, approved by the Engineer, and containing no iron filings.

Installation. - Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of posts. In general, in determining the post spacing, measurement will be made parallel to the slope of the natural ground, and all posts shall be placed in a vertical position, except in unusual locations where directed by the Engineer the posts shall be set perpendicular to the ground surface.

Corner posts shall be installed at the changes in horizontal line of 30 degrees or more.

Pull posts shall be installed at all changes in vertical line of 10 degrees or more. Pull or other type terminal posts shall be installed at intervals not to exceed 300 feet.

All posts shall be fitted with malleable iron, or 13-gauge minimum pressed steel, tops designed to prevent the entrance of water and carry the top rail, or top tension cable, as applicable. Each line post top shall have an opening to accommodate a 1.600-inch O.D. pipe top rail, or top tension cable, as applicable.

Each terminal post top shall be a driven fit. Surplus excavated material remaining after the fence has been constructed shall be disposed of as directed by the Engineer.

### 803.04 Fence Bracing

General. - Corner and pull posts for Types "B" and "C" fence shall each be braced in adjoining bays. All braces shall be fitted without end play.

Compression Braces. - Compression braces shall be 1.600-inch O.D. steel pipe weighing 2.27 pounds per linear foot and connected to the posts with end cups of either malleable iron or 12-gauge minimum pressed steel, and end bands.

Tension Braces. - Tension braces shall each be a 3/8-inch diameter rod fitted with turnbuckle, and connected to the terminal posts with an end band and connected to the line post either with an end band or, in the case of Type "C" fence, to the end cup of the compression brace.

Top Rails, Couplings, and Cups. - Top rails for Types "A" and "C" fence shall be 1.660" O.D. steel pipe weighing 2.27 pounds per linear foot. No length of top rail between splices shall pass through less than 2 posts. The top rails shall pass through all intervening line post tops and form a continuous brace between terminal posts without end play.



Top rail couplings shall be malleable iron, or 14-gauge minimum pressed steel, not less than 6 inches long, inside sleeve type with outside center boss, or outside sleeve type with inside center boss. Rail cups shall be malleable iron, or 12-gauge minimum pressed steel. Lugs on rail cups may be offset.

### 803.05 Fence Tension Cables and Wires

General. - Bottom tension wires shall be installed on Types “A”, “B” and “C” fence. Top tension cables shall be installed on Type “B” fence.

All tension cables and wires shall be installed taut, straight, and without kinks.

Top Tension Cable. - A continuous, 7-strand, 3/8-inch diameter, steel tension cable shall be installed as shown on the plans, passing through the tops of all intervening line posts and connected to each terminal post with an end band and 2 cable clamps and with not less than one turnbuckle between terminal posts. The line post tops shall be of the type hereinbefore specified.

Bottom Tension Wire. - A continuous No. 7-gauge, coil spring steel, bottom tension wire shall be installed as shown on the plans, connected to the terminal posts with end bands and to all intervening line posts with fabric ties. Each run of bottom tension wire between terminal posts shall be fitted with not less than one turnbuckle.

Grade Between Posts. - The bottom tension wire shall be installed on a straight grade between posts by excavating the high points of ground along the line of the fence. Unless otherwise shown on the plans or specified in the Special Provisions, depressions along the line of the fence shall not be filled.

### 803.06 Fence Fabric

General. - Chain link fence fabric shall conform to the requirements in AASHTO Designation: M 181 for Type I zinc coated fabric with a Class A coating.

Fence fabric shall be 2-inch square mesh, with horizontal and vertical diagonals, right-hand weave, copper bearing steel wire with knuckled selvages, stretched taut and securely fastened to the outside of the posts and other framework of the fence, and shall be continuous between terminal posts and spliced by weaving.

Gauge of fabric for Types “A” and “B” fence shall be 11 gauge.

Gauge of fabric for Type “C” fence shall be 9 gauge.

The fabric shall be installed on a straight grade between posts by excavating the high points of ground.

Connections to Terminal Posts. - Connections to terminal posts shall be with 1/4-inch x 3/4-inch minimum, stretcher bars and bands using steel bolts not less than 5/16-inch diameter.

End bands and stretcher bar bands shall be of steel not less than 1/8-inch x 3/4-inch and fitted with steel bolts not less than 3/8-inch diameter except as hereinbefore specified.

Connections to Line Posts, T Rails, Top Tension Cable, and Bottom Tension Wire. - Connections to Line posts and top rails shall be with fabric ties of 6-gauge aluminum wire minimum. Top tension cable and bottom tension wire fabric ties shall be 9-gauge aluminum wire minimum or 12-gauge steel wire hog rings.

### 803.07 Gates

Drive gates shall be of the widths shown on the plans or specified in the Special Provisions. Walk gates shall be 4 feet wide. Gates greater than 8 feet in length shall have interior vertical members installed so that no panel exceeds 8 feet in length. Gate posts shall be as hereinbefore specified.

Gate frames shall be rigid and shall be constructed of not less than 13-inch diameter (1.900-inch O.D.) galvanized standard weight pipe conforming to the requirements of ASTM “Standard Specifications for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses”, Designation A 120. Gate frames shall be cross-trussed with 3/8-inch diameter adjustable truss rods. Corners of gate frames shall be fastened together and reinforced with malleable iron fittings designed for the purpose, or by welding. Pressed steel fittings shall have a nominal thickness, before galvanizing of not less than 0.135-inch

and shall be fastened suitably to develop the strength of the connected members. Welding shall conform to the best commercial practice; all welds shall be sound and shall develop the strength of the connected member. All welds shall be smooth.

The hereinbefore specified chain link fence fabric shall be attached to gate frames by the use of stretcher bars and fabric tie wires, as specified for fence construction. Stretcher bar bands or bolts shall be spaced at approximately one-foot intervals.

Each gate shall be hung by at least 2 steel or malleable iron hinges not less than 3 inches in width and so designed as to securely clamp to the gate post and permit the gate to be swung back against the fence. The bottom hinge shall have a socket to take the ball end of the gate frame.

Each gate shall be provided with a combination steel or malleable iron catch and locking attachment of approved design which will not rotate around the latch post. A stop shall be provided to hold each gate open and a center rest with catch shall be provided for each gate, all where required. Each gate shall be equipped with an approved lock. Two keys shall be furnished for each lock and each key shall have attached to it a one-inch round brass key tag stamped as specified in the Special Provisions.

### 803.08 Galvanizing

General. - All steel and iron fencing materials shall be hot-dip galvanized in accordance with the applicable requirements set forth in Section 807; moreover, the galvanizing of certain units and appurtenances as specified hereunder shall fulfill the requirements for weight of zinc coating as set forth in ASTM "Standard Test Methods for Weight of Coating or Zinc Coated (Galvanized) Iron or Steel Articles", Designation A 90.

The Contractor shall give sufficient notice to the Engineer as to when the material will be delivered to the job site so that samples may be procured and tested.

Framework. - Terminal posts, line posts, braces, top rails, gate parts, and all other appurtenances constituting the fence framework, excepting tension cable, tension wire, bolts, hog rings, and tie wires, shall be hot-dip galvanized.

Fabric. - Fence fabric shall be hot-dip galvanized after weaving; galvanizing shall be of Class II weight class with a minimum of 2.0 ounces of zinc per square foot of uncoated wire surface in accordance with ASTM "Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric", Designation A 392.

The fabric test shall be performed on one section of wire picket selected by the Engineer from material at the site. The section shall be at least 12 inches long and shall include at least one bend and one straight side of the formed link.

Appurtenances. - Appurtenances such as tension cable, tension wire, bolts, hog rings, and tie wires shall be hot-dip galvanized.

All tests will be performed by the Department of Public Works at no cost to the Contractor.

The Contractor shall not proceed with any part of the work until he has been notified by the Engineer that the materials have successfully undergone the test hereinbefore specified.

### 803.09 Payment

Chain link fence, including gates, satisfactorily constructed as specified, will be paid for at the price bid per linear foot, measured along the top rail or top tension cable, as applicable, of the completed fence between centers of posts.

## **804 Pipe Handrailing**

### **804.01 General**

The Contractor shall construct pipe handrailing complete, in place, as shown on the plans including drilling vent holes, welding, expansion joints, grinding, cleaning, galvanizing and grouting, and painting where specified.

### **804.02 Materials**

Pipe handrailing shall consist of handrailing elements supported by metal brackets (wall type) or handrailing elements supported by tubular steel posts (post type).

Handrailing elements shall be either structural tubing as specified herein for tubular steel posts or commercial quality standard steel pipe. Tubular steel posts shall be round, seamless or welded structural tubing conforming to the provisions of ASTM "Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing", Designation A 501, and shall have a wall thickness not less than that of standard steel pipe of the same nominal size.

Brackets, bolts, threaded studs, nuts, washers, and other fittings shall be commercial quality structural steel, except that standard steel pipe fittings may be used where shown on the plans.

The railing shall be fabricated by welding. Welding shall be in accordance with the requirements of Section 806. All welds and sharp edges shall be ground perfectly smooth. Neat regular bends shall be made where indicated on the plans and where required to fit conditions.

Only those welds necessary, as shown or indicated on the plans, for the fabrication of the handrailing and provision of the specified expansion joints will be allowed. The Contractor shall not construct or cut sections of handrailing, for galvanizing or for any other reason, so that any welds in addition to those specified hereinbefore will be required.

Fabrication and installation drawings shall be furnished in accordance with the requirements of Section 106.08.

Particular attention shall be given to the finish of the rails. Any imperfections or roughness, and all sharp edges, shall be ground smooth.

Railing dented, bent, broken, warped or otherwise damaged, shall be immediately and satisfactorily repaired or replaced, as applicable, by the Contractor at his sole expense.

### **804.03 Galvanizing**

Prior to galvanizing, adequate vent holes shall be drilled in each closed element of the railing.

Handrailing and appurtenances shall be hot-dip galvanized in accordance with the requirements of Section 807.

### **804.04 Erection**

The pipe railing, as erected in final position, shall be rigid and without any loose joints or connections. Posts shall be vertical within a tolerance not to exceed 0.02-foot in 10 feet. Posts shall be set in sockets or on mortar pads as shown on the plans.

Where a pipe is to be embedded in an oversize hole formed in concrete, the annular space between such pipe and the concrete shall be filled with a dry-packed expansive mortar, approved by the Engineer, containing no iron filings.

### **804.05 Payment**

Pipe handrailing, satisfactorily constructed as specified, will be paid for at the price bid per linear foot, measured along the top rail between the extreme ends of the railing as installed.

## **805 Bridge Railing**

### **805.01 General**

The Contractor shall construct bridge railing complete, in place, as shown on the plans, including drilling vent holes, welding, expansion joints, grinding, cleaning, galvanizing, grouting and painting.

### **805.02 Materials**

The top and bottom rails, and the posts and balusters of the bridge railing shall be structural steel tubes, shapes and bars, or steel pipe, as shown on the plans, conforming to ASTM “Standard Specification for Structural Steel”, Designation A 36, or ASTM “Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing”, Designation A 501, as applicable, and the applicable requirements of Section 802 of these Standard Specifications.

### **805.03 Fabrication**

Bridge railing shall be fabricated by welding. Welding shall be in accordance with the requirements of Section 806. All welds and sharp edges shall be ground perfectly smooth. Neat regular bends shall be made where indicated on the plans and where required to fit conditions. The method of anchoring and supporting the railing shall be as shown on the plans.

Expansion joints shall be spaced as shown on the plans, and shall have a straight and close smooth fit, but allow movement due to expansion and contraction.

Only those welds necessary, as shown or indicated on the plans, for the fabrication of the metal railing and provision of the specified expansion joints will be allowed. The Contractor shall not construct or cut sections of railing, for galvanizing or for any other reason, so that welds in addition to those specified hereinbefore will be required. Fabrication and installation drawings shall be furnished in accordance with the requirements of Section 106.08.

The railing shall conform closely to the horizontal and vertical lines shown on the plans or ordered by the Engineer. Railings shall conform to the curvature by means of a series of short chords, from center to center of rail posts, except the railing noted on the plans or specified in the Special Provisions shall be shop bent to fit the curvature. Joints shall be matchmarked. The railing shall present a smooth, uniform appearance in its final position.

Particular attention shall be given to the finish of the horizontal rails. Any imperfections or roughness thereof shall be ground smooth. No offset shall occur at the expansion joints, and all sharp edges shall be ground smooth.

Railing dented, bent, broken, warped or otherwise damaged, shall be immediately and satisfactorily repaired or replaced, as applicable, by the Contractor at his sole expense.

### **805.04 Galvanizing**

Prior to galvanizing, adequate vent holes shall be drilled in each closed element of the railing.

Bridge railing and appurtenances shall be hot-dip galvanized in accordance with the requirements of Section 807. To reduce the number of field welds to a minimum, galvanizing shall be done after fabricating the railing into the largest units possible to galvanize in accordance with the hereinbefore specified limitation on cuts and welds.

### **805.05 Installation**

The bridge railing, as erected in final position, shall be rigid and without any loose joints or connections. The railings shall be carefully erected true to line and grade. The posts shall be vertical within a tolerance not to exceed 0.02-foot in 10 feet. Adjacent railing panels shall align with each other within 1/16 inch.

After erection, the base plates shall be grouted in place. The grout shall be in accordance with the requirements of Section 800.09, and shall contain an expansive admixture, approved by the Engineer, and

containing no iron. The grout shall be mixed with the minimum amount of water for proper hydration and shall be thoroughly packed in place.

### **805.06 Painting**

When specified, painting shall be in accordance with the applicable requirements of Section 809.

### **805.07 Payment**

Bridge railing, satisfactorily constructed as specified, will be paid for at the price bid per linear foot, measured along the top rail between the extreme ends of the railing as installed.

## 806 Welding

### 806.01 General

All welding shall be performed in accordance with the applicable requirements of the latest codes, rules, or specifications of the American Welding Society (AWS) and the requirements of these specifications and the Special Provisions, and shall be subject to the tests and examinations therein specified.

Structural steel shall not be welded unless specified on the plans or in the Special Provisions, or permitted in writing by the Engineer. Welding of structural steel, in general, shall be done by the shielded metal-arc welding process and in accordance with the latest “Standard Specifications for Welded Highway and Railway Bridges”, Serial Designation D 2.0, of the American Welding Society, except as otherwise recommended by the electrode manufacturer and approved by the Engineer.

Welding of other work shall be done in accordance with the applicable codes, rules, or specifications listed immediately hereinafter:

AWS “Standard Code for Arc and Gas Welding in Building Construction”, Serial Designation D 1.0, supplement AWS SUP 1 and addenda AWS SRI; AWS “Rules for Field Welding of Steel Storage Tanks”, Serial Designation D 5.1;

AWWA - AWS “Standard Specifications for Elevated Steel Water Tanks, Stand Pipes and Reservoirs”, Serial Designation D 5.2; and

AWWA - AWS “Standard Specifications for Field Welding of Steel Water Pipe Joints”, Serial Designation D 7.0.

Weldability and welding of reinforcing steel shall be in accordance with the applicable requirements of AWS D 12.1 and Sections 405, 805, and 2408 of ACI Standard 318.

All welding applications for which the San Francisco Building Code requires, or would require, Special Inspection will receive such inspection, as therein defined, at no cost to the Contractor.

Welding of work not covered by the requirements listed hereinbefore shall be done in accordance with the requirements of the welding codes, rules, regulations, or specifications of those societies, institutes, bureaus or associations referred to on the plans or in the Special Provisions, or shall be done as otherwise specified.

### 806.02 Welding Operators

All welding operators shall be qualified in accordance with the requirements of AWS Standard Qualification Procedure B3.0, and welders of structural and reinforcing steel shall be certified for all positions of welding in accordance with such Procedure. Qualification tests shall be run by a recognized testing laboratory at the Contractor’s expense. Previous recent qualification by the State of California, Department of Transportation, will be acceptable.

All welding operators shall be subject to examination for requalification using the equipment, materials and electrodes employed in the execution of the contract work. Such requalification, if ordered by the Engineer, shall be done at the expense of the Contractor.

### 806.03 Arc-Welding Electrodes

Arc-welding electrodes shall comply with the requirements of AWS Specifications, and shall be of Classification E-60 Series. Electrodes shall be compatible with welding positions, type and polarity of current, and other conditions of intended use.

Bare electrodes shall not be used as such electrodes reduce the strength of the weld. Welding work to be subsequently galvanized, therefore, shall be thoroughly cleaned and prepared so as not to impair the quality of the galvanizing.

### 806.04 Gas-Welding Rods

Iron and steel gas-welding rods shall comply with the requirements of AWS specifications. The welding and rod classification numbers selected shall be suitable for the condition of intended use.

### **806.05 Gauges**

Gauges for checking weld dimensions shall preferably be the standard gauges specified by the American Welding Society, but other gauges may be used if specially adapted to the work and approved by the Engineer. The Contractor shall supply at least 2 gauges to the Engineer for his use during the period of welding operations.

### **806.06 Workmanship and Technique**

Workmanship and technique shall conform with the applicable requirements of the latest codes, rules, or specifications of the American Welding Society, except as otherwise specified.

All welding shall be done in the shop before galvanizing, if the latter is required, except as specifically otherwise permitted by the Engineer.

Surfaces to be welded shall be cleaned by wire brushing, chipping, or hammering away any loose mill scale, rust, paint or other foreign matter present on the metal. The cleaning shall extend at least 2 inches on each side of the weld, except as otherwise specified. Welds shall be cleaned each time the electrode is changed.

In assembly and during welding, the component parts shall be held by sufficient clamps or other adequate means to keep the parts in their proper positions and in close contact.

Welds shall show uniform sections, smoothness of metal, feather edges without undercuts or overlays and freedom from cracks, porosity or clinkers. Visual inspection of edges and ends of fillets and butt joint welds shall indicate good fusion with, and penetration into, the base metal. All burrs and lumps of metal shall be removed, leaving a neat and workmanlike appearance.

All weld slag and spatter shall be completely removed before galvanizing or painting.

### **806.07 Defective and Deficient Welds**

Welds or portions of welds found defective by the Engineer shall be removed and replaced, or if deficient in dimensions, shall be corrected, all in accordance with the applicable requirements of the latest codes, rules, or specifications of the American Welding Society, and to the satisfaction of the Engineer.

### **806.08 Payment**

Welding shall be done as Incidental Work and payment therefore shall be included in the price or prices bid.

## 807 Galvanizing

### 807.01 General

Galvanizing of steel and iron shall be done where specified in these Standard Specifications or the Special Provisions, or where shown on the plans.

Products, fabricated from rolled, pressed and forged steel shapes, plates, bars and strip, 1/8-inch thick and heavier, required to be galvanized, shall be hot-dip galvanized in accordance with the requirements of ASTM "Standard Specifications for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip", Designation A 123 except that complete seal welding of tightly contacting surfaces of such products prior to galvanizing is required only where seal welding is shown on the plans or specified in the Special Provisions. Galvanizing shall be performed after fabrication, and after modification if such operations involve machine or die work, milling, cutting, shearing, punching, drilling, forming, bending, thread cutting, welding, riveting, or the like.

Material required to be galvanized shall not be shop painted.

All components of bolted assemblies including bolts, nuts, washers, etc., shall be galvanized separately before assembly.

To reduce the number of field welds to a minimum, galvanizing shall be done after fabrication into the largest sections possible to galvanize in accordance with the hereinbefore specified limitation on cuts, welds, connections, etc.

When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating.

The Contractor shall thoroughly clean all grease, paint, rust and other foreign materials from the surface of the steel by pickling. After pickling, the steel shall be wire-brushed to remove any remaining foreign material.

The temperature in the galvanizing tank shall be continuously maintained during all galvanizing operations at the lowest temperature between the limits of 825 and 835 degrees Fahrenheit that will result in the complete and uniform galvanizing of all immersed surfaces.

The weight of the zinc coating deposited on each of the surfaces of the steel to be galvanized, for 1/8-inch and 3/16-inch thick steels, shall average for the entire work not less than 2.0 ounces per square foot of each surface, and for any individual specimen shall not be less than 1.8 ounces per square foot of surface. For 1/4-inch thick and heavier materials, the coating weights shall average not less than 2.3 ounces per square foot and not individual specimen shall show less than 2.0 ounces per square foot.

The galvanizing shall be applied in such a manner that the zinc coating will not peel off, will be adherent, thorough, continuous and smooth, and will be free from imperfections such as blisters, gritty areas, uncoated spots, acid spots, black spots, dross and flux. All galvanized surfaces having such imperfections shall be satisfactorily recleaned and regalvanized by the Contractor at his sole expense. The zinc coating may have chill spots, rack marks, lumps and other projections that can be satisfactorily corrected by filing smooth, yet leaving a sound, adequately thick zinc coating. Such projections shall be filed smooth.

Two coats of unthinned zinc-rich paint, conforming to the requirements of Military Specification DOD-P-21035A, shall be applied to any final assembly field cuts and welds necessary, in the judgment of the Engineer, to be made after galvanizing, after such welds have been ground smooth. Spray cans shall not be used. It is emphasized that such welds will not be allowed to compensate for errors in planning, cutting or fitting, and shop hot-dip galvanizing will be required after any such modification.

Galvanized surfaces that have become abraded or otherwise damaged to such extent as to expose the base metal at any time after the application of the zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coatings, after which the cleaned areas shall be painted as indicated hereinbefore.

### 807.02 Iron and Steel Hardware

Iron and steel hardware, including castings, rolled, pressed, and forged articles, bolts, screws, nuts, washers, rivets, nails, and similar articles, required to be galvanized, shall be hot-dip galvanized after fabrication in accordance with the applicable requirements set forth in Section 807.01 and the requirements of ASTM



“Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware”, Designation A 153, except whenever threaded studs, bolts, nuts, and washers are specified to conform to ASTM Designation A 307, A 325, A 449, or A 563, and galvanizing is required, they shall be hot-dip zinc coated or mechanically zinc coated in accordance with the requirements of said ASTM Designations. The requirements set forth in Section 807.01 and ASTM A 153 provide for zinc coatings ranging from not less than 0.85 ounce per square foot of surface in the case of small bolts, screws, nuts and washers, and rivets and nails, to not less than 1.80 ounces per square foot of surface in the case of castings, and rolled, pressed, and forged articles.

Components of bolted assemblies shall be galvanized separately before assembly. No tapping or “cleaning up” of threads after galvanizing will be permitted. All galvanized nuts shall have a free running fit.

The minimum pitch diameter of the threaded portion of all bolts, anchor bars, or studs shall conform to ANSI Standard B1.1, having a Class 2A tolerance before galvanizing. After galvanizing, the pitch diameter of the nuts or other internally threaded parts may be tapped over ANSI Standard B1.1, Class 2B tolerance by the following maximum amounts:

7/16" and smaller .....	0.016" oversize
1/2" and through 1" .....	0.021" oversize
1 1/8" and larger .....	0.031" oversize

Galvanized surfaces which are specified to be painted after galvanizing shall not be chemically treated after galvanizing and prior to cleaning and painting.

### **807.03 Sheets Less Than 1/8-Inch Thick**

Steel sheets less than 1/8-inch in thickness, required to be galvanized, unless otherwise specified, shall be hot-dip galvanized in accordance with the applicable requirements set forth in Sections 807.01 and 807.02; however, the sheets may be galvanized either before fabrication in conformance with the requirements set forth in Sections 807.01 and 807.02; however, the sheets may be galvanized either before fabrication in conformance with the requirements of ASTM “Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process”, Designation A 525, Coating Designation G210, or after fabrication in conformance with the requirements of ASTM “Standard Specification for Zinc Coating (Hot-Dip) on Assembled Steel Products”, Designation A 386, except that the weight of zinc coating shall average not less than 1.2 ounces per square foot of actual surface area with no individual specimen having a coating weight of less than 1.0 ounce per square foot.

### **807.04 Other Steel or Iron Products**

The galvanizing of other steel or iron products shall be in accordance with the requirements of the appropriate ASTM Standard Specifications.

### **807.05 Payment**

Galvanizing shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## 808 Blast Cleaning of Steel

### 808.01 General

Blast cleaning of steel shall be done when specified on the plans or in the Special Provisions, or when it is necessary for preparing surfaces for subsequent painting thereof. Generally speaking, blast cleaning will be required only for existing structures in need of repairs or painting.

Adequate measures shall be taken to protect persons and property while blast cleaning is in progress; for example, when blast cleaning is being performed on structures open to traffic the Contractor shall provide suitable protective devices to prevent damage to such traffic.

When blast cleaning is being performed near machinery, all journals, bearings, motors, moving parts, etc., shall be sealed against entry of dust, sand, grit, shot, or other abrasive materials, before cleaning begins.

When blast cleaning is specified on the plans or in the Special Provisions as a prerequisite to painting, all blast cleaned surfaces shall be primed the same day blast cleaning is performed; the intent being to make certain that the paint is applied to absolutely rust-free surfaces. In the event that rust should reform on any such surface during the period intervening between the blast cleaning and the painting, such rust shall be completely removed by suitable means before the paint is applied.

All sand, grit, shot, or other abrasives, deposited at, or adjacent to, the work, as a result of the blast cleaning operations, shall be removed from the site by the Contractor, unless otherwise specified.

All preparatory or other solvent cleaning, preparatory hand cleaning or power tool cleaning, and blast cleaning proper shall be done in accordance with the applicable requirements of the "Steel Structures Painting Manual, Volume 2, Systems and Specifications", by the Steel Structures Painting Council, particularly with respect to the material in "Section 2 SSPC Surface Preparation Specifications", of which components Nos. 5 and 6 are reproduced in part hereinafter for the Contractor's convenience, and are considered to be a part of these Standard Specifications. Blast cleaning of steel shall be performed either as blast cleaning to "white" metal, commercial blast cleaning, or brush-off blast cleaning, as required by the plans or Special Provisions, and as hereinafter specified.

### 808.02 Blast Cleaning to "White" Metal

The Steel Structures Painting Council Surface Preparation Specifications (SSPC-SP5, November 1, 1982) are reproduced in part as follows:

#### "SURFACE PREPARATION SPECIFICATION NO. 5, WHITE METAL BLAST CLEANING

##### "1 Scope

- 1.1 This specification covers the requirements for white metal blast cleaning of steel surfaces.

##### "2 Definition

- 2.1 White metal blast cleaning is a method of preparing steel surfaces which, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, and paint.

##### "3 Appearance of the Completed Surface

- 3.1 The surface shall be roughened to a degree suitable for the specified paint system.
- 3.2 The completed surface shall be cleaned to a gray-white metallic color. The appearance of the surface may be affected by the particular blasting abrasive used. Uniformity of color may be affected by the grade, original surface condition, and configuration of the material being cleaned, as well as by discolorations from mill or fabrication marks, and the shadowing from blast cleaning patterns.
- 3.3 SSPC-Vis 1 or other visual standards of surface preparation agreed upon by the contracting parties may be used to further define the surface.

##### "4 Reference Standards

- 4.1 The standards referenced in this specification are listed in Section 4.4 and form a part of the specification.
- 4.2 The latest issue, revision, or amendment of the reference standards in effect on the date of invitation to bid shall govern unless otherwise specified.
- 4.3 If there is a conflict between the requirements of any of the cited reference standards and the specification, the requirements of the specification shall prevail.
- 4.4 STEEL STRUCTURES PAINTING COUNCIL (SSPC) SPECIFICATIONS:

- SP 1 Solvent Cleaning Vis 1 Pictorial Surface
  - Vis 1 Pictorial Surface Preparation Standards for Painting Steel Surfaces

#### “5 Surface Preparation Before and After Blast Cleaning

- 5.1 Before blast cleaning, remove visible deposits of oil or grease by any of the methods specified in SSPC-SP1.
- 5.2 After blast cleaning and prior to painting, perform the following:
  - 5.2.1 Remove rust which becomes visible when viewed without magnification.
  - 5.2.2 Remove visible deposits of oil, grease, or other contaminants (See Section 5.1).
  - 5.2.3 Remove dust and loose residues from dry abrasive blast cleaning. Acceptable methods include brushing, blowing off with clean, dry air, or vacuum cleaning. (When compressed air is used for blow-off, use and maintain moisture and oil separators and traps to provide a clean and dry air supply).
  - 5.2.4 If the surface was wet abrasive blast cleaned, rinse with fresh water to which sufficient corrosion inhibitor has been added to prevent rusting, or with fresh water followed by an inhibitive treatment. Supplement this cleaning by brushing, if necessary, to remove any residues.
  - 5.2.5 Rectify surface imperfections which become visible after blast cleaning as specified in the procurement documents.

#### “6 Blast Cleaning Methods and Operation

##### 6.1 METHODS:

- 6.1.1 Dry abrasive blasting using compressed air, blast nozzles, and abrasive;
- 6.1.2 Dry abrasive blasting using a closed cycle, recirculating abrasive system with compressed air, blast nozzle, and abrasive, with or without vacuum for abrasive recovery;
- 6.1.3 Dry abrasive blasting, using a closed cycle, recirculating abrasive system with centrifugal wheels and abrasive;
- 6.1.4 Wet abrasive blasting using compressed air, blast nozzles, water, and abrasive followed by rinse (see Section 5.2.4).

##### 6.2 OPERATION:

- 6.2.1 When compressed air is used for nozzle blasting, use and maintain moisture and oil separators and traps to provide a clean, dry air supply.
- 6.2.2 Perform blast cleaning operations so that no damage is done to partially or entirely completed portions of the work.

#### “7 Blast Cleaning Abrasives

##### 7.1 ABRASIVES SHALL CONFORM TO THE FOLLOWING REQUIREMENTS:

- 7.1.1 The abrasive shall be free of corrosion-producing contaminants and also free of oil, grease, or other deleterious contaminants.
- 7.1.2 Selection of abrasive size and type shall be based on the type, grade, and surface condition of the steel to be cleaned, and on the finished surface to be produced for the subsequent paint system.
- 7.1.3 The cleanliness and sizing of the abrasive shall be maintained to insure compliance with this specification.”

### 808.03 Commercial Blast Cleaning

The Steel Structures Painting Council Surface Preparation Specifications (SSPC-SP6, November 1, 1982) are reproduced in part as follows:

#### “SURFACE PREPARATION SPECIFICATION NO. 6, COMMERCIAL BLAST CLEANING

##### “1 Scope

- 1.1 This specification covers the requirements for commercial blast cleaning of steel surfaces.

##### “2 Definition

- 2.1 Commercial blast cleaning is a method of preparing steel surfaces which, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, and paint. Generally evenly dispersed very light shadows, streaks, and discolorations caused by stains of rust, stains of mill scale, and stains of previously applied paint may remain on no more than 33% of the surface. Slight residues of rust and paint may also be left in the craters of pits if the original surface is pitted.

##### “3 Appearance of the Completed Surface

- 3.1 The surface shall be roughened to a degree suitable for the specified paint system.
- 3.2 The appearance of the surface may be affected by the particular blasting abrasive used. Uniformity of color may be affected by the grade, original surface condition, and configuration of the material being cleaned, as well as by discolorations from mill or fabrication marks, and the shadowing from blast cleaning patterns.
- 3.3 SSPC-Vis 1 or other visual standards of surface preparation agreed upon by the contracting parties may be used to further define the surface.

##### “4 Reference Standards

Same as 4 of “No. 5, White Metal Blast Cleaning.

##### “5 Surface Preparation Before and After Blast Cleaning

- 5.1 Before blast cleaning, remove visible deposits of oil or grease by any of the methods specified in SSPC-SP 1.
- 5.2 After blast cleaning and prior to painting, perform the following:
- 5.2.1 Remove visible deposits of oil, grease, or other contaminants (See Section 5.1).
- 5.2.2 Remove dust and loose residues from dry abrasive blast cleaning. Acceptable methods include brushing, blow off with clean, dry air, or vacuum cleaning. (When compressed air is used for blow-off, use and maintain moisture and oil separators and traps to provide a clean and dry air supply.)
- 5.2.3 If the surface was wet abrasive blast cleaned, rinse with fresh water to which sufficient corrosion inhibitor has been added to prevent rusting, or with fresh water followed by an inhibitive treatment. Supplement this cleaning by brushing, if necessary, to remove any residues.
- 5.3 Rectify surface imperfections which become visible after blast cleaning as specified in the procurement documents.”

##### “6 Through to 7.

Same as 6 through to 7 of “No. 5, White Metal Blast Cleaning”.”

### 808.04 Brush-Off Blast Cleaning

Brush-off blast cleaning, when specified on the plans or in the Special Provisions, shall be in accordance with the Steel Structures Painting Council Surface Preparation Specifications, “No. 7 Brush-Off Blast Cleaning”, (SSPC-SP7, November 1, 1982).

### **808.05 Payment**

Blast cleaning of steel shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## 809 Painting

### 809.01 General

Painting shall include proper preparing of the surfaces to be painted, furnishing, mixing, and applying the painting materials, drying and protecting the paint coatings, and furnishing, maintaining and removing scaffolding and other equipment and appurtenances required for the work, together with all proper facilities for the storing and moving of materials, equipment and appurtenances and the protection of the public and the work from damage and nuisance resulting from the painting operations. Painting shall be carefully, neatly and expertly done in accordance with the best practices of the trade by skilled and competent painters who are thoroughly familiar with the type of work they are performing.

The Contractor shall notify the Engineer forty-eight hours prior to the time he intends to commence painting and also shall notify the Engineer immediately after each coat has been completed. All work and materials will be subject to continuous inspection during the progress of the work, and upon completion.

Unsatisfactory work, and defects, caused by improper conditioning of surfaces for painting, faulty materials or workmanship, or completed painted surfaces not in accordance with the specifications, shall be satisfactorily corrected by the Contractor at his sole expense, to the extent required by the Engineer, including removal of unsatisfactory paint coatings and subsequent repainting.

The Contractor shall furnish, maintain, and remove as his property upon completion of the work, all scaffolding, planking and other equipment and appurtenances which he may required for the proper execution and completion of the work.

The Contractor shall set aside a shed, room or other satisfactory space in which to store and mix materials and shall provide suitable vessels in which all paint mixing shall be done. The Contractor shall not allow discarded paint materials, cans, oily rags, waste, and combustible or flammable materials to accumulate, but shall remove them from the work each night, and shall exercise all other reasonable precautions to prevent fire.

In areas where painting is in progress, the Contractor shall provide and properly locate sufficient drop cloths to protect the work and other property from paint splashes or damage. Special care shall be taken to protect hardware, light fixtures, glassware, finished brickwork, finished floor and wall surfaces, sidewalks, and parked automobiles.

Where painting is in progress in buildings being utilized, particular attention shall be paid to office machines, equipment, desks, chairs, and the like, which shall be adequately protected by drop cloths. The Contractor shall place such drop cloths at the start of each of his work periods and where required shall remove them at the conclusion of each such work period.

The color of each coat of primer and paint shall be as specified, or as designated by the Engineer, and samples of the colors and shades to be used shall be submitted by the Contractor, for selection and approval by the Engineer, sufficiently in advance to cause no delay in the work.

If the paint the Contractor proposes to use is not the usually used product and factory color for the application involved and exactly as specified, he shall not commence painting any surface therewith prior to approval by the Engineer of actual samples of each color and shade prepared by the Contractor from the paint intended for use in the work. The samples shall be of adequate size to allow the Engineer to reasonably pass judgment on color, shade, texture and gloss. All paint shall be factory mixed to its final color whenever practicable.

When equipment to be painted by the manufacturer is not manufactured locally, the Contractor shall secure and submit to the Engineer the equipment manufacturer's certification that the preparation of surfaces and application of the prime coats have been made in accordance with the recommendations of the paint manufacturer.

No prime coat will be required on work which has been shop coated or previously painted, except that damaged areas of such primer or paint shall be suitably touched up with primer, to the satisfaction of the Engineer, before application of a subsequent coat of paint.

The metal surfaces of pipe to be insulated shall not be primed or finish painted unless otherwise specified.

Other metalwork not to be painted unless specified, shall be that metal embedded in concrete, piping buried in the ground, brass, bronze, other non-ferrous metal, stainless steel, and certain equipment and parts thereof designated by the Engineer.

Paint shall be applied only on thoroughly dry surfaces during periods of favorable weather, and unless otherwise specified, in accordance with the manufacturer's recommendations. Painting will not be permitted in rainy, damp, misty, or frosty weather; when freshly painted surfaces may become damaged by rain, fog, condensation, or frost; or when in the opinion of the Engineer, conditions are otherwise unsatisfactory. The temperature shall be that which will not materially alter the characteristics of the paint.

Where necessary, the Contractor shall take adequate steps to eliminate dust before painting.

## 809.02 Materials

General. - All painting materials shall be pure, unadulterated, of first quality, of the type expressly designed for the surface and condition for which its use is required, and shall be delivered to the work in original unbroken containers, bearing the manufacturer's name and other information necessary for identification. Materials shall be delivered not less than one week before they are intended to be used, to permit required sampling and testing, and containers shall be opened and materials mixed at the site of the work in the presence of the Engineer. Materials whose containers are not originally opened in the presence of the Engineer, or materials which are not in accordance with the specified requirements, will be rejected and immediately shall be removed from the work by the Contractor.

Specification of materials by manufacturers' trade names and designations is not intended to imply or suggest that products of these manufacturers are preferred or need to be used, but only to designate a standard of quality and type of material required.

If the Contractor elects to furnish substitute paint materials in lieu of those specified, he shall furnish to the Engineer upon request a certificate from the manufacturer that the substitute materials comply with the specifications, accompanied by a certified formula of constituents for each of the substitute materials.

Paints, stains, primers and sealers shall not be thinned by any material not specifically recommended or approved for such purpose by the manufacturer of the paint, stain, primer or sealer, as applicable, and then not in excess of the amounts recommended or approved by such manufacturer.

No primer or sealer shall be used unless that type of primer or sealer is specifically recommended or approved by the manufacturer of the paint or stain which will be applied over the primer or sealer, as applicable.

Aluminum Paint. - Aluminum paint shall consist of aluminum pigment paste mixed in a vehicle, in the proportion of not less than 2 pounds of paste per gallon of vehicle. The aluminum pigment paste shall comply with ASTM "Standard Specifications for Aluminum Pigments, Powder and Paste, for Paints", Designation D 962.

Linseed Oil. - Raw and boiled linseed oil shall be in accordance with the requirements respectively, of ASTM "Standard Specifications for Raw Linseed Oil", Designation D 234, and "Standard Specifications for Boiled Linseed Oil", Designation D 260.

Turpentine. - Turpentine shall be pure, either gum or steam distilled spirits, in accordance with the requirements of ASTM "Standard Specifications for Spirits of Turpentine", Designation D 13.

Mineral Spirits. - Mineral spirits shall be in accordance with the requirements of ASTM "Standard Specifications for Petroleum Spirits (Mineral Spirits)", Designation D235.

Driers. - Driers shall be in accordance with the requirements of ASTM "Standard Specifications for Liquid Paint Driers", Designation D 600.

Denatured Alcohol. - Denatured alcohol shall be United States Internal Revenue Formula No. 5.

## 809.03 Preparation of Surfaces

General. - The Contractor shall not commence the painting of any surface until that surface has been satisfactorily prepared by him and subsequently examined and approved for painting by the Engineer. Paint

coatings applied to surfaces that have not been approved by the Engineer will be considered unsatisfactory coatings and, as hereinbefore specified, will be subject to removal.

All surfaces to be painted shall be thoroughly cleaned of all rust, corrosion, loose mill scale, welding flux, dirt, dust, mud, oil, grease, wax, old paint that is loose, blistered, cracked or otherwise unsatisfactory, loose surface materials, moisture, acids, alkalies, or other foreign matter.

Metal Surfaces. - Metal surfaces shall be thoroughly cleaned by wire brushing, scraping, chiseling, hammering, blast cleaning, or other approved means, and the surface wiped clean. Exposed metal surfaces coated with dirt and grease only, may be washed with benzine to remove same. No larger area of metal shall be cleaned in advance of painting than can be completely painted before further corrosion, oxidation or dirt accumulation begins. If previously cleaned surfaces are not painted prior to further corrosion, oxidation or dirt accumulation, they shall be recleaned as necessary.

Prime coated surfaces showing signs of rust or other defects, prior to field painting, shall be thoroughly cleaned and reprimed.

Galvanized metal surfaces shall be prepared for painting using Wyandotte Chemical Company, Phosit, or E.I. Dupont de Nemours and Company, No. 5717, or equal, applied in the presence of the Engineer and in accordance with the manufacturer's instruction, and shall be primed with one coat of Subox, Inc., SUBALOX No. 111FD, or Dupont, No. 67-Y-744, or equal primer.

Where solder fluids have been used, metallic surfaces shall be thoroughly cleaned with lacquer thinner before any paint is applied.

Wood Surfaces. - Unless otherwise specified, all wood surfaces, except exterior wood surfaces, shall be sandpapered before any finish is applied, and, where necessary, further sandpapered between coats. All knotholes, pitch pockets or sappy portions shall be sealed with shellac or approved resin sealer under natural finishes, and aluminum paint under paint finishes. Shellac shall not be used on surfaces exposed to the weather. After priming or sealing, all nail holes shall be carefully filled with putty colored to match the finish. All wood to be painted shall be dry before paint is applied.

Plaster Surfaces. - All plaster surfaces shall be properly sized and sealed as necessary to prevent stains and burns, overcome excessive suction, seal air checks and fine cracks and otherwise provide a suitable surface. Sizing shall be such that no peeling, flaking, or popping will result from the use thereof. The sealer shall be capable of bridging air checks and fine cracks.

Concrete Surfaces. - All concrete surfaces shall be wire brushed, blast cleaned or power sanded to remove all traces of form oil and glaze, after which they shall be treated with a solution of 3 pounds of zinc sulphate to one gallon of warm water. The solution shall be brushed on warm and allowed to dry thoroughly, or for not less than twenty-four hours, after which the surface shall be thoroughly flushed with clean water or wiped with damp burlap and allowed to dry, then further prepared by the application of an approved sealer-primer.

## 809.04 Application

All paint and related products not obtainable factory mixed shall be mixed, thinned if required for proper workability, and applied in strict accordance with the recommendations of the manufacturer.

Priming and painting shall be commenced immediately after the surfaces have been approved therefor, except that it shall be the responsibility of the Contractor not to commence work or to halt work, if weather or other conditions that will affect the work become unfavorable.

Care shall be exercised to maintain surfaces in the specified condition until the paint is applied; adequate provision shall be made to protect and maintain the newly painted work.

Prior to application, paint shall be mixed a sufficient length of time to thoroughly mix the pigment and vehicle together and during application, paint shall be kept thoroughly mixed to keep the pigments in suspension. Paint shall be stored on the job in sealed containers.

All paint shall be applied at the proper viscosity. In cool weather, paint shall be heated to reduce its viscosity and facilitate its use. Such heating shall be accomplished by immersing the paint containers in hot water, or heating by other approved means.



Paint materials shall be applied, either by brush or spray, or roller, or any combination of these methods. The coats shall be uniform and free of runs, sags, thin areas, skips or holidays.

Paint brushes shall be of the best quality, of the proper size, and shall have sufficient body and length of bristle to spread the paint in a uniform coat. In general, the primary movement of the brush shall describe a series of small circles, to fill all irregularities in the surface, after which the coating shall be smoothed by a series of parallel strokes. Paint shall be evenly spread and thoroughly brushed out. If a considerable amount of brush marks appear, it will be considered that the paint has been improperly applied. For painting structural steel, round or oval brushes, or approved flat brushes not over 4 inches in width, shall be used. On all surfaces which are inaccessible for painting by regular means, the paint shall be applied by sheepskin daubers, bottle brushes, or by any other means necessary to obtain the proper thickness of paint.

Power spray equipment, if used, shall be modern, in good order, shall include approved water traps, and shall apply the paint in a fine, even spray. When spray methods are used, the operator shall be thoroughly experienced. Runs, sags, thin areas in the paint coat, or skips and holidays shall be considered as evidence that the work is unsatisfactory and the Contractor may be required to apply the remainder of the paint by brush. In any event, uniform coverage, free of wrinkles, blisters or airholes shall be obtained with each coat of paint.

Rollers, when used, shall be of a type which do not leave a stippled texture in the paint film and shall be compatible with the paint type and surface condition as specified by the manufacturer.

When more than one coat of paint is specified, each undercoat shall be a near match in color to the finish coat, but enough difference in color shall exist to distinguish between separate coats. Each coat of paint shall be slightly darker than the preceding coat, unless otherwise directed by the Engineer. The final coat shall be of the color selected by the Engineer from samples as hereinbefore specified.

The first field coat on metalwork shall be applied immediately after installation. The last field coat shall be applied after final cleaning up of the work and final testing of equipment.

The paint for each coat shall be both mixed and applied so that the painting will be smooth, uniform, and spread so that no excess paint will collect at any point.

The thickness of each coat shall not exceed that which will result in uniform drying throughout the paint film. In certain critical cases, the thickness of each coat will be specified on the plans or in the Special Provisions.

No intermediate or final coat of paint shall be applied until the preceding coat is dry and hard, except in the case of exterior cement-type paint. Time allowed for drying shall in all cases be ample to secure the best possible results.

Sufficient paint shall be applied, in successive coats, to provide a satisfactory cover when the work is completed, but the quantity used for any individual coat or portion thereof shall not be excessive or such as to result in a thicker application than will properly set within a reasonable period, forming a hard, firm and uniformly smooth coating free of blisters, flat spots and similar defects.

The finish work shall show no cloudiness, spotting, holidays, laps, brush marks, runs, curtains, sags, ropiness, or other surface defects not consistent with first class workmanship. Identification and rating plates of equipment shall be painted with three coats of clear varnish only.

### **809.05 Final Cleanup**

The Contractor shall remove all dropped and splattered paint and other stains and blemishes resulting from his operations. If such stains or blemishes cannot be satisfactorily removed from surfaces painted by him, or from existing finished surfaces, such surfaces shall be satisfactorily repainted or otherwise refinished by him at his expense in such manner that all stains and blemishes will be obliterated and the finished surface will be as specified, or in the case of existing surfaces, shall match satisfactorily the adjacent surfaces in color and texture.

### **809.06 Deterioration of Painted Surfaces**

Painted surfaces that, within one year after painting, are found to be non-uniform in color or texture or show evidence of excessive deterioration such as cracking, crazing, blistering, running, peeling, sealing, checking, alligatoring, streaking or staining, will be considered the result of faulty materials or workmanship

and shall be satisfactorily refinished by the Contractor in accordance with the requirements of Section 105.10. All painted surfaces shall be capable of withstanding the chemical and physical action of washing with alkali-free soap and water to remove surface dirt without causing the aforementioned deterioration.

**809.07 Payment**

Painting shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## 810 Engineering Fabrics

### 810.01 General

Engineering fabrics consisting of pavement reinforcing fabric and filter fabric shall conform to the requirements of this Section 810.

Engineering fabrics shall be placed in accordance with plans and drawings or as specified in the Special Provisions.

Engineering fabrics shall be furnished in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water. A Certificate of Compliance for each kind of engineering fabric used on the project shall be furnished to the Engineer in advance. The certificate must be signed by the manufacturer stating that the fabric conforms to the requirements set forth in Section 810.02 or 810.03.

### 810.02 Pavement Reinforcing Fabric

Pavement reinforcing fabric shall be manufactured from polyester, polypropylene, or polypropylene-nylon material. The fabric shall be nonwoven, and shall conform to the following:

<u>Property</u>	<u>Unit</u>	<u>Value</u>	<u>ASTM Designation</u>
Weight .....	ounce/yd <sup>2</sup>	3.0 to 8.0	D 1910
Grab tensile strength (1" grip) .....	Lbs	90, min.	D 1117
Elongation at break .....	%	40, min.	D 1117
Fabric thickness .....	mm	12 to 100	D 461

### 810.03 Filter Fabric

Filter fabric shall be manufactured from polyester, nylon, or polypropylene material, or any combination thereof. The fabric shall be nonwoven, shall not act as a wicking agent, shall be permeable, and shall conform to the following:

<u>Property</u>	<u>Unit</u>	<u>Edge Drains</u>	<u>Underdrains</u>	<u>ASTM Designation</u>
Weight .....	ounce/yd <sup>2</sup>	4.0	4.0	D 1910
Grab tensile strength (1" grip) in each direction .....	Lbs	50, min.	90, min.	D 1682
Elongation .....	%	10, min.	30, min.	D 1682
Toughness (%Elongation × Grab tensile strength) ....	Lbs	3000 min	4000 min	...

### 810.04 Payment

Pavement reinforcing fabric will be paid for in accordance with the requirements of Section 221.04. Filter fabric shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.

END PART 8

**Part 9****Auxiliary Water Supply System for Fire Protection****Table of Contents**

---

900	General Requirements . . . . .	253
901	Ductile Iron Pipe . . . . .	255
902	Ductile Iron Special Castings . . . . .	257
903	Gray Cast Iron Special Castings . . . . .	259
904	Cast Steel Special Castings . . . . .	261
905	Bolts, Tie Rods and Other Connection Devices . . . . .	262
906	Pig Lead and Yarn . . . . .	263
907	Radiographic Inspections . . . . .	264
908	General Installation Requirements for AWSS . . . . .	265
909	Installation of Ductile Iron Pipe and Fittings . . . . .	270
910	Installation of Gray Cast Iron Pipe and Fittings . . . . .	272
911	Payment . . . . .	274

---

## **900 General Requirements**

### **900.01 General**

The Auxiliary Water Supply System (AWSS) is a high pressure water supply system for city fire protection under the authority and management of the San Francisco Fire Department, Superintendent of the Bureau of Engineering and Water Supply. The Contractor shall conduct all his business with the San Francisco Fire Department (SFFD) through the Engineer only.

### **900.02 Quality of Materials and Workmanship**

All materials shall be free from defects throughout their mass, and shall be of uniform high quality.

All castings shall conform to the shapes and dimensions shown on the plans and shall be made in such molds and with such cores as will render the castings clean, smooth, and free from undue cooling strains. Castings shall remain in the flasks a sufficient length of time to prevent unequal contraction in cooling.

The castings shall be true to patterns, sound, smooth, and free from all flaws, defects or imperfections of any kind which, in the judgment of the Engineer, render them unfit for the use for which they are intended. All projections resulting from gates or risers shall be cut off and ground smooth with the surface of the casting.

No plugging, filling or welding of defects in castings will be allowed, except in the case of cast steel castings if specifically approved by the Engineer.

All machined surfaces shall be true and smooth and the parts containing such surfaces shall be finished to conform to gauges, templates or jigs, so that all parts will be interchangeable.

### **900.03 Guarantee of Castings**

The Contractor shall furnish the Engineer with six copies of a guarantee certifying that the manufacturer has fabricated the castings in conformity with all applicable provisions of the latest ASTM and ANSI Specifications, and that the dimensions and details of the castings comply with the plans and specifications.

### **900.04 Hydrostatic Testing**

All special castings made under the terms of these Standard Specifications or the Special Provisions shall be hydrostatically tested in the presence of the Engineer or his authorized representative. The Contractor shall give the Engineer sufficient notice of time and place of testing so that arrangements may be made for the Engineer to be present. If the plant or foundry is located farther than 50 miles from San Francisco, the Contractor, at his own expense, shall secure the services of a city approved independent testing laboratory to witness the testing of the castings. The Contractor shall submit to the Engineer for approval the name of the testing laboratory and a list of the tests performed by same on similar work with dates of tests indicated.

### **900.05 Patterns Availability and Patterns Made by Contractor**

Patterns required for use in casting the fittings may be available from the City. The Contractor shall check the availability of the patterns by contacting the San Francisco Fire Department Pipe Yard. Requests for the use of existing patterns shall be made in writing to the Fire Department. In the event the pattern is not available the Contractor, at his own expense, shall make the pattern, templates and gauges of wood or other permanent material satisfactory to the Engineer and all such pattern, templates and gauges shall become the property of the City after use by the Contractor and shall be delivered to the City as directed by the Engineer.

### **900.06 Connections to be Made in the Presence of Fire Department Rep.**

The Contractor shall notify the Engineer at least one week in advance of the date on which he proposes to interrupt service to any portion of the system so that the Engineer can notify the San Francisco Fire Department.

The Contractor shall not make any connection to, or otherwise interfere with any part or appurtenance of the Auxiliary Water Supply System, except in the presence of the Engineer and a representative of the Fire Department.

The Contractor shall so conduct his operations that at no time shall more than two adjacent high pressure hydrants be out of service along the line of the work, unless otherwise authorized by the Engineer.

The San Francisco Fire Department may, at its own discretion, activate any portion of the facility for fire fighting.

#### **900.07 Shut-Down of Any Work Portion of Fire Protection to be Minimized**

In the interest of public safety, it is essential that the period of shut-down of any portion of the Auxiliary Water Supply System for fire protection be kept, by proper planning and preparation and expeditious work, to the practicable minimum as hereinafter specified.

It is understood and agreed, therefore, that the Contractor, before any such interruption, shall have on hand at the site all labor, materials, equipment and tools necessary in the opinion of the Engineer for the satisfactory completion of all the work, including testing and backfilling, necessary, or required, to restore the fire protection system to service, all where and as shown on the plans and in accordance with the Special Provisions.

Once the Contractor begins work on the AWSS pipeline, he shall continuously prosecute all such work to completion.

#### **900.08 Engineer to be Notified**

The Contractor shall notify and make arrangements with the Engineer forty-eight hours in advance of the day that the opening or closing of any AWSS valve is required.

#### **900.09 Work to be Complete**

The Contractor shall do all work and furnish all materials, other than those specified to be furnished by the City, or salvaged by the Contractor, which are necessary, or required, to complete the work, such as bolts, nuts, washers, lead, yarn, paint, machine oil, graphite, concrete thrust blocks, bracing, brackets, hangers, clamps, inserts, gaskets, etc., in accordance with applicable sections of these Standard Specifications, whether or not specified or shown on the plans or specified in the Special Provisions, and the cost thereof shall be included in the price or prices bid.

## 901 Ductile Iron Pipe

### 901.01 General

The Contractor shall install ductile iron pipe including all excavating, lagging, backfilling, restoring pavement and other Incidental Work, necessary or required for a complete, satisfactory installation, where and as shown on the plans, or where directed.

### 901.02 Pipe

Ductile iron pipe shall conform to ANSI Specification A21.51.

All pipe shall be thoroughly cleaned inside and outside without the use of acids or harmful liquids.

### 901.03 Joints

Pipe joints shall be the push-on type and shall conform to Section 11-2.3 of ANSI Specification A21.11.

### 901.04 Tests and Test Specimens

Hydrostatic and acceptance tests shall conform to ANSI Specification A21.51. The pipe manufacturer shall furnish in quintuplicate, a written certification to the effect that:

- (a) The pipe has passed successfully a 500-psi hydrostatic shop test in accordance with the Section 51.9 of ANSI Specification A21.51.
- (b) The pipe has passed the acceptance test in accordance with Section 51.12 of ANSI Specification A21.51.

The manufacturer shall also submit with the written certification a physical test report tabulation indicating the tensile and impact test results.

Test specimens, as required by ANSI Specification A21.51 for ductile iron pipe shall be furnished by the Contractor, at his own expense, to the Engineer for testing by the City.

### 901.05 Thickness and Tolerances

Ductile iron pipe shall be as tabulated below:

Pipe Size (Inch)	Thickness Class	Wall Thickness (Inch)
8	2	0.33
10	3	0.38
12	3	0.40
14	4	0.45
16	5	0.49
18	6	0.53
20	6	0.54

Tolerances or maximum permitted variations in dimensions, thicknesses and weights shall conform to Section 51-7 of ANSI Specification A21.51. Each pipe shall be weighed before application of the coating and the weight shall be shown on the outside of the spigot or bell.

### 901.06 Coating

The ductile iron pipe shall be coated on the outside with a bituminous coating of either coal-tar or asphalt base approximately 1 mil thick. The finished coating shall be continuous, smooth, neither brittle when cold nor sticky when exposed to the sun and shall be strongly adherent to the pipe.

**901.07 Lining**

The ductile iron pipe shall be cement lined in accordance with ANSI Specification for “Cement Mortar Lining for Cast Iron Pipe and Fittings For Water”, Designation A21.4. The thickness requirement shall be 1/16-inch minimum.



## **902 Ductile Iron Special Castings**

### **902.01 General**

The ductile iron castings covered hereunder are a special design of the City. All ductile iron castings shall be fabricated in a foundry having had at least five years experience in the manufacture of ductile iron castings. The Contractor shall submit to the Engineer for approval the name of the foundry and a list of representative installations with the date of manufacture indicated. AU castings shall be in strict accordance with the plans and the following requirements. All fittings specified under this section shall be made of ductile iron.

### **902.02 Ductile Iron**

Ductile iron castings shall conform to the requirements of ASTM "Standard Specification for Ductile Iron Castings", Designation A 536, Grade 80-55-06.

### **902.03 Tests and Test Specimens**

All fittings shall be subjected to a hydrostatic shop test at a pressure of 600 psi for a period of not less than four minutes. Any casting which shows any defect by leaking or sweating shall be rejected.

Test specimens as required in ASTM Designation A 536 shall be furnished by the Contractor, at his own expense, to the Engineer for testing by the City.

### **902.04 902.04**

Mechanical joint dimensions shall be in accordance with "Standard Mechanical Joint Dimensions" of ANSI Specification A21.11. All mechanical joint fittings shall be supplied with the necessary ductile iron mechanical joint glands, gaskets, and tee bolts manufactured in strict accordance with ANSI Standard A21.11, except that the tee bolt lengths for various sizes of pipe shall be as indicated on the plans.

### **902.05 Flanges**

The flange dimensions shall conform to ANS Standard B16.5, 600 lbs. Flanges shall be faced, drilled, spot-faced on the back, and have a raised face 1/4-inch thick.

### **902.06 Tolerances**

Wall thickness, body length, form and dimensions for all fittings hereunder shall conform to the dimensions, standards, and codes shown on the Contract Plans.

The Contractor shall furnish all necessary tolerance gauges which may be required by the Engineer to check dimensions of the castings for conformity with the Contract Plans and allowable tolerances.

- (a) Diameters: The inside diameters of the sockets shall not vary from the standard dimensions by more than 0.06 inch.
- (b) Depths of Sockets: Depths of sockets shown on the Contract Plans shall be considered minimum with a tolerance not to exceed 0.10 inch.
- (c) Thickness: Thickness of the material shall not be more than 1/16-inch less or 1/8-inch more than the dimensions shown on the Contract Plans.

### **902.07 Marking Castings**

Each fitting or collar shall have the name or symbol of the manufacture, the letters “AWSS DI” and the size of the fitting or collar on the exterior surface of the casting. The letters and numbers shall be arranged in a manner satisfactory to the Engineer.

The collars shall also have the type of collar marked, such as “Bell Collar” or “Stop Collar” at the locations shown on the Contract Plans. Where elbows are shown on the plans, the amount of bend shall also be indicated. For example: AWSS DI, 18”-45° Elbow.

The letters or numbers shall be not less than one-half inch in height nor less than one-eighth inch in relief and shall be cast at a distance not less than 12 inches from any spigot end.

In case any casting shall be rejected, the letters AWSS shall be erased by the Contractor under the supervision of the Engineer.

### **902.08 Coating**

After testing, all castings shall be thoroughly cleaned and coated with two coats of bitumastic coating on the interior and exterior of the castings.

### **902.09 Accessories**

All fittings shall be supplied with the necessary accessories as specified or as required. All stop and bell collars shall be supplied with the necessary AISI type 316 stainless steel tie bolts as detailed on the Contract Plans.

## 903 Gray Cast Iron Special Castings

### 903.01 General

The castings covered in this Section are of City design, and include sleeves, caps, plugs, offsets, line reducers, valve reducers, hydrant tees, blow-off tees, bell and spigot elbows, double spigot elbows, fire boat wharf manifolds, and other special castings. All castings shall be in strict accordance with the plans or samples provided by the City.

### 903.02 Cast Iron

Cast iron shall be in accordance with the requirements for Class "A" of ASTM - "Standard Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings", Designation A 126.

### 903.03 Tests and Test Specimens

Test specimens, as required by the ASTM Specifications, shall be furnished by the Contractor, at his own expense, to the Engineer for testing by the City.

### 903.04 Tolerances

The Contractor shall furnish all the necessary tolerance gauges and any other gauges which may be required by the Engineer to check the dimensions of the castings for conformity with the plans and the allowable tolerances.

Diameters. - The inside diameters of the bells and the outside diameters of the spigot ends shall not vary from the standard dimensions by more than 0.10 of an inch.

Depth of Bell. - The depth of bell shown on the standard or detail plans shall be the minimum with a plus tolerance not to exceed 0.10 of an inch.

Thickness. - The variation of the standard thickness shall not exceed 0.12 of an inch.

### 903.05 Marking Castings

Every casting shall have distinctly cast upon the outside surface in raised letters, not less than 1/2-inch in height and 1/8-inch in relief: AWSS, the nominal diameter, and the class. For example: AWSS 12" x 10" GH.

The letters shall be arranged in a manner satisfactory to the Engineer. In the case of elbows, the amount of bend shall also be indicated as required hereinbefore.

Letters and figures for marking castings shall be cast at a distance not less than 12 inches from any spigot end.

In case any castings shall be rejected, the letters AWSS shall be erased by the Contractor under the supervision of the Engineer.

### 903.06 Hydrostatic Testing

The castings shall be subjected to hydrostatic shop test pressure for a period of not less than four minutes. The castings shall be subjected to a hammer test while under pressure.

Class A-B specials shall be tested at a pressure of 450 psi and castings of all other classes shall be tested at a pressure of 600 psi.

Any casting which shows any defect by leaking or sweating, which cannot be stopped by peining, will be rejected.

**903.07 Coating**

After testing, every casting shall be cleaned and then coated inside and outside with bituminous coating in accordance with ANSI Specification A21.10.

## 904 Cast Steel Special Castings

### 904.01 General

The steel castings covered in this Section are of City design, and include sleeves, crosses, tees, valve reducers, double bell elbows, equalizer rings, strongbacks, and other Special castings. All castings shall be in strict accordance with the plans, or samples provided by the City.

Before being coated, as required in Section 903.07, all the castings shall be subjected to a hydrostatic shop test pressure of 650 psi for a period of not less than four minutes. The castings shall be subjected to a hammer test while under pressure.

Any casting which shows any defect by leaking or sweating, which cannot be stopped by peining, will be rejected.

### 904.02 Cast Steel

Cast steel shall be in accordance with the requirements for Grade 70-36 of ASTM "Standard Specifications for Mild to Medium Strength Carbon - Steel Castings for General Application". Designation A 27.

### 904.03 Tests and Test Specimens

Test specimens, as required by the ASTM Specifications, shall be furnished by the Contractor, at his own expense, to the Engineer for testing by the City.

### 904.04 Tolerances

The Contractor shall furnish all the necessary tolerance gauges and any other gauges which may be required by the Engineer to check the dimensions of the castings for conformity with the plans and the allowable tolerances.

Diameters. - The inside diameters of the sockets and the outside diameters of the spigot ends shall not vary from the standard dimensions by more than 0.06 of an inch.

Depth of Socket. - The depth of socket shown on the standard or detail plans shall be the minimum with a plus tolerance not to exceed 0.10 of an inch.

Thickness. - The thickness of metal shall not be more than 1/16-inch less than, or 1/8-inch more than, the dimensions shown on the plans.

### 904.05 Marking Castings

Every casting shall have distinctly cast upon the outside surface in raised letters, not less than 1/2-inch in height and 1/8-inch in relief: AWSS, the nominal diameter, and the class. For example: AWSS 12" x 10" GH.

The letters shall be arranged in a manner satisfactory to the Engineer. In the case of elbows, the amount of bend shall also be indicated as required hereinbefore.

Letters and figures for marking castings shall be cast at a distance not less than 12 inches from any spigot end. In case any casting shall be rejected the letters AWSS shall be erased by the Contractor under the supervision of the Engineer.

### 904.06 Coating

After testing, every casting shall be thoroughly cleaned and shall then be coated inside and outside in the manner specified in Section 903.07 for gray cast iron special castings, all the requirements of which shall apply.

## **905 Bolts, Tie Rods and Other Connection Devices**

### **905.01 General**

The Contractor shall furnish and install all bolts, tie rods, nuts, sleeve nuts, washers and other connecting devices necessary for the bolting together of pipe joints and other connections and parts of pipe lines. Such devices shall conform to the standard plans, except that special lengths may be required by the Engineer.

All washers shall be perfectly flat and true to required dimensions, and all nuts and bolts shall have their bearing surfaces smooth and at right angles to the axis of the thread.

All threads shall be thoroughly coated with lubricating oil to which has been added flake graphite in the amount of one ounce per quart of oil.

### **905.02 Material**

All of the connecting devices described hereinbefore shall be of austenitic stainless steel conforming to American Iron and Steel Institute (AISI) and American Society of Testing Materials (ASTM) specifications. All bolts shall conform to ASTM A 193, Symbol B8M (AISI Type 316). All nuts and sleeve nuts shall conform to ASTM A 194, Symbol 8M (AISI Type 316). All tie rods, threaded rods and washers shall conform to AISI Type 316.

### **905.03 Wire Binders**

Wire binders, where required to hold bolts and rods firmly in place in the lugs, shall be furnished and installed by the Contractor. They shall consist of 3 turns of No. 10 BWG soft stainless steel wire, wrapped tightly around the entire set of bolts or rods, with the ends twisted tightly together.

For each set of bolts or rods less than 24 inches in length, one binder will be required.

For each set of bolts or rods 24 inches or more in length, two binders will be required when used in open lugged devices, each binder being placed as close to lugs as possible.

### **905.04 Painting**

After installation, following satisfactory hydrostatic test of pipe and appurtenance, all the bolts, nuts, and other connection devices shall be painted with two coats of an approved coal tar base paint applied in accordance with the applicable requirements of Section 809.

## **906 Pig Lead and Yarn**

### **906.01 Pig Lead**

Lead shall be in accordance with the requirements for Common Desilverized Lead of ASTM “Standard Specifications for Pig Lead”, Designation B 29.

### **906.02 Yarn**

Yarn used for joint packing shall be braided or twisted jute packing yarn, uniform, best quality, free from tar.

## 907 Radiographic Inspections

When steel castings are specified to be radiographically inspected, the Contractor shall make gamma-ray, or 250 kv (or greater) X-ray, radiographs of complete castings, or any portion thereof, as selected by the Engineer or his authorized representative. The total number of Standard 14-inch x 17-inch radiographic films to be utilized, however, will not exceed 20. Radiographs resulting from such examination shall be properly exposed and easily readable films. Any faulty, underdeveloped, overdeveloped, or excessively foggy films shall be rejected and replacement films shall be exposed, developed and resubmitted for evaluation at no cost to the City. All inspection shall be made in accordance with ASTM "Recommended Practice for Radiographic Testing", Designation E 94.

The quality of such steel castings shall be evaluated by comparing the radiographs of each casting with the standard plates comprising the "Gamma-Ray Radiographic Standards", ASTM Designation E 71. Said standard plates shall be made available by the Contractor to the City.

The comparison shall be made on the basis of either "Class 2", or "Class 3", whichever is indicated on the Standard Plan of the particular casting being examined. The radiographs and standard plates shall be compared in the presence of the Engineer or his authorized representative, and any casting which, in his opinion, is not acceptable in Groups "A" through "G", inclusive, of such standards, will be rejected, and the repair thereof by any means whatsoever will not be permitted.

The Contractor shall furnish all labor, materials and facilities required for the specified radiographic inspection of the steel casting and shall include in his bid prices the entire cost, except the wages of the Engineer, of making such inspection.



## **908 General Installation Requirements for AWSS**

### **908.01 General**

The Contractor shall lay AWSS pipe, fittings, and appurtenances where and as shown on the plans, or specified, or where directed by the Engineer, and shall do all trenching and excavating necessary for the proper placing of the AWSS facilities, and all required backfilling and restoration of pavement.

The Contractor shall prepare trench subgrade for AWSS facilities not less than 30 linear feet in advance of the AWSS pipe construction.

All abandoned structures shall be removed to a depth of not less than one foot below the bottom of the required construction. Moreover, in order to allow sufficient space for making joints, the clearance between any lead joint in the high pressure pipeline installed and any structure or other interference shall be not less than 18 inches.

Immediately prior to installation, to prevent the entrance of any foreign matter into the lines, all pipes, valves, hydrants, other castings, and appurtenances shall be cleaned by the Contractor by brushing and washing, and all dirt and other foreign matter removed.

As the pipe laying proceeds, an approved mandrel, provided by the Contractor, shall be drawn forward as each pipe or special casting is laid. All branches or other openings shall be protected and kept sealed during installation by inserting turned wooden plugs until permanent connections are made. Plugs shall be at the site before work begins. During the progress of the work the lines shall be kept thoroughly clean throughout, and at the conclusion of the work, left clean. Any obstruction or deposit discovered in the lines during inspection of the work shall be removed at once by the Contractor.

AWSS installation work shall be done and supervised by journeyman plumbers. Qualifications of the journeyman plumbers shall be subject to approval by the Engineer.

### **908.02 Yard**

AWSS materials are stored at the San Francisco Fire Department Pipe Yard located at 2245 Jerrold Avenue. Except on Saturdays, Sundays and legal holidays, the yard will be open for receiving or delivering materials during the periods 8:00 A.M. to 12:00 noon and 1:00 P.M. to 4:00 P.M. The Contractor shall make all arrangements for pick-up or delivery 48 hours in advance by contacting the supervisor plumber at the Pipe Yard.

### **908.03 Borrowing of City Material**

With the approval of the Engineer, the Contractor may borrow materials from the Yard. The Contractor will be required to fill out an irrevocable purchase order prior to removing the materials from the Yard.

### **908.04 Hauling Pipe and Materials Furnished by the City**

All pipe, valves, hydrants and other appurtenances and materials furnished by the City to the Contractor for use in the work, shall be handed, loaded, and hauled by the Contractor from the Pipe Yard or other locations within the City limits to the site of the work.

### **908.05 Responsibility for Materials Obtained from the City**

The contractor shall carefully inspect all materials and appurtenances delivered to him by the City and shall not accept any materials or appurtenances that are cracked, broken or defective in any way. The Contractor shall be responsible for all materials and appurtenances delivered to him by the City, and should any materials or appurtenances, in the judgment of the Engineer, be damaged after they are delivered to the Contractor, they shall be promptly replaced with new materials or appurtenances by the Contractor at his sole expense. Failure to so replace such damaged materials or appurtenances will be cause for replacement by the City and all expense of such replacement will be deducted from moneys due the Contractor.

### **908.06 Return Materials to Pipe Yard**

All materials to be returned to the Pipe Yard, and all patterns that are, or become, the property of the City, shall be loaded and hauled by the Contractor to the Pipe Yard or other designated location within the City limits, and there placed by him where directed. The Contractor will be issued a receipt for said materials.

### **908.07 Excavating and Lagging**

Excavating and lagging shall be in accordance with the applicable requirements of Sections 700, 701 and 702, except as otherwise specified.

### **908.08 Access to SFFD Hydrants and Valves**

It is essential that access to San Francisco Fire Department Hydrants and Valves be maintained at all times free and clear of all obstacles which, in the opinion of the Fire Department, will hinder the use of their equipment in cases of emergency.

### **908.09 Removing and Salvaging Existing Facilities**

The Contractor shall, where and as shown on the Contract Plans, or as specified in the Special Provisions, remove and salvage existing facilities.

All lead joints of pipes and fittings and valves to be removed and salvaged shall have the lead completely melted out by means of a welding torch with an appropriate tip.

Salvaged materials damaged or improperly removed by the Contractor shall be cause for rejection and replacement by the Contractor at his expense. All salvaged pipe and special castings shall be thoroughly cleaned, both inside and outside, by sandblasting, of all dirt, rust, scale, and loose paint. After cleaning, the pipe shall be painted both inside and outside with one coat of Pabco P and B preservative, Polyken No. 927 by Kendall, or equal.

Exterior iron surfaces of any hydrant or valve to be salvaged shall be cleaned by sandblasting and the interior washed with clean water. After all cleaning has been completed, the Fire Department shall be given the opportunity to inspect, overhaul or repair, as necessary each such hydrant or valve.

After the Fire Department completes work on the hydrant or valve, the exterior surfaces of the hydrant or valve to be installed underground shall be painted with one coat of Pabco P and B preservative or pipe line primer Polyken No. 927 by Kendall or an approved equal. The exterior surfaces of the hydrant to be installed above ground shall be painted prior to the hydrostatic field test with three prime coats of approved red lead paint, and after satisfactory completion of the hydrostatic field test, shall be painted with two finish coats of approved high gloss enamel, all in accordance with the applicable requirements of Section 809.

Materials to be returned to the Pipe Yard at 2245 Jerrold Avenue shall be completely disconnected, cleaned, and painted as specified herein, before being delivered to the Pipe Yard and placed where directed by the Engineer.

Removed bolting materials and lead melted from existing joints shall be salvaged as the property of the City, but shall not be reused in the work.

### **908.10 Removal and Disposal of Existing Facilities**

All materials to be removed but not salvaged shall be removed and disposed of as the Contractor's property. The Contractor will not be allowed to store such removed materials at the project site.

### **908.11 Installation of Hydrants**

The Contractor shall install hydrants where shown on the plans or where directed by the Engineer.

Each hydrant shall be carefully examined, the elbow and foot valve thoroughly cleaned, and all dirt and other foreign matter removed, before setting the hydrant in place.

Hydrants shall be set exactly plumb, and at the proper elevation, each on a block of reinforced concrete or in a vault recess, as shown on the plans.

In compacting the backfill, the hydrants shall be kept plumb, and adequate support to prevent future movement shall be provided. Any hydrant which is out of plumb or not firmly supported shall be properly reset by the Contractor at his sole expense.

### **908.12 Installation of Valves**

The Contractor shall install valves in the line, each complete with valve box assembly or valve vault, as applicable, where shown on the plans or where directed by the Engineer.

### **908.13 Air Valve Assemblies**

The Contractor shall tap the line and shall furnish and install air valve assemblies, each complete with valve, riser, and valve box assembly, where shown on the plans or where directed by the Engineer.

### **908.14 Valve Box Assemblies**

The Contractor shall furnish and construct valve box assemblies over all air valves, 8-inch valves, and 10-inch valves. Each valve box assembly shall be complete with a cast iron cover, dust pan, and frame set on a reinforced concrete block, and shall include a cast iron valve box unless otherwise specified or shown on the plans, and a steel, ductile iron, or gray cast iron pipe casting riser extending from the valve box or valve, as applicable, to the reinforced concrete block, all where and as shown on the plans or where directed by the Engineer. In the case of air valves and 8-inch valves, unless otherwise specified or shown on the plans, no cast iron valve box will be required, and the cast iron casting shall extend from the backfilled material to the concrete box. Valve box assemblies shall be constructed true and plumb, and cast iron frames and covers shall be set to the pavement surface. The backfilled material shall be satisfactorily compacted in place before the concrete block is constructed thereon.

### **908.15 Valve Vaults**

The Contractor shall furnish all materials for and shall construct, reinforced concrete valve vaults, each complete, with a cast iron frame, cover and dust pan, for all 12-inch, or larger, valves, where shown on the plans, or where directed by the Engineer.

Valve boxes shall be constructed water tight, and cast iron frames and covers shall be set to the pavement surface in such manner that the length of the lifting handles will be in the direction of vehicular traffic flow.

### **908.16 Bolting Devices**

All bolting devices shall be brought to a snug fit against the lugs but shall have no excessive tension applied. The Contractor may use the bolting devices as a means of homing the pipe or fitting but shall remove all excessive tension from the bolts and return them to a snug bearing before the hydrostatic field test.

### **908.17 Minimum Clearance**

The minimum clearance between the AWSS pipe, fitting or appurtenance, as the case may be, and other facilities shall be not less than 6 inches. The clearance between any AWSS lead joint installed and any utility or other facility shall be not less than 18 inches.

### **908.18 Thrust Blocks**

All bends, offsets, dead ends, hydrant tees, and crosses with plugged outlet shall be braced with wedge shaped concrete anchor blocks. The blocks shall be of Class 5.5-3000-1-1/2 concrete, of such size as the

Engineer may direct, and shall be poured against undisturbed ground in the bottom and side of trench. The backfill around the blocks shall be thoroughly tamped.

### **908.19 Backfilling**

Backfilling shall be in accordance with the requirements of Section 703, except that sand shall be placed to at least one foot above the top of the pipe and to a depth 4 inches below the line of the bells of the pipe. All excavated materials not suitable for backfilling and all surplus excavated materials shall be removed from the site by the Contractor as his property.

### **908.20 Cistern Identification**

Where required on the plans or in the Special Provisions, the Contractor shall mark the existing center cistern manhole frame using the specified outside diameter. The Contractor shall remove the existing brick cistern location ring from the site as his property and fill the resulting voids as set forth under Section 217.01.

### **908.21 Restoration of Pavements and Related Improvements**

Pavements and related improvements shall be restored in accordance with the requirements of Section 109, and construction thereof shall be in accordance with the requirements of Part 2 of these Standard Specifications.

### **908.22 Hydrostatic Field Tests and Permissible Leakage**

Installed pipe and appurtenances shall be tested hydrostatically after installation, but before the joints are backfilled, at the pressure specified in the Special Provisions.

The tests shall be made between plugs or valves in the main line and shall include the hydrant branches either up to the 8-inch valve or to the foot valve of the hydrant, as the Engineer may direct. Where the main line test extends only to the valve on a hydrant branch, the portion of the 8-inch pipe between the valve and hydrant shall be separately tested.

The Contractor shall furnish all the labor and materials necessary to make the tests and to perform any work incidental thereto. The trench between joints shall be partially backfilled before making tests.

Prior to the hydrostatic test periods, the Contractor shall furnish and install, as directed, suitable temporary thrust blocks and other anchorages to prevent any movement whatever of the AWSS pipeline and appurtenances during the hydrostatic field tests.

The hydrostatic field tests shall be conducted by the Contractor in the presence of the Engineer, who shall be notified by the Contractor at least forty-eight hours in advance thereof.

The sections of pipe and appurtenances to be tested shall be completely filled with fresh water at line pressure of the respective AWSS pressure zone in which the work is being done, which pressure shall be maintained for a period of not less than sixteen hours. At the end of the period, the hydrostatic pressure shall be increased to the pressure required for the class of pipe installed, as specified. The Fire Department, upon request and at no cost to the Contractor, will increase the hydrostatic pressure to the test pressure hereinbefore specified. The Fire Department may delay this phase of the test, if a large emergency demand upon fire-fighting equipment makes the withdrawal from active service of a pumping engine imprudent. The Fire Department further reserves the right to deny the use of a pumper for a retest where said retest is required due to failure of the Contractor to be present or ready at the original time scheduled for a test or because the installation fails the test due to poor workmanship. If the Fire Department denies the use of a pumper for a retest, the Contractor, shall, at his own expense, provide the equipment to accomplish the retest to the satisfaction of the Engineer. It shall be the Contractor's responsibility to provide connections and appurtenances for supplying water and applying hydrostatic test pressure for sections of pipe and appurtenance which are to be tested and are not connected to an existing Auxiliary Water Supply System.

The Contractor shall take all necessary precautions to prevent any joints drawing while pipe and appurtenances are being tested, and he shall, at his own expense, repair any damage to the pipe and appurtenances, or any other structures resulting from or caused by the tests.

No visible leakage will be allowed for each section tested under the pressures specified. If visible leakage occurs, the Contractor shall remake the joints and replace the defective work until the leakages are eliminated.

## **909 Installation of Ductile Iron Pipe and Fittings**

### **909.01 Cutting and Marking Pipes and Nipples**

All cutting of pipes or nipples shall be done with a device which, in the judgment of the Engineer, is suitable for this purpose. The cut ends of the pipe or nipples shall be clean and straight, made at an angle of 90 degrees with the longitudinal axis of the pipe. The outside of the cut end shall be tapered about 1/8-inch at an angle of approximately 30 degrees with the centerline of the pipe.

Every reusable nipple cut from a larger piece of pipe shall have painted thereon with yellow paint the word "DUCTILE".

The cutting of all pipe and nipples shall be done as Incidental Work. All measurements for nipple lengths shall be the responsibility of the Contractor.

Closing nipples shall be cut to exact length, with a minus tolerance only, not to exceed 1/8-inch.

Cut pipe and nipples, other than closing nipples, shall, unless otherwise designated on the plans, be cut to a plus-minus tolerance of 1/8-inch.

Under no circumstances will forcing, raising or jacking of the pipe be permitted in order to comply with proper length requirements. A realignment in plan or elevation to comply to the length requirements is also prohibited, unless approved in writing by the Engineer.

### **909.02 Joints**

In constructing joints the Contractor shall not use any method which, in the opinion of the Engineer, would result in damage to the gasket. Excessive forcing, raising or jacking the joints into place from blocks or rollers will not be permitted.

All components of the joint shall be kept clean throughout the assembly.

### **909.03 Push-On Joints**

All foreign matter in the bell shall be removed. The gasket seat shall be thoroughly inspected to be certain it is clean. The gasket shall be wiped clean with a clean cloth, flexed, and then placed in the bell. The gasket shall be fitted snugly in the retainer seat. A thin film of approved lubricant shall be applied to the inside surface of the gasket which will come in contact with the entering spigot end of the pipe. The spigot end of the pipe shall be hung on a sling, aligned and carefully entered into the bell until it just makes contact with gasket. A reasonable force shall be applied so that the spigot end of the entering pipe makes contact with the bottom of the bell.

### **909.04 Gland Joints**

Prior to slipping the gasket over any spigot end into the bell, the surface to which the gasket comes in contact shall be thoroughly wire brushed clean of all rust, all foreign material shall be removed and the gland lubricated with a soap and water solution or other approved lubricant in order to facilitate the making of a tight joint. Mechanical joint glands shall be tightened evenly with a torque wrench by partially tightening the bolts diametrically opposite until the gasket is fully seated. The torque obtained in tightening the bolts shall not be less than 60 foot pounds and not more than 90 foot pounds. in no case shall the Contractor tighten the bolts in excess of 90 foot pounds torque in an attempt to correct a faulty joint.

### **909.05 Flanged Joints**

All flanged joints shall be made in accordance with the best standard practice. The Contractor shall install gaskets where necessary or required when making up joints for flanged fittings. All gaskets shall be carefully cleaned before being fitted and bolted. Flanges and gaskets shall be treated, on assembly, with approved commercial compounds to make all joints tight.

### 909.06 Deflection

Deflection at any one joint shall not exceed the deflection listed below for an 18-foot length:

<u>Pipe Size</u>	<u>Mechanical Joint</u>	<u>Push-on Joint</u>
8"	20"	19"
10"	20"	19"
12"	20"	19"
14"	13 <sup>1</sup> / <sub>2</sub> "	11"
16"	13 <sup>1</sup> / <sub>2</sub> "	11"
18"	11"	11"
20"	11"	11"

Lesser deflections for shorter lengths shall be determined by calculating the length ratio times the allowable deflection for the size listed in the table.

### 909.07 Welded Collar Stops

When pipe collars and stops are specified or required, stops of the required form and dimension shall be welded on to the pipes as shown on the Contract Plans.

The welding rod shall be NI-ROD-55, or Xyron 2-24, or equal. The bell and pipe collars, if required, shall be installed prior to welding of the stops on to the pipe.

### 909.08 Welder Qualifications

All welders employed by the Contractor to do welding on ductile iron pipe shall be certified welders experienced in the type of welding required. Upon request from the Engineer, the Contractor shall arrange for a representative from the City to witness the techniques to be employed for welding mild steel stops on ductile iron pipe. The Contractor shall follow welding instructions furnished by the weld rod supplier. Special attention shall be given to type and polarity of current and current level to be used. All welders employed by the Contractor on this project shall meet all applicable requirements as prescribed in ASME Boiler and Pressure Vessel Code. Section IX.

### 909.09 Weld Inspection

The Engineer may provide services of an independent laboratory to inspect the welds on pipe stops. For testing purposes, an ultrasonic testing device or X-ray will be used when required. The Contractor shall arrange the pipe in such a manner that the welds will be readily accessible for testing prior to installation of the pipe. He shall remove or rotate the pipe as required for proper inspection. The Contractor shall notify the Engineer 10 days in advance of any welding, stating where the welds can be inspected. The welds will be rated according to the method outlined in ASME Boiler and Pressure Vessel Code, Section VIII, UW-51. Any weld showing excessive amounts of inclusions, slag, blowholes, surface defects, shallow penetration or any other fault that will weaken weld shall be rejected. All rejected welds shall be repaired to the satisfaction of the Engineer. Before any welding is begun the metal to be welded shall be cleaned by scraping and wire brushing. No welding shall be performed until the surfaces to be welded are clean and free of paint, rust or any other material that will weaken the weld.

## **910 Installation of Gray Cast Iron Pipe and Fittings**

### **910.01 Cutting and Marking Pipes and Nipples**

All cutting and grooving of pipes or nipples, except the cutting of pipe risers for valve boxes, shall be done in a machine shop with a machine which, in the judgment of the Engineer, is suitable for this purpose. The cut ends of the pipe or nipples shall be clean and straight, and the cut grooves shall conform with the plans as to shape, size and location.

Every reusable nipple cut from a longer piece of pipe shall have painted thereon with yellow paint the size and class of the original full length of pipe, for example:

10"-H

The length of pipe from which the nipples have been cut shall, if the original cast no letter has been destroyed, also have the size and class painted on the outside of the pipe and also on the inside near the spigot end.

The cutting, grooving, machining, and cartage of all pipe and nipples shall be done as Incidental Work. Such cutting and grooving shall be made at an angle of 90 degrees with the longitudinal axis of the pipe. All measurements for nipple lengths shall be the responsibility of the Contractor.

All cut ends of pipe shall be grooved except when the remaining cut pipe is less than the Standard minimum nipple length.

Closing nipples shall be cut to exact length, with a minus tolerance only not to exceed 1/8-inch.

Cut pipe and nipples, other than closing nipples, shall, unless otherwise designated on the plans, be cut to a plus-minus tolerance of 1/8-inch.

Under no circumstances will forcing, raising or jacking of the pipe be permitted in order to comply with proper length requirements. A realignment in plane or elevation to comply to the length requirement is also prohibited, unless approved in writing by the Engineer.

The City reserves the right to furnish pipe for nipples, when specified, in approximate lengths, at no cost to the Contractor, from the Pipe Yard at 2245 Jerrold Avenue.

### **910.02 Making of Joints - General**

The Contractor shall make all lead joints in accordance with the requirements set forth in Section 901.03 through 910.07, inclusive, as applicable.

### **910.03 Bell and Spigot Joints**

The spigot end of the pipe or special casting shall be inserted into the bell the full depth of the bell, and the spigot adjusted in the bell so as to give a uniform space for the joint, which shall be made up of lead and yarn as specified in Section 906. The packing shall be thoroughly and evenly packed into the bell, filling it tightly for a depth of one inch. The remaining space shall then be filled with lead, a bead being left on the outside of the face of the bell sufficient to allow for caulking so that when the joint is properly caulked the lead will be flush with the face of the bell. The use of cold plugs will not be allowed.

### **910.04 Double Spigot Joints**

In laying double spigot pipe, and in installing sleeves on bell and spigot or double spigot pipe, the sleeve shall be adjusted so as to be centered with both pipes and cover each pipe equally to make a joint symmetrical both radially and along the axis of each pipe. Reference marks satisfactory to the Engineer shall be placed on each pipe to show any displacement of the sleeve in caulking the joint, and the joint shall be caulked so as to prevent a material endwise displacement of the sleeve. The two joints of sleeves shall receive alternate partial caulking, or another method of caulking satisfactory to the Engineer may be employed.



### **910.05 Pipe Laid on Grades**

Where pipe is laid on grades, the bells pointing down grade shall have the lead joint made so as to avoid any material collection of air bubbles at the top of the joints.

### **910.06 Pouring of Lead**

Only one pouring shall be made for each joint. The joint shall be perfectly clean and dry when the lead is applied. Dross shall not be allowed to accumulate in the melting pot.

In pouring lead joints, no pour-through will be allowed. Any point in which lead pours through to the interior of the Pipe shall be rejected, the joint disassembled, and all lead removed from the interior of the pipe.

Lead extruded 1/8-inch or less from a joint under pressure may be recaulked upon approval of the Engineer; lead extrusion greater than 1/8-inch, and those not approved by the Engineer for recaulking, shall be melted out completely and remade. Furthermore, no leakage will be permitted at the joints. All joints not rendered leakproof by recaulking shall be melted out completely and remade. The hydrostatic field test shall be repeated and repair made as necessary to provide a completely leakproof line.

Pneumatic hammers used for caulking lead joints shall be Chicago Pneumatic Tool Company "Boyer Superior" No. 1, or equal, sleeve valve chipping hammers and each shall have a net weight of 10.50 +0.5 pounds, and at 90 psig air pressure shall deliver a minimum of 5.5 foot pounds per blow and approximately 3000 blows per minute.

### **910.07 Melting of Joints**

All lead joints of pipes to be disconnected, or altered by deflection, shall be melted out by means of a welding torch with an appropriate tip.

## 911 Payment

Auxiliary Water Supply System for Fire Protection work, satisfactorily furnished, installed, or furnished and installed, as specified, will be paid for as set forth in the Schedule of Bid Prices.

END PART 9

---

## Part 10

# Landscape Work

### Table of Contents

---

1000 General Requirements . . . . .	276
1001 Site Preparation . . . . .	277
1002 Earthwork . . . . .	278
1003 Sewerage and Drainage . . . . .	281
1004 Paving . . . . .	282
1005 Structures . . . . .	283
1006 Irrigation Work . . . . .	284
1007 Planting . . . . .	291
1008 Maintenance and Plant Establishment . . . . .	298
1009 Restoration of Existing Lawn and Other Planting . . . . .	301
1010 Imported Furnishings . . . . .	303
1011 Payment . . . . .	304

---

## 1000 General Requirements

Unless otherwise indicated on the plans or specified in the Special Provisions, the performance of Landscape Work shall be in accordance with the requirements set forth in these Standard Specifications. Furthermore, all performance of Landscape Work shall be coordinated with the installation of all systems and facilities as integral components of Landscape Work. Due to the broad subject area of Landscape Work, references to specific sections shall be made to eliminate repetition and to maintain a uniformity in methods of operation. The Contractor shall inform himself of, and consequently comply with, Sections 100, 101, 102, 103, 105, 106, 107 and 108 as applicable to materials' purchase, installation and operational procedures.

## **1001 Site Preparation**

### **1001.01 General**

This work shall consist of the removal of all objectionable material from within the project limits in preparation for and in connection with the following Landscape Work: grading, irrigation, drainage, concrete and masonry construction, wood construction, planting, and installation of site furnishings (play equipment, benches, fences, etc.). Site preparation/clearing for all work shall be performed in accordance with these Standard Specifications.

### **1001.02 Protection of Existing Trees**

The Contractor shall protect existing trees scheduled to remain on site against injury or damage including cutting, breaking or skinning of roots, trunks or branches, smothering by stockpiled construction materials, excavated materials or vehicular traffic. Trees designated to remain on site shall be protected with a temporary four-foot high double-rail wood fence enclosure. This enclosure shall be an eight-foot square centered around the trunk of the tree. The size of the enclosure shall be increased for larger trees as directed by the Engineer.

All temporary fencing shall be constructed before site preparation work. Temporary fencing shall remain during the full construction period and be removed only when no longer needed or when deemed acceptable to the Engineer. Branches of trees that are to remain which interfere with construction shall be removed only when directed by the Engineer.

All trees damaged by construction operations shall be repaired or replaced depending upon the condition and extent of damage and as approved by the Engineer. Trees to be replaced due to damage caused by construction operations shall be replaced with trees of similar size and species. Cost for tree replacement shall be determined in accordance with the Tree Evaluation Formula as described in "A Guide to the Professional Evaluation of Landscape Trees, Specimen Shrubs and Evergreens", published by the International Society of Arboriculture. Repair and replacement of trees scheduled to remain which are damaged by construction operations shall be at the Contractor's expense.

## **1002 Earthwork**

### **1002.01 Topsoil Fill**

Topsoil shall consist of fertile, friable soil of loamy character and shall contain an amount of organic matter normal to the region. Topsoil shall be free of subsoil, heavy or stiff clay, stones, rocks, gravel, weeds, brush, litter, refuse and other extraneous materials. Topsoil shall not be infested with noxious animal life or toxic substances and shall be obtained from well-drained, arable land and shall be of even texture.

Topsoil shall be obtained from sources within the project as directed by the Engineer or shall be imported if required by the Special Provisions. Topsoil shall be obtained from sources within the project as directed by the Engineer or shall be imported if required by the Special Provisions.

Topsoil shall not be worked when it is so wet or so dry as to cause excessive compaction or the forming of hard clods or dust.

Topsoil shall be spread at the rate shown on the plans or as specified in the Special Provisions.

### **1002.02 Grading and Cultivating**

Subsoil in planting areas shall be spread in rough contours to a depth of 3 inches and shall be free of weeds and extraneous material prior to spreading topsoil.

Prior to planting, the soil shall be graded, cultivated or raked as required to obtain a uniform, smooth, fine-textured surface.

Areas having slopes steeper than 2:1 shall not be cultivated, but any weeds thereon shall be cut to stubble 2 inches maximum in height.

Finished surfaces of planting areas adjacent to curbs or pavements shall be graded 1 inch below curb or pavement elevations.

### **1002.03 Erosion Control**

Erosion Control shall consist in general of furnishing erosion control materials; preparing slopes and planting areas; applying and incorporating straw; applying fertilizer, seed, fiber, and stabilizing emulsion; and planting the areas as shown on the plans or designated in the Special Provisions.

Topsoil preparation shall be in accordance with Section 1002.01.

Erosion Control work shall consist of applying straw, seed and fertilizer; or erosion control work shall consist of hydroseeding as specified in Section 1002.09.

Preparation shall include all work required to make ready the areas for erosion control materials including the cultivation necessary to incorporate straw. Areas to receive straw application shall be prepared such that the straw will be incorporated into the soil to the degree specified in the Special Provisions.

Topsoil shall be spread uniformly at the rate shown on the plans or noted in the Special Provisions and cultivated if necessary to a sufficient depth to break up compaction resulting from spreading operations. Cultivation shall not be performed until all other equipment operations are complete.

Debris and rocks brought to the surface during cultivation shall be removed and disposed of outside of the project limits at the Contractor's expense.

### **1002.04 Straw**

Straw shall be derived from wheat, oats, or barley. Straw which has been used for stable bedding shall not be used.

Straw shall be spread uniformly at the rates shown on the plans or specified in the Special Provisions.

Straw may be applied pneumatically, weather permitting. Straw shall be applied with a roller equipped with straight studs placed and staggered approximately eight inches apart and made of approximately seven-eighth inch steel plate. Length of studs shall not exceed six inches, and studs shall be rounded. Weight of roller shall be sufficient to incorporate straw into soil so as not to support combustion.

**1002.05 Fiber**

Fiber shall be produced from non-recycled wood such as wood chips or similar wood material and shall not be produced from paper, cardboard, sawdust, or other such products nor may it contain any toxins. Fiber shall be of such character that the fiber, when mixed with water, will be dispersed in a uniform slurry. Water content of fiber prior to mixing with water shall not exceed 15% of the dry weight of the fiber. Commercially packaged fiber shall have the moisture content of the fiber marked on the package. Fiber shall be colored to contrast with the area to which it is to be applied. Color shall be non-toxic to plant or animal life and shall not stain concrete, masonry or painted surfaces.

**1002.06 Seed**

Seed requiring labeling under the California Food and Agriculture Code shall be labeled in compliance with said codes.

Prior to seeding the Contractor shall furnish written evidence to the Engineer that seed not requiring labeling under the above mentioned code conforms to the germination requirements and purity as designated on the plans or specified in the Special Provisions. If seed conforming to the specified purity and germination requirements is not available, seed with less than specified purity and germination requirements may be substituted. Application rates for such seed shall be increased to attain such requirements and any additional seed required shall be furnished and applied at the Contractor's expense. Prior to seeding, see type and rates shall be subject to the approval of the Engineer.

Seed treated with mercury compounds shall not be used. All legume seed shall be pellet-inoculated with a viable bacteria compatible for use with the particular seed variety. Such seed shall be labeled to show date of inoculation, seed weight, and source of inoculant. Inoculation process shall conform to standards provided in Bulletin AXT-280 "Pellet Inoculation of Legume Seed", of the University of California Agriculture Extension Service with the exception that inoculation materials shall be added at five times the rate as recommended on the inoculant package.

**1002.07 Stabilizing Emulsion**

Stabilizing emulsion shall be of a liquid chemical type forming a plastic film upon drying while allowing air and water penetration. Material shall be nonflammable and have an effective life of one year.

Stabilizing emulsion shall be capable of being mixed with water at the time of application to plant and animal life and non-staining to concrete, masonry, wood, and painted surfaces. Material shall be registered and licensed with the State of California, Department of Food and Agriculture.

**1002.08 Commercial Fertilizer**

Commercial Fertilizer to be applied during erosion control operations shall be in pelleted or granular form and shall be applied at the rates as specified on the plans or in the Special Provisions. Fertilizer shall contain a minimum guaranteed chemical analysis of 16% nitrogen and twenty percent phosphoric acid.

**1002.09 Hydroseeding**

Hydroseeding shall consist of mixing and applying er and water with a mixture of seed, commercial fertilizer and stabilizing emulsion or any combination thereof at rates specified on the plans or in the Special Provisions. Materials shall be mixed in a tank equipped with a continuous agitation system to achieve a homogeneous mixture and with a discharge system capable of applying the mixture at a uniform rate.

Any mixture containing a stabilizing emulsion shall not be applied when the soil temperatures are below 45°F or during rainy weather. Care shall be taken so that equipment or pedestrians are not permitted in areas to which the stabilizing emulsion has been applied. Any material determined by the Engineer to be considered harmful shall not be used.

**1002.10 Payment**

Erosion control satisfactorily furnished and placed as specified shall be paid for as specified in the Special Provisions. When erosion control is specified to be paid for at the price bid per square foot, the area to be paid for shall be the actual area of sloped ground surface which the material covers.



## 1003 Sewerage and Drainage

Sewerage and drainage consists of all structures for the transportation of waste and water from the site and the construction of such structures on the site including the connections to the existing storm drain and sewage lines. All runoff and sewage shall be taken off the site by means detailed in 3 of these Standard Specifications. The Contractor shall do all excavating of pavement and earth materials, shall construct sheet piling and lagging as set forth in 7 of these Standard Specifications and shall supply all the materials, work and knowledge of the applicable laws and specifications necessary for the satisfactory completion of the required sewerage and drainage work. Work shall be based on the plans, Special Provisions, and these Standard Specifications.

The Contractor, in accordance with the requirements of Sections 703, 707, and 109, shall do all backfilling and restore all pavements and related improvements removed, destroyed, damaged or undermined as a result of his operations.

## 1004 Paving

Paving consists of performing all work and furnishing and installing all materials required to attain the surface at the grade, color, texture and physical dimensions described in the plans and Special Provisions. Excavation and preparation of the subgrade and the compaction thereof shall be done as described in Part 7 of these Standard Specifications. The paving construction shall conform to Part 2, and Section 418 of these Standard Specifications. Any special jointing, surfaces, patterns or techniques shall be constructed as described in the Special Provisions. The Contractor shall supply all materials, work and knowledge of the applicable laws and specifications necessary for the satisfactory completion of the required paving work.

## **1005 Structures**

### **1005.01 General**

This work consists of all work and materials required to erect and complete all landscape structures and surfaces to said structures as described in the plans and Special Provisions. Excavation and preparation of the subgrade and any needed compaction thereof is to be performed as described in Part 7 of the Standard Specifications. Structures shall be in conformance with the applicable portions of Sections 411, 412, 413, 414, 415, and 416 of these Standard Specifications. Any special details, methods and designs shall be constructed as described in the Special Provisions. The Contractor shall supply all materials, work and knowledge of the applicable laws and specifications necessary for the satisfactory completion of the required construction work.

### **1005.02 Wood Treatment**

All lumber and timber to be used in Landscape Work shall be treated with nontoxic elements, including wood used for decks, fences, trellises, retaining walls, pathways, furniture, containers, and play structures. All treated surfaces shall conform to the Health and Safety Code of California, SB 946, and the Federal Specification TT-W-571 and shall bear a stamp from a certified quality control inspection agency assuring that the wood has been treated to the specification noted above.

All cutting, adzing, boring, chamfering, gaining, mortising, and surfacing shall be done prior to treatment. Fire retardant treated wood shall meet the requirements for the specific use intended, as mentioned above and conform to the Building Code, Part II, Chapter I, of the San Francisco Municipal Code. The Contractor shall acquire knowledge of all applicable laws and specifications necessary for the satisfactory and safe use and implementation of treated lumber and use as mentioned in the plans, Special Provisions, and these Standard Specifications.

## 1006 Irrigation Work

### 1006.01 General

The Contractor shall furnish, install and test irrigation facilities as shown on the plans and specified in these Standard Specifications and the Special Provisions. Irrigation plans are diagrammatic and correct for general design only; exact locations and dimensions shall be verified at the job site by the Contractor in the presence of the Engineer. The Contractor shall be responsible for laying out irrigation facilities so that coverage is complete and adequate. The Contractor shall do all related and Incidental Work, including connections to water and electrical supplies, excavation, backfill, and restoration of all disturbed planting areas, as well as supply all labor and materials, including those not specifically mentioned, for the complete installation and proper operation of the new irrigation system.

The Contractor shall be responsible for repair of damage to any property, facility, or work resulting from installation of the irrigation system or from leaks in the system, caused by the Contractor.

### 1006.02 Water Meters and Service

General. - The City will make all necessary arrangements for the installation of water meters at the locations shown on the plans. The installation of the meters, including service piping and connection thereof to City water mains, will be accomplished by the City and costs thereof will be solely the responsibility of the City. The Contractor shall cooperate, and coordinate his work, with the San Francisco Water Department as necessary.

Existing Water Meters and Service. - The Contractor shall make a complete downstream piping connection to each existing water meter.

### 1006.03 Existing Irrigation Systems

General. - Existing irrigation systems are to be kept operational during construction. When it is necessary to deactivate existing systems or portions thereof the Contractor shall coordinate such deactivation with the gardener so as not to unduly hamper his maintenance work. Any damage to existing systems resulting from the Contractor's work shall be repaired promptly by the Contractor at no cost to the City.

Existing Irrigation Systems to Remain in Service. - The Contractor shall maintain the existing irrigation system completely operable, all to the satisfaction of the Engineer.

It shall be the responsibility of the Contractor to locate and ascertain the extent of the existing irrigation system affected by the new irrigation system to be installed and the Contractor shall support, work around, protect, and relocate such facilities, as required.

Existing Irrigation Systems to be Abandoned. - When the Special Provisions require that existing irrigation facilities be abandoned upon completion of the new work, the following shall apply:

All underground piping shall be abandoned in place; all piping on or above grade shall be removed to a depth of 16-inches and disposed of by the Contractor. All brass goods, quick coupling valves, box hydrants, and usable equipment shall be salvaged.

Equipment to be Salvaged. - All existing equipment specified to be salvaged shall remain the property of the City. The Contractor shall disconnect and remove all such items, package and deliver them to the Recreation & Park Maintenance Yard in Golden Gate Park at Bowling Green Drive and South Drive, Phone: 415-558-4431; or Bureau of Street Cleaning and Urban Forestry at 2323 Army Street, Phone: 415-695-2017, as directed by the Engineer. Arrangements shall be made prior to delivery of the salvaged equipment.

### 1006.04 Drawings, Data and Instructions

General. - The Contractor shall submit drawings, data, instructions, etc.; for all material, equipment, systems, etc., required by the Special Provisions.

Mechanical submittals are required as follows:

- (1) Pipe
- (2) Fittings and Solvent
- (3) Gate Valves and Check Valves
- (4) Valve Boxes
- (5) Sprinklers and spray heads
- (6) Remote Control Valves
- (7) Quick-Coupling Valves
- (8) Backflow Preventers
- (9) Pumps
- (10) Others - as specified in Special Provisions

Electrical submittals are required as follows:

- (1) Irrigation Controllers
- (2) Wiring
- (3) PVC Conduits
- (4) Pull Boxes

New facilities shall not be installed before the Engineer has received and has on hand, approved "shop drawings", and related literature for all the material and equipment the Contractor intends to furnish and install.

Record Drawings. - The Contractor shall provide and keep up to date a complete "As-Built" record of black line prints for each subcontractor's work such as plumbing, electrical, etc. These prints shall show every change from the approved drawings and specifications and the exact "As-Built" location, size and type of every valve fixture, run of pipe, wire and conduit. Prints for this purpose may be obtained from the City. The job set of these drawings shall be kept on the job site and be used only as a record set. On completion of the work, the record set shall be turned over to the Engineer.

Valve Location Records. - The Contractor, with the aid of the Engineer shall locate exactly in the field and record locations on contract plans all shutoff and remote control valves installed below grade. These locations shall be established using triangulation techniques giving distances from two adjacent sprinklers to each valve or; other similar method as approved by the Engineer that will allow maintenance personnel to accurately and easily locate all valves. The Contractor shall deliver the valve location record sheets to the Engineer upon completion of the work.

### 1006.05 Pipe and Fittings

General. - Pipe and fittings shall be as specified in these Standard Specifications and the Special Provisions. All pipe and fittings shall be continuously and permanently marked with manufacturer's name or trademark, kind and Internal Pipe Size (IPS) of pipe, material, manufacturer's lot number, schedule or type and National Sanitation Foundation's (NSF) seal of approval. All piping under constant pressure shall be galvanized steel. Installation shall be in strict accordance with the manufacturer's instructions.

Ductile Iron Pipe and Fittings. - Ductile iron pipe shall be push-on joint type, cement-lined, Class 51, and shall conform to ANSI A21.51; fittings shall be push-on joint, ANSI A21.10, complete with necessary adapters to make connections to galvanized steel pipe.

Steel Pipe and Fittings. - Steel pipe and couplings shall conform to the "specifications of ASTM Designation: A 120, standard weight, galvanized. Fittings, except for couplings, shall be galvanized malleable iron, banded and threaded, conforming to ANSI standard: B16.3, 150 pound class.

Polyvinyl Chloride (PVC) Pipe and Fittings. - All PVC pipe shall meet the requirements ASTM 1785. All PVC pipe shall be pressure rated, Type I, Grade I, solvent-weld or push-on joint type and shall be in accordance with ASTM D 1784 and D 2241. Push-on joint pipe shall also meet the requirements of ASTM D 3139.

PVC lateral outlets for sprinklers shall be made with PVC tees or polypropylene split saddles. The top half of the saddle body shall have an integral positioning neck and an iron pipe tap outlet with a stainless steel reinforcing cap, sized to suit the runout piping. An o-ring gasket, bonded in place under the boss section, shall provide a positive seal. The split halves of the saddle body shall be assembled with two stainless steel band clamps, adjusted to provide a positive hydraulic seal without deforming the PVC piping.

Fittings shall be rated at the same pressure requirements as the pipe and shall be furnished by the pipe manufacturer. Material shall be Type I, Schedule 40 PVC as per ASTM D-2466 for socket fittings; Schedule 80 per ASTM D-2464 for threaded fittings. Sockets shall be tapered conforming to the outside diameter of the pipe, as recommended by the pipe manufacturer.

Schedule 80 PVC threaded adapter shall be used in transition between threaded and socket welded piping.

Joint connections shall be made with ring gaskets supplied by the pipe manufacturer.

Minimum length of PVC nipples shall be 3 inches.

45° fittings shall be used at all changes in depth of pipe.

Couplings shall be of the same material and wall thickness as the pipe used. On PVC to metallic connections, the metallic connections shall be made up first. Teflon tape shall be applied to all threaded PVC to metallic connections and light wrench pressure is all that should be used. Connections between straight lengths of steel pipe and PVC pipe shall be made with straight couplings.

PVC Pipe Handling. - The Contractor shall use care in handling, loading and storing pipe to avoid damage. Pipe and fittings shall be stored under cover and protected from sunlight before using, and transported in a vehicle with a bed long enough to allow the length of Pipe to lay flat, so as not to be subjected to undue bending or concentrated external load at any point. Any pipe that has been dented or damaged will not be accepted.

Joining Pipe by Solvent Weld. - Pipe shall be cut square, and connecting surfaces shall be cleaned, and dried. All burrs shall be removed inside and outside of pipe ends. Outside of pipe ends shall be chamfered before assembly. Make up of joints shall be accomplished in accordance with the pipe and fitting manufacturer's directions.

Pipe in Common Trench. - Parallel runs of piping, in a common trench, shall be laid on a horizontal plane with 2-inch clear minimum separation. Crossovers shall be accomplished by means of 45° or 90° fittings so as to cause no undue "flexing" of pipe runs.

Pipe Installation. - PVC Pipe up to and including 3 inches in size may be installed by a suitable trenchless technique (pulled in) where possible. Open trench installation shall be used where soil conditions

are unsuitable for pulling or where terrain dictates. No loss of warranty due to installation technique will be allowed.

Pipe Installation, Trenchless Method. - Existing lines shall be located with a suitable metal detector by the Contractor prior to pulling lines. Lines shall be assembled solvent welded. Fittings for sprinklers and valve connections, etc., shall be installed after pipe is in the ground. Lines to be “pulled” in shall be assembled no less than sixteen hours before “pulling”. When pulling line, the pulling blade shall be stopped before hitting each existing line, retracted, the existing line exposed, the materials repositioned for the pull to be continued. Installed lines shall have a minimum cover of 15 inches.

Pipe Installation by Trenching Method. - Trench depth shall allow a minimum of fifteen inches from the surface to the top of the pipe. The bottom of the trench shall be free of rocks, clods and other sharp edged objects, sand shall be added to cover any sharp objects. Pipe shall be lowered into the open trench after it is assembled on the surface. A firm, uniform bearing for the entire length of each pipe line shall be provided to prevent uneven settlement. The pipe shall be snaked from side to side of the trench bottom to allow for expansion and contraction. One additional foot of pipe is the minimum allowance for snaking. PVC pipe shall not be placed when there is water in the trench or when the temperature is 32° F or below. Solvent-weld joints shall be given fifteen minutes minimum set-up time for curing before pipe is moved. Backfill shall be compacted to ninety percent relative compaction. Backfill material shall be as recommended by the pipe manufacturer.

Thrust Blocks. - Concrete thrust blocks shall be provided for all unrestrained (push-on) piping at all changes in direction, change in size, and at dead ends, and shall be of sufficient size to safely withstand thrusts due to 150 psi internal pipe pressure. Thrust blocks shall be not less than one (1) cubic foot in volume. Concrete shall be class 6-3000-3/4.

Unions. - Unions shall be 150-lb malleable iron, ground joint, brass-to-iron seat and shall be installed adjacent to all screwed valves which do not have integral union connections in order to facilitate removal of the valves.

## 1006.06 Control Valves

Control valves shall be normally closed, diaphragm type and slow-closing. Control valves shall be actuated by a solenoid, which is rated 24 VAC, is integral to the valve and is completely molded in epoxy and encased in a moisture-proof housing.

The valve body shall be of straight or angle globe pattern, made of bronze, cast iron or brass construction, and have threaded connections. All internal valve components shall be removable for maintenance without removing valve body from the system piping.

Flow control mechanism shall be designed for both automatic and manual operation of the valve. The valve shall operate when dirt and sand are in the irrigation water. The valve shall be self-flushing and self-cleaning without the use filters or screens.

Control valves shall be in regular production and marketed for at least five years. Flow coefficient ( $C_v$ ) shall not be less than the following values for the valve sizes indicated:

Valve Size	$C_{v, \text{ min.}}$
1" . . . . .	13.5
1 <sup>1</sup> / <sub>4</sub> " . . . .	16.6
1 <sup>1</sup> / <sub>2</sub> " . . . .	26
2" . . . . .	52
2 <sup>1</sup> / <sub>2</sub> " . . . .	65

## 1006.07 Valve Boxes

Valve boxes shall be of reinforced concrete or fiberglass reinforced polyester premix with one piece covers marked “WATER” in cast-in letters not less than one inch high. Valve box covers shall weigh less than 35

pounds. Valve boxes shall be installed with all required extensions. Valve boxes shall have a locking feature so as to minimize or prevent vandalism.

### **1006.08 Gate Valves**

Gate valves shall be as specified on the plans or in the Special Provisions; shall be flanged, threaded or ring type; shall have an iron or bronze body, with non-rising stem; and shall withstand a cold water working pressure of 200 pounds per square inch. All threaded type valves, except gate valves for backflow preventers, shall be provided with a union on each side of the valve.

### **1006.09 Quick-Coupling Valves**

Quick-coupling valves shall be brass or bronze, 1" IPS, two-piece valve, single slot, white vinyl cover with lock top.

### **1006.10 Strainers**

Strainer shall have a Y-Pattern cast iron or bronze body with a removable No. 20 mesh stainless steel or monel screen. The screen element shall be rolled into the shape of a cylinder and the ends shall be reinforced. The connection may be screwed or flanged but the working pressure shall be at least 125 pounds. If the Contractor chooses to use screwed connections, then there shall be unions in all connecting pipes to allow removal of the strainer. The size shall be the same as the connected piping, disregarding the diameter of the blow-off pipe.

Strainers shall be equipped with a hose bib. Hose bibs shall be threaded or flanged and of the same size as the blow-off outlets of the strainers.

### **1006.11 Backflow Preventers with Pads and Enclosures**

Reduced-Pressure Backflow Preventer. - Each reduced-pressure backflow preventer shall have two independently acting spring-loaded check valves with an automatically operating pressure differential relief valve located between the two check valves; two gate valves with non-rising stem, one located at each end of the unit; and four properly located test cocks. A protective reduced-pressure zone shall be maintained between the two check valves against backpressure and back siphonage. All parts shall be removable and replaceable without disassembling the whole unit from the line. Pressure loss across each 2-inch unit shall not be more than 7.5 psi at 120 GPM. Working pressure rating shall be 150 psi. Each unit shall meet the specifications of AWWA, International Association of Plumbing Mechanical Officials (IAPMO), and the University of Southern California (USC) Foundation for Cross Connection Control.

Tests shall be conducted by the Contractor on each backflow preventer in accordance with the manufacturer's literature to assure the proper function of the two check valves and the pressure-relief valve, and to verify a minimum 2 psi differential pressure between the inlet pressure and the pressure between the two check valves, at which the pressure-relief valve shall remain open.

The Contractor shall obtain, at no extra cost to the City, the services of a certified backflow preventer device tester to inspect and check all installed reduced-pressure backflow preventers for proper installation and operation; all in compliance with applicable health codes and backflow prevention device standards. A written certification by the certified tester for each inspected reduced pressure backflow preventer shall be forwarded to the City by the Contractor.

Enclosures. - The Contractor shall furnish and install Type "A" chain-link enclosures set on concrete pads, where and as shown on the plans, and in accordance with Section 803 of these Standard Specifications.

### **1006.12 Pumps**

Pumps shall conform to requirements in the Special Provisions and as shown on the plans.

Pumps shall be bronze-fitted, single-stage, close-coupled uni-type, centrifugal pumps. Pumps shall be so constructed so that the motor and rotating parts can be removed without disturbing the volute case or the



pipng. Pumps shall be furnished with a heavy cast iron base. The entire pump assembly shall have a shop applied baked enamel epoxy finish.

### 1006.13 Sprinklers

General. - The sprinklers shall conform to the requirements in the Special Provisions and as shown on the plans and as set forth in these Standard Specifications. All sprinklers shall be set perpendicular to finish grade.

#### Rotary Pop-Up Sprinklers.

Materials of construction - All Rotary pop-up sprinkler parts subjected to mower induced loads including but not limited to nozzles, nozzle holder, and outer housing shall consist of suitable metal in adequate thickness to carry such loads without damage resulting in sprinkler breakdown.

Vandalism requirements - Rotary pop-up sprinklers shall have no easily removable fasteners, no small easily removable parts which are exposed at rest or during operation, and no easily changed operating adjustments, and shall pass destructive tests which include forced turning of nozzle assembly, and steady and shock loads in vertical and horizontal directions on exposed parts both at rest and during operation.

Note: Impact arm devices have been found to be too easily jammed and will not meet City vandalism requirements

Rotary pop-up sprinklers shall have vandal-resistant fasteners as approved by the City for securing the sprinkler covers.

Anti-drainage valves - Rotary pop-up sprinklers shall be provided with anti-drainage valves to prevent drainage on grades, where a sprinkler is installed 3 feet or more below the highest common outlet. Anti-drainage valves shall be installed with triple swing joint assembly and shall match thread diameter of sprinkler inlet. The anti-drainage valves shall have less than 2.0 psi loss at rated sprinkler flow.

Manufacturer's warranty - The nozzles, nozzle holder and outer housing of these products shall be guaranteed for a period of 7 years to be free of field breakage or defects in workmanship or material. The manufacturer shall repair or replace any of these parts without charge, provided equipment has been installed and used in accordance with the manufacturer's instructions and is returned to the manufacturer at the expense of the City. This guarantee shall be absolute and shall not be prorated.

The gear train of these products shall be guaranteed for a period of 7 years to be free of defects in workmanship or material. The manufacturer shall repair or replace any part of the gear train developing defects within the guaranteed period without charge provided it has been installed and used in accordance with the manufacturer's instructions and is returned to the manufacturer at the expense of the City. This guarantee shall be absolute and shall not be prorated.

Construction details - Rotary pop-up sprinklers shall have the nozzles and internal drive mechanisms readily accessible without removing the sprinkler housing from the ground. Each sprinkler shall be supplied with rubber cap and sprinkler cover.

Production History - The sprinklers shall have been in regular production for at least 7 years unless otherwise specified.

Performance requirements - Full circle and part circle rotary pop-up sprinklers shall meet the following performance criteria:

Operating pressure (psig) . . . . .	30 to 50		40 to 55
Flow rate (gpm) $\pm 10\%$ . . . . .	9.8 to 12	OR	13 to 15.7
Minimum spacing	50 ft.		58 ft.

Uniformity criteria at square spacing with up to 3 mph wind shall be as follows:

Christiansen coefficient of uniformity ( $C_u$ ) of 92 or more, and

<u>Max. area involved</u>	<u>Variation from mean precipitation rate</u>
0%	less than 50%, greater than 150%
2%	less than 60%, greater than 140%
4%	less than 70%, greater than 130%

Performance requirements for low-pressure rotary pop-up sprinklers - Sprinklers specified on the plans as low-pressure rotary pop-up sprinklers shall have been in regular production for at least two years and meet the following performance criteria:

- 1) Minimum coverage of 35 to 38 ft radius at a base pressure of 20 to 30 psi.
- 2) Rate of discharge 3.9 to 5.0 gpm.

#### **1006.14 Triple Swing Joint Assemblies**

Each triple swing joint assembly shall be made out of PVC and have a 6-inch nipple of schedule 80 PVC. On swing-ell shall be affixed together and affixed to the nipple. A swing-ell is a street ell constructed so that the male threaded portion may be freely turned independently of the ell. To prevent leakage between male threaded portion and the body, two Buna-N O-rings shall be used. The assembly shall have a factory three year warranty and shall be rated for 150 psig working pressure.

#### **1006.15 Testing of Irrigation Facilities**

The Contractor shall flush and test all irrigation piping furnished and installed under the contract prior to the backfilling of pipe trenches and installation of the sprinklers and valves. The piping may be flushed and tested in sections as approved by the Engineer.

Each piping system shall be flushed clean with water and then tested at a hydrostatic pressure of 100 psig for a period of one hour. All detectable leaks, regardless of amount of leakage shall be corrected.

After completion of a satisfactory test for each piping system the Contractor shall install the sprinklers and quick-coupling valves, and make all necessary adjustments for proper sprinkler coverage, all to the satisfaction of the Engineer.

The Contractor shall furnish all labor, material, equipment and tools for flushing, testing and adjusting of the entire irrigation system. All flushing, testing and adjusting shall be done in the presence of the Engineer.

The Contractor shall not backfill or cover any of his work until it has been inspected, tested and approved by the Engineer. If any part of the irrigation system is found to be at fault and if coverage is found to be inadequate, the Contractor shall make all restoration and repairs so that the system will be in order. At final inspection, the system shall be thoroughly clean and operable and meet the requirements set forth in the plans, the Special Provisions and these Standard Specifications.

#### **1006.16 Additional Irrigation Work not Shown on Plans**

The Engineer will determine at any time during the course of the work under this contract the extent or amount of additional irrigation work required, if any.

Payment for additional irrigation work, satisfactorily done, complete in place, as specified, will be made at the respective unit price bid therefor, as set forth in the Schedule of Bid Prices in the Proposal.

If there is no unit price Bid Item or Items for irrigation work in the Schedule of Bid Prices, then such additional irrigation work, if authorized by the Engineer, will be done as Extra Work.

## 1007 Planting

### 1007.01 General

The work covered under this Section is considered specialty work and the Contractor must have a California License in Class C-27 or he must employ as a sub-contractor a person or persons holding such license. Only experienced landscape Contractors shall handle, plant, trim, prune or water nursery stock.

As set forth in Section 105.01, the Contractor shall keep himself informed of and shall comply with the laws and regulations applicable to the work, particularly those laws related to the transportation and shipment of plants and materials. Certification of inspection of nursery stock shall be provided as required by Federal, State and local laws.

Planting shall be done only during weather that is favorable for the particular type of planting operation and plant involved. The Contractor shall supply at his sole expense all water hose and other equipment as required to properly maintain the nursery stock for the duration of the contract. Names, quantities and sizes of plants shall be as set forth in the Plant list on the drawing.

The Contractor shall prepare the site for planting by:

- A) clearing the areas of weeds, roots, debris, rocks and underground obstructions to an acceptable planting depth prior to placing imported material and/or prepared backfill mix;
- B) treating the soil with a selective pre-emergence herbicide, so as to eliminate weeds or other undesirable plants;
- C) providing proper moisture for optimum planting conditions;
- D) cultivating, raking and rolling areas before planting.

The Contractor shall furnish and install all plants and materials, including imported soils, herbicide fertilizers, stakes, ties, straps and other accessories not called out but required to complete the work as intended.

### 1007.02 Soil Sterilization

Application of a soil sterilizing, or selective pre-emergence herbicide agent to the area or material shall be in strict accordance with the recommendations of the manufacturer. The Contractor, by instituting all precautions necessitated by the type of chemical agent and its application, shall prevent any contact of the agent occasioned by wind or otherwise with persons or animals or with existing planting on private property or otherwise not specifically intended to be destroyed. Any such planting destroyed or damaged shall be replaced at the sole expense of the Contractor with healthy planting of the type and at the stage of growth identical to that being replaced. Soil sterilizer or weed killer shall be an approved type which will permit planting and not inhibit normal growth of the nursery stock planted three weeks after application. Compounds containing cyanide or arsenic will not be acceptable.

### 1007.03 Imported Soil

The Contractor shall furnish and place imported soil in the planting areas indicated on the plans. The soil to be imported shall conform to the following standards:

- 1) Particle size distribution;
  - Minimum 95% passing a 25.4 mm screen;
  - Minimum 85% passing a 9.5 mm screen;
  - Fraction passing a 9.5 mm screen shall contain 15% min and 40% max total silt and clay.
- 2) Agricultural suitability;
  - Salinity (EC X10) less than 4.0 at 25° Centigrade;

Sodium absorption ratio (SAR) less than ten;  
Boron in saturation extract less than 1.0 ppm;  
pH (soil reaction) 6.0-7.5

3) Pests;

The population of any single species of plant pathogenic nematode less than 500 per pint of soil.

The Contractor shall make the site of his soil source known to the Engineer two weeks minimum prior to the date he proposes to do hauling and placing of soil. The Engineer will inspect the site, collect samples of the soil, and deliver the samples to an accredited soils laboratory for analysis and report. The Contractor shall pay all costs for the required analysis and reports. Upon receipt of the analysis and report from the laboratory indicating compliance with the standards set forth in the Specifications, the Engineer will notify the Contractor that he may proceed with the importation of soil. No importation of soil shall be done prior to notification to the Contractor by the Engineer. Only approved soil shall be used for the entire project and substitutes will not be acceptable.

Imported soil shall be delivered to the site in a reasonably dry and workable condition; it shall not be muddy or wet. Imported soil shall be placed and spread to the lines and grades shown on the plans and as directed by the Engineer. Any extraneous or unacceptable materials not previously removed shall be raked off and removed from the site at the time of spreading. Imported soil shall be compacted to a uniform specified depth as shown on the plans or directed by the Engineer.

The character of the imported soil shall conform to the character of the existing soil so that the final product in:

- a) Lawn areas shall be a coarse, sandy loam with optimum drainage characteristics. The soil type in lawn areas shall be free of imported soil amendments. Optimum imported soil types shall include; Banks sand, Dillon Beach, Orly #2, Presidio Shoal or Lapis.
- b) Ground cover, shrub or areas other than lawn areas shall be a coarse sandy loam with optimum drainage characteristics similar to the types listed above with a ten to 25% addition of soil amendment.

#### **1007.04 Soil Amendment**

Soil amendment shall be fresh raw fir or pine bark and consist of 99% bark and less than 1% wood; fine grind, 1/8 to 0 inch particle size, contain a minimum of 92% organic matter on a dry weight basis with a dry bulk density of 450-580 lbs. per cubic yard. Salinity shall not measure over 4.0 millimhos per centimeter at 25 degrees Centigrade as measured by saturation. It shall be stabilized with 0.8-1.2% nitrogen, 0.08% iron and a non toxic biodegradable wetting agent.

Samples of soil amendment and source of supply shall be submitted to the Engineer for testing and approval prior to delivery to the site. Only approved amendment and source of supply shall be utilized, and no substitutions will be accepted.

#### **1007.05 Prepared Soil**

Prepared soil or backfill mix shall consist of, by volume, two thirds imported soil and one third soil amendment. The prepared soil shall be mixed on the site and no more shall be mixed than can be used in one day. It shall be thoroughly mixed and turned over four times minimum with a shovel to assure a good mixture.

#### **1007.06 Fertilizers**

Commercial fertilizers shall be pelleted in form and shall be of the following formula: 6% nitrogen, 9% phosphoric acid, and 6% potash. Fertilizer planting tablets shall be composed of slow release fertilizers compressed into tablets of twenty one gram weight and specifically designed for root zone placement. They shall be of the following formula: 20% nitrogen, 10% phosphoric acid, and 5% potash. All fertilizers shall be brought to the job site in the manufacturer's unopened containers and shall carry labels stating manufacturer's name, fertilizer weight and assurance that analysis has been made.

### 1007.07 Nursery Stock

Nursery stock shall be first class, representative of the normal species or variety, equal to, or exceeding the standards of the American Association of Nurserymen and applicable Federal and State Codes and of the size and caliber specified on the plans or in the Special Provisions. Only fresh, vigorous, healthy, full, bushy, not leggy, well-rooted, branched, shaped and established nursery stock, free from insects, disease, disfiguring knots, sun scald injuries, bark abrasions, or other disfigurements shall be furnished. Plants that become wilted anytime before planting will not be considered acceptable.

The soil level in 15 gallon and larger containers shall not be lower than 4 inches below the top of the container, 3 inches below the top of the container for the 5 gallon size, and 2 inches below the top of the container for the 1 gallon size. Ground cover plants shall be grown in flats and will be inspected at the nursery by the Engineer, and shall be delivered to the job site in the flats in which they were grown.

Nursery stock nomenclature is based on the American Joint Committee on Horticultural Nomenclature, or on names generally accepted in the nursery trade. Each plant shall be well formed, undamaged, not root bound and shall not have a deformed root system.

In 15 gallon containers, each tree trunk shall not have any limbs over  $\frac{1}{4}$  inch in diameter from ground level to a height of 6 feet. Such limbs shall be removed as directed by the Engineer. However, light growth along the tree trunk is desirable. Each tree shall have a dominant leader, untrimmed, unbroken and trained to a vertical position. Any tree having a weak crotch will be rejected. Due to plants' varied growing habits, any exceptions to the standards set forth here shall be approved by the Engineer prior to accepting any plants.

The Engineer will attach a tag to each tree, shrub and container of ground cover accepted for planting. Any plant not tagged will be considered as a reject and shall not be planted. At time of planting, a plant which has been tagged yet shows signs of neglect will be rejected. Each and every variety of nursery stock shall be identified by its botanical name, specie and variety printed on a hardwood tag which shall be fastened to the trunk of the tree, shrub or to the flat of ground cover. Identification tags shall be fastened to every tree and to 20% of the shrubs in each grouping of each variety throughout the project. Ground cover shall have one tag for each flat of each variety.

The Contractor shall notify the Engineer forty-eight hours in advance of the time the nursery stock is to be received at the site. All nursery stock shall be available for inspection at a nursery located within fifty measured road miles from San Francisco's City Hall. If not available within this area, all additional expenses for transportation, board and lodging resulting from the Engineer's inspection shall be borne by the Contractor.

### 1007.08 Planting Procedures for Plants in Containers

Planting pits for plants supplied in containers shall conform to the following minimum standards; a 1 gallon container shall be 12 inches wider and 6 inches deeper than the container size; a 5 gallon container shall be 16 inches wider and 9 inches deeper than the container size, and a 15 gallon container shall be 24 inches wider and 12 inches deeper than the container size. The soil in the planting pits shall be of optimum moisture content at the time of planting. Excessively wet or dry soil as well as unfavorable weather conditions shall be considered unacceptable transplanting conditions.

All containers shall be cut with tin snips or approved can cutters. An axe shall not be used.

When planting, the root balls shall be handled carefully so that they do not crack or fall apart. The Engineer may require light slashing of the sides and/or a crisscross across the bottom of the root ball to sever exposed roots growing in a circular manner.

All planting pits shall be backfilled with "prepared soil" as specified in Section 1007.05.

In planting, the plant root ball shall be placed high enough in the pit so that after due natural settling the top of the root ball soil is not more than one inch below the surface of the surrounding adjacent ground. This will be checked specifically during the premaintenance inspection. Adjustments shall be made by the Contractor to achieve the Specified positioning.

After the root ball is in position, more "prepared soil" shall be added and hand-tamped into place to bring the back fill up to grade.

When the backfill is approximately in place, fertilizer tablets shall be placed alongside and around the root ball according to the following schedule:

1 gallon plant .....	3 tablets
5 gallon plant .....	5 tablets
15 gallon plant .....	6 tablets
24 inch box .....	8 tablets
36 inch box .....	10 tablets
48 inch box .....	12 tablets
54 inch box .....	14 tablets

After planting, the Contractor shall build a six-inch high berm around the root ball forming a basin to facilitate watering. The berms shall be maintained throughout the planting and maintenance periods. No berms are required in grass areas.

All plants shall be watered immediately after planting. Trees shall be staked and tied immediately after planting.

### 1007.09 Tree Staking

Each tree shall be staked at the time of planting using stakes, tree straps and nails.

Each tree shall be double staked with two cross braces and two ties minimum. Cross bracing material shall be made of redwood or douglas fir construction grade wood with dimensions of one inch by three inches by the distance between the two stakes.

The position of the cross braces shall be determined for each tree according to the height and branching structure of the tree.

Stakes shall be positioned so as to miss the root ball completely. Stakes shall be made of douglas fir or redwood construction grade or lodgepole pine wood with dimensions of two inches by two inches by twelve feet long. Stakes shall be hardwood pointed at one end and treated after being pointed with copper naphthanate which shall penetrate the stake to a minimum of one-quarter inch depth. Four feet of the stake shall lie below grade level.

Each tree shall be secured to the cross braces using two straps (minimum) in a figure-eight tie. Tree ties shall be made of a durable corded rubber and of sufficient length so that they are semi-loose with approximately one-quarter inch clearance between the tree trunk and the strap. The straps shall be secured to the braces by nailing with eleven-gauge galvanized roofing nails placed at the center of the brace.

### 1007.10 Guying

Guying material shall consist of zinc coated number ten BWG guy wire connected with galvanizing turnbuckles, one per line. Plastic ribbon tie one inch wide with a minimum tensile strength of five hundred pounds shall be used to connect guy wire to tree branch.

A deadman stake two inches by four inches by two feet long or a three-quarter inch diameter by three feet long steel pipe shall be used to hold each guy wire in place. One-half inch polyethylene tubing painted white shall be used to cover guy wire.

For 24 inch and 36 inch boxes, a minimum of three guy wires shall be used. For 48 inch boxes and 54 inch boxes a minimum of four guy wires shall be used for safety.

### 1007.11 Ground Cover

Ground cover nursery stock and lawn and the planting thereof shall be in accordance with the applicable requirements of Section 1007.08.

Ground cover shall not be planted in an area until all trees and shrubs for that particular area have been planted and all surplus material removed.

Spacing of ground cover nursery stock shall be as indicated on the plans or specified in the Special Provisions.

Ice Plant (*Mesembryanthemum edule*) cuttings shall be planted one to a hole, or at one-foot centers, in rows one foot apart ground measurement. Plants in adjacent rows shall be staggered.

### 1007.12 Sequencing of Planting for Ground Cover Nursery Stock

Planting pits shall be excavated to the proper size and depth to accommodate root systems without cramping.

Each plant shall be centered in the pit in a plumb position, regardless of the slope of the ground.

The pit shall be backfilled with native soil material unless otherwise specified.

The soil shall be carefully tamped around the plant, taking care not to bruise the plant.

The area planted with ground cover plants shall be watered immediately after planting.

The soils shall be cultivated to a uniform grade between plants and commercial fertilizer shall be applied on the ground surface over the entire area at a rate of 15 pounds per 1000 square feet.

### 1007.13 Grass Seed

Each variety of seed shall be packed separately, delivered in good condition and clearly tagged as required by law showing the variety, purity, germination and weed content. The seed shall be delivered as specified and must be guaranteed to be as stated on the tags. The following mixture of grass seed shall be used unless otherwise stated in the Special Provisions, the plans or as directed by the Engineer:

<u>Name of Seed</u>	<u>Percent of Mix</u>
Perennial Rye	
Yorktown 2 .....	25%
Manhattan .....	25%
Hybrid Blue Grass	
A-24 .....	30%
Baron .....	20%

### 1007.14 Grass Seed Sampling and Testing

Determination of purity shall be made separately for each type of seed in the mixture. A minus tolerance of 0.2% in the specified purity of each type of seed will be allowed.

The following tolerances in germination will be allowed:

96 or over .....	5
90 or over, but less than 96 .....	6
80 or over, but less than 90 .....	7
70 or over, but less than 80 .....	8
60 or over, but less than 70 .....	9
Less than 60 .....	10

The Engineer will take a representative sample of each type of seed, seal the container and forward the sample to the State Department of Agriculture Seed Testing Division. The samples will be tested for purity, germination and weed content. The seals on the seed containers shall not be broken until the Engineer consents to same in writing. The Engineer may condemn any seed on which the seal has been broken prior to the time he consents to this action.

If the seed sample does not pass the specifications as determined by the tests made by the State Department of Agriculture, the Contractor shall immediately remove from the work the seed which did not meet specifications.

If it is in the City's best interest, the Engineer may allow the seed to be sampled and tested by an approved private laboratory but all fees and expenses connected therewith shall be paid by the Contractor.

### 1007.15 Lawn Planting

After the area is to receive lawn has been graded and cultivated, it shall be disced and cross-disced in two directions or rototilled, thoroughly pulverizing the surface.

Fertilizer shall be applied to indicated turf areas at a rate equal to one pound of actual nitrogen per one thousand square feet. Fertilizers shall be applied by mechanical rotary or drop soil to a depth of three inches. Areas inaccessible to power equipment shall be fertilized with hand tools and incorporated into the soil. The Contractor shall restore prepared areas to the specified condition prior to seeding if eroded, settled, or otherwise disturbed after fine grading.

Only skilled workmen will be allowed to sow the seed. The surface shall be raked lightly and the seed sown evenly by a mechanical seeder at the rate of one pound per one hundred square feet. Sowing shall be done only in calm weather and in the presence of the Engineer.

After the seed has been sown, the surface of the soil shall be raked very lightly, so that the germination is even throughout. After raking, the surface shall be rolled with a light roller to achieve an even surface free of humps and surface irregularities to facilitate mowing.

Immediately after completion of planting, the seeded area shall be watered with a fine spray to provide a one-inch depth of penetration into the soil. The top surface shall not be allowed to dry out at any time.

### **1007.16 Lawn Sod**

Lawn sod shall be at least ten months old and have a well developed root system firmly knitted together. The sod shall be free from weeds and shall be treated with a lawn moth control agent. Sod shall be delivered in one foot wide strips, five feet long and one and one-half inches thick. Sod shall be as specified in the Special Provisions or on the plans.

### **1007.17 Lawn Sod Planting**

Preparation for lawn sod planting shall be similar to that as required for lawn planting in Section 1007.15.

The Contractor shall lay sod to form a solid mass with tightly fitted joints. Ends and sides of sod strips shall be butted together and edges shall not be overlaid. Strips shall be staggered to offset joints in adjacent courses. All excess sod shall be removed to avoid smothering of adjacent grass. The top of the sod pad shall be flush with adjacent curbs, sidewalks, drains and seeded areas.

Sod shall not be installed on saturated soil. The initial row of sod shall be installed in a straight line beginning at the bottom of slopes, perpendicular to the direction of the sloped areas. Subsequent rows shall be placed parallel to and tightly against previously installed rows. Sod placed on slopes greater than three to one shall be pegged to prevent slippage. . Place two stakes per yard of sod.

Sod shall be thoroughly watered with a fine spray immediately after laying. Sod shall be rolled with a light lawn roller to ensure contact with subgrade.

### **1007.18 Street Tree and Median Planting**

All street tree and median planting shall be performed in accordance with the requirements of Section 1007.08, except as hereinafter specified. The Engineer shall be notified forty-eight hours prior to planting. In street tree planting, the tree's root ball shall be flush with the bottom edge of the bricks or precast covers in the sidewalk areas.

All plantings in center islands having an irrigation system, in areas not requiring slope stabilization or in removed sections of the sidewalk, shall be planted without basins or berms around the pits and shall not be mulched.

### **1007.19 Cutting Concrete and Asphalt Pavements**

Concrete and asphalt sidewalk and island pavement shall be cut along the edge of each tree pit with a concrete cutting saw, as specified in Section 701.03, to a depth of two inches to isolate the section of concrete or asphalt to be removed and to leave a clean-cut edge on the remaining sidewalk or pavement. Edges shall be cut parallel and perpendicular to the curb and shall be squared and true except for pits in traffic islands which shall be aligned as directed by the Engineer.



### **1007.20 Bricks of Precast Covers Set on Sand**

Bricks or precast covers set on a sand bed shall not be placed until the last days of the "Plant Establishment Period". The prepared backfill in the tree pits shall have settled and present a firm bed, as determined by the Engineer, before placing the sand bed. Bricks shall be burned solid clay masonry units, standard building bricks, brick-red colored, smooth-faced texture and shall conform to the requirements for Grade MW of ASTM "Standard Specifications for Building Brick (Solid Masonry Units from Clay or Shale)", Designation C62.

Prepared backfill in planting pits shall be regraded to receive the bricks or precast cover on the sand bed. The Contractor shall make certain that backfill is firmly packed under adjacent sidewalk and pavement and shall hand-tamp fill material under adjacent sidewalk and pavement if necessary at the same time the sand bed is placed. A two inch layer of clear river sand shall be placed over the prepared backfill to form a firm setting bed for the bricks or precast cover. The top surface of the bricks or precast cover shall be flush with the adjacent pavement surface.

After the bricks have been placed and full-joint mortared, clean sand shall be placed around the tree to about one-half inch below the surface of the bricks and the bricks shall be brushed clean. Any bricks that within a one year period tip, rock or settle, shall be removed and reset to finished grade in accordance with Section 105.10.

### **1007.21 Tree Guards**

Except for conifers, all trees planted in paved areas Shall have a tree guard constructed of  $\frac{3}{4}$  mesh, 16 gauge, 4 feet wide galvanized wire cloth, placed immediately around the tree. Each guard shall be securely fastened top and bottom to the inner side of the tree stakes with  $\frac{3}{4}$  inch galvanized staples. The guard shall be positioned with the joint at the inside of the stakes so that passers-by will not get snagged. The bottom edge of the tree guards shall be a maximum of 18 inches above the adjacent grade.

### **1007.22 Payment**

Imported soil satisfactorily furnished and placed as Specified shall be paid for as specified in the Special Provisions. When imported soil is specified to be paid for at the price bid per unit volume, the depth to be used in computing the volume shall be the depth measured normal to the slope of the natural grade with compacted soil in place, multiplied by the area measured along the surface of the finished grade. When imported soil is specified to be paid for at the price bid per unit area, the area shall be measured along the surface of the finished grade.

## **1008 Maintenance and Plant Establishment**

### **1008.01 General**

The Contractor, from the time of planting, shall maintain all nursery stock and other planting planted under the contract, shall do all work to establish the satisfactory growth of such planted nursery stock and other planting, shall maintain the entire of the areas landscaped under the contract, shall continue such maintenance throughout the “Plant Establishment Period”, and shall do all related and Incidental Work.

Maintenance shall include replacing any planted nursery stock or other planting which fails to establish normal healthy growth, as determined by the Engineer. Replacement with healthy stock shall be made immediately upon withering or failure to grow, or within forty-eight hours after notification by the Engineer; in addition, any replacements which fail to grow satisfactorily, as determined by the Engineer, shall be satisfactorily replaced by the Contractor; all at no additional cost to the City.

Maintenance shall also include keeping the landscaped areas free of weeds, rocks, debris and other deleterious material; maintaining and keeping plant irrigation basins and saucers properly formed; cultivating; restoring ground areas damaged by erosion or trespassing; doing all necessary watering including furnishing water and equipment for the use thereof; and doing all other work necessary, or required, for the satisfactory establishment of normal healthy growth of the planted nursery stock or other planting.

### **1008.02 Inspection**

After planting, the site will be periodically inspected by the Engineer. Should the Contractor, after written notification by the Engineer of any deficiency in the maintenance or necessity for replacement of plants, fail to remedy such deficiency or make such replacement, the Engineer may cause such deficiency to be remedied or replacement made and the cost thereof deducted from moneys due the Contractor. Should the best interest of the City require immediate remedy without the delay incident to such notification, remedial action, as necessary to alleviate the emergency will be taken and the cost thereof deducted from moneys due the Contractor.

### **1008.03 Pre-Maintenance Inspection and Approval**

The Contractor shall notify the Engineer in writing, at least one week prior to the completion of all planting and related work that all plant material, will at the time stated, be satisfactorily in place, weed free, and in satisfactory condition.

The Engineer will schedule and make arrangements for the planting inspection. Approval of the planting at this inspection signifies that the planting has been satisfactorily completed and the “Plant Establishment Period” may commence.

If the inspection reveals deficiencies in the planting, the Engineer will give the Contractor a list of deficiencies to be corrected by the Contractor before the “Plant Establishment Period” may commence.

If the inspection reveals deficiencies in the planting, the Engineer will give the Contractor a list of deficiencies to be corrected by the Contractor before the “Plant Establishment Period” may begin. The Contractor shall correct the deficiencies, request a second inspection to verify that the corrections have been made, and if so verified, the Engineer will notify the Contractor to begin the “Plant Establishment Period”. If deficiencies still exist, the procedure shall be repeated and the beginning of the “Plant Establishment Period” shall be delayed until all noted deficiencies have been corrected.

### **1008.04 Plant Establishment Work**

The “Plant Establishment Period” shall be a period of continuous satisfactory maintenance, the duration of which shall be as specified in the Special Provisions.

The “Plant Establishment Period” shall commence on the date designated by the Engineer after satisfactory completion and approval of the planting and related work.

Weeding shall be done periodically, often enough to prevent weeds from growing to two inches in height.

Weed control by chemical treatment will be permitted, but the Contractor shall be responsible for any damage to adjacent plants by the use thereof. The use of mowers and scythes will not be allowed.

Sand in planting pits for trees planted in sidewalk areas shall be replenished every thirty days prior to final inspection.

Irrigation basins shall be reformed and remulched prior to final inspection.

Additional work, in the judgment of the Engineer necessary for proper plant establishment, shall be done as Incidental Work. Examples of such work are: wind guards for trees and shrubs, stakes for shrubs, additional protective fencing, and drainage ditches.

Planting shall be replaced as necessary in accordance with the requirements of Section 1008.01. In addition, replacement trees and shrubs planted during the "Plant Establishment Period" shall each be clearly identified by a large, white, wooden tag attached thereto, showing the date of planting.

Plants, replacing those previously planted and not observed for the full "Plant Establishment Period", which, after acceptance of the work, fail to establish normal healthy growth shall be considered to be defects in the work, and subject to the requirements of Section 105.10.

### **1008.05 Tree and Shrub Maintenance**

Maintenance of trees and shrubs, and plant establishment work therefor, shall be in accordance with the applicable requirements of Sections 1000 and 1008.

Any plants that have settled so that the top of the root ball is below the bottom of the basin or finished grade, as applicable, shall be raised to the specified level. All plants that have settled deeper than as specified immediately hereinbefore, and have failed to grow, shall be removed and replaced by the Contractor at his sole expense.

### **1008.06 Ground Cover Nursery Stock Maintenance**

Midway in the "Plant Establishment Period", 15 pounds of commercial fertilizer shall be applied per 1000-square feet of ground cover area.

Nursery stock shall be watered sufficiently to keep the ground moist well below the root system, throughout the life of the contract.

### **1008.07 Lawn Maintenance**

Areas planted with lawn shall be watered sufficiently to Keep the area uniformly moist throughout the life of the contract.

The lawn shall be mowed and trimmed when the grass reaches a height of two inches, after which the area shall be satisfactorily rolled. After initial mowing, the lawn shall be mowed once a week.

All bare spots on the lawn shall be reseeded. The lawn shall be maintained for the duration of the "Plant Establishment Period" at the end of which time the lawn shall be mowed, weeded, and trimmed for final inspection.

### **1008.08 Sod Maintenance**

While the grass is growing the Contractor shall keep the lawn free from weeds and disease. Either chemical weeding, hand weeding, or both may be used to maintain healthy lawn growth. The grass shall be cut as many times as required to keep the height of the grass below two inches. No cut grass shall be allowed to lay on the turf. Any bare spots shall be filled with sod to fit. No seeding will be allowed.

### **1008.09 Cultivating**

The area between plants shall be kept cultivated and shall have been cultivated within seven days prior to the pre-maintenance inspection and within seven days prior to the final acceptance inspection.

**1008.10 Final Acceptance Inspection and Approval**

At least one week in advance of the expiration of the “Plant Establishment Period”, the Contractor shall request the Engineer to schedule a final acceptance inspection. The inspection will be similar to the pre-maintenance inspection. If any deficiencies are noted by the Engineer at the final inspection, the “Plant Establishment Period” will be extended until such deficiencies are satisfactorily corrected. The Contractor shall bear all costs required to maintain the plantings during the extended “Plant Establishment Period” and if the time allowed for completion of the job is exceeded, will be liable for liquidated damages.

## **1009 Restoration of Existing Lawn and Other Planting**

### **1009.01 General**

The Contractor shall not disturb or cause neglect to existing lawn and planting within or outside the contract area due to his operations.

Where trenches and other excavations and land used by the Contractor are in existing lawn or other existing planted areas, the Contractor, as specified in the Special Provisions or designated on the plans, shall either replace existing lawn by reseeding or shall remove, store and subsequently replace existing lawn by resodding; and shall remove, store and subsequently replant all other existing vegetation other than ground cover planting; all, except as otherwise specified, to the extent required to be removed as a result of his operations; and shall maintain for the duration of the contract, all lawn and other planting replaced by him.

Lawn and other planting not required to be removed but damaged or destroyed by the Contractor's operations, plants not acceptable for replanting due to improper removal and storage, plants which the Contractor chooses to replace, and ground cover planting, shall be replaced with lawn and other planting, as applicable, at least equivalent in quality to that which existed prior to the work under the contract. In this case, replacement of existing lawn shall be by reseeding.

In order that future growth can be assured, the Contractor shall not delay completion of backfill and restoration of lawn and other planting.

All lawn and other planting replaced by the Contractor shall be planted, maintained, and inspected prior to acceptance as hereinbefore specified for the respective type of planting.

### **1009.02 Materials**

Commercial fertilizer, imported soil, plantings, grass seed, and other materials necessary or required for the satisfactory restoration of existing plantings shall be as specified in Section 1007.

### **1009.03 Replacement of Topsoil**

When excavating in existing lawn and other planted areas, the Contractor shall properly separate, as determined by the Engineer, topsoil from the other material excavated; or in lieu thereof, may furnish imported soil at his own expense. The Contractor shall construct compacted backfill to the required subgrade for topsoil and shall comply with the provisions of Section 1001.

He shall place topsoil or imported soil as the case may be, and in lawn area replace the lawn sod if specified to a thickness at least equal to that of the adjacent existing topsoil. In any case, a minimum depth of 8 inches of topsoil or imported soil and lawn sod, as applicable, shall be placed.

Imported soil shall be in accordance with the requirements of Section 1007.

Before any tree, shrub or ground cover replanting or lawn resodding or reseeding, topsoil or imported soil shall be fertilized with an application of commercial fertilizer, mixed thoroughly in the top  $\frac{1}{4}$  inch of topsoil or at the rate of 2 pounds per 100 square feet.

### **1009.04 Replacement of Lawn by Resodding**

Before removal of any lawn sod, the lawn shall be cut short and well watered. Lawn sod shall be lifted in 12 inch squares, 2 inches in thickness; shall be laid flat so that no square rests on top of another square and placed in a shaded place and shall be protected during storage and be watered at least 3 times each day, when and as directed by the Engineer.

The Contractor shall carefully replace and tightly butt the squares of lawn sod, firmly hand tamp the replaced area and fill any voids between squares with fine topsoil seeded as directed. The replaced lawn sod shall provide a smooth continuous lawn completely covering the appropriate area and conforming to adjacent grade and shall be watered immediately following the replacement.

**1009.05 Restoration of Lawn by Reseeding**

Restoration of existing lawn areas by reseeded shall be in accordance with the requirements of Section 1007.15.

Maintenance and plant establishment shall be in accordance with the applicable requirements of Section 1008.

**1009.06 Payment**

Restoration of existing lawn and other planting damaged, destroyed or removed by the Contractor in the performance of his work shall be done as Incidental Work and payment thereof shall be included in the price or prices bid.

## 1010 Imported Furnishings

The furnishing and installation of prefabricated site furnishings such as benches, play equipment, kiosks, trash enclosures, fire pits, bicycle racks, etc. and imported furnishings such as sand used in play areas, shall meet all requirements as set forth in these Standard Specifications.

In the event there is a conflict between the method of installation of prefabricated site furnishings required by the specifications and that recommended by the manufacturer, the Contractor shall request resolution of such conflict by the Engineer.

## **1011 Payment**

Landscape work satisfactorily constructed or furnished and installed as specified, will be paid for at the lump sum price bid therefor, except as otherwise specified in the Special Provisions.

END PART 10