

PART 8

CONCRETE, METALWORK, PAINTING,
AND MISCELLANEOUS

SECTION 800

PORTLAND CEMENT CONCRETE
AND RELATED MATERIALS AND 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 percent 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 percent by weight of alkalis, calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O , 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 percent.

(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 percent and shall not contract in air more than 0.048 percent 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 percent.

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 percent.

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 percent 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 COARSE 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 percent 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 percent 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:

Sieve Sizes	Percentage by Weight Passing	
	Primary Aggregate Nominal Sizes	
	1½X¾"	¾"xNo.4
2".....	100
1½".....	85 -100
1".....	0 - 66	100
¾".....	0 - 20	85-100
⅜".....	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 1½-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 ¾-inch nominal size the maximum variation from an approved gradation of the percentage of material passing the ⅜-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 ¾-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:

Tests	Test Method	
	No. Calif.	Requirements
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>Percentage by Weight Passing</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 percent; and the difference between the percentage passing the No. 30 and No. 50 sieves shall be between 10 and 40 percent.

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.

Sieve Sizes	Percentage by Weight Passing	
	1½" Max.	¾" Max.
2".....	100
1½".....	90-100
1".....	50- 86	100
¾".....	45- 75	90-100
⅜".....	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 Aggregate. - Fine and coarse lightweight aggregates in each batch of 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 SO₄. 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 SO₄. 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 percent nor a reduction in the compressive strength of mortar at 14 days of more than 5 percent 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 SO₄.

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 ($\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$) as determined on the filtrate. The specific gravity of such water mixture shall not exceed 1.03 and shall not vary more than ± 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 one percent 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 percent.

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 A 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 percent 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 percent and no single test value shall exceed $5\frac{1}{2}$ percent.

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 percent 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 percent 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 percent 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 Ft. of Sand</u>
A	Finish mortar for curbs and steps; Caulking 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:

Percentage by Weight Passing

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 Cu. Yd. of Concrete</u>	<u>Min.Strength in Lbs. per Sq. Inch at 28 Days (f'c)</u>	<u>Max.Size of Coarse Aggregates In Inches</u>	<u>Slump in Inches</u>
7-4000-1½	7	4000	1½	4 max.
7-4000-¾	7	4000	¾	4 max.
6.5-3500-¾	6.5	3500	¾	4 max.
6-3500-1½	6	3500	1½	4 max.
6-3000-¾	6	3000	¾	4 max.
5.5-3000-1½	5.5	3000	1½	3 max.
5.5-2500-¾	5.5	2500	¾	4 max.
5-2500-1½	5	2500	1½	4 max.
4-2000-1½	4	2000	1½	4 max.

The class of concrete used shall be as specified. If the concrete class is not specified, Class 6-3000-¾ shall be used.

Where concrete containing 1½-inch maximum size aggregate is specified, but reinforcement clearances or structural dimensions will not permit the use of 1½-inch aggregate, the Contractor, with the approval of the Engineer, may substitute concrete of like strength with ¾-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 percent 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 1/2 percent 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 for 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.

SECTION 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 percent of that indicated on the plans for any particular casting, and not more than 4 percent 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 1½ 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 percent of that indicated on the plans for any particular casting, and not more than 3 percent 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 1½ 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.

SECTION 802

MISCELLANEOUS 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.

SECTION 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" O.D. Steel Pipe at 3.65 Lbs./Lin. Ft. or 2" Steel Square Section at 3.65 Lbs./Lin.Ft.	1.900" O.D. Steel Pipe at 2.72 Lbs./Lin. Ft. or 1.875" Steel "H" Section at 2.75 Lbs./Lin. Ft.
"B"	2.875" O.D. Steel Pipe at 5.79 Lbs./Lin. Ft. or 2½" Steel Square Section at 5.79 Lbs./Lin. Ft.	2.375" O.D. Steel Pipe at 3.65 Lbs./Lin. Ft. or 2¼" Steel "H" Section at 4.1 Lbs./Lin. Ft.
"C"	2.875" O.D. Steel Pipe at 5.79 Lbs./Lin. Ft. or 2½" Steel Square Section at 5.79 Lbs./Lin. Ft.	2.375" O.D. Steel Pipe at 3.65 Lbs./Lin. Ft. or 2¼" Steel "H" Section at 4.1 Lbs./Lin. Ft.

Note: 1½ inch nominal size pipe has 1.900-inch outside diameter (O.D.)
 2-inch nominal size pipe has 2.375-inch outside diameter (O.D.)
 2½ inch nominal size pipe has 2.875-inch outside diameter (O.D.)

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 Size of Post in Inches</u>	<u>Nominal Weight of Post Per linear Foot in Pounds</u>
Up to and including 6 feet	1½ (2.875 O.D.)	5.79
Over 6 feet to 13 feet, incl.	3½ (4.000 O.D.)	9.11
Over 13 feet to 18 feet, incl.	6 (6.625 O.D.)	18.97
Over 18 feet	8 (8.625 O.D.)	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-inch 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, Top 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 1½-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.

SECTION 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 AND FABRICATION. - 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.

SECTION 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.

SECTION 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.

SECTION 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 judgement 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-inch and smaller	0.016-inch oversize
1/2-inch through 1-inch	0.021-inch oversize
1-1/8-inch and larger	0.031-inch 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.

SECTION 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 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.

- 5.3 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.

SECTION 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 require 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, scaling, checking, alligating, 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.

SECTION 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:

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

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>For Edge Drains</u>	<u>For Underdrains</u>
Weight, ounces per square yard, min. ASTM Designation D 1910.....	4.0	4.0
Grab tensile strength (1-inch grip), pounds, min., in each direction ASTM Designation D 1682.....	50	90
Elongation, percent, min. ASTM Designation D 1682.....	10	30
Toughness, pounds, min. (Percent elongation x grab tensile strength).....	3000	4000

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