

PART XIV - MARINE AVIATION FACILITIES
(US Customary Units)

ITEM M-100 TIMBER STRUCTURES

DESCRIPTION

100-1.1 This work shall consist of furnishing, preparing and erecting, structural timber or dimension lumber, including preservative treatment and all hardware for structures and incidental construction in conformance with the Plans and specifications.

MATERIALS

100-2.1 The materials shall conform to the following:

- a. Timber shall be No. 1 grade Douglas Fir, per West Coast Lumber Inspection Bureau (WCLIB) grading rules No. 17, no loose knots. Commercial inspection with certification is required, mill certificates not acceptable. No express guarantee attached to certificate if subsequent inspection reveals unacceptable material.

Timber shall be S4S unless otherwise noted on the Plans. All timber shall be pressure treated as per M-100-2.2.

- b. Glued-laminated members shall be constructed of Douglas Fir conforming to the latest Standard Grading Rules for West Coast Lumber published by the WCLIB and of the combination shown on the Plans. Glue-laminated members shall be produced in conformance with the requirements of U.S. Commercial Standard PS 56-73. Laminating adhesives shall be for wet conditions of use. Appearance of glued-laminated members shall be Industrial grade or better. Inspection shall be in accordance with American Institute of Timber Construction, AITC 200 Inspection Manual. All glue-laminated members shall be pressure treated as per M-100-2.2.

- c. Structural steel plates, rods and shapes shall be galvanized ASTM A 36 unless otherwise noted.

- d. All bolts, screws and drive spikes for timber shall conform to ASTM A 307 and shall be galvanized.

Bolts with heads in contact with timber and drive spikes shall be manufactured with economy heads. Nuts facing timber shall be washered with galvanized malleable iron castings.

For malleable castings the diameter shall be equal to 4 times the diameter of the bolt, and the thickness shall be equal to 1/2 the diameter of the bolt. All bolts with heads facing decking shall be countersunk. Depth of countersink to be equal to the bolt head thickness + 1/16 inch, width of the countersink to be equal to the bolt head width + 1/4 inch.

- e. Timber connectors shall conform to the requirements specified in the latest edition of the *AASHTO Standard Specifications for Highway Bridges*, Section 2.20.1, Timber Structures.

100-2.2 PROTECTIVE TREATMENT. All timber and glu-lam members shall be accurately cut, drilled and countersunk before pressure treatment. All members below deck level or submerged shall be creosote treated to 25 pcf retention by assay per AWWA C18. Glu-lam deck members shall be treated with pentachlorophenol in light solvent (Type C), to 0.6 pcf retention by assay, empty cell process (or treated with copper naphthenate to 0.060 pcf retention by assay), per AWWA C28. All other members such as bumper boards, decking, hand rail components, chocks, curb and bull/tiedown rails shall be treated with ACZA to 0.6 pcf retention by assay per AWWA C18. Retreatment shall not be allowed.

Retorts shall be cleaned between changes in preservative types. Any visual or physical evidence in the treated product of contamination shall be grounds for rejection.

Treated timber shall be handled carefully without dropping, breaking of outer fibers, or bruising or penetrating the surface with tools.

All cuts or abrasions occurring after creosote pressure treatment shall be carefully trimmed and brush-coated with at least three applications of hot creosote oil (150 to 200 °F). All cuts or abrasions occurring after ACZA or pentachlorophenol pressure treatment shall be carefully trimmed and brush-coated with at least three applications of a copper naphthenate solution of not less than 2% copper metal. Field treatment must meet AWPA M4.

Before driving bolts, all holes bored after treatment shall be saturated with hot creosote oil or copper naphthenate solution.

Any unfilled holes bored after treatment, after being treated as per above shall be plugged with creosote or copper naphthenate saturated plugs.

CONSTRUCTION REQUIREMENTS

100-3.1 GENERAL.

- a. **Workmanship.** Competent carpenters shall be employed and all framing shall be true and exact. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Use of nail guns will not be allowed. The workmanship on all metal parts shall conform to the requirements specified for those materials.
- b. **Storage of materials.** All lumber and timber on the site of the work shall be stacked to prevent warping. Treated timber shall be stored close-stacked and shall be stacked above the ground on blocks or lagging. The ground underneath and in the vicinity of all stacks shall be cleared of weeds and rubbish.

Pre-fabricated timber structures shall be stored as specified. All non-removable erection marks on fabricated timber shall be located so as to be hidden from view in the completed work.

- c. **Handling.** Timber members shall not be dragged or dropped. Slings and chokers used to handle timber members shall be of the web belting type. Protection angles or blocking shall be applied at pickup points to protect corners.

100-3.2 HOLES FOR BOLTS, DOWELS, RODS, AND LAG SCREWS. Holes for round drift-bolts and dowels shall be bored with a bit 1/16 inch smaller in diameter than that of the bolt or dowel to be used. The diameters of holes for square drift-bolts or dowels shall be equal to one side of the bolt or dowel. Holes for machine bolts shall be bored with a bit 1/16 inch larger than the diameter of the bolt. Holes for lag screws shall be bored with a bit with the same diameter and length as the unthreaded body and pilot bored using a drill not larger than the diameter of the screw at the root of the thread for the full depth of thread penetration. Holes for deck dowels in glued-laminated timber deck panels shall be 1/2 inch greater in depth than the dowel embedment. Holes in glu-lam timber deck panels for receiving dowels may be bored a maximum of 1/32 inch oversize.

100-3.3 BOLTS AND WASHERS. Washers of the size and type specified shall be used in contact with all noneconomy bolt heads or nuts that would otherwise be in contact with wood.

100-3.4 FRAMING. All lumber and timber shall be accurately cut and framed to a close fit so that the joints will have even bearing over the entire contact surfaces without shimming.

100-3.5 LAMINATED OR STRIP FLOORS. Care shall be taken to have each piece vertical and tight against the preceding one, and bearing evenly on all the stringers.

Pieces shall be of sufficient length to bear on at least four stringers. End joints on any one stringer shall be no closer than every third piece. End joints in adjoining pieces shall be no closer than every second stringer.

Joints between adjacent glu-lam timber deck panels shall be coated with mastic sealer before the panels are drawn together.

METHOD OF MEASUREMENT

100-4.1 No measurement of quantities for payment will be made.

BASIS OF PAYMENT

100-5.1 Payment for Treated Timber covers all costs associated with furnishing and installing treated timber, including mastic sealer, elastomeric bearing pads, and hardware.

When the bid schedule does not contain a pay item for Treated Timber, all costs associated with furnishing and installing treated timber are subsidiary to the structure in which it is incorporated.

Payment will be made under:

Item M-100a Treated Timber - per lump sum

ITEM M-110 TIMBER FLOATS

DESCRIPTION

110-1.1 This work shall consist of the construction of timber floats in conformance with the Plans and specifications.

MATERIALS

110-2.1 Structural steel plates, shapes, tubing and pipe shall be the size shown on the Plans and per Section M-300.

Structural aluminum plates, shapes, tubing and pipe shall be the grade and size shown on the Plans. Cover plates shall have a checker pattern on the exposed surface.

Timber shall be the sizes shown on the Plans and per Section M-100.

Timber hardware shall be the sizes shown on the Plans and per Section M-100.

Cleats shall be cast gray iron, hot dip galvanized, heavy dock cleats as follows: 8 inch cleats shall weigh a minimum 3 lbs each and be secured with two 7/16 inch Ø bolts; 10 inch cleats shall weigh a minimum 6 lbs each and be secured with two 1/2 inch Ø bolts; 12 inch cleats shall weigh a minimum 10 lbs each and be secured with two 5/8 inch Ø bolts.

Polystyrene flotation billets shall be of the size called for on the Plans. They shall have a density of 1.3 to 1.4 lb/ft³. They will have a 1 inch radius on the edges (except ends). Polystyrene shall be virgin new material throughout. Material that has exceeded the manufacturer's recommended shelf life will not be allowed nor will molded, stuffed or reground material be permitted. Voids shall not exceed 1% by area as measured on any internal X-sectional cut surface. The knit or weld between the individual bead cells shall be such that a minimum of 60% of the beads fracture rather than separate when subjected to bending stresses.

Molded rubber float bumpers where noted shall be heavy duty #1093 straight type and #1094 corner type as manufactured by Griffith Rubber Mills, or approved equal.

"D" fenders shall have tapered sides, 4-1/2 inch base, 3-3/4 inch height and a 2 x 2-1/4 inch bore. Maximum tolerances $\pm 4\%$ on faces; $\pm 8\%$ on bore and 1/2 inch on length. Rubber for "D" fenders described above shall conform to ASTM D 2000 4CA 720 or 4AA 720 virgin natural rubber. Suffix requirements for either type/class shall be B10 (25% max.), C12, F17, EA13 (5% vol. change max.), G12.

110-2.2 PROTECTIVE COATINGS AND TREATMENT. Flotation billets shall be coated a minimum of 50 mil thickness with an approved 100% solids polyurethane. Coating shall be made to withstand the effects of ultraviolet exposure. Shop drawing submittals shall include a sample of the billet material to be used coated with the coating proposed to be used (minimum sample size 6 x 6 x 4 inches). The coating must adhere to the polystyrene without damaging it. Field damaged coating shall be repaired with a field applicable two component urethane mastic manufactured by the coating supplier. Field repair to be approved by the Engineer.

CONSTRUCTION REQUIREMENTS

110-3.1 FABRICATION REQUIREMENTS. Steel and aluminum components shall be shop fabricated and treated as applicable with specified protective coatings.

Welding shall be per Section M-300.

Lumber shall be cut and predrilled prior to preservative treatment per Section M-100.

No field cutting or trimming of the flotation billets will be permitted. Any coating damaged after fabrication shall be repaired as per Section M-110-2.2.

METHOD OF MEASUREMENT

110-4.1 Timber floats will be measured by the square foot, using nominal width times length measured along center line.

BASIS OF PAYMENT

110-5.1 Payment covers constructing timber floats complete, including all connection plates, weldments, and cleats.

Payment will be made under:

Item M-110a Timber Float - per square foot

ITEM M-200 STRUCTURAL CONCRETE

DESCRIPTION

200-1.1 This work shall consist of furnishing and placing Portland cement concrete for structures and incidental construction in conformance with the Plans and specifications.

200-1.2 CLASSIFICATION. The following classes of concrete shall be used where required:

Class A concrete shall be used, unless otherwise specified.

Class A-A concrete shall be used for all cast-in-place or pre-cast nonprestressed concrete structures or portions of structures which will be subject to immersion in salt water.

MATERIALS

200-2.1 Materials shall conform to the following and the Contractor shall provide certification from an independent laboratory documenting required conformance.

a. Aggregates shall conform to the following:

Coarse aggregate for concrete shall conform to the requirements of AASHTO M 80, with the following exceptions:

Delete the following methods of sampling and testing:

Material passing the No. 200 sieve	AASHTO T 11
Sieve analysis	AASHTO T 27

And substitute the following:

Material Passing the No. 200 sieve	WAQTC FOP for AASHTO T 27/T 11
Sieve analysis	WAQTC FOP for AASHTO T 27/T 11
Friable Particles	AASHTO T 112
Sticks and Roots	Visual Separation Percent by wet weight

Add the following: AASHTO T 104 shall be performed using sodium sulfate solution.

Fine Aggregate for concrete shall conform to the requirements of AASHTO M 6 with the following exceptions:

Delete paragraph 8.2 of AASHTO M 6.

Delete the following methods of sampling and testing:

Amount of material passing a No. 200 sieve	AASHTO T 11
Sieve analysis	AASHTO T 27
Soundness (freezing and thawing)	AASHTO T 103

And substitute the following:

Amount of material passing a No. 200 sieve	WAQTC FOP for AASHTO T 27/T 11
Sieve analysis	WAQTC FOP for AASHTO T 27/T 11

b. Cement shall conform to ASTM C 150 and may be either type 1, 2 or 3. The tricalcium aluminate (C₃A) content of the cement must be less than 5% and the alkali content (Na₂O and K₂O) must be less than 0.6%.

Unless otherwise permitted, the product of only one mill of any one brand and type of portland cement shall be used on the project.

The Contractor shall provide suitable means for shipping, storing and protecting the cement against dampness. Cement which, for any reason, has become partially set or which contains lumps of caked cement shall be rejected. Cement salvaged from discarded or used bags shall not be used.

- c. Water used in mixing or curing concrete shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable or other substance injurious to the finished product. Water will be tested in accordance with, and shall conform to the suggested requirements of AASHTO T 26. Water known to be of potable quality may be used without test.
- d. Admixtures to be used in concrete shall be subject to approval by the Engineer.

Air-entraining admixtures shall conform to the requirements of ASTM C 260.

The use of superplasticizers in the concrete mix to improve the workability of mixes with low water cement ratios may be permitted subject to approval. Admixtures which lower the freezing point, accelerate or retard the hardening of the concrete or reduce the cement content shall not be used.

- e. Reinforcing Steel shall conform to the requirements of Section M-310.

200-2.2 NOT USED.

200-2.3 CASTING YARD. The pre-casting of concrete members may be done at any location selected by the Contractor, subject to approval. The Engineer shall be notified of the location of all precast work prior to production in accordance with the General Provisions.

The plant used to produce precast concrete units shall conform to the requirement of Division IV, Sections 1 and 2, and Division V, Sections 1,2, 3 and 4 of *Prestressed Concrete Institute Manual* MNL-116. The Contractor shall furnish to the Engineer, evidence that the plant meets the requirements specified prior to the start of production and that all recommended certifications, checks, and tests are performed at the recommended intervals. This evaluation shall be performed by a licensed Professional Civil Engineer, or independent laboratory experienced in such evaluations. Where specific requirements differ from MNL-116, this contract shall govern.

In addition to the compressive test cylinders required by MNL-116 the Contractor shall make a minimum of four cylinders per concrete batch. Two cylinders shall be broken at 7 days and the remaining two shall be broken at 28 days.

Each unit cast shall have a unique identification number applied to it which shall be correlated to the Quality Control program required by these specifications.

Copies of all required certifications and test results shall be available to the Engineer prior to field inspection, incorporation into the work, or consideration for payment for materials on hand per Section 90-07.

CONSTRUCTION REQUIREMENTS

200-3.1 PROPORTIONING. The Contractor shall be responsible for designing a concrete mix conforming to the limitations given below and producing a workable concrete. The concrete shall have a 28 day compressive strength equal to that called for on the Plans or as specified herein, in that order.

The proposed mix shall be submitted a sufficient time (30 days minimum) in advance of production of the concrete to permit testing and approval by the Engineer. Alternatively, the Contractor may furnish certification from an independent testing laboratory prior to production stating that the proposed mix

conforms to the contract requirements and has consistently produced concrete of the required strength when used with the materials to be furnished for that project.

The Contractor shall be responsible for producing and placing specification concrete and shall determine the final proportions including free moisture in the aggregates to produce concrete conforming to the Plans and these specifications with a cement content within tolerance of 2% for the particular class of concrete being made.

PROPORTIONING LIMITS

	CLASS OF CONCRETE	
	A	A-A
Minimum Cement Content, sacks/yd ³	6	7.5
Maximum Water Cement Ratio, gal/sack	5.5	4.5
Slump Range, inches	2-4	1-3
Entrained Air Range, %	5-7	5-7
Coarse Aggregate Gradation (AASHTO M 43)	No. 67	*
Fine Aggregate Tolerance on Fineness Modulus	0.2+	0.2+

Cement factors are based on 94 pound sacks.

* For Class A-A Gradation No.67 shall be used, except for float units Gradation No. 7 shall be used.

The Contractor may, subject to prior approval in writing, use alternative sizes of coarse aggregate as shown in Table 1 of AASHTO M 43. If the use of an alternative size of coarse aggregate produces concrete which exceeds the permissible water-cement ratio specified herein, thereby requiring additional cement above that specified, no compensation will be made to the Contractor for the additional cement.

MINIMUM STRENGTH

(28 day)

	CLASS OF CONCRETE	
	A	A-A
Compressive Strength (psi)	3500	4500

200-3.2 ADJUSTMENTS IN PROPORTIONS.

- a. **Adjustment for Variation in Workability.** If it is found that the concrete does not have the desired placeability and workability with the proportions originally designed, the Contractor upon approval may make such changes in aggregate proportions as are necessary provided that in no case shall the cement content originally designated be changed, except as provided hereinafter.
- b. **Adjustment for Variation in Yield.** If the cement content of the concrete, determined by means of the yield test, WAQTC FOP for AASHTO T 121, varies more than 2% from the designated value in Section M-200-3.1 the proportions shall be adjusted by the Contractor to maintain a cement content within these limits. The water cement ratio shall in no case exceed the specified amount.
- c. **Adjustment for Excess Water-Cement Ratio.** If when using the designated cement content, it is impossible to produce concrete having the required consistency without exceeding the maximum

allowable water-cement ratio specified in Section M-200-3.1, the cement content shall be increased so that the maximum water-cement ratio shall not be exceeded.

- d. **Adjustment for New Materials.** No change in the source or character of the materials shall be made without due notice to the Engineer, and no new materials shall be used until the Engineer has approved such materials and the Contractor has determined new proportions, based on tests of trial mixes as provided in Section M-200-3.1.

200-3.3 BATCHING. Except as provided hereinafter, the handling, measuring, and batching of materials shall be done at a central batching plant.

- a. **Portland Cement.** Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed.

All bulk cement shall be weighed on an approved weighing device.

Accuracy of batching shall be within 1% of the required weight of cement.

- b. **Water.** Water may be measured either by volume or by weight. The accuracy shall be within 1%.

- c. **Aggregates.** Aggregates shall be measured by weight on an approved weighing device. Stockpiles shall be built up in a manner that will prevent segregation. Aggregates from different sources and of different gradings shall not be stockpiled together.

Aggregates shall be handled in such a manner as to maintain a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched.

In case the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required.

Aggregates containing ice or in a frozen condition shall not be used. When aggregates are thawed only steam-coil or water-coil heating will be permitted, except that other methods, when approved, may be used.

Aggregates which have been heated directly by gas or oil flame, heated on sheet metal over an open fire, or by live steam shall not be used.

Batching shall be conducted to result in the weights of aggregate required, within a tolerance of 2%.

- d. **Air-entraining Admixtures.** Satisfactory devices shall be provided at the plant or at the concrete mixer for weighing or measuring air-entraining admixtures, or other additives.
- e. **Bins and Scales.** The batching plant shall include adequate bins for each required size of aggregate, unless otherwise permitted. Each bin shall be designed to discharge freely into the weighing hoppers. Control shall be provided so that, as the quantity desired in the weighing hopper(s) is being approached, the material may be added slowly and shut off with precision. Means of removing an overload of any material shall be provided. Hoppers shall be constructed so as to eliminate accumulations of tare materials and to fully discharge without jarring the scales. Partitions between bins and hoppers shall prevent spilling. All batching plant structures shall be maintained level to the accuracy required by the weighing mechanism.

The bulk cement weighing hopper shall be properly sealed and vented to preclude dusting during operation. The discharge chute shall not be suspended from the weighing hopper and shall be so arranged that cement will not lodge in it nor leak from it. The discharge mechanism of the bulk

cement hopper shall be interlocked as follows: against opening before the full batch is in the hopper and while the hopper is being filled; against closing before the contents of the hopper are entirely discharged and the scales are back in balance; and against opening if the batch in the hopper is either over or under weight by more than 1% of the amount specified.

Scales for weighing aggregates and cement shall be either the horizontal beam or the springless-dial type, designed as an integral unit of the batching plant, accurate within a tolerance of 1/2%.

When beam type scales are used, a "tell-tale" dial shall be provided for indicating to the operator that the required load in the weighing hopper is being approached. The device shall indicate at least the last 200 pounds of load. Poises shall be designed for locking in any position and to prevent unauthorized removal. The weigh beam and "tell-tale" device shall be in full view of the operator while charging the hopper, and he shall have convenient access to all controls.

Clearance between scale parts, hoppers, and bin structures shall be such as to avoid displacement of or friction between parts. Pivot mountings shall be designed to assure unchanging spacing of knife edges under all circumstances.

Scales shall be kept clean. The Contractor shall furnish suitable weights for checking.

- f. **Delivery.** When batches are hauled to the mixer, bulk cement shall be transported either in waterproof compartments or between the fine and coarse aggregates. When cement is placed in contact with the aggregates, batches may be rejected, unless mixed within 1-1/2 hours of such contact. Sacked cement may be transported on top of the aggregates.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped cleanly into the mixer without loss, and, when more than 1 batch is carried on the truck, without spilling of material from one batch compartment into another.

- g. **Non-Plant Batching.** In cases where the volume of concrete to be placed is small or where, for other reasons, proportioning by batching equipment is impracticable, the materials may, with written approval, be proportioned by weighing on approved platform scales or by loose volume. The quantities shall be measured separately in an approved manner, for which purpose the Contractor will be required to use such equipment as will insure uniform proportioning. The use of approved wheelbarrows or bottomless boxes, whose volumes have been carefully predetermined, or other equally satisfactory methods may be employed. Proportioning by means of shovels will not be permitted. In determining the volumes of the aggregates, due consideration shall be given to bulking effect of any moisture contained in these materials.

Immediately before use, liquid air entraining agents shall be stirred and agitated until thoroughly mixed. The air entraining agent shall be added to the mix simultaneously with the water, except that when water heated above 80 °F is used for mixing, the air entraining agent shall be added after the aggregate and water are mixed together.

200-3.4 MIXING. Concrete may be mixed at the construction site, at a central mixing plant, in a truck mixer or by a combination of central plant and truck mixing.

- a. **Mixing at Site of Concrete Construction.** Concrete shall be mixed in a clean batch mixer of approved type and capacity for a period of not less than 1 minute after all component materials, including water, are in the drum. The charging of water into the mixer shall begin before the cement and aggregates enter the drum. During mixing, the drum shall be operated at speeds specified by the manufacturer and shown on his name plate on the machine. Pickup blades in the drum of the mixer, which at any point are worn down 3/4 inch or more, must be replaced. The entire contents of the mixer shall be discharged from the drum before materials for a succeeding batch are placed therein.

The mixer shall be equipped with an approved timing device to insure mixing for the minimum time specified. The volume of a batch shall not exceed the manufacturer's rated capacity of the mixer. No mixer whose rated capacity is less than 1 cubic yard shall be used, unless written permission is obtained.

The concrete shall be mixed only in such quantities as are required for immediate use. Retempering of concrete will not be allowed.

- b. Central Plant Mixing.** When concrete is mixed at a central plant, the mixer and methods used shall be in accordance with the requirements of Section M-200-3.3.

Mixed concrete shall be transported from the central mixing plant to the site of work in agitator trucks of approved design, operated in accordance manufacturer's instructions.

The agitating speed of the drum shall be not less than 2 nor more than 6 revolutions per minute.

Concrete shall be delivered to the site of the work, discharged from the truck completely and be in the forms, ready for vibration within 1-1/2 hours after introduction of the cement to the aggregates. At the discretion of the Engineer, the above period may be extended 1 minute for every degree of temperature at which the concrete is delivered below 70 °F to a maximum total time of 2 hours. In hot weather, or under conditions contributing to quick setting of the concrete, a discharge time less than 1-1/2 hours may be required.

All concrete, regardless of agitation time shall conform to all limitations of Section M-200-3.1. The concrete mixture shall be agitated continuously until discharged from the truck.

- c. Truck Mixing.** Concrete may be mixed in a truck mixer of approved design and operated in accordance with the manufacturer's recommendations. Truck mixing shall be in accordance with the following provisions:

The truck mixer shall be either a closed, watertight, revolving drum or an open-top, revolving-blade or paddle type. It shall combine all ingredients into a thoroughly mixed and uniform mass and shall discharge the concrete with satisfactory uniformity. A maximum difference of 1 inch between slumps of samples from the 1/4 and 3/4 points of the discharged load shall be deemed satisfactory.

Mixing speed for the revolving-drum type mixer shall be not less than 4 revolutions per minute of the drum nor greater than a speed resulting in a peripheral velocity of the drum of 225 feet per minute. For the open-top type mixer, mixing speed shall be not less than 4 nor more than 16 revolutions per minute of the mixing blades or paddles.

Agitation speed for both the revolving-drum and revolving-blade type mixers shall be not less than 2 nor more than 6 revolutions per minute of the drum or mixing blades or paddles.

The capacities of truck mixers shall be in accordance with the manufacturer's ratings except that they shall not exceed the limitations specified herein. Normal rated capacities, expressed as percentages of the gross volume of the drum or container, shall not exceed 57.5% for truck mixing, and 80% for agitating. When the manufacturer's ratings of capacity are less than the limits indicated above, the manufacturer's ratings shall govern.

The amount of mixing shall be designated in numbers of revolutions. When the concrete is mixed in a truck mixer loaded to its normal rated capacity, the number of revolutions of the drum or blades at mixing speed shall not be less than 50 nor more than 100, after all materials, including mixing water, have been charged into the drum. If the batch is greater than normal rated capacity, but not more than 10% greater, the number of revolutions of the drum or blades at mixing speed shall be not less than 70 nor more than 100. All revolutions after 100 shall be at agitating speed.

A suitable counter shall be provided which will indicate the number of revolutions of the drum or blades.

Concrete shall be delivered to the site of the work, discharged from the truck completely and be in the forms ready for vibration within 1-1/2 hours after introduction of the cement to the aggregates. At the discretion of the Engineer, the above period may be extended 1 minute for every degree of temperature at which the concrete is delivered below 70 °F to a maximum total time of 2 hours.

In hot weather, or under conditions contributing to quick setting of the concrete, a discharge time less than 1-1/2 hours may be required.

All concrete regardless of agitation time shall conform to all limitations of Section M-200-3.1.

The concrete mixture shall be agitated continuously until discharged from the truck.

When the concrete is mixed in a truck mixer, the mixing operation shall begin within 30 minutes after the cement has been intermingled with the aggregates.

Except when intended for use exclusively as agitators, truck mixers shall be provided with a water-measuring device to measure accurately the quantity of water for each batch. The device may be mounted on the truck mixer or located at the point of loading the truck mixer. The tank shall be readily accessible for the determination of the amount of water delivered. The delivered amount of water shall be within a tolerance of 1% of the indicated amount when the tank, if mounted on the truck mixer, is stationary and practically level.

When wash water (flush water) is used as a portion of the mixing water for the succeeding batch, it shall be accurately measured and taken into account in determining the amount of additional mixing water required. When wash water is carried on the truck mixer, it shall be carried in a compartment separate from that used for carrying or measuring the mixing water. The Engineer will specify the amount of wash or flush water, when permissible, and may specify a "dry" drum if wash water is used without measurement or without supervision.

- d. **Hand Mixing.** Hand mixing will not be permitted except in case of emergency and with written permission. When permitted, it shall be performed only on watertight platforms. 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 two layers being not more than 1 foot in total depth. On this mixture shall be spread the dry cement and the whole mass turned not less than two times dry; then sufficient clean water shall be added, evenly distributed, and the entire mass turned and returned at least six times and until all particles of the coarse aggregate are covered thoroughly with mortar, and the mixture is of a uniform color and general appearance. Hand-mixed batches shall not exceed 1/2 cubic yard in volume. Hand-mixing will not be permitted for concrete that is to be placed under water.

200-3.5 COLD WEATHER CONCRETE. Concrete shall not be placed when the descending air temperature in the shade, away from artificial heat, falls below 40 °F nor resumed before the ascending air temperature reaches 35 °F, without specific written authorization. When the air temperature falls below 40 °F, or is, in the opinion of the Engineer, likely to occur within a 24 hour period after placing concrete, the Contractor shall have ready on the job, materials and equipment required to heat mixing water and aggregate and to protect freshly placed concrete from freezing.

The Contractor shall be wholly responsible for the protection of the concrete during cold weather operations and any concrete injured by frost action or overheating shall be removed and replaced at his expense.

- a. **Temperature of Concrete.** Concrete placed at air temperatures below 40 °F shall have a temperature not less than 50 °F nor greater than 70 °F when placed in the forms. These

temperatures shall be obtained by heating the mixing water and/or aggregate. Mixing water shall not be heated to more than 160 °F Aggregate shall be heated as provided in Section M-200-3.3.

When the temperature of either the water or aggregate exceeds 100 °F, they shall be mixed together so that the temperature of the mix does not exceed 80 °F at the time the cement is added.

- b. **Cold Weather Placement.** When placing concrete in cold weather, the following precautions shall be taken in addition to the above requirements:

Heat shall be applied to forms and reinforcing steel before placing concrete as required to remove all frost, ice, and snow from all surfaces, which will be in contact with fresh concrete.

When fresh concrete is to be placed in contact with hardened concrete, the surface of the previous pour shall be warmed to at least 35 °F, thoroughly wet, and free water removed before fresh concrete is placed.

- c. **Protection of Concrete.** When, in the opinion of the Engineer, greater protection is required to maintain the concrete temperature, the fresh concrete shall be completely enclosed and an adequate heat source provided. Such enclosure and heat source shall be so designed that evaporation of moisture from the concrete during curing is prevented. Precautions shall be taken to protect the structure from overheating and fire.

At the end of the required curing period protection may be removed, but in such a manner that the drop in temperature of any portion of the concrete will be gradual and not exceed 30 °F in the first 24 hours.

For concrete placed underwater and cured underwater, the above conditions may be waived provided that the water in contact with the concrete is not permitted to freeze. Dewatering shall not be carried out until the Engineer determines that the concrete has cured sufficiently to withstand freezing temperatures and hydrostatic pressure.

200-3.6 FORMS. Unless otherwise specified, forms for exposed surfaces shall be made of plywood, hard-pressed fiberboard or metal in which all bolt and rivet holes are countersunk, so that a plane, smooth surface of the desired contour is obtained. Rough lumber may be used for surfaces that will not be exposed in the finished structure. All lumber shall be free from knotholes, loose knots, cracks, splits, warps, or other defects affecting the strength or appearance of the finished structure. All forms shall be mortar tight, free of bulge and warp, and shall be cleaned thoroughly before reuse.

Forms shall be so designed and constructed that:

- a. Placement and finishing of the concrete will not impose loads on the structure resulting in adverse deflections or distortions. Deflection of plywood, studs, and walers shall not exceed 1/360 of the span between supports.
- b. Portions covering concrete that is required to be finished may be removed without disturbing other portions that are to be removed later. As far as practicable, form marks shall conform to the general lines of the structure.

When possible, forms shall be daylighted at intervals not greater than 10 feet vertically, with openings sufficient to permit free access to the forms for the purpose of inspecting and working.

Metal ties or anchorages within the forms shall be constructed to permit their removal to a depth of at least 1 inch from the face without injury to the concrete. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size.

- c. They may be removed without injuring the concrete.

- d. For float construction forms shall be constructed so that pontoons can be cast without construction joints and shall be so constructed and braced that all principal planes will be either true horizontal or true vertical. Dimensional variations shall not exceed 1/16 inch from those given, including corner to corner across diagonals.

Exposed top edges may be given a bull nose trowel finish using a 3/4 inch radius edging tool in lieu of chamfer strips.

All other exposed edges 90° or sharper shall be chamfered 3/4 inch Chamfering of forms for re-entrant angles shall be required only when specifically indicated on the Plans.

Forms shall be inspected immediately prior to the placing of concrete. Dimensions shall be checked carefully and any bulging or warping shall be remedied and all debris within the forms shall be removed. Special attention shall be paid to ties and bracing and where forms appear to be braced insufficiently or built unsatisfactorily, either before or during placing of the concrete, the Engineer may order the work stopped until the defects have been corrected.

Forms shall be constructed true to line and grade. Clean-out ports shall be provided at construction joints.

All porous forms shall be treated with non-staining form oil or saturated with water immediately before placing concrete.

Falsework shall be built to carry the loads without appreciable settlement. Falsework that cannot be founded on solid footings must be supported by ample falsework piling. Falsework shall be designed to sustain all imposed loads.

Detail drawings of the falsework shall be submitted for review, but such review shall not relieve the Contractor of any of his responsibility under the contract for the successful completion of the structure.

Forms and falsework shall not be removed without the consent of the Engineer. The Engineer's consent shall not relieve the Contractor of responsibility for the safety of the work. Blocks and bracing shall be removed at the time the forms are removed and in no case shall any portion of the wood forms be left in the concrete.

200-3.7 PLACING CONCRETE.

- a. **General.** All concrete shall be placed before it has taken its initial set and, in any case, within 30 minutes after mixing, except as otherwise permitted in Section M-200-3.4. Concrete shall be placed in such a manner as to avoid segregation of coarse or fine portions of the mixture, and shall be spread in horizontal layers when practicable. Special care shall be exercised to assure the working of the concrete around nests of reinforcing steel, so as to eliminate rock pockets or air bubbles. Enough rods, spades, tampers and vibrators shall be provided to compact each batch before the succeeding one is dumped and to prevent the formation of joints between batches. Extra vibrating shall be done along all faces to obtain smooth surfaces.

Concrete shall not be placed in decks or other sections requiring finishing on the top surface when precipitation is occurring or when, in the opinion of the Engineer, precipitation is likely before completion of the finishing, unless the Contractor shall have ready on the job all materials and equipment necessary to protect the concrete and allow finishing operations to be completed.

Troughs, pipes or short chutes used as aids in placing concrete shall be arranged and used in such a manner that the ingredients of the concrete do not become separated. Troughs and chutes shall be of steel or plastic or shall be lined with steel or plastic and shall extend as nearly as possible in the point of deposit. The use of aluminum pipes, chutes or tremies is prohibited.

Dropping the concrete a distance of more than 5 feet or depositing a large quantity at any point and running or working it along the forms will not be permitted, except that concrete for filling piles may be discharged directly into the pile. The placing of concrete shall be so regulated that the pressures caused by wet concrete shall not exceed those used in the design of the forms.

High frequency internal vibrators or external form vibrators of an approved type shall be used for compacting concrete in all structures. The number of vibrators used shall be ample to consolidate the fresh concrete within 15 minutes of placing in the forms. Prior to the placement of any concrete, the Contractor shall demonstrate that the vibrators are in good working order and repair and ready for use.

Vibrators shall not be held against forms or reinforcing steel nor shall they be used for flowing the concrete or spreading it into place. Vibrators shall be so manipulated as to produce concrete that is free of voids, is of proper texture on exposed faces, and of maximum consolidation. Vibrators shall not be held so long in one place as to result in segregation of concrete or formation of laitance on the surface.

Concrete shall be placed continuously throughout each section of the structure or between indicated joints. If, in an emergency, it is necessary to stop placing concrete before a section is completed, bulkheads shall be placed as the Engineer may direct and the resulting joint shall be treated as a construction joint.

The presence of areas of excessive honeycomb may be considered sufficient cause for rejection of a structure. Upon written notice that a given structure has been rejected, the Contractor shall remove and rebuild the structure, in part or wholly as specified, at his own expense.

- b. Pumping Concrete.** Concrete may be placed by pumping provided the Contractor demonstrates that the pumping equipment to be used will effectively handle the particular class of concrete with the slump and air content specified and that it is so arranged that no vibrations result that might damage freshly placed concrete. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned. Slump tests shall be taken at the discharge end of the pipe.
- c. Concrete Deposited Under Water.** Concrete deposited underwater shall be placed by means of a tremie or pump. The concrete shall be carefully placed in a compact mass and shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit.

A tremie shall consist of a watertight tube having a hopper at the top. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete.

Tremie tubes or pump discharge tubes used to deposit concrete under water shall be equipped with a device that will prevent water from entering the tube while charging the tube with concrete. Such tubes shall be supported so as to permit free movements of the discharge end over the entire top surface of the work and to permit rapid lowering, when necessary to retard or stop the flow of concrete. The tubes shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tube shall contain sufficient concrete to prevent any water entry. The flow shall be continuous until the work is completed and the resulting concrete shall be monolithic and homogeneous.

- d. Forming Construction Joints.** Construction joints shall be located where shown on the Plans or as permitted. Construction joints shall be perpendicular to the principal lines of stress and shall be provided with concrete shear keys at least 1-1/2 inches deep and 1/3 of the concrete thickness in width unless otherwise shown on the Plans.

Before placing fresh concrete, the surfaces of construction joints shall be washed and scrubbed with a wire broom, drenched with water until saturated, and kept saturated until the new concrete is placed. Immediately prior to placing new concrete, the forms shall be drawn tight against the concrete already in place and the old surface shall be coated thoroughly with a very thin coating of neat cement mortar. Where construction joints are necessary, reinforcing bars shall extend across the joint to make the structure monolithic, unless otherwise shown on the Plans.

200-3.8 FINISHING CONCRETE SURFACES.

- a. **Decks.** Finishing of concrete placed in decks and tops of launching ramp planks consist essentially of striking off the surface of the concrete true to the required grade and cross section and floating the surface so struck off.

The placing of concrete will not be permitted until the Engineer is satisfied that the rate of producing and placing concrete will be sufficient to complete the proposed placing and finishing operations within the scheduled time, that experienced concrete finishers are employed to finish the work and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use.

After the concrete has been placed and consolidated, the surface of the concrete shall be carefully struck off by means of a hand-operated strike board operating on headers, or by a finishing machine operating on rails. A uniform surface true to the required grade and cross section shall be obtained. The use of "doodle bug" or open mesh tampers will not be permitted.

Once the concrete has achieved initial set the concrete shall be worked with magnesium or magnesium alloy floats to mortar in the surface and given a broom finish. The use of water or mortar topping to ease finishing or brooming shall not be permitted.

- b. **Formed surfaces shall have an ordinary finish.** An ordinary finish is defined as the finish left on a surface after the removal of the forms, the filling of all holes left by form ties, and the repairing of all defects. The surface shall be true and even, free from stone pockets and depressions or projections.

As soon as the forms are removed, metal devices that have been used for holding the forms in place, and which pass through the body of the concrete, shall be removed or cut back at least 1 inch beneath the surface of the concrete. Fins of mortar and all irregularities caused by form joints shall be removed.

All small holes, depressions, and voids, that show upon the removal of forms, shall be filled with cement mortar mixed in the same proportions as that used in the body of the work. In patching larger holes and honeycombs, all coarse or broken material shall be chipped away until a dense uniform surface of concrete exposing solid coarse aggregate is obtained. Feathered edges shall be cut away to form faces perpendicular to the surface. All surfaces of the cavity shall be saturated thoroughly with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with stiff mortar composed of 1 part of Portland cement to 2 parts of sand, which shall be thoroughly tamped into place. The mortar shall be pre-shrunk by mixing it approximately 20 minutes before using. The length of time may be varied in accordance with brand of cement used, temperature, humidity, and other local conditions. The surface of this mortar shall be floated with a wooden float before initial set takes place and shall be neat in appearance. The patch shall be kept wet for a period of 5 days.

For patching large or deep areas, coarse aggregate shall be added to the patching material. All mortar for patching on surfaces which will be exposed to view in the completed structure shall be color matched to the concrete. Test patches for color matching shall be conducted on concrete that will be hidden from view in the completed work and shall be subject to approval.

200-3.9 CURING CONCRETE.

- a. Water Curing.** All concrete surfaces shall be kept wet for at least 7 days after placing if Type I or II cement has been used or for 3 days if Type III cement has been used. Concrete shall be covered with wet burlap, or wet cotton mats immediately after final finishing or brooming of the surface. These materials shall remain in place for the full curing period. The materials shall be kept thoroughly wet for the entire curing period. If wood forms are allowed to remain in place during the curing period, they shall be kept moist at all times.
- b. Membrane Curing.** Type I liquid membrane curing compound meeting the requirements of ASTM C 309 may be permitted, subject to approval. All finishing of concrete surfaces shall be performed to the satisfaction of the Engineer prior to applying the impervious membrane curing compound. The concrete surfaces must be kept wet with water continuously until the membrane has been applied. The manufacturer's instructions shall be carefully followed in applying the membrane and in all cases, the membrane curing compound must always be thoroughly mixed immediately before application. In case the membrane becomes marred, worn, or in any way damaged, it must immediately be repaired by wetting the damaged area thoroughly and applying a new coat of the impervious membrane curing compound.
- c.** If the Contractor elects to cure by any other method, the method and its details shall be subject to approval.

200-3.10 BACKFILLING AND OPENING TO USE. Unless otherwise noted on the Plans no traffic will be allowed until the minimum 28 day compressive strength of the concrete has been attained.

The compressive strength shall be determined from informational test cylinders cured on the site under similar conditions of temperature and moisture as the concrete in the structure.

200-3.11 CLEANING UP. Upon completion of the structure and before final inspection, the Contractor shall remove all falsework, and falsework piling shall be removed or cut off at least 2 feet below the finished ground line.

METHOD OF MEASUREMENT

200-4.1 No measurement of quantities for payment will be made.

BASIS OF PAYMENT

200-5.1 Payment covers all costs associated with furnishing and installing Class A and/or Class A-A concrete.

When the bid schedule does not contain a pay item for Class A and/or Class A-A concrete, costs associated with furnishing and installing Class A and/or Class A-A concrete are subsidiary to the structure in which it is incorporated.

Payment will be made under:

- Item M-200a Class A Concrete - per lump sum
- Item M-200b Class A-A Concrete - per lump sum

ITEM M-210 PRESTRESSED CONCRETE STRUCTURES

DESCRIPTION

210-1.1 This work shall consist of prestressed concrete structures, and the prestressed concrete portions of concrete, steel, timber, and composite structures, constructed in conformance with the Plans and specifications.

It shall include the manufacture, transportation, and storage of modules, beams, slabs, and other structural members of pre-cast concrete, prestressed by either pre-tensioning or post-tensioning methods. It shall also include the installation of all pre-cast, prestressed members.

The Contractor at his option may submit an alternative design of prestressed members for approval. Any such substitutes, including modification to other portions of the structure necessary to accommodate the substitution and submission of design by an Alaska Registered Civil Engineer, shall be made at the expense of the Contractor and no adjustment in unit prices or pay quantities shall be made.

Alternate girder designs shall be in accordance with the latest *AASHTO Specifications for Highway Bridges*, including applicable interim specifications and as modified herein.

Girder designs shall be proportioned for zero tension stress at full service load after losses have occurred. Girder designs utilizing lightweight concrete will not be permitted.

All concrete deck slabs, cast integral with the girders, shall provide a minimum of 2-1/4 inches of concrete cover above the top mat of deck slab reinforcing steel, and all cast-in-place deck slabs shall provide a minimum of 2-1/2 inches cover. Where required, curb and sidewalks shall be cast-in-place after erection of the girders.

The roadway surface of the girder shall conform to the indicated grade line.

Adjustments shall be made in girder forming to compensate for the predicted long-term camber resulting after loss of prestress and dead load deflection have occurred.

210-1.2 PRESTRESSING METHODS. The method of prestressing to be used shall be optional with the Contractor, subject to all requirements hereinafter specified.

Prior to casting any members to be prestressed, the Contractor shall submit for approval, complete details of the method, materials, and equipment he proposes to use in the prestressing operations. Such details shall outline the method and sequence of stressing, complete specifications and details of the prestressing steel and anchoring devices proposed for use, anchoring stresses, strand release sequence, type of enclosures, and all other data pertaining to the prestressing operations, including the proposed arrangement of the prestressing units in the members.

For prestressed concrete flexural members the anticipated camber at time of transfer of prestressing force and at other significant times shall be computed and shown on the shop drawings as a time/deflection curve and is subject to approval.

The design of prestressed concrete members utilizing concrete having a design strength between 4000 and 8000 psi shall be based on the following assumed losses of prestressing force:

Pretensioning strand:	45,000 psi
Post-tensioning strand excluding friction losses:	35,000 psi
Post-tensioning bar excluding friction losses:	25,000 psi

Should other materials be used, the assumed prestress losses shall be increased and are subject to approval.

210-1.3 CONSULTING SERVICE. Unless otherwise permitted, the Contractor shall certify that a technician skilled in the approved prestressing method will be available to the Contractor to give such aid and instruction in the use of the prestressing equipment and installation of materials as may be necessary to obtain required results.

MATERIALS

210-2.1 The materials shall conform to the following:

Water	M-200-2.1.c
Coarse Aggregate for Concrete Structures	M-200-2.1.a
Fine Aggregate for Concrete Structures	M-200-2.1.a
Cement	M-200-2.1.b
Reinforcing Steel	M-310-2.1 & M-310-2.2
Prestressing Reinforcement Steel, Hardware and Duct	M-310-2.1
Admixtures	M-200-2.1.d
Structural Steel	M-300-2.1 & M-300-2.2
Timber and Hardware	M-100-2.1 & M-100-2.2

210-2.2 PROPORTIONING CONCRETE. The Contractor shall be responsible for designing a concrete mix conforming to the limitations given below and producing a workable concrete. The concrete shall have a 28 day compressive strength equal to that called for on the Plans.

The proposed mix shall be submitted a sufficient time in advance of production of the concrete to permit testing and approval by the Engineer. Alternatively, the Contractor may furnish certification from an independent testing laboratory prior to production stating that the proposed mix conforms to the limitations below and has consistently produced concrete of required strength when used with the materials to be furnished for that project.

Proportioning Limitations - Prestressed Concrete

Minimum Cement Content, sacks/cubic yard	7.0
Maximum Water Cement Ratio, gallons/sack	4.5
Slump Range, inches	1-3
Entrained Air Range, percent	6-8
Maximum Coarse Aggregate Size, inches	3/4

CONSTRUCTION REQUIREMENTS

210-3.1

- a. **General.** Concrete production and placement for prestressed concrete structural members shall conform to the requirements of Section M-200 and reinforcing steel shall be placed in accordance with the requirements of Section M-310 subject to modifications and amendments contained herein.
- b. **Prestressing Equipment.** Jacks shall be equipped with accurate pressure gages or other devices for measuring jacking force. All devices, whether hydraulic jack gages or other wise, shall be calibrated and, if necessary, recalibrated so as to permit the stress in the prestressing steel to be computed at all times. A certified calibration curve shall accompany each device.

- c. **Casting Yard.** The pre-casting of prestressed concrete structural members may be done at any location selected by the Contractor, subject to approval. The Engineer shall be notified of the location of all precast work prior to production in accordance with the General Provisions.

The plant used to produce prestressed precast concrete units shall conform to the requirement of Division IV, Sections 1 and 2, and Division V, Sections 1,2, 3 and 4 of Prestressed Concrete Institute Manual MNL-116. The Contractor shall furnish to the Engineer, evidence that the plant meets the requirements specified prior to the start of production and that all recommended certifications, checks, and tests are performed at the recommended intervals. This evaluation shall be performed by a licensed Professional Civil Engineer, or independent laboratory experienced in such evaluations. Where specific requirements differ from MNL-116, this contract shall govern.

Copies of all required certifications and test results shall be available to the Engineer prior to field inspection and incorporation into the work and prior to consideration for payment for materials on hand per Section 90-07.

- d. **Enclosures for Post-Tensioning.** Enclosures for prestressing reinforcing shall be accurately placed at locations shown on the shop plans or as approved. The shop plans shall show the location of tendons at 10 foot maximum intervals along the length of the tendon.

Enclosures shall be accurately placed as shown on the shop plans and shall be of adequate strength and secured in position in such a manner so as to maintain their shape and location under such forces as will come upon them, including the lateral force of adjacent tendons.

Where pressure grouting or lubrication is specified, the enclosures shall be provided with pipes or other suitable connections for the injection of grout or lubricant after the prestressing operations have been completed in accordance with Section M-310.

- e. **Placing Steel.** All steel units shall be accurately placed in the position shown on the shop plans, and firmly held during the placing and setting of the concrete.

Distances from the forms shall be maintained by stays, blocks, ties, hangers, or other approved supports. Blocks for holding units from contact with the forms shall be pre-cast mortar blocks or plastic chairs of approved shape and dimensions. Layers of units shall be separated by mortar blocks or other equally suitable devices. Wooden blocks will not be permitted.

Wires, wire groups, parallel-lay cables, and any other prestressing elements shall be straightened to insure proper positioning in the enclosures.

Suitable horizontal and vertical spacers shall be provided, if required, to hold the wires in place in true position in the enclosures.

- f. **Pre-Tensioning.** The prestressing elements shall be accurately held in position and stressed by jacks. A record shall be kept of the jacking force and the elongations produced thereby. Several units may be cast in one continuous line and stressed at one time. Sufficient space shall be left between ends of units to permit access for cutting stressing elements after the concrete has attained the required strength. No bond stress shall be transferred to the concrete, nor end anchorages released, until the concrete has attained a compressive strength, as shown by cylinders made in accordance with WAQTC FOP for AASHTO T 23 and tested in accordance with AASHTO T 22, of at least that called for on the Plans, and until after any patching or repair to concrete which may be required or permitted has been satisfactorily completed. The elements shall be cut or released in such an order that lateral eccentricity of prestress will be a minimum.

The temperature of strands at the time of tensioning and concrete placement shall be within 25 °F of the concrete temperature. During the interval between tensioning and concrete placement the

stress level increase in the strands due to a temperature drop shall not be permitted to exceed 0.05 GUTS (guaranteed ultimate tensile strength) nor cause the stress in the strand to exceed 0.80 GUTS.

- g. Placing Concrete.** Concrete shall not be deposited in the forms until the placement of the reinforcing, enclosures, anchorages, and prestressing steel have been inspected and approved. The Concrete shall be vibrated internally or externally, or both, as directed. The vibrating shall be done with care and in such a manner as to avoid displacement of reinforcing, conduits, or wires.
- h. Post-tensioning.** Tensioning of the prestressing steel shall not be commenced until tests on concrete cylinders, manufactured of the same concrete and cured under conditions as outlined in WAQTC FOP for AASHTO T 23, and tested in accordance with AASHTO T 22, indicate that the concrete of the particular member to be prestressed has attained compressive strength of at least that shown on the Plans and until after any patching or repair to concrete which may be required or permitted has been satisfactorily completed.

Tensioning of segmental units shall not be commenced until the details of the tensioning and erection methods including stage stressing, false work and launching have been submitted for approval.

After the concrete has attained the required strength and required information on stressing approved, the prestressing steel shall be stressed by means of jacks to the desired tension and the stress transferred to the end anchorage.

The tensioning process shall be so conducted that the tension being applied and the elongation of the prestressing elements may be measured at all times.

The stress losses due to friction between the duct and prestressing steel may be estimated from the following formula:

$$T_o = T_x e^{(KL+ua)}$$

- Where:
- T_o = Steel stress at jacking end
 - T_x = Steel stress at any point x
 - e = Base of Napierian logarithms
 - u = Friction curvature coefficient
 - a = Total angular change of prestressing steel profile in radians from jacking end to point x
 - L = Length of prestressing steel element from jacking end to point x
 - K = Friction wobble coefficient per foot of prestressing steel

Values of K and u to be applied in the preceding formula are listed in the following table:

TABLE M-210-1

Type of Steel	Type of Duct	K	u
Wire cables	Bright metal sheathing	0.0020	0.30
	Galvanized metal sheathing	0.0015	0.25
	Greased or asphalt- coated and wrapped	0.0020	0.30
	Direct contact with concrete	0.0015	0.45
High-strength bars	Bright metal sheathing	0.0003	0.20
	Galvanized metal sheathing	0.0002	0.15
	Direct contact with concrete	0.0005	0.40
Galvanized	Bright metal sheathing	0.0015	0.25
	Galvanized metal sheathing	0.0010	0.20

strand	Direct contact with concrete	0.0015	0.50
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A record shall be kept of gage pressures and elongation at all times and submitted for approval.

i. Curing.

(1) Water Curing. Water curing shall conform to Section M-200-3.9.a.

(2) Steam Curing. Steam curing may be used as an alternative to water curing. The casting bed for any unit cured with steam shall be completely enclosed by a suitable type of housing, tightly constructed so as to prevent the escape of steam and simultaneously, exclude outside atmosphere. The first application of steam shall be made after the concrete has undergone initial set but not less than 2 hours after placing. Water curing shall be temporarily applied when the waiting period from concrete placement to application of steam exceeds 4 hours.

The steam shall be at 100% relative humidity to prevent loss of moisture and to provide moisture for proper hydration of the cement. Application of the steam shall not be directly on the concrete. During application of the steam, the ambient air temperature shall increase at a rate not to exceed 40 °F per hour until a maximum temperature of from 160 °F is reached. The maximum temperature shall be held until the concrete has reached the desired strength.

In discontinuing the steam application, the ambient air temperature shall not decrease at a rate to exceed 40 °F per hour until a temperature has been reached 20 °F above the temperature of the air to which the concrete will be exposed. The concrete shall not be exposed to freezing temperatures before the specified 28 day strength is obtained.

(3) If the Contractor elects to cure by any other special method, the method and its details shall be subject to approval. Approved steam heated casting beds with moisture tight covers may be used in lieu of live steam for the curing operation.

j. Camber. Camber is defined as the upward deflection which occurs in prestressed concrete flexural members due to the combination of stressing forces and dead load. It does not include dimensional inaccuracies due to errors in manufacture.

Concrete properties, the placing, curing, curing times, tensioning procedures and the storage of precast prestressed beam sections shall be carefully controlled so that the shape and amplitude of the deflection curves for all girders will be within specified tolerances and as nearly alike as possible. Camber shall preferable be measured with girder supported at bearing points only. When it is impractical to support girders on their bearing points for purposes of measuring camber, alternative support points may be utilized subject to approval and provided the Contractor submits calculations indicating the effects of the alternative supports on girder camber. Actual camber at time of transfer of prestressing force shall be measured and compared with computed values and tolerance.

k. Dimensional Tolerances. Precast prestressed concrete members shall conform to the following dimensional tolerances unless otherwise approved in writing.

- (1) **Length:** ± 3/4 inch
- (2) **Girder width** (overall): ± 1/4 inch subject to limitation (11) below.
- (3) **Depth:** ± 1/4 inch
- (4) **Width of webs, stems and bottom flanges:** -1/8 to +3/8 inch
- (5) **Flange thickness:** +1/4 inch, -1/8 inch
- (6) **Horizontal alignment** (deviation from straight line parallel to centerline of member): 1/2 inch, subject to limitation (11) below.

- (7) **Camber:** Variation from approved camber shall not exceed $\pm 1/8$ inch per 10 feet of length with a maximum of 1 inch. In addition the camber of any girder shall not differ from that of any other girder by more than 1/2 inch.
 - (8) **Position of tendons:** +1/4 inch
 - (9) **Longitudinal position of deflection point for deflected strands:** +1 inch, -0 inch.
 - (10) **Position of weld plates:** ± 1 inch measured along joint. $\pm 1/8$ inch transverse to joint.
 - (11) **Deck Width** (measured out to out of all girders in the span): +2 inches, except that this limit shall not exceed +1/2 inch where more precision is dictated by substructure details such as anchor bolts, parallel wing walls, etc.
 - (12) **Parallelism of Top and Bottom Flanges:** The depth of any deck type girder at any transverse cross section shall not vary more than 1/4 inch when measured perpendicular from a line coincident with the surface of the bottom flange(s) to the deck surface at the edges of the girder.
 - (13) **Diagonals:** The length measured in plan view from opposing edges of deck out to out of girder, 1/4 inch maximum difference between the diagonals.
- I. **Match Casting.** Mating surfaces of segmental prestressed concrete units shall be match cast so that the matching faces of each adjoining module shall be in intimate contact in a plane perpendicular to the axis of the units when post-tensioned.
 - m. **Exposed Ends and Anchorages.** Ends of strands remaining after stress transfer and cutoff and end anchorages shall be protected by enclosure in grouted recesses with 2 inch minimum cover or by coating with 20 mils min. thickness by a two component solvent free urethane mastic approved by the Engineer. Application shall be in accordance with the manufacturers recommendations.

210-3.2 BONDING AND LUBRICATION.

- a. All prestressing reinforcing to be bonded to the concrete shall be free of dirt, loose rust, grease, or other deleterious substances.

The annular space between the perimeter of the enclosure and the steel shall be pressure grouted after the prestressing process has been completed. The grout shall be made to the consistency of thick paint and shall be mixed in the proportions by volume of 1 part Portland cement to 0.75 part (maximum) of sand passing a No. 30 sieve and 0.75 part (maximum) of water. Within the limits specified, the proportions of sand and water shall be varied to produce the required strength and fluidity. It may be necessary to eliminate the sand from the mix and use neat cement grout.

The final pressure placed on the grout shall be 50 to 100 psi.

- b. All prestressing steel to be lubricant protected shall be free of dirt, loose rust or other deleterious substances. The duct work shall be filled with a lubricant manufactured specifically for the purpose, and approved by the Engineer, after prestressing is completed. Protective lubricant shall be heated, as recommended by the manufacturer, to improve pumpability.

The final pressure placed on the lubricant shall be 50 psi minimum.

210-3.3 HANDLING. Care shall be taken during transporting, storage, hoisting, and handling of the pre-cast units to prevent cracking or damage. Units damaged by improper storing or handling shall be replaced by the Contractor at his expense.

Shop drawings shall show points of support and restraint, and shall show location and type of lifting devices, used during production, storage, handling and shipping.

- a. **Flexural Units.** Unless otherwise approved, pre-cast girders and slabs shall be transported in an upright position and the points of support and direction of the reaction with respect to the member shall be approximately the same during transportation and storage as when the member is in its final position. If the Contractor requests to transport or store pre-cast girders in other than this position he shall submit the proposal as required for shop drawings together with calculations for effects on camber and for stress at all critical locations. No additional compensation will be made for engineering cost, delays or erection difficulties resulting from transportation and/or storage of girders regardless of methods used.
- b. **Floating Units.** Unless otherwise permitted floating modules shall be lifted by methods which support the unit evenly approximating the buoyant condition as closely as practicable.

Storage or stockpiling of units shall be such that straining of the concrete will not occur. The units shall be placed on sleepers, bunks or cradles, firmly bedded and adjusted to align in a true plane to avoid twisting. multiple supports shall be used to minimize stresses, deflection, and creep.

If the Contractor requests to transport or store pre-cast units in other than this manner he shall submit the proposal as required for shop drawings together with calculations for effects on camber and for stress at all critical locations. No additional compensation will be made for engineering costs, delays or erection difficulties resulting from transportation and/or storage regardless of methods used.

210-3.4 ERECTION. Unless otherwise approved, the Contractor shall make provisions for and use of forcing devices, as recommended by the manufacturer and approved, which will maintain the top edges of adjacent girders at the same elevation during the welding of diaphragms and shear connector plates and during placing and curing of grout in the shear keys.

Interchangeable girders shall be set at locations so that the initial difference between the top surfaces of the edges of adjacent girders is no more than 1/2 inch at midspan and no more than 1/4 inch at the bearings.

Field welds shall be made in accordance with the applicable provisions of Section M-300 as modified below.

These modifications shall apply only to welding on precast or precast-prestressed concrete structures:

- a. Galvanizing damaged by field welding shall be hand cleaned and repaired in accordance with AASHTO M 36. The repair of the spelter coat shall be performed by the Contractor at no additional cost to the State.
- b. If, in the opinion of the Engineer, normal field welding procedures are damaging the concrete, smaller weld beads and multiple passes shall be utilized to reduce the intensity of heat transferred to the concrete.
- c. Radiographic and magnetic particle testing will not be required for field welds or welds performed after a portion of the assembly is embedded in concrete.

The cumulative width of the girders shall be checked as erection proceeds and contact surfaces shall be ground as necessary to obtain the deck width shown.

When the Plans provide for keyways between adjacent concrete members to be filled with grout, the grout shall consist by volume of 1 part Portland cement, 3 parts clean concrete sand and minimum water necessary for placement. The Portland cement shall conform to Section M-200-2.1. The concrete sand shall conform to Section M-200-2.1 except 100% shall pass the No. 8 sieve.

Alternatively, a premixed grout having a minimum 28 day compressive strength of 4000 psi may be used subject to approval. Proprietary grout mixtures shall be utilized in accordance with the recommendations of the manufacturer.

Concrete areas to be in contact with the grout shall be cleaned of all loose and foreign matter that would in any way prevent bond between the mortar and the concrete surfaces and shall be kept thoroughly saturated with water for a period of not less than twenty-four hours immediately prior to placing the grout.

The grout shall contain only sufficient moisture to permit packing and shaping. The grout shall be tightly packed in the keys and spaces. After placing, all exposed surfaces of the grout shall be kept covered with a heavy thickness of burlap saturated with water for a period of three days at a minimum temperature of 45 °F. All improperly cured or otherwise defective grout shall be removed and replaced at the Contractor's expense. No load shall be placed on the grout until it has set for at least ninety-six hours.

Girder bearings shall be placed in accordance with Section M-300-3.2.h.

METHOD OF MEASUREMENT

210-4.1 The pay quantity will be the actual number of pre-cast prestressed concrete structural members, of the several types and sizes, installed in place, completed, and accepted.

BASIS OF PAYMENT

210-5.1 Payment for Prestressed Concrete Structural Members covers all concrete, reinforcing, and prestressing steel, enclosures for prestressing steel, anchorages, plates, nuts, and other such material contained within or attached to the unit; all structural steel diaphragms, bolts, studs, anchor bars, deck ties and other miscellaneous steel embedded in or attached to the girders or diaphragms; all concrete and reinforcement in end diaphragms; all bearing pads, grout, and expanded polyethylene; and all timber or timber hardware attached to prestressed concrete structural members.

The quantities of other contract items which enter into the completed and accepted structure will be measured for payment in the manner prescribed for the several items involved.

When the bid schedule does not contain a pay item for prestressed concrete units, costs associated with furnishing and installing prestressed concrete members are subsidiary to the structure in which they are incorporated.

Payment will be under:

Item M-210a Prestressed Concrete Structural Members (**identification**) -per each

ITEM M-220 CONCRETE FLOATS

DESCRIPTION

220-1.1 This work shall consist of the construction of concrete floats in conformance with the Plans and specifications.

MATERIALS

220-2.1 Structural steel plates, shapes, tubing and pipe shall be the size shown on the Plans and per Section M-300.

Structural aluminum plates, shapes, tubing and pipe shall be the grade and size shown on the Plans.

Cover plates for trenches and interior pile collar voids between units shall be 6061-T6 aluminum patterned plate or galvanized ASTM A 36 steel patterned plate in conformance with the following thickness table:

Float Gap or Trench Width (in.)	Aluminum Plate Thickness (in.)	Steel Plate Thickness(in.)
24	5/16	1/4
16	5/16	1/4
12	1/4	3/16
8 or 9	1/4	1/8

Plate length is a Contractor's option providing plates do not cross hinged or float unit joints, and plates extend to outboard edge of bumpers or float unit whichever is applicable.

Timber shall be the sizes shown on the Plans and per Section M-100.

Structural concrete shall be per Section M-200.

Reinforcing steel and fittings shall be the sizes called for on the plan and per Section M-310.

Inner core of the concrete units shall be solidly filled with 1.1 lb/ft³ (+ 0.15 lb/ft³) density polystyrene foam per ASTM D 1621. Foam shall be virgin new material.

Timber hardware shall be the sizes shown on the Plans and per Section M-100.

Cleats shall be cast gray iron, hot dip galvanized, heavy dock cleats as follows:

8 inch cleats shall weigh a minimum 3 lbs each and be secured with two 7/16 inch \varnothing bolts; 10 inch cleats shall weigh a minimum 6 lbs each and be secured with two 1/2 inch \varnothing bolts; 12 inch cleats shall weigh a minimum 10 lbs each and be secured with two 5/8 inch \varnothing bolts.

Bolt inserts shall be Dayton Sure-Grip and Shore Co. threaded inserts or approved equal as follows:

- a. Endwall- F-42 ferrule loop insert, 3/4 inch \varnothing , 2500 lbs safe tension load, hot dip galvanized.
- b. Slab- F-44 thin slab ferrule insert, 1/2 inch \varnothing , 600 lbs safe tension load, 5/8 inch \varnothing , 1000 lbs safe tension load, hot dip galvanized.
- c. Slab- F-42 ferrule loop insert, 3/8 inch \varnothing , 1500 lbs safe tension load, hot dip galvanized.

Electrical ducting in float units shall be 2-1/2 inch schedule 40 PVC or 3 inch diameter Type DB pipe, as shown on the Plans, for straight runs and shall be 3 inch diameter Schedule 40 PVC for swept sections. Electrical ducting shall meet Underwriter Laboratories specifications for 90 °C wire rating.

Sleeves for all 5/8 inch diameter and 3/4 inch diameter connecting rods shall be 3/4 inch diameter, Class 125, 160, or 200 PVC pipe. Sleeves shall extend through pontoons and have a minimum of 2 inches cover, measured from exterior to centerline of pipe, over full length.

Molded rubber float bumpers where noted shall be heavy duty #1093 straight type and #1094 corner type as manufactured by Griffith Rubber Mills, or approved equal.

"D" fenders shall have tapered sides, 4-1/2 inch base, 3-3/4 inch height and a 2 x 2-1/4 inch bore. Maximum tolerances \pm 4% on faces; \pm 8% on bore and 1/2 inch on length.

"D" fenders for joints shall be 6 inch x 6 inch with 3 inch x 3 inch D shaped bore. Maximum tolerances \pm 4% on faces; \pm 8% on bore and 1/8 inch on length.

Rubber for "D" fenders described above shall conform to ASTM D 2000 4CA 720 or 4AA 720 virgin natural rubber. Suffix requirements for either type/class shall be B10 (25% max.), C12, F17, EA13 (5% vol. change max.), G12.

Thru rods shall be the size shown on the Plans and shall be galvanized ASTM A 307 steel.

Cover plate screws shall be stainless steel with flat heads of the size called for on the Plans.

Polyethylene pile collar liners shall be fabricated from UHMW polyethylene containing carbon black to stabilize it against ultraviolet light.

220-2.2 PROTECTIVE COATING AND TREATMENTS. All new concrete float surfaces, above the midpoint of the water depth, shall be treated with a surface seal. This treatment shall be applied per manufacturers written recommendations and instructions to insure that the manufacturers warranty is in effect. Material shall be as follows:

Material shall be Alkyl-Alkoxy silane with a minimum of 40% solids by weight. CHEM-TRETE-BSM by TROCAL waterproofing systems has been approved for use on this project. Their address is 10 Link Drive, Rockleigh, New Jersey 07647. Phone: (201) 767-1660. Sil-Act ATS 42 by Advanced Chemical Technologies Co. has also been approved for use on this project. Their address is Oil Center Building, Suite 1103W, 2601 NW Expressway, Oklahoma City, Oklahoma 73112. Phone: (405) 843-2585. IsoFlex 618 by Peterson Elastomers has also been approved for use on this project. Their address is 4150 S. Lapeer Rd., Pontiac, MI 48057. Phone: (313) 373-8100.

Surface sealer shall meet the following test procedures of NCHRP Concrete Sealers Study:

Reduction of salt water absorption into concrete	70% min.
Reduction of chloride content into concrete exposure test	76% min.

A Certification of Compliance shall be submitted stating material is manufactured to the same specification as material used in the test.

Surface seal shall be applied as follows:

- a. The sealer will be applied after concrete has cured 28 days. Surface shall be water blasted and blown clean with oil-free compressed air.

- b. Apply sealer at a surface temperature of 40 °F or above with low pressure, (15 psi maximum) airless spraying equipment. The spray equipment shall have a fan type spray nozzle. All equipment must be dry prior to use.
- c. Surface seal shall be applied per manufacturers written instructions for both horizontal and vertical surfaces. Manufacturers literature shall be provided to the Engineer prior to commencing application.

CONSTRUCTION REQUIREMENTS

220-3.1 FABRICATION. Steel and aluminum components shall be shop fabricated and treated as applicable with specified protective coatings.

Welding per Section M-300.

Lumber shall be cut and predrilled prior to preservative treatment per Section M-100.

Concrete float units shall be precast and delivered to the project site as completely fabricated units.

The exterior concrete walls of pontoons shall form an enclosing envelope cast around an expanded polystyrene core. The core shall be pre-formed to the interior concrete configuration as a solid block of polystyrene. Cores shall be securely anchored in place during pontoon construction to prevent displacement or distortion during concrete casting.

Trenches shall be formed as detailed on the Plans.

Cover plates shall be shipped attached to the float unit. Cover plates to be drilled to insure countersinking of bolt.

Fabricator to insure cover plates and/or duct sweeps are coordinated with the electrical meter base.

220-3.2 FLOAT CONSTRUCTION. Concrete floats shall be constructed as shown on the drawings. If alternates on float depth are proposed, calculations shall be provided with the shop drawings to show effect on freeboard. Altered floats shall have calculated freeboards within $-1/2$ inch to $+1$ inch of design freeboard shown on the Plans.

The timber wale joints shall be staggered and centered on the float units as shown on the drawings. Glu-Lam stall float wales shall be full length without joints. Cleats shall be installed as shown.

Rubber bumpers shall be installed at the locations indicated using No. 12 x 2-1/2 inch long galvanized flat head wood screws through 5/16 inch galvanized flat washers (14 per bumper). "D" fender shall be installed as shown.

A malleable iron washer shall be placed between nut and wood surfaces in all instances. Field cuts and bolt holes shall be treated per Section M-100.

All joints in PVC conduit encased within the float units shall be solvent cemented in accordance with the manufacturer's recommendation.

Exposed ends of rods terminating in the utility trench shall be coated with G.E. "Glyptol 1201 A".

METHOD OF MEASUREMENT

220-4.1 Concrete floats will be measured by the square foot, computed by multiplying the float width measured out-to-out of the timber wales by nominal float lengths along centerline of float, plus the area of stall float fillets where applicable.

BASIS OF PAYMENT

220-5.1 Payment covers all costs associated with constructing concrete floats complete-in-place and accepted, including all connection plates and hardware, weldments, timber, trenches and cover plates, conduit and incidentals required to complete the float system and providing for utilities in conformance with the Plans and specifications.

Any modifications to cover plates to accommodate utility installation are subsidiary.

Payment will be made under:

Item M-220a Concrete Floats - per square foot

ITEM M-300 STEEL STRUCTURES

DESCRIPTION

300-1.1 This work shall consist of steel structures and the structural metal portions of composite structures, constructed in conformance with the Plans and specifications.

The work shall include the furnishing, fabricating, erecting, and protective coating of structural metals shown on the Plans. Structural metals shall include structural steel of all grades, welding, special and alloy steels, metallic electrodes, steel forgings and castings, and iron castings. This work shall also include any incidental metal construction and elastomeric material not otherwise provided for, all in accordance with the contract.

Subject to written approval, the Contractor may substitute a grade of steel, equal or superior in both physical and chemical properties to that specified on the Plans or in these specifications, for the particular application for which the substitution is desired. Substitution may be made for any steel item, but any such substitution shall be at no increase in cost to the State.

This work shall also include structural steel gangways as shown on the Plans and in conformance with these specifications.

MATERIALS

300-2.1 Structural steel plates and shapes shall be the sizes shown on the Plans and shall be galvanized ASTM A 36 unless otherwise noted.

Structural steel tubing shall be the sizes shown on the Plans and shall be galvanized ASTM A 500 grade B unless otherwise noted.

Open metal grate decking and steel grating shall be the sizes and have the section properties shown on the Plans and shall be galvanized ASTM A 36. Top edges of all grating decking members shall be serrated and in the same plane unless otherwise noted.

Group 2 Charpy V-notch toughness requirements are mandatory for material designated on the Plans as main load carrying member components subject to tensile stress.

Sampling and testing procedures shall be in accordance with the requirements of ASTM A 673, the (H) frequency of testing shall be used.

Test reports of Charpy impact testing shall be submitted to the Engineer.

High strength bolt, nut and washer material shall conform to the requirements of ASTM A 325. Bolts and nuts shall be the heavy hex type and galvanized if components connected are galvanized.

Machine bolts shall conform to ASTM A 307 and be galvanized.

Stud shear connectors shall be the sizes and dimensions shown on the Plans and shall conform to ASTM A 108, Grade 1015, 1017 or 1020 and shall be galvanized if the piece they are attached to is galvanized.

Steel forgings shall conform to the dimensions shown on the Plans and the following:

- a. Alloy Steel Forgings for general industrial use shall conform to ASTM A 668, Class G, unless otherwise specified.

- b. Carbon Steel Forgings for general industrial use shall conform to ASTM A 668, Class C, unless otherwise specified.
- c. Pins and Rollers. Pins and rollers more than 7 inches in diameter shall be annealed carbon-steel forgings conforming to ASTM A 668, Class C.

Pins and rollers 7 inches or less in diameter shall be either annealed carbon-steel forgings conforming to ASTM A 668, Class C or cold finished carbon-steel shafting conforming to ASTM A 108, Grade 1016 to 1030, inclusive, with a minimum Rockwell Scale B hardness of 80. Material not conforming to the specifications for hardness may be accepted provided it develops a minimum tensile strength of 66,000 psi and a minimum yield point of 33,000 psi.

Threads for pins shall conform to the American Standards Association B 1.1 Coarse Thread Series, Class 2-A. Pin ends having a diameter of 1-1/2 inch or more shall be threaded six threads in 1 inch.

Steel, gray-iron castings shall conform to the size and dimensions shown on the Plans, shall be true to pattern in form and shall conform to the following requirements, unless otherwise specified:

(1) Carbon Steel Castings Grade 65-35	ASTM A 27
(2) Chromium Alloy Steel Castings Grade CA-15	ASTM A 743 and A 744
(3) Gray-Iron Castings Class 30	ASTM A 48
(4) Malleable Iron Castings Grade 35018	ASTM A 47

Five copies of a CERTIFIED mill test report covering mechanical and physical tests conducted on the structural steel and steel forgings shall be submitted to the State for the material in each shipment.

300-2.2 PROTECTIVE COATINGS AND TREATMENT. Except as noted on the Plans all structural steel and hardware shall be galvanized after fabrication in accordance with appropriate ASTM specification. Assemblies or subassemblies too large for available galvanizing equipment may be galvanized in pieces, then spliced. Splices shall be shop galvanized using hot applied galvanize coatings per Section M-300-3.3.

Field Coating Repair. Field splices, welds and damaged areas will be repaired, per Section M-300-3.3.

Structural steel not to be galvanized shall be painted in accordance with the painting Specifications.

CONSTRUCTION REQUIREMENTS

300-3.1 FABRICATION.

- a. **Shop Inspection.** The Contractor shall furnish 30 days notice of the beginning of work at the mill or in the shop, so that inspection may be provided. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured.
- b. **General.** Workmanship and finish shall be equal to the best practice in modern fabrication shops. Portions of the work exposed to view shall be finished neatly. Shearings, flame cutting, and chipping shall be done carefully and accurately.

Structural material, either plain or fabricated, shall be stored at the fabricating shop above the ground on platforms, skids, or other supports. It shall be kept free from dirt, grease, or other foreign matter, and shall be protected, as far as practicable, from corrosion.

Rolled material, before being laid off or worked, must be straight. If straightening is necessary, it shall be done by methods that will not injure the metal. Sharp kinks and bends shall be cause for rejection of the material.

Steel or wrought iron may be flame cut, provided a smooth surface is secured by the use of a mechanical guide. Flame cutting by hand shall be done only where approved, and the surface shall be made smooth by planing, chipping, or grinding. The cutting flame shall be adjusted and manipulated so as to avoid cutting beyond the prescribed lines. Re-entrant cuts shall be filleted to a radius of not less than 3/4 inch.

Finishing and Shaping. Finished members shall be true to line and free from twists, bends, and open joints.

Edge Planing. Sheared edges of plates more than 5/8 inch in thickness and carrying calculated stresses shall be planed to a depth of 1/4 inch. Re-entrant cuts shall be filleted before cutting.

Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet ANSI surface roughness requirements as defined in B46.1, surface roughness waviness, and lay, Part I:

Steel Slabs	ANSI 2,000
Heavy plates in contact in shoes to be welded	ANSI 1,000
Milled ends of compression members, stiffeners, and fillers	ANSI 500
Bridge rollers and rockers	ANSI 250
Pins and Pin rockers	ANSI 125
Slide Bearings	ANSI 125

Abutting Joints. Abutting joints in compression members and girder flanges, and in tension members where so specified on the drawings shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed 1/4 inch.

Bent Plates. Cold-bent load-carrying rolled-steel plates shall conform to the following:

They shall be so taken from the stock plates that the bendline will be at right angles to the direction of rolling.

The radius of bends, measured to the concave face of the metal, shall not be less, and preferably shall be greater than shown in the following tabulation, in which T is the thickness of the plate.

Angle Through Which Plate is Bent	Minimum Radius
61-90 Degrees	1.0 T
91-120 Degrees	1.5 T
121-150 Degrees	2.0 T

If a shorter radius is essential, the plates shall be bent hot.

Before bending, the edges of the plate shall be rounded to a radius of 1/16 inch throughout that portion of the plate where the bending is to occur.

Fit of Stiffeners. Fitting up and attachment of end and intermediate stiffeners shall be shown on the Plans.

Ends of stiffeners and other attachments shall not be welded to flanges unless shown on the Plans.

Stress Relieving. Where called for on the Plans, welded members shall be stress relieved in accordance with the requirements of Article 3.9 of the AWS specifications.

- c. **Shop Splices.** In addition to those shown on the Plans, girder webs and flanges may contain a maximum of 2 shop splices per plate per span, at the option of the Contractor. All such splices shall be indicated on the shop drawings and are subject to approval. These splices are subject to the following limitations:

All splices shall be full penetration butt welds. Flange splices shall be ground flush. Web splices shall be ground flush on outside face of exterior girders only. All such grinding shall be parallel to the longitudinal axis of the girder.

No bottom flange or bottom chord splice will be permitted within the middle third of any span. Tension flange splices will be permitted only as shown on the Plans or as approved.

Each element of a girder, i.e., flange or web, shall be completely welded before being attached to any other element. All splices shall be at least 6 inches from the nearest stiffener plate. Web and flange splices shall be offset a minimum of 6 inches.

- d. **Pins and Rollers.** Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth and free from flaws.
- e. **Bolt Holes.** All holes for bolts shall be either punched or drilled. Material forming parts of a member composed of not more than 5 thicknesses of metal may be punched 1/16 inch larger than the nominal diameter of the bolts whenever the thickness of the metal is not greater than 3/4 inch for structural carbon steel or 5/8 inch for alloy steel.

When there are more than 5 thicknesses or when any of the main material is thicker than 3/4 inch in carbon steel, or 5/8 inch in alloy steel all the holes shall be subpunched or subdrilled 3/16 inch smaller and, after assembling, reamed 1/16 inch larger, or drilled from the solid to 1/16 inch larger than the nominal diameter of the bolts.

Punched Holes. The diameter of the die shall not exceed the diameter of the punch by more than 1/16 inch. If any holes must be enlarged to admit bolts, they shall be reamed. Holes must be clean cut, without torn or ragged edges. Poor matching of holes will be cause for rejection.

Reamed or Drilled Holes. Reamed holes shall be cylindrical, perpendicular to the member, and not more than 1/16 inch larger than the nominal diameter of the bolt. Where practicable, reamers shall be directed by mechanical means. Drilled holes shall be 1/16 inch larger than the nominal diameter of the bolt. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist drills.

Accuracy of Punched and Subdrilled Holes. All holes punched full size, subpunched, or subdrilled shall be so accurately punched that after assembling (before any reaming is done) a cylindrical pin 1/8 inch smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75% of the contiguous holes

in the same plane. If the requirement is not fulfilled, the badly punched pieces will be rejected. If any hole will not pass a pin 3/16 inch smaller in diameter than the nominal size of punched hole, this will be cause for rejection.

All steel templates shall have hardened steel bushings in holes accurately dimensioned from the center lines of the connection as inscribed on the template. The center lines shall be used in locating accurately the template from the milled or scribed ends of the members.

- f. **Bolted Connections, High-Tensile Strength Bolts.** Bolt Lengths. Bolt lengths shall be determined by adding the grip length values given in Table M-300-1 to the total thickness of connected material. These values compensate for thickness of nut and bolt point. The total length shall be adjusted to the next longer 1/4 inch increment up to a 5 inch length and to the next longer 1/2 inch increment for lengths over 5 inches.

TABLE M-300-1

BOLT LENGTH DETERMINATION

Bolt Diameter Size (in.)	Added Length (in.)
1/2	11/16
5/8	7/8
3/4	1
7/8	1-1/8
1	1-1/4
1-1/8	1-1/2
1-1/4	1-5/8

Bolted Parts and Assembly. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or other interposed compressible material.

When assembled, all joint surfaces, including those adjacent to washers, shall be free of scale except tight mill scale. They shall be free of dirt, loose rust, burrs, and other defects that would prevent solid seating of the parts.

Contact surfaces shall be free of oil, paint or lacquer.

When the other face of the bolted parts has a slope of more than 1:20, a smooth beveled washer shall be used in contact with the sloped surface.

Where bolted connections do not connect or splice main stress-carrying members, the Engineer may permit a simplified bolting procedure to be utilized, provided that all bolts are satisfactorily tightened. Diaphragm connections shall be made utilizing the procedure below.

Bolting of joints shall be accomplished by the following procedure:

The joint shall be fitted up and aligned with drift pins. The number of pins will vary with the size and type of joint.

Fitting up bolts shall be placed in at least 50% of the field holes. Sufficient force shall be applied to bring faying surfaces of steel into close contact. If high strength bolts are used as fitting up bolts, they shall be clearly marked for identification.

High strength bolts shall be installed in remaining field holes and brought up to a snug tight condition such as can be produced by a few blows of an impact wrench, or by an ordinary spud wrench.

Bolts shall be tightened by turn of the nut method and shall be match-marked and tightened in accordance with Table M-300-2 progressing from most rigid part of joint toward the free edges.

Fitting up bolts, if high strength bolts, shall then be loosened and retightened by the same procedure; if not high strength bolts, they shall be replaced with high strength bolts tightened as above.

TABLE M-300-2

REQUIRED TIGHTENING FROM SNUG TIGHT CONDITION
(TURN OF THE NUT METHOD)
(Tolerance 30° over, nothing under)

Bolt Diameter (in.)	1/3 Turn for Grips	1/2 Turn for Grips
3/4	2 inch & under	above 2 inches
7/8	2-1/2 inch & under	above 2-1/2 inches
1	3 inch & under	above 3 inches

Impact wrenches shall be of adequate capacity and sufficiently supplied with air to perform the required tightening in approximately 10 seconds.

If required because of bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. In any case, the element not being turned shall be prevented from rotating.

Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well-pinned, and firmly drawn together with bolts before reaming is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The members shall be free from twists, bends, and other deformation.

Preparatory to the shop bolting of material punched full-size, the bolt holes, if necessary, shall be spear-reamed for the admission of the bolts. The reamed holes shall not be more than 1/16 inch larger than the nominal diameter of the bolts.

Drifting for Holes. The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the bolts, they shall be reamed.

Match-Marking. Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished to the Engineer.

- g. Welding.** All welding on bridges or gangways shall conform to the requirements of the AASHTO/AWS Bridge Welding Code D1.5, except welding on tubes which shall conform to AWS Structural Welding Code D1.1. All other welding shall conform to AWS Structural Welding Code D1.1.

Welding of members or components of members designated as fracture critical shall be done in accordance with the applicable provisions of AASHTO/AWS Bridge Welding Code D1.5.

Location, method, and extent of mandatory nondestructive testing to be performed shall be per applicable welding code.

AASHTO/AWS Bridge Welding Code D1.5 Section 6.6.5 is modified to read as follows: For welds not designated for mandatory NDT, the QA inspector may require NDT of any weld that in his opinion does not meet the criteria for NDT acceptance. For welds not meeting NDT acceptance criteria, the costs associated with NDT and repair shall be borne by the Contractor. For welds NDT inspected under this subsection which meet NDT acceptance criteria, costs associated with NDT shall be borne by the Department.

300-3.2 ERECTION.

- a. **General.** The Contractor shall provide all materials labor, tools and equipment necessary for the expeditious handling of work, and shall erect the structural steel, remove the temporary construction, and do all work necessary to complete the structure, as required by the contract and in accordance with the Plans and specifications. All temporary field welds to structural steel shall be made in accordance with the procedures required by these specifications. Sharp kinks or bends shall be cause for rejection of the Steel. Heat straightening of ASTM A 514 or A 517 steel will be governed by special provision when used.
- b. **Handling and Storing Materials.** Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members shall be adequately supported on skids to prevent injury from deflection.
- c. **Falsework.** The falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The Contractor shall prepare and submit plans for falsework or for changes in an existing structure necessary for maintaining traffic.
- d. **Method and Equipment.** Before starting the work of erection the Contractor shall inform the Engineer fully as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use.

Handling and erection procedures shall be conducted in such a manner as to avoid inducing critical buckling stresses in the structure and to avoid damaging the protective coating or paint system. Plans showing the method of erection shall be submitted for approval. Stress sheets and deflection diagrams for any design or unusual erection method shall be furnished, if requested.

All of the above shall be subject to approval. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the Plans and specifications. no work shall be done until approval has been obtained.

- e. **Straightening Bent Material.** The straightening of plates and angles or other shapes shall be done by methods not likely to produce fracture or other injury. The metal shall not be heated unless permitted by the Engineer, in which case the heating shall not be to a higher temperature than that producing a "dark cherry red" color.

After heating, the metal shall be cooled as slowly as possible. Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture and the protective coating or paint shall be repaired as specified.

- f. **Assembling Steel.** The parts shall be accurately assembled as shown on the Plans and match-marks shall be followed. The material shall be carefully handled so that no parts will be bent,

broken, or otherwise damaged. Hammering which will injure or distort the members will not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled.

- g. Pin Connections.** Pilot and driving nuts furnished by the Contractor shall be used in driving pins. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and secured as shown on the Plans.
- h. Setting Shoes and Bearings.** Shoes, bearing plates and elastomeric bearing pads set directly on concrete surfaces shall be placed on bearing areas that are properly finished. The concrete surfaces shall be floated on a level plane which shall not vary more than 1/16 inch from a straightedge placed in any direction across the area. The finished surface shall not vary more than 1/8 inch from the elevation shown on the Plans. The shoes, elastomeric bearing pads, and bearing plates shall be set as shown on the Plans in exact position with full and even bearing.

Grout to be placed under masonry plates shall consist by volume, of 1 part Portland cement and 3 parts clean concrete sand. Alternatively, a premixed non-shrink grout may be used subject to approval. Grout shall contain only sufficient water to permit packing and shaping. Concrete areas to be in contact with the grout shall be cleaned of all loose or foreign matter that would in any way prevent bond between the mortar and the concrete surfaces and shall be kept thoroughly saturated with water for a period of not less than 24 hours immediately prior to placing grout.

The grout shall be tightly packed under the masonry plates to provide full bearing. After placing, all exposed surfaces of grout pads shall be kept covered with a heavy thickness of burlap saturated with water for a period of 3 days. All improperly cured or otherwise defective grout shall be removed and replaced at the Contractor's expense. No load shall be placed on the grout until it has set for at least 96 hours.

The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit the free movement of the span.

300-3.3 REPAIRING GALVANIZED COATING AFTER WELDING. Repair sticks used to repair galvanizing shall be zinc-cadmium alloys (melting point 518-527 °F), such as "Rev-Galv" or zinc-tin-lead alloys (melting point 446-500 °F), such as "Galv-Weld, "Zilt" and "Gallover". The zinc-tin-lead alloys shall comply with U.S. Federal Specification O-G-93, November, 1949, and contain fluxing ingredients.

The procedure for using repair sticks is as follows:

- a.** Remove welding slag by chipping hammer and clean weld or damaged area by vigorous wire brushing.
- b.** Preheat the region to be repaired by means of an oxyacetylene torch or other convenient method to 600 °F. The alloys do not spread well at lower temperatures.
- c.** Wire brush surface again.
- d.** Apply coating by rubbing bar of the alloy over the heated surface while it is hot enough to melt the alloy.
- e.** Spread the molten alloy by briskly wire brushing or rubbing with a flat edged strip of steel or palette knife.
- f.** Remove flux residues by wiping with a damp cloth or rinsing with water.
- g.** Brush apply two coats zinc rich paint (cold galvanize repair).

It is possible to utilize the residual heat in the weld to melt the repair stick, and the procedure for welds that are still hot (600 °F or over) is:

- a. Remove slag and wire brush vigorously.
- b. Apply coating of alloy as above and paint as per g above after cooling.

In all cases, the repair stick should not be applied to a surface much above 600 °F, because too much dross will be formed. Some of these repair components are also available in powder form which is applied in a similar manner to the sticks.

Contractor may optionally elect to utilize metallizing techniques to spray apply a zinc protective coating as a substitute for zinc stick repair technique. If metallizing technique is employed, surface preparation and application of zinc coating shall be per current AWS specification C2.2.

300-3.4 CLEANUP. Upon completion and before acceptance of the structure the Contractor shall remove all falsework , and falsework piling down to 2 feet below the finished ground line.

METHOD OF MEASUREMENT

300-4.1

- a. **Structural Steel** quantities will not be measured for payment.
- b. **Structural Steel Gangways** will be measured by the number of gangways completed and accepted.

BASIS OF PAYMENT

300-5.1 The lump sum or unit price covers all structural steel furnished, fabricated and erected, including gangway hangers, miscellaneous hardware, and transitions.

No additional payment will be made for increases in structural steel quantities made necessary by the Contractor's method of erection.

Unless otherwise specified, structural steel for precast or prestressed concrete bridges is subsidiary.

Where no pay item appears in the bid schedule structural steel is subsidiary to the structure in which it is incorporated.

Payment will be made under:

- | | |
|-------------|--------------------------------------|
| Item M-300a | Structural Steel – per lump sum |
| Item M-300b | Structural Steel Gangways – per each |

ITEM M-310 REINFORCING STEEL, PRESTRESSING STEEL AND FITTINGS

DESCRIPTION

310-1.1 This work shall consist of furnishing and placing reinforcing steel and/or prestress reinforcement and hardware in conformance with the Plans and specifications.

MATERIALS

310-2.1 The materials shall conform to the following:

- a. **Reinforcing Steel.** Reinforcing steel shall conform to the requirements of the following specifications.

Billet-Steel Bars for Concrete Reinforcement	ASTM A 615
Fabricated Steel Bar or Rod Mats for Concrete Reinforcement	ASTM A 184
Welded Steel Wire Fabric for Concrete Reinforcement	ASTM A 185
Cold-Drawn Steel Wire for Concrete Reinforcement	ASTM A 82
Spiral Reinforcement(minimum yield of 60,000 psi)	ASTM A 82

Only Grade 60 reinforcing steel shall be used with the exception of launching ramp stirrups which shall be Grade 40.

Spiral reinforcing steel may be either smooth or deformed bars and shall be furnished in one continuous or butt welded bar except that spirals with a height exceeding 20 feet may be field spliced using laps of one and one-half turns.

- b. **Ducts.** Ducts for float tendons shall be polyvinyl chloride conforming to ASTM D 2665. Ducts shall be watertight and their ends shall be effectively protected to prevent entry of water, concrete, or any debris.

Ducts for flexural member tendons shall be metallic and shall be mortar tight, with the exception that the Contractor, at his option, may form the enclosures by means of cores or ducts composed of rubber or other suitable material which can be removed prior to installing the prestressing reinforcing.

For tendons made up of a plurality of wires, bars, or strands, duct area shall be at least twice the net area of the prestressing steel.

For tendons made up of a single wire, bar or strand, the duct diameter shall be at least 1/4 inch larger than the nominal diameter of the wire, bar or strand.

Where pressure grouting or lubrication is specified, the enclosures shall be provided with pipes or other suitable connections for the injection of grout or lubricant after the prestressing operations have been completed. Fittings shall be provided at anchorages and at high and low points for ejection of trapped air and water respectively. Fittings shall also be provided at each end of each float module unless otherwise approved.

- c. **Prestressing Steel.** This specification provides the minimum requirements for prestressing steel and fittings used in pre-tensioned and post-tensioned and concrete construction.

(1) **Strand:** Strand used for pre-tensioning or post-tensioning shall conform to ASTM A 415.

(2) **Wire:** Wire used in post-tensioning tendons shall conform to ASTM A 421. Oil tempered wires shall not be used.

Strands or wire not specifically itemized in ASTM A 416 or A 421, including low relaxation strand or wire, may be used provided they conform to the minimum requirements of these specifications and have no properties which make them less satisfactory than those listed in ASTM A 416 or A 421.

(3) High-strength Prestressing Bars: High-strength steel alloy prestressing bars shall conform to the requirements of ASTM A 722.

(4) Anchorages: The anchorage system used in post-tensioned concrete construction shall be designed so that the bearing stresses created by the anchorage will not exceed the values from the following equations:

(a) At working load: $f_{cp} = 0.6f'_c A_b'/A_b$ but not greater than f'_c

(b) At transfer load: $f_{cp} = 0.8f'_{ci} (A_b'/A_b) - 0.2$ but not greater than $1.25f'_{ci}$

where f_{cp} = permissible compressive concrete stress

f'_c = compressive strength of concrete

f'_{ci} = compressive strength of concrete at time of initial prestress

A_b' = maximum area of the portion of the concrete anchorage surface that is geometrically similar to and concentric with the area of the anchorage.

A_b = bearing area of the anchorage

(c) As used in the above equations, f_{cp} is the average bearing stress (P/A) in the concrete computed by dividing the force P of the prestressing steel by the net projected area A_b between the concrete and the bearing place or other structural element of the anchorage which has the function of transferring the force to the concrete.

The anchorages shall develop at least 90% of the specified minimum ultimate strength of the prestressing steel. Localized yielding of anchor components is permitted; however, generalized permanent yielding or deformation is not permitted.

(5) Couplings: Couplings of tendons shall be used only when approved. All couplings shall develop at least 95% of the specified minimum ultimate strength of the prestressing steel without permanent deformation. Localized yielding of coupling components is permitted; however, generalized permanent yielding is not permitted. The coupling of tendons shall not reduce the elongation at rupture below the requirements of the tendon itself. Couplings and/or coupling components shall be enclosed in housings large enough to permit the necessary movements and fittings shall be provided to allow complete grouting of all the coupling components.

(6) Conformance Testing: The post-tensioning system supplier shall submit data from conformance tests to confirm the adequacy of the system. Minimum requirements for the conformance tests are listed in the following paragraph.

The test assembly shall consist of standard production quality components and the tendons shall be at least 10 feet long. The test assembly shall be tested in such a manner to allow accurate determination of the yield strength, ultimate strength and percent elongation of the complete system to insure compliance with this specification.

(7) Sampling: All wire, strand, or bars to be shipped to the site shall be assigned a lot number and tagged for identification purposes.

(a) Strand. A 7 foot sample of the strand shall be submitted to the Engineer for test from each size and type of strand. A sample shall be taken from either end of each roll.

(b) Wire. A 5 foot sample shall be taken from each ten coils or less in a lot. A lot shall consist of all coils of wire of same nominal wire size contained in an individual shipping release or shipping order.

(c) Bar. A 7 foot sample of the bar shall be submitted to the Engineer for test from each size and type of bar.

310-2.2 PROTECTIVE COATINGS AND TREATMENTS.

a. Reinforcing Steel. All reinforcing steel shall be hot dip galvanized per ASTM A 767. Bend reinforcing steel prior to galvanizing.

b. Prestressing Steel. Prestressing steel and fittings shall be provided uncoated unless otherwise shown on the Plans.

310-2.3 HANDLING OF MATERIALS. Reinforcing steel and prestressing steel shall be protected at all times from damage. Prestressing steel shall be packaged & marked as per ASTM A 416 Sec. 14.1.

All systems for handling reinforcing bars shall have padded contact areas for the bars wherever possible. All bundling bands shall be padded and all bundles shall be lifted with a strong back, multiple supports or a platform bridge to prevent bar to bar abrasion from sags in the bar bundle. The bars or bundles shall not be dropped or dragged.

CONSTRUCTION REQUIREMENTS

310-3.1 BAR LISTS. The bar list and bending schedule are made for the purpose of arriving at an estimate of quantities. The Contractor shall verify the quantity, size and shape of the bar reinforcement against the structure drawings and make any corrections before ordering.

Where bar lists and bending schedules do not appear on the Plans, order lists and bending diagrams shall be furnished by the Contractor for approval in accordance with the General Provisions. The approval of order lists and bending diagrams will not relieve the Contractor of the responsibility for their accuracy. Any expense incident to the revision of material furnished in accordance with such lists and diagrams to make it comply with the design drawings shall be borne by the Contractor.

Reinforcement not shown but required to resist anchorage stresses or where details are not complete or are optional to the Contractor shall be provided by the Contractor at no additional expense. These bars shall be shown on the shop drawings.

310-3.2 BENDING. Unless otherwise permitted, all reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent except as shown on Plans. All hooks and bends shall conform to the current manual of standard practice of the CRSI unless otherwise noted.

310-3.3 PLACING AND FASTENING.

a. Reinforcing Steel. Reinforcing bars shall be accurately placed as shown on the Plans or approved shop drawings and shall be securely held in position during the placing and setting of the concrete. Bars shall be tied with No. 14 or No.16 gauge coated steel wire at all intersections except where bar spacing is 12 inches or less in both direction, in which case alternate intersections shall be tied. Cut ends of ties shall be turned in so as not to decrease the cover.

Unless shown on the Plans or permitted by the special provisions, reinforcing steel shall not be welded without written authorization.

Distances from the forms shall be maintained by means of precast mortar blocks or metal chairs, spacer, metal hangers or supporting wire of sufficient strength to resist movement under construction loads. Metal supports which extend to the surface of the concrete shall be stainless steel or protected by plastic coating to prevent corrosion. Wooden supports shall not be used. Supports under deck slab reinforcement shall be spaced not more than 4 feet apart in each direction.

Placing bars on layers of fresh concrete as the work progresses and adjusting bars during placing of concrete will not be permitted.

All reinforcing steel, other than stirrups, spacers or deck bars noted in Section M-210-1.1, shall have a coverage of 2 inches, measured from the surface of the concrete to the outside of the bar, unless otherwise shown. Stirrups and spacers shall be embedded not less than 1 inch clear, except when exposed to earth the minimum embedment shall be 1-1/2 inches.

- b. **Prestressing Steel.** Placing, fastening and tensioning of prestressing steel, fittings and hardware shall be in accordance with Section M-210.

310-3.4 REINFORCING STEEL SPLICING. Unless otherwise shown on the Plans, bars to be spliced shall be lapped at least 20 bar diameters, except that bars near the top of beams and girders having more than 12 inches of fresh concrete below the bars shall be lapped at least 35 bar diameters.

Number 14S and 18S bars shall not be spliced except as shown on the Plans or as directed.

METHOD OF MEASUREMENT

310-4.1 Prestressing steel, reinforcing steel, hardware, ductwork, and fittings will not be measured for payment.

BASIS OF PAYMENT

310-5.1 Prestressing steel and reinforcing steel are subsidiary to other items of work.

ITEM M-400 PILES

DESCRIPTION

400-1.1 This work shall consist of piles furnished and driven in conformance with the Plans and specifications.

The Contractor shall be responsible for furnishing piles of sufficient length to obtain the required bearing capacity and/or required penetration shown on the Plans, and penetrate to practical refusal when specified. The Contractor may, at his own expense drive test piles, make borings, or make such other investigations as he deems necessary to determine pile lengths required.

It shall also include drilled pile sockets in conformance with the Plans and specifications.

MATERIALS

400-2.1 The materials shall conform to the following:

- a. **Steel Pipe Piles.** Pipe piles shall be the diameter and wall thickness shown on the Plans and shall conform to ASTM A 252 Grade 2, A 501 or A 53 grade B, type E or S, specifications.
- b. **Steel H-Piles.** Steel H-piles shall be the sizes shown on the Plans and conform to ASTM A 36.
- c. **Steel Sheet Piles.** Steel for sheet piles to be a permanent part of the structure shall conform to the requirements of ASTM A 328 unless otherwise specified. The integrity of the interlock shall be maintained when the piles are in place. Sheet piles shall be the sizes shown on the Plans.

Steel Piles shall not exceed the camber and sweep permitted by allowable mill tolerance. Piles bent or otherwise damaged will be rejected.

Four copies of a CERTIFIED mill test report covering chemical and physical tests conducted on the steel shall be furnished to the Engineer for each heat number of metal included in the shipment.

- d. **Timber Piles.** Timber piles shall have the butt or tip circumferences shown on the Plans. Piles shall be Coast Region Douglas Fir conforming to ASTM D 25 with the following modification:

In ASTM D 25 delete Section 11. Straightness in its entirety and substitute the following:

11. Straightness.

11.1 A straight line from the center of the butt to the center of the tip shall lie entirely within the center one-quarter of the diameter of the pile anywhere along the length of the pile.

11.2 Piles shall be free from short crooks that deviate more than 1 inch from straightness in any 5 foot length (see Fig. I) Piles whose axis of section above short crook is not parallel or coincident with axis below the crook shall not be accepted.

11.3 For piles with turned butts, axis of turning shall coincide with a straight line from the center of the butt to the center of the tip.

400-2.2 PROTECTIVE COATINGS AND TREATMENT.

- a. **Steel.** Steel piles shall be galvanized per ASTM A 123. Piles too long for available galvanizing equipment may be galvanized in pieces, then spliced. Such splices shall be shop galvanized using hot applied galvanize coating per Section M-300-3.3.

Field splices, welds and damaged areas will be repaired using hot applied galvanize coating per Section M-300-3.3.

- b. **Timber.** Timber piles shall be creosote pressure treated per AWPA C-3 to 20 lbs/ft³ retention by assay. Retreatment shall not be permitted.

Piles damaged during handling shall be evaluated by the Engineer for repair or replacement.

All cuts in treated piles and all abrasions, after having been carefully trimmed, shall be coated with at least 3 applications of hot creosote oil (between 150 °F and 200 °F) and covered with hot roofing pitch. Before bolts are driven, all holes shall be saturated with hot creosote oil. All unfilled holes after being treated shall be plugged with creosoted plugs.

CONSTRUCTION REQUIREMENTS

400-3.1 TEST PILES. For his own information the Contractor may drive such test piles as he may consider necessary. They shall be of the material shown in the Plans and shall be driven to refusal or to such tip elevation or bearing value as the Engineer may request. Hammer used to drive test piles shall be the same as used to drive service piles.

Test piles may be included as part of the completed structure provided they conform to the requirements of these specifications.

400-3.2 PILE BEARING VALUES. When lateral restraint values dictate (float restraining piles), piles shall be driven to penetration depths indicated on the Plans.

When bearing capacity is the overriding criteria, piles shall be driven to a bearing value of not less than the design load or practical refusal, as shown on the Plans. The safe bearing value of each pile shall be determined by whichever of the following formulae is applicable.

- a. Gravity hammers:
$$P = \frac{2 WHQ}{S + 1}$$

- b. Single-acting hammers with unrestricted rebound of ram:

$$P = \frac{2 WHQ}{S + 0.1}$$

- c. Double-acting hammers with enclosed rams:

$$P = \frac{2 EQ}{S + 0.1}$$

Where: P = Safe bearing value, in pounds

W = Weight of the striking parts of the hammer, in pounds

H = Effective height or fall of the ram, in feet. For diesel hammers with unrestricted rebound of ram, this value shall be the observed average height of fall for the blows used to determine average penetration per blow.

Q = Batter factor equal to $\cos \theta$, where θ is the angle from vertical to the centerline of the pile

S = Average penetration per blow, in inches, for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for steam, air, or diesel hammers

E = The manufacturer's rating of energy developed by double acting steam or air hammer in foot-pounds. (The average equivalent energy shall be determined for the blows used to determine average penetration per blow by use of a gage attached to the hammer and accompanying charts to evaluate equivalent energy from recorded gage readings. This type of hammer must be equipped with such gage and charts before its use will be permitted.

- d. The above formulae are applicable only when: The hammer has free fall. The head of the pile is square and in good condition. Penetration is at a reasonably quick and uniform rate. There is no appreciable bounce of gravity hammers after the blow. A follower is not used.
- e. For gravity hammers, if there is appreciable bounce, twice the height of bounce shall be deducted from H to determine its value in the formula.
- f. When a follower is used to drive piles, an allowance shall be made for the energy dissipated by the follower in determining the safe bearing value of the piles so driven.

400-3.3 JETTED PILES. In determining the safe bearing values of jetted piles, jets shall not be used during the test blows.

400-3.4 MINIMUM PENETRATION. All efforts shall be made to drive all piles at least to the minimum or required penetration or to practical refusal as shown on the Plans.

400-3.5 STEEL PILE EXTENSIONS, SPLICES, AND BUILD-UPS. Extensions, splices, and build-ups, when necessary, shall be made as shown on the Plans and in accordance with the following:

If the length of a steel pile is not sufficient to obtain the required bearing capacity, an additional length shall be spliced to it. Additions shall have cross sections identical to the pile cross sections. Unless otherwise shown on the Plans, splices shall be made with full penetration butt welds over the entire cross section. Piles may be fabricated from pile cut-offs and short pieces as approved by the Engineer providing no piece used in fabrication shall be less than 10 feet in length.

Welding shall be in accordance with Section M-300.

Timber piles shall not be spliced.

400-3.6 TIMBER PILE STRAPPING. Piles shall be strapped as follows: One strap approximately 18 inches from the top, one strap approximately 24 inches from the top, and one strap approximately 12 inches from the bottom. Additional straps shall be provided at approximately 15 foot centers between the top and bottom. Strapping should encircle the pile once and be tensioned as tightly as possible. Straps shall be 1-1/4 inch wide, 1/32 inch thick, cold rolled, fully heat treated, high tensile strapping, painted and waxed, with an ultimate tensile strength of 5,100 lbf. The seal shall be 2-1/4 inches long, 20 gage, crimped with a notch type sealer to furnish a joint yielding 80% of the strap tensile strength.

Piles shall be strapped after treatment. Straps shall be removed subsequent to driving from top to lowest anticipated tide level. Straps shall be removed without damage to piling.

400-3.7 PILE TIP REINFORCEMENT. Metal shoes or reinforced tips of the design shown on the Plans shall be used as indicated on the Plans or ordered in writing by the Engineer.

400-3.8 DRIVING PILES. All piles shall be driven as shown on the Plans or as ordered in writing by the Engineer, should pile anchors or anchorage systems be required they shall be installed in accordance with Section M-410.

- a. Structural bearing piles shall be driven within an allowed variation as to direction of pile not more than 1/8 inch per foot. The position of the piles at cut-off elevation shall be within 1-1/2 inches of the

position shown on the Plans. Distance between any 2 bearing piles shall not vary more than 3 inches from that shown on the Plans.

Timber bearing piles shall be driven tip down.

- b. Float piles shall be driven in true alignment and location with a maximum allowable variation from design position of 2 inches. Piles shall be located so that binding within pile collars does not occur during tidal movement (i.e. extreme high to extreme low).

Timber float piles shall be driven butt down.

- c. Fender piles shall be driven in true alignment and location with a maximum allowable variation from design position of 6 inches at the mudline and 2 inches at the cutoff.

Timber fender piles shall be driven tip down.

- d. Dolphin piles shall be driven in true alignment and location with a maximum variation from design position of 6 inches provided such variation will allow prefabricated caps to be field connected. Allowable variation as to direction shall be a maximum of 1/8 inch per foot. Timber dolphin piles shall be driven butt down.

Pile heads shall be cut squarely and a driving cap provided to hold the axis of the piles in line with the axis of the hammer.

Piles shall be driven with steam, air, or diesel hammers, or a combination of hammers with water jets, except that with written permission from the Engineer gravity hammers may be used for driving timber piles. Consideration will be given by the Engineer to the use of vibratory hammers when requested by the Contractor and when circumstances permit the determination of bearing capacity and required penetration by means other than a dynamic driving formula. The plant and equipment furnished shall have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. The boiler or tank shall be equipped with an accurate pressure gage, and another gage shall be supplied at the hammer intake. The valve mechanism and other parts of the hammer shall be maintained in first class condition so that length of stroke and number of blows per minute for which the hammer is designed will be obtained. Inefficient hammers shall be removed from the work.

Pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer, and they shall be held in such a manner to provide lateral support to the pile during driving. The leads in general shall be of sufficient length to make the use of a follower unnecessary.

In lieu of the above, air hammers with helmets and boots to fit the various diameters of pile may be used for driving float pile thru tightly blocked pile collars or tight collars mounted solidly on the driving barge for all other vertical pile; batter piles driven with a booted hammer shall be driven thru a template which may or may not be part of the completed structure.

Any hammer used shall be capable of developing not less than 15,000 ft-lbs of total energy per blow for steel piles and not greater than 12,000 ft-lbs of total energy per blow for timber piles, unless otherwise authorized by the Engineer. Total energy for diesel hammers with enclosed rams shall be taken as 90% of manufacturer's maximum rating. For diesel hammers with unrestricted rebound of ram, total energy shall be taken as the product of the ram weight and the maximum height of fall.

For special types of piles, driving heads, mandrels, or other devices in accordance with the manufacturer's recommendations shall be provided so that the pile may be driven without injury.

Full-length piles shall be used where practical. Where splices are required, the method of splicing shall be in accordance with the provisions of Sections M-400-3.5 and M-400-2.2.

In the event that the desirable penetration shown on the Plans cannot be obtained by the driving methods and equipment utilized by the Contractor and/or structural damage to the piles is, in the opinion of the Engineer, likely to result from continuation of these methods, the Contractor shall install the piles in drilled pile sockets in conformance with the Plans and Section M-400-3.13. The Engineer may give consideration to acceptance of the piles at a lesser penetration when, in the Engineer's judgment, the adequacy and safety of the resulting structure will not be jeopardized by such acceptance, or if in the case of float piles, it can be demonstrated that adequate lateral pile support, as determined by the Engineer, exists to restrain and secure the floats.

400-3.9 DEFECTIVE PILES. The method used in driving piles shall not subject them to excessive and undue abuse producing injurious splitting, splintering, and brooming of the wood, or deformation of the steel. Manipulation of the piles to force them into proper position, if considered to be excessive, will not be permitted. Any pile damaged in driving by reason of internal defect, damaged by improper driving or driven out of its proper location shall be corrected at the Contractor's expense by one of the following methods approved for the pile in question.

- a. The pile shall be withdrawn and replaced by a new and, when necessary, longer pile.
- b. The pile shall be spliced or built up as otherwise provided herein.

400-3.10 CUTTING OFF PILES. Piles shall be cut off at the elevations and to the grades shown on the Plans. Steel piles and timber bearing piles shall be cut off $\pm 1/16$ inch from planned elevation. Timber fender and float pile shall be cut off level at grade or as shown on the Plans.

400-3.11 FLOAT PILE CUT-OFF TREATMENT. Timber float pile tops shall be cut off horizontally. Immediately after the piles are cut off either 1 inch diameter vertical holes, 2 inches deep, shall be bored in the pile top, beginning at the center of the pile and radiating outward at approximately 2 inches on center, or 2 inches deep vertical chain saw cuts, which intersect at 90° shall be made at approximately 2 inches on center. Neither the drilled holes nor the saw cuts shall approach closer than 1/2 inch to the exterior of the pile.

Immediately after the pile tops are bored or cut crystalline Ammonium Bifluoride, (NH_4HF_2), shall be applied to approximately 1/8 inch above the pile top.

Immediately following the application of NH_4HF_2 the pile shall be capped with coal tar cement.

Steel pile tops shall be treated in accordance with Section M-300-3.3 of these specifications.

400-3.12 Timber Bearing Pile Cut-Off Treatment. Subsequent to final cut-off and dowel or cap connector preboring, the cut-off end of bearing piles shall be treated by one of the following methods:

- a. A fluid-tight sheet metal ring (approximately 12 gauge x 4 inches high) formed slightly less than pile diameter and driven lightly into the pile top will be filled with hot creosote oil (between 150 °F and 200 °F) and left until creosote is absorbed. Ring is then removed and pile top coated with a 1/8 to 1/4 inch thick layer of nonhardening antifungicidal bedding compound, similar to Dolfinite 3905 TX as manufactured by Woolsey Marine Industries, or approved equal.
- b. Or felt or thin metal will be banded to the pile top creating a 3 inch deep fluid tight cup which is then filled with hot creosote oil and treated as per above.

400-3.13 PILE SOCKET DRILLING, SETTING AND BACKFILLING. Equipment and technique are optional to the Contractor providing they are in conformance with plan details and requirements.

METHOD OF MEASUREMENT

400-4.1

- a. **Piles, Furnished.** The length of each pile will be measured in feet, along its centerline, from pile tip to plan cut-off elevation. The pay quantity is the sum of pile lengths in the completed structure.
- b. **Piles, Driven.** The pay quantity is the number of piles driven in place in the completed structure.
- c. **Drilled Pile Sockets.** The pay quantity is the number of piles socketed, as required.
- d. **Sheet Piles.** Sheet piles will be measured in square feet in final position in the permanent structure.

BASIS OF PAYMENT

400-5.1 The quantities, determined as provided above, shall be paid for at the contract price per unit of measurement, respectively, for each of the particular pay items listed below that is shown in the bid schedule.

- a. **Piles, Furnished.** Payment covers pile materials delivered to the site; pile crew time, including payroll and administrative additives; and equipment rental for the driving crane, tug, barge, leads and hammer. All other costs associated with pile work will be paid for under Piles, Driven.
- b. **Piles, Driven.** Payment covers all work related to piles which is not included in Piles, Furnished, including but not limited to: equipment movements, pile splices, cut-offs, templates, crane or work platforms, pile cleanout, jetting or preboring to specified depths, reinforcing steel, concrete fill, and other fixed or variable items. This pay item is independent of pile length and, therefore, will not change with variations from estimated pile tip elevations. No adjustment in the contract unit price for piles, driven, will be made as a result of revisions ordered to the pile tip elevations.
- c. **Drilled Pile Sockets.** Payment covers setting up, drilling, and backfilling. Driving the piles into sockets will be compensated for under items M-400b and M-400d.
- d. **Sheet Piles.** Payment covers all work related to furnishing and driving sheet piles.

Pile shoes, reinforced tips, and splices are subsidiary.

Payment will be made under:

Item M-400a	Treated Timber Piles, Furnished - per foot
Item M-400b	Treated Timber Piles, Driven - per each
Item M-400c	Structural Steel Piles, Furnished - per foot
Item M-400d	Structural Steel Piles, Driven - per each
Item M-400e	Drilled Pile Sockets - per each
Item M-400f	Structural Steel Sheet Piles, Furnished and Driven - per square foot

ITEM M-410 PRESTRESSED PILE ANCHORS

DESCRIPTION

410-1.1 This work shall consist of furnishing and installing prestressed pile anchors and all incidental construction required to install the anchors in conformance with the Plans and specifications. It shall include concrete placement in the piles, drilling, fabrication, placing, grouting, and stressing of prestressed anchors.

The Contractor shall be responsible for providing prestressed anchors and incidentals of sufficient capacity and length to withstand 150% of the design uplift force shown on the Plans.

These anchors shall be used preferably in rock; however, use in material such as dense glacial till will be allowed provided the anchor can withstand initial prestressing.

410-1.2 CONSULTING SERVICE. Unless otherwise permitted the Contractor shall certify that a representative of the anchor manufacturer and a skilled technician, acceptable to the Engineer, will be available to aid and instruct him in the determination of the primary grout length and in the use of the prestressing and grouting materials and methods to obtain the required results.

410-1.3 SHOP DRAWINGS. Shop drawings showing complete details of anchor fabrication, details of anchorage components, grouting pressure, grout strength and methods, and stressing procedure shall be submitted for approval by the Engineer.

MATERIALS

410-2.1 Class A concrete for filling the pile shell shall conform to the requirements of Section M-200.

Prestressing steel and hardware shall conform to the requirements of Section M-310.

Pipe used for tendon ducting shall conform to the size requirements in Section M-310-2.1.b and shall conform to ASTM A 53.

Cement used for grouting shall conform to the requirements of Section M-200-2.1.b.

Water used for grouting shall conform to the requirements of Section M-200-2.1.c.

Non-shrink admixture used for grouting shall be subject to approval of the Engineer.

CONSTRUCTION REQUIREMENTS

410-3.1 GENERAL. Prior to dewatering the pile to be anchored shall be driven to practical refusal in accordance with Section M-400.

All soil need not be removed from within the pipe; however, all loose soil and water must be removed. If dewatering cannot be accomplished by pumping, a short tremie plug of concrete will be required.

410-3.2 DUCT AND CONCRETE FILL. After dewatering, the prestressing casing shall be placed as shown on the Plans and the pile filled with Class A concrete. The concrete shall be placed in one continuous operation.

Concrete may be discharged directly into the pile and permitted to free fall into place. Interior reinforcement shall be used where shown on the Plans. The top 20 feet of concrete shall be vibrated.

After a pile has been filled with concrete no pile shall be driven within 20 feet thereof until at least 7 days after filling.

Concrete placed shall be protected from freezing until the concrete has cured.

Adequate blockouts shall be left at the anchorage locations to allow placement of a concrete cap over the anchorage with 3 inches of cover minimum or as indicated on the Plans.

410-3.3 DRILLING. Drilling equipment may be percussion, rotary or any type able to supply a hole of adequate diameter as recommended by the anchor manufacturer. Holes shall be free of dog legs or protrusions and be able to accommodate the anchor and grouting equipment without crowding.

Holes shall be drilled to a depth which will insure proper primary grout zone length and location. In no case shall the holes be drilled less than 20 feet below the pile tip elevation.

Length shall be checked by the drilling contractor prior to placing of the prestressed anchor.

The anchor holes shall be water pressure tested at grouting pressure using approved hydraulic or pneumatic/hydraulic methods.

If in the opinion of the Engineer the leakage is excessive, the hole shall be pressure grouted and redrilled.

Before placing the anchor, each hole shall be cleaned thoroughly of all dirt cuttings, grease or any other debris and dirt by a method approved by the Engineer.

410-3.4 ASSEMBLY AND PLACEMENT. Anchors shall be fabricated in accordance with detailed shop drawing as approved by the Engineer.

Anchors, free of dirt, loose rust, grease or any other deleterious substances shall be placed and securely fastened in the duct to prevent any movement during the grouting.

Grout vent networks shall be checked with water or compressed air to insure that they are clear.

Unless otherwise permitted, personnel required by subsection M-410-1.2 shall be on site during assembly, placement, grouting and stressing.

All the equipment used for fabricating, handling and placing the rock anchors shall be such that it does not damage or deteriorate the prestressing steel or the anchorages.

410-3.5 GROUTING. Grout used with rock anchors shall consist of a mixture of Portland cement, water and a non-shrink admixture approved by the Engineer.

The water content shall be the minimum necessary for proper placement and shall not exceed 5 gallons per sack of cement.

Cement shall be sieved and free of lumps or other indication of hydration.

Grouting equipment shall be capable of continuous mechanical mixing that will produce uniform and thoroughly mixed grout.

Grouting equipment shall be capable of grouting at a pressure of at least 150 psi and prevent introduction of oil, air or other foreign substance into the grout. No loss of water from the grout due to poor seals, connections or other causes shall be permitted.

The grouting equipment shall have a screen with 0.07 inch maximum clear opening to sieve the grout before being introduced into the grout pump.

- a. **Primary Grouting.** After placing, anchors shall be primary grouted (first stage grouting) in order to bond to the rock or dense till.

All grout piping shall be clean and free of deleterious materials that would interfere with grouting procedure. Piping shall be thoroughly cleaned and blown out prior to grouting.

The grout shall be injected into the hole starting at the low end. The grouting tube shall at all times be buried in the grout to prevent entrapment of air. Approved methods shall be used to determine the accuracy of the grout height.

- b. **Secondary Grouting.** Subsequent to completion of stressing, the anchors shall be secondary grouted (second stage grouting) to fill the annular space over the stressing length. The prestressing system used shall permit the venting of air from within the stressing anchorage during secondary grouting to assure that the points of stress transfer are adequately protected against corrosion.

The same requirements as listed under a. above apply for the secondary grouting.

After the secondary grouting is completed, the exposed post-tensioning anchorage recess shall be filled with concrete. This work shall be performed as soon as it is practical after the secondary grouting.

410-3.6 STRESSING. After tests indicate that the primary grout has reached specified strength, the anchor shall be stressed in accordance with Section M-210-3.1.h, as modified below.

Stressing elements of the anchor shall be stressed simultaneously. The maximum temporary stress shall never exceed 80% of the guaranteed ultimate strength of steel. The anchor shall be locked at the initial stress shown in the computation, but never above 70% of the guaranteed ultimate tensile strength of prestressing steel.

The anchors shall be temporarily stressed to 150% of the design uplift force shown on the Plans and then released to 75% of that value. The Engineer will determine to his satisfaction the length of time to hold the stressing force at 150% in order to establish the anchor adequacy. If the anchor fails to sustain this load, it shall be removed and replaced using deeper embedment. This additional work will be done at no increase in contract price.

Safety precautions shall be taken to prevent workers from standing behind the jacks when anchors are stressed.

METHOD OF MEASUREMENT

410-4.1 The pay quantity will be the number of prestressed pile anchors in place, completed, and accepted.

BASIS OF PAYMENT

410-5.1 Payment covers all drilling, grouting, concrete, anchor steel, casting conduit, tensioning, and other incidentals required to complete each anchor.

Payment will be made under:

Item M-410a Prestressed Pile Anchors - per each

ITEM M-420 LAUNCHING RAMP

DESCRIPTION

420-1.1 This work shall consist of constructing the launching ramp in conformance with the Plans and specifications.

MATERIALS

420-2.1 Structural concrete shall be per Section M-200.

Timber shall be the sizes shown on the Plans and per Section M-100.

Reinforcing steel and fittings shall be the sizes called for on the Plans and per Section M-310.

Timber hardware shall be the sizes shown on the Plans and per Section M-100.

Select fill shall contain no muck, frozen material, roots, sod or other deleterious materials and shall conform to the following gradation:

REQUIREMENTS FOR GRADING FOR SELECT FILL

Sieve Designation	Percent Passing by Weight
2 inch	100
No. 4	30-70
No. 40	30
No. 200	0-12

Filter cloth shall be as shown on the Plans and specifications.

Structural steel plates shall be the size shown on the Plans and per Section M-300.

Class I Stones. No more than 10% of the stones by total weight shall weigh more than 15 lbs per piece. The remainder of the material shall consist of stones, spalls and fines thoroughly mixed to produce a product graded as determined by WAQTC FOP for AASHTO T 27/T 11 as follows:

REQUIREMENTS FOR GRADING OF CLASS I STONES

Sieve Designation	Percent Passing by Weight
6 inch	80-100
4 inch	50-80
2 inch	10-50
No. 200	10 Max.

CONSTRUCTION REQUIREMENTS

420-3.1 EXISTING RAMP AREA. The existing slope shall be cut and/or filled to the required grade. See the Plans for details.

420-3.2 GENERAL. Select fill shall then be placed, leveled and compacted to the satisfaction of the Engineer to the tops of timber support sills. Filter cloth shall be placed as indicated on the Plans and in

accordance with the specifications. After the launching ramp planks have been placed, spaces between the planks shall be filled with select fill.

After the launching ramp planks have been placed the Class I stones shall be placed as detailed on the Plans.

The Contractor will be responsible for obtaining his own material sources for select fill and Class I stones.

The concrete abutment shall be constructed as detailed on the Plans and shall be filled with select fill.

METHOD OF MEASUREMENT

420-4.1 No measurement of quantities for payment will be made.

BASIS OF PAYMENT

420-5.1 Payment includes full compensation for constructing the launching ramp in place, complete, and accepted. It covers establishing the grade, placing select fill, sills, filter cloth, Class I stones, concrete planks, and concrete abutment.

Payment will be made under:

Item M-420a Launching Ramp – per lump sum

ITEM M-500 WATER SYSTEM - FLOATS

DESCRIPTION

500-1.1 This work shall consist of constructing the water system in conformance with the Plans and specifications.

MATERIALS

500-2.1 Flexible Pipe and appurtenances shall conform to the following:

All flexible pipe shall be PE 3408 polyethylene of the sizes called for on the Plans. Maximum standard diameter ratio (SDR) = 16.

Polyethylene pipe shall be stabilized against ultraviolet rays with 2% minimum carbon black.

All polyethylene joints shall be butt fused.

Transition fittings shall be composite polyethylene and stainless steel pipe of the same diameter.

All steel shall be as called for on the Plans and per Section M-300. Hardware shall be as called for on the Plans and per Section M-100.

Concrete weights shall be as called for on the Plans and per Section M-200.

All valves and fittings shall be as called for on the Plans.

Slip on Flanges and connecting bolts shall be stainless steel.

Pipe hangers shall be as called for on the Plans.

Hose shall be 3/4 inch \varnothing Arctic Ortac as manufactured by Goodyear or approved equal.

The butt fusion equipment shall be as recommended by the polyethylene pipe supplier. It shall be a 2 to 4 inch \varnothing machine with inserts to handle 3/4 inch \varnothing pipe and a sidewall fusion unit. This material shall become the property of the municipality or local utility and shall be left with the airport manager at completion. In addition this section shall include providing the airport manager with the following lengths of pipe: 100 feet of 2 inch \varnothing polyethylene and 40 feet of 3/4 inch \varnothing polyethylene.

CONSTRUCTION REQUIREMENTS

500-3.1 INSTALLATION. Buried portions of the float water system shall be installed in accordance with Section M-520, and the manufacturer's written recommendations with additional requirements as specified in this section.

The remainder of the float water distribution system and fittings shall be installed in accordance with these specifications and the manufacturer's written recommendations.

Pipe interiors shall be thoroughly cleaned of all foreign matter before being installed. At all times when work is not in progress open ends of pipe and fittings shall be securely closed so that no water, rodents or other substances may enter.

Cutting of pipe for closure or other reasons shall be done in a neat workmanlike manner by methods which will not damage the pipe and which will assure tight joints.

A cloth swab saturated in clean water shall be drawn through each length of pipe immediately prior to installation. Swabs may be kept in the pipe and pulled forward past each joint immediately after joining.

Pipe shall be inspected for defects after installation in the hangers. All defective, damaged or unsound pipe shall be rejected. Any section of pipe already laid but found damaged or defective shall be replaced with new pipe at no additional expense to the Department.

Connection to the existing system shall not be permitted, in the case of new mains, until new mains and adjoining service lines have been flushed, pressure tested, disinfected and accepted.

Fittings shall be located as shown on the Plans or as required.

Services and other connections shall be installed in accordance with the details and location shown on the Plans. Pipe ends for future connections shall be plugged or capped as shown on the Plans or as otherwise directed and shall be provided with thrust blocks.

- a. **Testing.** All pipe and appurtenances shall be subjected to a hydrostatic test after they are installed. Each float section of pipe between gate valves shall be tested as soon as possible after installation, or when directed by the Engineer. Pipelines shall be flushed clean of dirt or debris prior to testing.

Pipelines shall maintain a minimum hydrostatic test pressure of 125 psi for a period of 15 minutes without pumping unless otherwise directed by the Engineer. Pressure shall be measured at the low point of the section being tested.

A positive displacement type pump shall be furnished by Contractor for the testing. Feed for the pump shall be from a container wherein the actual amount of "make up" water can be measured. The Engineer, at his option, may furnish his own pressure gage.

Defective materials or workmanship, discovered as a result of hydrostatic field test, shall be replaced by the Contractor at his expense. Whenever it is necessary to replace defective material or correct the workmanship, the hydrostatic test shall be re-run at the Contractor's expense until a satisfactory test is obtained.

Conduct all tests in the presence of the Engineer.

- b. **Sterilization.** The completed waterline shall be sterilized with chlorine before acceptance for domestic operation. Chlorine shall be introduced into the lines to a concentration of not less than 50 parts per million. Contact period shall be not less than 24 hours. System shall than be flushed with clean water until residual chlorine is not more than 1 part per million. Valves in lines being sterilized shall be opened and closed several times during contact period.

After the system has been thoroughly flushed, samples shall be taken from representative points in the system, in sterile bottles, and shall be submitted to proper authorities, as directed, for bacteriological examination. If the report of the bacteriological examination is unsatisfactory, this disinfection procedure shall be repeated until satisfactory results are obtained.

METHOD OF MEASUREMENT

500-4.1 No measurement of quantities for payment will be made.

BASIS OF PAYMENT

500-5.1 Payment covers all costs associated with furnishing, installing and testing the water supply system.

Item M-500a Float Water System – per lump sum

ITEM M-510 FIRE EXTINGUISHERS AND CABINETS

DESCRIPTION

510-1.1 This work shall consist of furnishing the specified number of fire extinguishers and cabinets to house the extinguishers. Cabinets shall have breakglass access to door handles.

MATERIALS

510-2.1 Fire extinguishers shall conform to the following:

- a. ABC Multi-purpose, rechargeable, dry chemical extinguisher, hose type.
- b. Minimum rating of 40 A:240 B:C.
- c. Minimum capacity of ___ lbs and a maximum charged weight of ___ lbs.
- d. Heavy duty steel cylinders with corrosion and impact resistant finish.
- e. Nitrogen charged, outside cartridge unit.
- f. Wheeled unit, with a minimum wheel diameter of 16 inches.
- g. Minimum hose length of 50 feet.
- h. Metal valves and replaceable seals.

The ___ Model Number ___ has been approved for this project. Alternate fire extinguishers, meeting this specification, must be approved by the Engineer.

All extinguishers shall be new and fully charged. Each extinguisher shall have the date of original charging stamped on the cylinders or on the band. No extinguisher shall have been charged prior to _____.

510-2.2 Cabinets shall conform to the following:

- a. Walls and roof shall be 5/8 inch Marine plywood.
- b. Hinges shall be stainless steel and full length of doors.
- c. Hardware shall be per Section M-100.
- d. Timber shall be ACZA treated per Section M-100.
- e. Breakglass access with a stainless steel frame and breakglass approved for fire apparatus access.
- f. Frame shall be lockable so that airport manager can gain access without breaking glass.

510-3.1 CONSTRUCTION REQUIREMENTS. Extinguishers shall be located as shown on the Plans.

Cabinets shall be:

- a. lagged to tiedown rail.
- b. 12 inches wider than extinguisher wheel width.
- c. tall enough to allow easy access to fire extinguisher.
- d. painted red with the words FIRE EXTINGUISHER painted in bold white letters on the front.

510-4.1 METHOD OF MEASUREMENT The pay quantity will be the number of fire extinguishers with cabinets in place, completed, and accepted.

510-5.1 BASIS OF PAYMENT Payment covers all work associated with furnishing fire extinguishers and cabinets.

Item M-510a Fire Extinguisher and Cabinet – per each

ITEM M-520 WATER SYSTEM - UPLANDS

DESCRIPTION

520-1.1 This work shall consist of constructing the water system in conformance with the Plans and specifications. The uplands portion of the waterline shall begin at the connection to the existing water main and include all conduit and fittings up to the beginning of the Float Water System as shown on the Plans.

MATERIALS

520-2.1 Ductile iron water main and appurtenances shall conform to the following:

Ductile iron pipe shall be of the sizes shown on the Plans and shall be centrifugally cast, rubber gasket "Tyton" type joint, mortar lined, bituminous coated inside and out, minimum thickness class 50 conforming to AWWA C151. Joints shall conform to AWWA C111, and mortar lining to AWWA C104.

Fittings shall be cast iron or ductile iron conforming to AWWA C110, minimum pressure, class 125, cement lined to AWWA specifications.

Flexible couplings, if used, shall be cast iron, Rockwell, Baker, Dresser, Romac or equivalent.

Coupling adapters shall be malleable or ductile iron, Rockwell Figure 912, Dresser Style 127, Baker Series 601 or equivalent, for buried service. Provide full-faced gaskets.

Gate valves shall be the size shown on the Plans and shall conform to AWWA C500 and shall be iron body, bronze mounted, Mueller series A-237 resilient seat and 'O'-ring stuffing box, mechanical joint or flanged as required. All bolts are to be greased prior to installation. Valves shall be nonrising stem, counterclockwise opening, with standard square stem nuts. Contractor shall furnish one "Tee" type valve wrench for valve operation.

Valve boxes shall be Olympic Foundry Seattle Standard cast iron, buffalo and sliding extension type, bituminous coated, with lid marked "Water".

Hydrant shall be Mueller Improved No. A24015 and painted yellow.

All hardware shall be as called for on the Plans and per Section M-300.

Concrete for thrust anchors shall be 3000 psi minimum.

Bedding material shall conform to the requirements of fine aggregate for concrete contained in ASTM C 33.

CONSTRUCTION REQUIREMENTS

520-3.1 INSTALLATION. At least 24 hours prior to connection to the existing water main the Contractor shall notify the municipality or utility.

The water distribution system and fittings shall be installed in accordance with these specifications and the manufacturer's written recommendations.

Pipe shall be laid to the lines and grades shown on the Plans. Minimum cover over pipe will be 5 feet.

Pipe interiors shall be thoroughly cleaned of all foreign matter before being lowered into the trench. At all times when work is not in progress open ends of pipe and fittings shall be securely closed so that no

trench water, earth, rodents or other substances may enter. Trenches shall be kept sufficiently dry so that no pipe will be laid in water nor shall pipe be laid when trenches or weather conditions are unsuitable for such work, unless otherwise directed.

Cutting of pipe for closure or other reasons shall be done in a neat workmanlike manner by methods which will not damage the pipe and which will assure tight joints.

A cloth swab saturated in clean water shall be drawn through each length of pipe immediately prior to installation. Swabs may be kept in the pipe and pulled forward past each joint immediately after joining.

Pipe shall be inspected for defects before lowering in the trench. All defective, damaged or unsound pipe shall be rejected. Any section of pipe already laid but found damaged or defective shall be replaced with new pipe at no additional expense to the Department.

Deflections from a straight line or grade resulting from horizontal or vertical curves or offsets shall not exceed the limits recommended by the Manufacturer. If the specified or required alignment requires deflections in excess of such limits the Contractor shall either provide special bends or a sufficient number of shorter lengths of pipe to provide angular deflections within such limits. All pipe threads and damaged galvanizing shall be coated with a zinc base paint after assembly.

Standard lengths of pipe shall be used except where short lengths are required for fittings, or wherever pipe passes through a rigid structure.

Fittings valves and hydrants shall be located as shown on the Plans or as required.

Hydrants shall be set at such elevations that the connecting conduit will drain to the main. Hydrants shall have the interiors cleaned of all foreign matter before installation.

Stuffing boxes shall be tightened and the hydrants shall be inspected in opened and closed positions to see that all parts are in working conditions.

A drainage pit 2 feet in diameter and 3 feet deep and filled with coarse sand to a depth of 6 inches above the hydrant opening, but leaving sufficient empty space in the pit to more than equal the volume of the barrel shall be constructed.

Services and other connections shall be installed in accordance with the details and location shown on the Plans. Pipe ends for future connections shall be plugged or capped as shown on the Plans or as otherwise directed and shall be provided with thrust blocks.

Concrete thrust blocks shall be furnished and installed as shown on the Plans. Placement shall be against firm natural ground at the sides of the trench. When the trench is in soft, unstable soil, a backing for the thrust block shall be formed by removing the soft soil and replacing it with ballast of sufficient size and weight to resist the thrust.

Connections to existing water lines and structures shall be made in a workman-like manner and in a manner to avoid contamination to water in lines in use.

The Contractor shall check with the local utilities, prior to excavating for the water lines, to familiarize himself with existing buried utilities.

Pipe shall be bedded and insulated as shown on the Plans. Excavated material may be reused as backfill above the insulation protection layer. Surplus excavation shall be disposed of off site. Bedding and backfill shall be compacted to the satisfaction of the Engineer. The excavation and spoil area shall be finish graded to the satisfaction of the Engineer.

Existing abandoned water pipe shall be removed and disposed of as necessary to accomplish the new work.

The water main will be provided with electrical continuity, as approved by the Engineer. If wedges are used, there will be a minimum of 3 wedges per joint.

520-3.2 TESTING AND STERILIZATION.

- a. **General.** All water main and service connection work, after laying, shall be subjected to pressure, conductivity, and leakage tests. Joints shall be left fully exposed and only sufficient backfill shall be placed between joints to hold that conduit in place while the tests are being conducted. Equipment for testing and all costs for labor, materials and supplies shall be furnished by the Contractor at his own expense and no extra payment will be made therefore. The Engineer shall have the right to test and approve all gages used.

Conduct all tests in the presence of the Engineer.

Tests shall be made upon completion of installation of the system or any reasonable length thereof, prior to backfilling and after thorough flushing of the portion to be tested.

- b. **Conductivity.** Electrical conductivity tests will be performed in the presence of the Engineer with all equipment being furnished by the Contractor. A machine capable of producing 300 amps DC current, as measured by the Engineer at or near the machine, shall be used. Duration of testing shall be 15 minutes. Continuity test sections shall not exceed 500 linear feet. All wires brought up to the surface shall be removed to a depth of 2 feet below finish grade of the street upon completion of tests.
- c. **Pressure.** Leakage tests shall be done only after the conduit has been filled with water for a maximum period of 24 hours.

Line shall be filled with water, making sure that all air is eliminated.

The pressure to be used for the test shall be 125 psi, or 1.5 time working pressure, which is greater. Pressure shall be maintained on the portion being tested for a minimum period of two hours using either pneumatic or hydraulic means to maintain the pressure.

Maximum leakage during the test shall not exceed 1 gallon per inch diameter per 3000 ft. of conduit.

Visible leakage, other than a minor amount of sweating, shall require immediate stoppage of the test and such tightening of the joint as to eliminate leakage when pressure is again placed on the system.

No caulking will be permitted nor shall paints, asphalts, enamels, or other types of compounds be used to eliminate leaks.

Leaking fittings, nipples, or lengths of conduit shall be replaced.

- d. **Sterilization.** The completed waterline shall be sterilized with chlorine before acceptance for domestic operation. Chlorine shall be introduced into the lines to a concentration of not less than 50 parts per million. Contact period shall be not less than 24 hours. System shall then be flushed with clean water until residual chlorine is not more than 1 part per million. Valves in lines being sterilized shall be opened and closed several times during contact period.

After the system has been thoroughly flushed, samples shall be taken from representative points in the system, in sterile bottles, and shall be submitted to proper authorities, as directed, for

bacteriological examination. If the report of the bacteriological examination is unsatisfactory, this disinfection procedure shall be repeated until satisfactory results are obtained.

METHOD OF MEASUREMENT

520-4.1 No measurement of quantities for payment will be made.

BASIS OF PAYMENT

520-5.1 Payment covers all work associated with furnishing, installing, testing, and sterilizing the complete water system in place and accepted, including all excavation, removal of abandoned conduits, bedding, backfill and finish grading.

Payment will be made under:

Item M-520a Uplands Water System – per lump sum

ITEM M-600 ELECTRICAL

DESCRIPTION

600-1.1 This work shall include furnishing all labor, material, equipment, incidentals and services required to construct and install the complete electrical systems in conformance with the Plans and specifications.

600-1.2 DRAWINGS. The electrical drawings show the general layout of the complete electrical system.

Field verification of scale dimensions on Plans is directed since actual locations, distances and levels will be governed by actual field conditions.

The electrical contractor shall also review the float and dock plans and shall adjust his work to conform to all conditions indicated thereon.

The drawings show the general location of the electrical features only, unless specifically dimensioned thereon. When necessary, to present a symmetrical appearance or to avoid interference with other installations, the Contractor shall make minor relocations as required. The drawings and specifications are complementary to each other and what is called for by one is as binding as if called for by both.

Discrepancies shown on the different plans, or between plans and actual field conditions, or between Plans and specifications, shall promptly be brought to the attention of the Engineer for a decision.

600-1.3 APPROVALS. Prior to the purchase or ordering of any materials or equipment, the Contractor shall submit to the Engineer for approval 6 copies of a complete brochure of items intended for use in the work. The brochure shall include the item, manufacturer, identifying manufacturer's number or nomenclature and such other information as necessary to properly describe the item. Where substitutions are proposed by the Contractor for the specific items described in the specifications, the submittal shall also include six copies of the manufacturer's bulletins or pamphlets which contain sufficient information to clearly establish the conformity of the proposed substitute item to the requirements of the specifications. One copy of the submitted material will be returned with the action to be taken indicated thereon.

MATERIALS AND EQUIPMENT

600-2.1 GENERAL. All materials, supplies and equipment shall be the standard products of manufacturers regularly engaged in the production of such items and shall be the manufacturer's latest standard design. Like items of equipment shall be the product of a single manufacturer.

600-2.2 GUARANTEE. The Contractor shall leave the entire electrical system in proper working order and shall, without additional charge, replace any work, materials or equipment furnished and installed by him under this contract which develops defects, except from ordinary wear and tear, within one year from the date of the final acceptance of the work.

600-2.3 CONDUIT. Rigid steel conduit shall be standard weight steel pipe, hot dipped, galvanized inside and outside, as made by Triangle, Youngstown, Republic or National.

EMT steel conduit shall be thin-wall, electro-galvanized steel as manufactured by Triangle, Youngstown, Republic or National.

Flexible Conduit shall be flexible "Sealite" type E.F.L., color grey, as manufactured by Anaconda, or approved equal.

600-2.4 WIRE.

- a. **Conduit.** RHW, THW or THWN, 600 volts, minimum #12 AWG stranded copper, as manufactured by General Cable, Anaconda, Republic or National.
- b. **Floats.** 4 or 5 conductor, copper, type W, flexible, double armored neoprene jacket, lead cured, size as noted on drawings, suitable for salt water immersion, as manufactured by Okanite, Bronco (Bronco 66), Carol or General Electric. The Contractor shall provide a factory certificate stating the date of manufacture, type of conductor, jacket material and applicable electrical tests conducted.
- c. **Aerial.** 4-conductor copper with steel messenger, General Electric Vulkene SI-58069, 600 volts, size as noted on the drawings.

600-2.5 CIRCUIT BREAKERS. NEMA 3R enclosure, Square D, Type KA or LA with padlock attachment, or approved equal, as shown on the drawings.

600-2.6 PHOTOELECTRIC CELL. Tork #2100 (120 v.), or approved equal, mounted on the north side of the light standard.

600-2.7 PANELBOARD LIGHTING. Panelboard shall have a main breaker with thermal-magnetic trip-bolted breakers, quick make, trip free, with solid neutral branches as noted. Boxes shall be code gauge sheet steel fitted with a stainless steel hinged door over breakers with provision for padlock. Unit to be suitable for NEMA 3R. Provide 60 ampere 3-pole electrically held contactor, Hand-Off-Auto control and meter as detailed. Control to be accessible behind hinged door. Panelboard shall be designed for 120/208 volt, 3-phase, 4-wire, solid neutral AC supply. Panelboard shall be similar to Square D NQOB except as noted. The number and capacity of the branch circuits shall be as specified.

Provide a neatly printed directory.

600-2.8 JUNCTION BOXES. Cast iron, hot dipped, galvanized, gasketed and bolted covers, suitable for NEMA 4, Crouse-Hinds or Hope, sizes as noted on the drawings. Coordinate taps.

600-2.9 DISTRIBUTION PANELS. Square D I-Line, or approved equal, mounted in a Hoffman NEMA type 12 enclosure, stainless steel hinges and padlock handle. Installed on legs as detailed. Breakers as shown on the drawings. Provide ground detector as noted.

600-2.10 METER STAND ASSEMBLIES. Meter Stand Assemblies shall be dual meter, dual outlet with the following features and as detailed. Meter socket 4 jaw for 120 volts, single phase.

- a. **Meter Assemblies,** Dual, prebussed, ringless, with plastic closure for each meter opening, horizontal 2 trough, 5 terminal sockets. Enclosure suitable for outdoor installation without knockouts, 16 gauge, zinc coated, corrosion resistant steel with baked enamel finish. To be Anchor Electric 2URS251-2-H4-LT-HP-RT, or approved equal, with lugs for #1/0 copper.
- b. **Conduit fittings.** Condulets appleton FDB-2L, cast, galvanized finish, two gang, with mounting lugs tapped to include type ECDB drain/breather and lug for grounding.
- c. **Circuit breaker.** Heinemann AM1-20 with strap to center in cover, 20 ampere single pole breaker. Cover with gasket On-Off, lockable, stainless steel screws, Appleton FSK-IVS.
- d. **Outlet.** Hubbell 26CM10 super twist lock, 3 wire grounded, 120 volts, 30 amperes and separate ground with gasketed #74CM24 cap and stainless steel screws.
- e. **Meter stand.** Fabricated as shown and erected on the drawings. Verify dimensions for equipment. Lag screws or bolts shall be hot dip galvanized. All other bolts shall be stainless steel as shown on the Plans. Concrete inserts and bolts shall be as shown on the Plans. Provide 1/4 inch spacing between equipment and mounting plate with spacers.

600-2.11 FLOAT AND DOCK SPECIALTIES.

- a. **Conduit Fitting.** Crouse-Hinds conduit type and style as required. All covers with gasket and stainless steel screws.
- b. **Miscellaneous Fittings.**
 - (1) **Cable terminator.** Crouse-Hinds type CGB or T & B. Coordinate terminator with cable size. All connections made up tight and waterproof. Touch up paint on all threads and abrasions. Provide stainless steel grip as noted.
 - (2) **Clamps.** Galvanized, one-hole malleable for rigid conduit, minimum 8 feet o.c. As noted for flexible conduit.
 - (3) **Ties.** T & B or Panduit (black) plastic ties as shown.
- c. **Fixtures, Fixture Auxiliaries, Lamps and Wiring.** All luminaires and lighting equipment shall be delivered to the site complete with suspension accessories, canopies, hickey, casings, sockets, holders, reflectors, ballasts, diffusing materials, etc., all wired and assembled as indicated.
 - (1) **Incandescent and Luminaire Wiring.** Luminaires with medium base sockets shall be wired with not smaller than No. 16 and mogul sockets with no smaller than No. 14 type AF asbestos-covered wire. No splice or tap shall be located within an arm.
 - (2) **Lamps.** All lamps shall be furnished and installed by the electrical contractor.
 - (3) **Ballasts and Starters.** Ballasts shall be of the high power factor type and shall bear the seal of the Certified Ballasts manufacturers and the seal of the Underwriters Laboratories (UL). Exterior ballasts shall be suitable for -10°F .
 - (4) **Fixture Schedule.** As shown on the drawings.
- d. **Ground Rods.** Hubbard 3/4 inch x 10 feet with clamp, or approved equal.
- e. **Transformers.** Dry type with taps and class H insulation, of the sizes and capacities as shown on the drawings. Winding to be encapsulated with epoxy for marine environment. Enclosure to be NEMA 3R suitable for outdoors. Transformers to be Sorgel or Tierney.
- f. **Panelboards.** The panelboards shall be square D, or approved equal, type NQOB for low voltage and type NEHB for 480 volts in a NEMA 3R enclosure. Branch circuit breakers, voltage and phase shall be as noted on the drawings.
- g. **Current Transformer Cabinet.** The cabinet shall be a Circle AW, or approved equal, suitable for 120/208 volts, 3 phase wye. Provide current transformers as noted.
- h. **Meter Sockets.** The main meter sockets are to be Circle AW as noted, or approved equal, coordinated with the utility.
- i. **Power Outlets.** The power outlets shall be Crouse-Hinds, 480 volts, 3 phase or 120 volts as noted. No substitutions. Coordinate the phase rotation.
- j. **Primary Transformer.** General Electric pad mount, or approved equal.

Phase	Three
Primary Voltage	12.47 Delta

Secondary	120/208 volts, 4-wire
Coolant	10 CA oil
Temperature Rise	65° (C)
Frequency	60 cycles
Rating	As noted
Taps Four	Two 2 1/2% above and below

The transformer and associated terminal compartments shall be designed and constructed to be tamperproof. There shall be no screws, bolts, or other externally removable fastening devices.

Full-height, air-filled incoming and outgoing terminal compartments with hinged doors shall be located side-by-side separated by a steel barrier, with the incoming compartment on the left. The incoming compartment will be accessible only after the door to the outgoing compartment has been opened. To facilitate making connections and permit cable pulling, the doors and compartment hood shall be removable. Removable door sill on compartments shall be provided to permit rolling or skidding of unit into place over conduit studs in foundation.

The incoming line compartment shall enclose the high voltage bushings and provide for incoming cable from below. The compartment shall have a hinged door with a fastening device, which is accessible only through the low voltage compartment and is lockable with a single padlock.

The incoming line equipment shall be arranged for loop feed. Equipment enclosed in the incoming compartment will include three internal, oil-immersed primary fuses with 6 terminations for #2 stranded cable.

The outgoing line compartment shall be arranged for cabling from below. The compartment door will be hinged and suitable for padlocking. Four low voltage spade bushings or three low voltage spade bushings and one solidly grounded neutral blade for 120/208 volt, 3 phase, 4 wire secondary voltage respectively.

The transformer shall be equipped with the following accessories as standard equipment:

- (1) High voltage compartment:
 - Lightning arrester mounting brackets (3 ea.)
 - Ground pad
 - Drain plug, 1/2 inch
 - Filling plug, 1 inch
- (2) Low Voltage Compartment:
 - Nameplate
 - Liquid level indication (1/2 inch pipe plug)

Optional accessories to be furnished are as follows:

- (1) High Voltage Compartment:
 - One 1 inch drain valve
 - One 1/2 inch sampling device
- (2) Low Voltage Compartment:
 - Dial type thermometer
 - Liquid level gauge
 - Provision for vacuum pressure gauge

Lifting lugs and provisions for jacking shall be provided as part of the transformers.

The design shall be arranged to use primary stress cone terminations similar to Elastimold.

All insulating components, oil, paper and wire enamel, shall be made of thermally upgraded materials, which are all compatible at today's industry standard 65 °C temperature rise.

The transformer shall be painted olive green color, Munsell Number 7GY3.29/1.5 to blend in with surrounding landscapes.

- k. **Primary Service.** As shown on the drawings. Provide #2 15 KV copper General Electric SI5224 or Anaconda #19141 for operation on 7.2/12.47 KV, 3 phase wye. Transformer to be connected delta-wye with termination at each end as approved by the Utility.
- l. **Meters.** Provide a General Electric type 62S or 65S class I0,000 or 200 cyco register as noted. Master meter for each service other than lighting to include 15-minute demand register for kilowatts. Meters to be for 120/208 volts, single or 3 phase as noted. All meters to be tagged or marked by the manufacturer with a block of numbers furnished by the Utility.

600-2.12 CONNECTORS. Connectors 600 volts and below shall be compression or mechanical type. Compression type connectors shall have adequate strength and ampacity for the conductors being connected.

CONSTRUCTION REQUIREMENTS

600-3.1 GENERAL. The installation shall comply with all laws applying to electrical installations in effect and with the regulations of the NEC where such regulations do not conflict with the laws in effect.

600-3.2 TEST. After completion of the entire electrical installation and at such time as the Engineer may direct, the Contractor shall conduct an operation test. The equipment shall be demonstrated to operate in the manner specified in the drawings and with the requirements of these specifications. These tests shall be accomplished in the presence of the Engineer or his authorized representative. These tests will include the insulation resistance tests of all wires and cables. The Contractor shall furnish all personnel and equipment necessary for the tests.

600-3.3 REPAIR OF EXISTING WORK. All work shall be carefully laid out in advance and where cutting, channeling, chasing or drilling is necessary for proper installation, support or anchorage of the conduit, raceways or other electrical work, this work shall be carefully done and any damage shall be repaired by skilled mechanics of the trades involved at the expense of the Contractor.

600-3.4 CONDUIT SUPPORTS. Conduit shall be securely fastened in place on maximum 8 foot intervals, and hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs or other approved devices with suitable bolts, expansion shields or beam clamps for mounting to structure or special brackets.

Adjustable hangers may be used to suspend 1 inch or larger conduits when separately located. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts or approved clamps shall be installed on each third intermediate trapeze hanger to fasten each conduit. Perforated straps shall not be used for supporting conduits.

600-3.5 FASTENINGS. Conduit supports, boxes and other electrical devices shall be fastened by wood screws on wood surfaces, sheet metal screws on sheet metal surfaces, or expansion bolts on concrete surfaces. Exposed screws in public areas shall be round head.

Exterior bolts, nuts, washers and screws larger than 1/4 inch shall be hot dipped galvanized. Bolts, nuts, washers and screws 1/4 inch or smaller shall be stainless steel or brass.

600-3.6 GENERAL WIRING. All wiring is to be continuous without splices from outlet to outlet and color coded by line or phase in accordance with Article 210-5 of the NEC. Joints and connections shall be made with T & B Sta-Kon pressure connectors, or approved equal, or solder and tape with heat shrink waterproof covers.

The following is the color code. Branch circuits shall be factory coded. Service and feeder conductors may be color coded by plastic tape applied to the cable ends in all enclosures.

	I20/208	277/480
Phase A	Black	Orange
Phase B	Red	Yellow
Phase C	Blue	Brown
Neutral	White	Natural Grey
Ground	Green	Green

600-3.7 RIGID CONDUIT. All exterior conduit and service to be rigid conduit, watertight. Minimum bury 18 inches except where noted, sand bed. Provide caution tape at 12 inches. Conduit within a building may be exposed EMT with watertight compression connectors at the Contractor's option.

600-3.8 GROUNDING. Grounding shall be in strict accordance with the NEC, Articles 250 and 555. Note separate ground conductors for all exterior circuits irrespective of conduit. Ground the neutral and ground system to salt water and the service.

600-3.9 CABLE INSTALLATION. The cable shall be installed as shown on the Plans.

600-3.10 THE MEGGER TEST. Prior to the energizing of any 480 volt circuit cable, the cable shall be tested with a megger to the rating of not less than as recommended by the manufacturer of the cable. The Contractor shall submit the test results in writing prior to energizing the cable.

600-3.11 PRIMARY PADS AND SERVICE. Primary pads shall be as shown on the drawings. Coordinate with transformer and utility.

Primary service shall be in rigid conduit as noted with tape "Caution Buried Cable" equal to Allen polyethylene film (4 mil) 12 inches above electric service. The Utility will furnish the cutout and make the final primary connection. The Contractor will furnish the lightning arrester terminator and primary tail at the pole as approved by Utility.

METHOD OF MEASUREMENT

600-4.1 No measurement of quantities for payment will be made.

BASIS OF PAYMENT

600-5.1 Payment includes providing a complete system, in place, and accepted.

Payment will be made under:

Item M-600a Electrical Power and Lighting System – per lump sum