

TECHNICAL SPECIFICATIONS
&
SPECIAL PROVISIONS
FOR THE WATER SYSTEM STANDARDS

FOR THE
MAKUU OFFSITE WATER SYSTEM, PHASE 2:
PRODUCTION WELL, RESERVOIR,
AND SUPPORTING FACILITIES
AT PAHOA, PUNA, ISLAND OF HAWAII, HAWAII

TAX MAP KEYS:
(3rd Division) 1-5-08: 1 AND 3

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TECHNICAL SPECIFICATIONS
&
SPECIAL PROVISIONS
FOR THE WATER SYSTEM STANDARDS

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SPECIAL PROVISIONS

The following special provisions and specifications modify and supplement the "Water System Standards" State of Hawaii, dated 2002, as amended, to render them applicable to this specific project. There are no deletions to the Standard "Standards" except for those subsections that are specifically deleted or added by these special provisions and specifications, or those which obviously cannot apply to this project. Where there is a discrepancy between the Special Provisions and the Standard Specifications, the provisions set forth in these Special Provisions shall govern.

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 303 - STRUCTURES

SECTION 303.03 CONCRETE WORK

- A. GENERAL: This section supplements the Water System Standards for the County of Hawaii Department of Water Supply, Section 303.03 and covers furnishing materials, labor, transportation, supervision and coordination required to complete in whole the concrete work for the general concrete work for the project, not including the prestressed concrete reservoir.
- B. Add the following requirements to Section 303.03.B.4, "Admixtures":
- a. Water reducing admixture shall conform to ASTM C494, Type A
 - b. Retarding admixture shall conform to ASTM C494, Type B
 - c. High-range, water reducing admixture (superplasticizer) shall conform to ASTM C494, Type F
- C. Add the following requirements to the end of Section 303.04.B, "Materials":
- Epoxy Adhesive: Adhesive shall be two-component, injectable, meeting the requirements of ASTM C881, Type IV, Grade 3. The adhesive product shall have a current ICBO or ICC ES Report permitting the use of the product in hard rock concrete with reinforcing steel dowels, such as Hilti 'HSE 2421 Epoxy Adhesive' or Simpson 'SET adhesive'.

Add the following to this section:

U. SLABS ON GRADE FOR CONTROL BUILDING

All concrete slabs shall be of DWS 3500 concrete. Slab underlayment shall receive a water vapor barrier of 6 mil Visqueen or approved equal where indicated on Drawings. The wearing surface shall receive smooth and even steel trowel finish.

Reinforcement shall be as shown on the plans.

All work shall be to the lines and grades shown on the plans.

The Contractor shall notify the Manager 48 hours in advance of concrete pour.

V. PUMP AND APPURTENANT EQUIPMENT BASES

Pump base shall be of DWS 3500 concrete. The wearing surface shall receive smooth, even wood float finish.

Reinforcement shall be as shown on the plans.

All work shall be to the lines and grades shown on the plans. The Contractor shall notify the Manager 48 hours in advance of concrete pour.

W. GROUTING

1. General:

This Article governs performing all operations in connection with grouting of machine and equipment bases as indicated on the drawings, in accordance with the requirements specified herein or required to complete the work.

2. Materials:

- a. Cement: ASTM C 150, Type 1, low alkali.
- b. Water: Potable water.
- c. Aggregates: ASTM C 404, fine or coarse, as required.
- d. Bonding Agents and Curing Compounds: Patented bonding agents and curing compounds shall only be used with the prior approval of the Manager.

3. Use and Location of Grout:

Grout shall not be placed until the item of equipment has been brought to proper elevation, leveled or plumbed as applicable, and anchor bolts tightened.

4. Proportioning and Mixing:

a. Dry-Pack Grout:

Proportioning:

Unless otherwise required for his equipment by a manufacturer or his field representative, or otherwise directed by the Manager, dry-pack grout shall consist of three parts sand to one part Portland cement, proportioned by weight, with only enough water to produce the required consistency.

Mixing:

The sand and cement shall be thoroughly mixed dry before commencing addition of water. No more grout shall be mixed at once than can be used

within 20 minutes. Grout shall not be retempered.

Use Restrictions:

Unused grout which has attained its initial set, or which has contained its mixing water for more than 30 minutes, shall not be used and shall be discarded.

5. Placing:

Grout shall not be placed when the ambient temperature is below 40 degrees F or above 90 degrees F. Once commenced, each unit of grouting shall be done quickly and in as nearly a continuous operation as possible, to avoid defects of overworking and seams between successive batches.

a. Dry-Pack Grout:

Bonding Coat:

Immediately before the operation of dry-packing, all free water shall be removed and accessible grouting surfaces of the concrete foundation shall be brush-coated with a slurry of Portland cement. The dry-packing shall then be accomplished before the brush coat dries.

Mortar Consistency:

Mortar for a dry-pack grouting shall be of such consistency that a mass squeezed in the hand will retain its shape.

Packing:

Packing under a machine or base plate shall be done by backing up one side of the open space and placing the mortar from the other side. Packing shall be accomplished by ramming with paddles of suitable size, shape and length. When the space between the base plate and foundation has been filled, the backing block shall be removed and the face of the mortar rammed from the opposite side.

Dry-packing around sleeved anchor bolts may be effectively accomplished by using a section of pipe that will fit the annular space between the bolt and the wall of the hole.

6. Finishing, Curing and Protecting:

a. Edge Finish:

Edges of all grout for base plates and equipment shall, unless otherwise directed by the Manager or shown on the drawings, be finished to a smooth, compressed surface sloping away from the base plate at an angle of approximately 45 degrees.

b. Curing and Protecting:

After edge finishing, and before any dry spots appear, all exposed grout surfaces shall be covered with burlap and shall be kept wet for a period of not less than seven (7) days. During this curing period, the grouted equipment shall not be operated. Curing compound may be used with the approval of the Manager.

WATER SYSTEM STANDARDS

DIVISION 300 SECTION 303 - STRUCTURES

SECTION 303.03A CONCRETE WORK FOR STRANDWRAPPED PRESTRESSED CONCRETE RESERVOIR

- A. DESCRIPTION: This section is in addition to Water System Standards for the County of Hawaii Department of Water Supply, Section 303.03 and covers furnishing materials, labor, transportation, supervision and coordination required to complete in whole the concrete work for the strandwrapped prestressed concrete reservoir including formwork.
- B. RELATED WORK: Related work specified in other sections:
- Section 303.03B - Hot Weather Concreting
 - Section 303.04 - Reinforcing Steel
 - Section 303.07 - Prestressed Concrete Tank
 - Section 303.07A - Earthquake Cables
 - Section 303.07B - Expansion and Construction Joints
 - Section 303.07C - Tank Wall Base Joint
 - Section 303.27 - Painting
- C. REFERENCED SPECIFICATIONS, GUIDES AND RECOMMENDATIONS
1. The latest edition of the following publications, form a part of this specification to the extent indicated by the references thereto.
 2. American Society for Testing and Materials
 - a. C 31-Making and Curing Concrete Test Specimens in the Field.
 - b. C 33-Specification for Concrete Aggregate.
 - c. C 39-Compressive Strength of Cylindrical Concrete Specimens.
 - d. C 40-Organic Impurities in Fine Aggregate for Concrete.
 - e. C 85-Cement Content of Hardened Portland Cement Concrete.
 - f. C 88-Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate.
 - g. C 94-Standard Specifications for Ready-Mixed Concrete.

- h. C131-Resistance to Degradation of Small Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine.
- i. C136-Method for Sieve Analysis to Fine and Coarse Aggregate.
- j. C143- Slump of Portland Cement Concrete.
- k. C150 Standard Specification for Portland Cement.
- l. C156-Water Retention by Concrete Curing Materials.
- m. C173-Air Content of Freshly Mixed Concrete by the Volumetric Method.
- n. C231-Air Content of Freshly Mixed Concrete by the Pressure Method.
- o. C233-Standard Method of Testing Air-Entraining Admixtures for Concrete.
- p. C260-Standard Specifications for Air-Entraining Admixtures for Concrete.
- q. C289-Standard Test Method for Potential Reactivity of Aggregates (Chemical Method).
- r. C441-Standard Test Method for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali-Aggregate Reaction.
- s. C457-Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete.
- t. C494-Standard Specifications for Chemical Admixtures for Concrete.
- u. C670-Preparing Precision Statements for Test Methods for Construction Materials.
- v. C683-Compressive and Flexural Strength of Concrete Under Field Conditions.
- w. C803-Penetration Resistance of Hardened Concrete.
- 3. Specifications for Structural Concrete for Buildings, ACI 301 as supplemented and modified herein.
- 4. Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete, ACI 211.1.

D. SUBMITTALS: The following shall be submitted:

- 1. The Shop Drawings shall show complete details and arrangement of reinforcing and

embedded items.

2. Product information for any proposed admixtures for the concrete mix designs shall be submitted to the Engineer for review.
3. Certificate of Compliance for aggregate documenting conformance with these Contract Documents, and source of supply and location of all materials and cement submitted.
4. Required concrete test results listed in Section 303.03A(DD) performed by an approved testing laboratory.
5. Forming
 - a. Forming, shoring and bracing designs for footings, walls and roofs shall be designed by the Contractor to meet all requirements specified here-in.
 - b. If requested by the Engineer, drawings and calculations shall be submitted verifying the selection of form ties, horizontal and vertical stiff-backs or braces for wall panels, forming and form openings, shoring of roof forms, or any other part of forming, shoring or bracing which may be considered critical by the Engineer.
 - c. All falsework and forming requirements for roof support systems must be designed by a licensed structural engineer registered in the state the tank is to be built. The falsework and forming drawings, with supporting calculations, must each be signed and sealed by the registered engineer. The Engineer shall review the roof support and form design prior to work beginning. The falsework design engineer must visit the site and approve the erection of all shoring prior to the placement of any concrete.
 - d. The Engineer's review or approval, or disapproval, time will be 2 weeks from date of receipt of each written submittal.
 - e. Contractor shall be solely responsible for the adequacy of the shoring and formwork. The Engineer's review or approval will not lessen or diminish the Contractor's liability.

E. CONCRETE MIX DESIGNS:

1. All concrete materials shall be proportioned so as to produce a workable mixture in which the water content will not exceed the maximum specified.
2. If the concrete mix designs specified herein have not been used previously by the ready mix supplier or if directed by the Engineer, mix proportions and concrete strength curves for regular cylinder tests, based on the relationship of 7, 14 and 28 day strengths versus slump values of 2, 4 and 6 inches, all conforming to these Specifications, shall be established by an approved ready mix supplier or an independent testing laboratory.

A laboratory, independent of the ready mix supplier, shall be required to prepare and test all concrete cylinders.

The costs for preparation of mix designs (if required by the Owner to be performed by an independent testing laboratory) and testing of concrete and materials shall be borne by the Owner, except when materials do not meet specified requirements, in which case such costs shall be borne by the Contractor.

If the mix design satisfies the conditions stated in Water Systems Standard, Section 303.03(D), mix design testing may not be required.

3. The weight proportions of materials used for concrete delivered to the jobsite shall conform to the approved mix design unless specifically so directed by the Engineer or Laboratory for improved specified strength or desired density, uniformity and workability.
 4. Mix design proportions shall be based on a full cubic yard of hardened concrete.
 5. Ready mix companies or jobsite batch plants shall furnish delivery tickets, signed by the Certified Weighmaster. Each delivery ticket state the weight of aggregates, sand, cement, admixtures and water and the number of cubic yards of concrete furnished, which will be compared against the approved mix design.
 6. There shall be no variation in the weights and proportions of materials from the approved mix design.
 7. There shall be no variation in the quality and source of materials once they have been approved for the specific mix design.
- F. **READY MIXED CONCRETE:** Ready mixed concrete shall conform to the requirements of ACI 301 and ASTM C 94. In case of conflict, ACI 301 shall govern.
- G. **CONCRETE COMPOSITION:** Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water, and specified additives so proportioned and mixed as to produce a plastic workable mixture in accordance with requirements of this section of the specifications and suitable to the specific conditions of placement.
- H. **PORTLAND CEMENT:**
1. Portland cement shall be from an approved source and shall conform to the requirements of the current ASTM Specification C-150, for Type II cement. Only one brand of cement from one manufacturing plant may be used for the reservoir concrete.
 2. The Contractor shall designate the source and quantity of cement required for the project at least 30 days prior to its use, so appropriate tests, inspection and certification can be performed.

3. The ready mix company shall furnish certified mill certificates for quality assurance of the cement to be used.
4. In addition, the Owner may conduct, at its own expense, any tests the Owner considers necessary, to insure that the cement furnished meets the specified requirements.
5. Cement not meeting the Specifications will be rejected.
6. The Owner may direct the use of another type of Portland cement than specified above, in which case the Owner shall be responsible for the additional cost or shall receive appropriate credit for the change in cement.

I. FINE AND COARSE AGGREGATES:

1. Fine aggregate shall be clean, natural sand consisting of hard, strong, durable and uncoated particles.
2. Material removable by decantation from fine aggregate shall not exceed five percent (5%) by weight.
3. The moisture content of fine aggregate shall be carefully monitored and taken into account when determining the amount of water to add in the concrete batching.
4. Fine aggregate shall conform to all requirements of these specifications.
5. Fine aggregate shall have a fineness modulus of 2.40 ± 0.10 .
6. Coarse aggregate shall be washed gravel or crushed stone consisting of hard, tough, durable particles free from adherent coating.
7. The coarse aggregate shall contain no organic or contain friable, thin, flat or elongated particles in quantities considered deleterious.
8. A thin, flat or elongated particle is defined as a particle having a maximum dimension in excess of five times its minimum dimension.
9. Aggregate which has disintegrated or weathered badly under exposure conditions similar to those which will be encountered in the work under consideration shall not be used.
10. When crushed stone is used, the crusher shall be equipped with a screening system which will entirely separate the dust from the stone and convey the dust to a separate bin.
11. The following substances shall not be present in the coarse aggregate in excess of the amount listed:

- (a) Soft fragments : 5%
 - (b) Clay lumps : 1.4%
 - (c) Material removed by decantation : 1%
-
- 12. When the material removed by decantation consists essentially of crushed dirt, the maximum amount permitted may be raised to one and one-half percent (1-1/2%).
 - 13. Coarse aggregate shall conform to all requirements of these Specifications.
 - 14. The maximum size of aggregate shall be as specified herein and the aggregate shall be uniformly well graded from coarse through fine.
 - 15. Corrective measures to remedy deficiencies in aggregate grading may be used only with the written approval of the Engineer.
 - 16. The Contractor shall furnish satisfactory evidence to the Engineer that all aggregate used in the work meets the requirements specified herein. Tests shall be performed by a reputable independent testing laboratory and the cost of testing be borne by the Contractor.
 - 17. If the Engineer deems that additional testing of aggregate is necessary, the Engineer may select samples from any of the aggregate delivered to the ready mix plant or jobsite and have them tested by a laboratory of his choice. Such material shall not be used in the work until test reports are available. If in such tests the material fails to meet the specified requirements, the aggregate will be rejected and the expense of testing shall be borne by the Contractor. If such tests show the aggregate to be satisfactory, the cost of this testing will be paid by the Owner but the Contractor shall have no claim for costs due to delays caused by testing.
 - 18. When tested in accordance with "Organic Impurities in Sands for Concrete" (ASTM C40), the fine aggregate shall provide a color in the supernatant liquid no darker than the reference standard color solution.
 - 19. When tested in accordance with "Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate" (ASTM C88), the loss resulting after five cycles shall not exceed 10% for fine aggregate and 12% for coarse aggregate when using sodium sulfate.
 - 20. When tested in accordance with "Resistance to Abrasion of Small Size Coarse Aggregate by use of the Los Angeles Machine" (ASTM C131), the coarse aggregate shall show a loss not exceeding 50% after 500 revolutions or 10% after 100 revolutions.
 - 21. When tested in accordance with "Potential Reactivity of Aggregates (Chemical Method)" (ASTM C289), the aggregates should be represented by points lying to the left side of the solid line of Figure 2.

J. WATER: Water for mixing shall be clean, fresh and free from injurious amounts of oil, acid, chlorides, sulfates, alkali or organic matter. Water shall conform to ACI 301.

K. ADMIXTURES:

1. All admixtures used in any mix design shall be manufactured and supplied by the same admixture company to insure compatibility.
2. Retarding Densifiers
 - a. Reservoir wall concrete placed with air temperature exceeding 85° F. shall contain a retarding agent such as DARATARD-17, as manufactured by W.R. Grace & Company (www.na.graceconstruction.com), or Pozzolith-122 R, as manufactured by BASF Construction Chemicals, LLC (www.basf-admixtures.com), in the amounts recommended by the manufacturer.
 - b. To be considered equal, any proposed alternate product shall not contain any calcium chloride, and shall be compatible with air-entrained cements and air-entraining admixtures conforming to the applicable ASTM, AASHTO, ANSI and Federal specifications.
 - c. Contractor shall certify that admixtures do not contain calcium chlorides or other corrosive materials by a written and sign statement by the admixture manufacturer.
3. Air-Entraining Agents
 - a. Unless specifically required by the Owner, Class "A" concrete shall not be air-entrained. Unless otherwise specified, the Contractor has the option of using air-entrainment for all other concrete.
 - b. Air-entraining agents shall conform to ASTM C-260.
 - c. The maximum total volumetric air content of the concrete before placement shall be 6 percent plus or minus one percent as determined by ASTM C-173 or ASTM C-231.
 - d. Subject to these Specifications, consideration will be given to the following products: W.R. Grace & Company "DAREX AEA", BASF Construction Chemicals, LLC "MB AE 90", or SIKA Corporation "AER".
4. Water Reducing Admixtures
 - a. In addition to air-entrainment, approved water reducing additives, which do not affect the ultimate performance of any steel in any way, may be added to maintain the maximum water content below that specified herein. Water reducing additives shall conform to ASTM C494, Type A or D.

- b. The use of water reducing additives shall not permit a reduction in the minimum specified cement content or in the specified amount of air-entrainment.
 - c. Admixtures shall contain no calcium chloride, tri-ethanolamine or fly ash. All admixtures shall be from the same manufacturer.
 - d. Superplasticizers, if allowed by the Engineer, shall conform to ASTM C494, Type F or G, batch plant added using second or third generation only.
 - 5. Shrinkage Reducing Admixture shall not contain any expansive materials, but reduce surface tension of water pores in the concrete without significantly affecting slump.
- L. PROPORTIONING NORMAL CONCRETE: Unless indicated otherwise on the Drawings, concrete shall be of the following classes, each meeting the mix and compressive strength requirements as specified hereafter, and shall be used as follows:
- 1. Class "A" : Prestressed concrete reservoir walls.
 - 2. Class "B" : Columns, roof slabs, drop panels, reservoir floors, wall and column footings, pipe blocks and appurtenances.

At the Contractor's option, Class "A" concrete may be substituted for Class "B" concrete. If Class "A" concrete is substituted for Class "B" concrete, such concrete shall be air entrained if the Class "B" concrete is required to be air-entrained.

M. MEASUREMENT:

- 1. All measurements shall be by weight. However, Contractor, at his own expense, may increase the cement content at a corresponding reduction in weight of aggregate and sand, whenever he is concerned that the minimum strength and mix ratio requirements under these specifications cannot be met. The amount of water to be used shall be the amount necessary to produce a plastic mixture of the specified slump within the stated limits. The measurement of materials shall meet the requirements stated in the Water System Standards, Section 303.03(G).
- 2. The concrete slump shall be between three inches and five inches when tested in accordance with ASTM C-143. The Engineer may allow variations in the slump range if admixtures, such as water reducers or superplasticizers, are utilized in the concrete mix. Regardless of the measured slump, adherence to the specified maximum water-cement ratios shall be maintained.

N. COMPRESSIVE STRENGTH, WATER AND CEMENT CONTENT:

- 1. Notwithstanding what has been stated here-before, and unless shown otherwise on the Drawings, the concrete shall meet the following requirements:

	<u>Class A</u>	<u>Class B</u> (DWS4000)
2. Minimum Compressive Strength	4,500 psi	4,000 psi
3. Maximum Water Content (gal / sack)	4.85 gallons	5.0 gallons
4. Min. Cement Content (94 lb. sack of cement per cubic yard of solid concrete)	7.0 sacks	7.0 sacks
5. Max. Water-Cement ratio (by weight)	0.43	0.45
6. The cement content is required irrespective of compressive strength obtained.		
7. The total chloride ion content of hardened concrete shall be less than 0.06 percent by weight of cement.		

O. WALL FORMS

1. Full Height Pours

The wall form design shall be such that wall sections can be poured full height without creating horizontal cold joints and without breaking form ties. Form ties shall be provided to prevent spreading of the forms during the placement of concrete and allow ready removal of the forms without spalling or damaging the concrete. A plastic shotcrete reglet shall be incorporated into the top of the tank corewall as shown on the Drawings.

2. Ties

- a. Form ties designed to remain in the corewall of water retaining structures shall have waterstops and a breakback or cone depth of one-inch minimum.
- b. Snap ties, if used, shall not be broken until the concrete has reached its design compression strength. Snap ties, requiring ends to be broken off before the forms can be removed, shall not be used. The use of tie wires as form ties will not be permitted. Fully threaded stub bolts may be used in lieu of smooth ties with waterstops.
- c. Taper ties with plastic or rubber plugs of an approved and proven design may be used. The plugs must be driven into the hole with a steel rod, placed in a cylindrical recess made in the plug. The plugs shall not be driven on the flat area outside the cylindrical recess. Plugs shall be 'DS A-58 SURE PLUG' as manufactured by MASCO, Portland, OR, [phone: (503) 234-4321 or www.masco.net].

- d. Ties shall secure the wall forms to the required dimension prior to and during concrete placement.
3. Form Size
- a. BURKE, ECONOMY, SYMONS, ALUMA, and regular plywood forms may be used for forming of circular walls, the maximum straight section of formwork shall be no longer than 36 inches around the outside circumference of walls.
 - b. The height of such wall panel forms shall not exceed 8 feet unless built-in pour openings are incorporated in the wall panel forms.
4. Form Stiffeners
- a. Horizontal walers shall consist of structural steel channels, angles or tubing of adequate size to retain the concrete without deflecting.
 - b. The walers shall be rolled or welded to the proper radii or offset brackets shall be used for shaping the wall to the dimensions shown on the Drawings and shall be used both for inside and outside wall forms in direct contact with the wall panels and at vertical spacing of no more than 96 inches on center.
 - c. There shall be at least one such waler within 24 inches of the top and bottom of the wall.
 - d. The largest dimension of the steel waler shall be in the radial direction.
 - e. Vertical structural steel or wood members shall be used at a minimum horizontal spacing of 74 inches and shall have sufficient rigidity and strength to insure the proper vertical alignments with the aid of braces under all predictable stress conditions.
 - f. In lieu of the above, a different system and spacing may be proposed if it can be satisfactorily demonstrated to the Engineer that it will be equally effective.

P. ROOF FORMS:

- 1. Forms and falsework supports for the roof shall be sufficiently rigid and strong to support the wet concrete and the workers and equipment necessary for its placement without appreciable deflections. A minimum of 40 PSF for live load shall be allowed in the falsework design.
- 2. Unless the level of roof screeds remain unaffected by the deflection of roof-forms, an upward camber, where necessary in the opinion of the Engineer, shall be provided to all form areas which will deflect under the concrete load.

- Q. EPOXY ADHESIVE: An approved non-sag epoxy adhesive shall be applied over all dry-packed holes on the inside surface of the corewall. An acceptable material is RHINO 1308 NC/RHINO 3142 HARDENER, as manufactured by RHINO LININGS, San Diego, CA (phone #858-410-6144) or LV EPOXY as manufactured by SIKA CORPORATION, (local distributor phone #808-842-9477). Approved equal materials may be used.
- R. CURING COMPOUND:
1. All horizontal, screeded and floated surfaces, exposed to drying winds and sunlight, shall be sprayed with ATLAS QUANTUM-CURE as manufactured by ATLAS CONSTRUCTION SUPPLY, Inc., San Diego, California (phone# (858) 277-2100), and subsequently covered with a 6 mil thick polyethylene.
 2. Alternate curing compounds will be accepted if it is water-based and leaves a bondable surface for further coatings or treatments and it is non-toxic to potable water with NSF 61 approval. Regardless of the type of curing compound used, Contractor shall assume complete responsibility for its adequacy.
- S. CONCRETE CONSTRUCTION QUALITY:
1. Concrete shall conform to the requirements of Section 303.03A of these Specifications. The required proportions shall be assembled, well mixed, transported, placed, consolidated, finished and cured as here-in-after specified. Concrete shall be uniformly dense and sound, free from faults, cracks, voids, honeycomb and other imperfections.
 2. Field testing of the concrete shall conform to the Water System Standards, Section 303.03(L) and Section 303.03A(DD) in this special provision.
 3. Concrete requirements shall follow ACI 301 where applicable, unless specifically noted in the Special Provisions.
- T. MIXING:
1. Concrete shall be batched in fully automatic or semi-automatic stationary plants or approved portable batch type plants, and mixed in stationary or truck mixers. Mixing equipment and mixing procedures shall be subject to the approval of the Engineer. Any site mixed concrete shall only be for small quantities of non-structural concrete and with the Engineer's written approval.
 2. Site-Mixed Concrete
 - a. Conform to ACI 304 except as modified by these Specifications.
 - b. Use a batch-type mixer capable of combining the aggregates, cement, and water within the specified time into a thoroughly mixed and uniform mass and discharging the mixture without segregation.

- c. Use supporting equipment that can accurately proportion the cement, the coarse and fine aggregates, the admixtures, and the water that enters the mixing drum. Proportion the cement and aggregate by weight.
- d. Discharge each entire batch before recharging. Do not allow the volume of the mixed materials per batch to exceed the manufacturer's rated capacity of the mixer.
- e. Mixing time shall be as follows:
 - 1) For mixer of capacity of 1 cubic yard or less, one and one-half minutes after batching is completed.
 - 2) For mixers of capacities larger than 1 cubic yard, one and one-half minutes plus one-half minute for each additional $\frac{1}{2}$ cubic yard capacity or fraction thereof in excess of 1 cubic yard.
 - 3) The mixer shall revolve at a uniform rate as specified by the manufacturer for the mixing equipment.

3. Ready-Mixed Concrete

- a. Provide central-mixed concrete conforming to ASTM C-94 except as modified by these Specifications.
- b. The haul time of central-mixed concrete shall be limited to maintain the specified slump without the onsite addition of water that will result in exceeding the mix design water-cement ratio. In no event shall the time exceed 90 minutes from the addition of water at the batch plant to the completion of the pour, unless specifically approved by the Engineer.
- c. Use truck-transported, dry-batched concrete when haul time is excessive. Do not retemper partially hardened concrete.

U. PROTECTION FROM ABRASION OR FIRE: Every reasonable precaution shall be taken to protect finished surfaces from abrasions or other damage. Concrete surfaces or edges likely to be injured during the construction period shall be protected by leaving the forms in place or by erecting satisfactory covers. No fire shall be permitted in direct contact with concrete at any time.

V. PLACEMENT OF CONCRETE:

- 1. Placement shall conform to ACI 304 except as modified by these Specifications.
- 2. Notify the Engineer of readiness, not just intention, to place concrete in any portion of the work. This notification shall be far enough in advance as the Engineer deems necessary to observe the preparations at the location of the proposed concrete placing. All forms, steel, anchors, ties, inserts, and other embedded items shall be in place

before the Contractor's notification of readiness is given to the Engineer.

3. Schedule sufficient equipment for continuous concrete placing, Contractor shall arrange for backup equipment, and plan actions to be taken in case of an interruption in placing. Provide extra concrete vibrators. Test the concrete vibrators the day before placing concrete.
4. Each wall section and column pour shall immediately be preceded with a cement/sand slurry mix consisting of equal parts cement and sand in combination with 4.5 gallons of water per sack of cement. A layer 1 inch average thickness for the wall and columns shall be placed in forms. The wall or column concrete shall be deposited before the slurry begins to set up.
5. Concrete in walls shall not be placed in layers thicker than 24 inches (vertical depth) at any one time except that the bottom layer shall be no thicker than 12 inches.
6. Concrete placed for walls and columns shall not exceed a drop greater than 5 feet, except for the initial 12-inch thick placement of concrete at the wall base, which shall not exceed 4 feet in height.
7. Each layer of concrete in walls and columns shall be vibrated thoroughly before the next layer may be placed thereon. Vibrators shall be taken through the top layer down through the full layer thickness below to insure proper integration of the concrete and to avoid the development of cold joints and honeycomb between the layers. In other words, each layer of concrete shall be vibrated at least twice.
8. Unforeseen cold joints in walls shall be roughened and then covered with an approved bonding material, before the pour may be continued.
9. Horizontal waterstops in floor and roof decks, if shown on the Drawings, shall be lifted up, while the concrete is placed under the waterstop, the waterstop shall then be laid down and additional concrete shall be placed on top of that waterstop to the approximate finish level of the concrete. The concrete shall be thoroughly vibrated in one continuous motion from one end of the waterstop to the other end without skipping any areas. Visual observation shall be performed by the Contractor to certify that voids under waterstops do not exist.
10. Cold joints in floor and roof slabs between construction joints shall be avoided at all costs. New concrete shall be continuously placed over previously placed concrete and shall be thoroughly integrated through vibration, even if it means that horizontal passes of only 6 inches in width be made until additional concrete and equipment becomes available to permit wider passes in concrete placement.
11. The following minimum equipment, in excellent working condition, shall be available on the site for every floor, wall and roof concrete placement operation:
 - a. Conveying: 2 pumps, or 2 cranes, or 1 pump and 1 crane (for floor and roof decks only).

- b. Vibrating: 3 vibrators of 14,000 vibrations per minute (minimum).
- c. Trowels: 2 power-operated trowel machines (for floor and roof decks only).

The Engineer shall be the sole judge as to the acceptability of the equipment condition and capacity. The Contractor shall assume complete responsibility for having adequate equipment.

- 12. Use mechanical vibration in placing concrete to eliminate rock pockets and voids, to consolidate each layer with that previously placed, to completely embed reinforcing bars and fixtures, and to bring just enough fine material to exposed surfaces to produce a smooth, dense, and even texture. Vibrators shall be of the high-frequency internal type, and the number in use shall be ample to consolidate the incoming concrete to a proper degree within 15 minutes after it is deposited in the forms. In all cases, at least three (3) operable vibrators shall be available at the site.
- 13. The surface between the floor and column footing joint shall be screeded with a steel brush after the initial set of the concrete. Screeding shall be postponed until the laitance of the concrete can be fully removed. Heavy sandblasting may be done in lieu of the above and with the approval of the Engineer. Curing compounds, if used, shall be removed from the keys, by sandblasting, prior to the pouring of the footing concrete.
- 14. Do not place concrete during rainstorms. Protect concrete placed immediately before rain to prevent rainwater from coming in contact with fresh concrete. Keep sufficient protective covering on hand at all times for this purpose.
- 15. Concrete placed for encasement or arch of PVC shall not be backfilled until the concrete has reached at least 50% of its 28-day compressive strength confirmed by concrete cylinder tests. The Contractor may mold and cure additional concrete cylinders as specified here in to verify that the 50% strength has been achieved, prior to the required 7-day test. The Contractor shall keep the encasement (pipe jacket) trench dewatered until backfilled.

W. Pumping Concrete

- 1. Determine pump size by the rate of concrete placement, length of delivery pipe or hose, aggregate size, mix proportions, vertical lifts, and slump of concrete. The minimum inside diameter of pipe or hose shall be based on the maximum aggregate size as follows:
 - 1-inch size maximum aggregate: 4 inches minimum I.D.
 - 3/4-inch size maximum aggregate: 3 inches minimum I.D.
- 2. Do not use aluminum pipes for delivery of concrete to forms.

3. Before starting to pump, the deliver pipe or hose shall be primed by pumping mortar through the line using 5 gallons of mortar for each 50 feet of delivery line. Do not deposit mortar in the forms and dispose of mortar off site.

X. General Forming

1. Purpose

- a. Forms shall be used, whenever necessary, to confine the concrete, to shape the concrete to the required lines and grades, and to obtain a thoroughly compacted dense concrete through proper vibrating.
- b. The forms shall have sufficient strength, rigidity and tightness to hold the concrete and to withstand the necessary pressure, tamping and vibration, without deflection from the prescribed lines.

2. Design

- a. The surfaces of all forms in contact with the concrete shall be clean, rigid, tight and smooth.
- b. Openings sufficient in size, number and location to permit convenient access to properly clean forms, inspect reinforcing and place and consolidate concrete within the forms shall be provided.
- c. Exposed corner edges shall be eliminated from finished concrete work by means of $\frac{3}{4}$ -inch triangular fillets or chamfer strips placed in the forms, unless shown otherwise.

3. Removal

- a. All forms shall be removed before backfilling is placed.
- b. Forms shall be so constructed that they can be removed without hammering on, or prying against, the concrete and shall be removed in such a manner as to prevent damage to the concrete and insure the complete safety of all parts of the structure.
- c. The removal of forms shall meet the requirements of the Water System Standards, Section 303.03(O)(3), unless specifically noted otherwise.

4. Form-Ties and Seepage

- a. Form-ties may be loosened temporarily to permit the removal of wall bulkheads.
- b. All forms, whether prefabricated or custom built, shall be assembled and

connected in such a manner that only minor mortar seepage through the joints will occur during vibration of the concrete resulting in no honeycombs forming.

5. Clean and Oil

- a. All dirt, chips, sawdust, mud, water, debris and other foreign matter shall be removed from within the forms and excavated areas, before concrete is deposited.
- b. Forms previously used shall be thoroughly cleaned of all dirt, mortar and foreign matter before being reused.
- c. Before concrete is deposited within the forms, all inside surfaces of steel and plywood forms shall be thoroughly, but not excessively, coated with an approved non-staining bond releasing form oil.

Y. WALL, COLUMN AND COLUMN FOOTING FORMS:

1. All vertical wall, column and column footing sides shall be formed by methods acceptable to the Engineer and to the correct elevations and location shown on the Drawings.
2. Wall Form Pour Openings
 - a. Wall concrete may only be placed through pour openings on one side of the wall, and may not be pumped or poured from the top with "elephant trunks" or tremies.
 - b. Contractor shall either erect the complete form on one side of the wall and then erect the form panels on the other side of the wall while the concrete pour is in progress or remove form panels from either the inside or outside form assembly before concrete pouring starts.
 - c. The horizontal centerline distance between pour openings shall not exceed 96 inches nor shall the distance between the nearest opening and the bulkhead for the vertical joint exceed 36 inches.
 - d. The vertical centerline distance between horizontal rows of openings shall not exceed 72 inches.
 - e. The minimum pouring opening size shall be 24" x 24".
 - f. The bottom of the lower openings shall be no more than 48 inches from the bottom of the wall.
 - g. Under no circumstances shall forms be provided that require the concrete to be

dropped in the forms more than 5 feet.

3. There shall be no blockouts or other types of wall-openings other than those shown on the Drawings.
4. Remove Wood Splinters
 - a. Contractor shall remove all wood splinters on concrete surfaces after stripping of wood forms.
 - b. Such work shall be completed before abrasive blasting of exterior wall surfaces may be started.
5. Bulkheads
 - a. Bulkheads to form vertical wall joints shall be strong enough to withstand concrete pressures during pouring and vibrating, and shall be properly placed between the forms and against the waterstop to avoid mortar seepage.
 - b. Holes shall be provided in the bulkheads to permit passage of horizontal mild steel reinforcing where required by the Drawings.
 - c. No chamfer strips shall be placed in the corners of vertical construction joints of reservoir walls.
6. Alignment and Tolerances
 - a. Every precaution shall be taken to see that all forms are in the proper alignment, plumb, placed to correct radius and that all form supports are secure and tight.
 - b. Form sills shall be used to contain or hold down neoprene pads and facilitate proper alignment of forms. The maximum permissible variation in the horizontal and vertical location of the waterstops, neoprene pads and seismic cables (if required) is plus or minus 1/4 of an inch.
 - c. The maximum permissible variation in tank radius, as measured from the center of the tank to the inside wall surface at the bottom, is plus or minus 3/8 of an inch.
 - d. The out-of-round tolerance is: 3/4" in 50', 3/8" in 10' and 3/16" in 24" from the true curvature specified at any point on the wall.
 - e. The maximum permissible variation in the vertical alignment, from the bottom to the top of the wall, is plus or minus 3/8-inch.
 - f. The allowable tolerance in the average wall thickness for poured walls shall

not vary more than 1/8 inch either way. All transitions from plus to minus shall be gradual, even and smooth, and without abrupt changes in the surfaces.

- g. Provide adequate time and cooperation for the Inspector to verify the compliance of these requirements prior to closing up the forms or pouring concrete.
- 7. The use of slipform construction on liquid-retaining walls will not be permitted on any part of the tank.
- 8. Form Removal
 - a. Forms may be removed as soon as the concrete has developed sufficient strength to prevent sagging, excess deflection, misalignment, spalling, cracking, breaking of edges and surfaces and any other damage to the concrete. Contractor shall be solely responsible for the amount of time beyond the stated minimums the forms shall remain in place in order to prevent any damage.
 - b. Wall and column forms shall not be removed sooner than 12 hours of accumulated time with the ambient air temperature above 50° after completion of the wall or column pour, respectively.
- 9. Irrespective of what has been stated elsewhere in this section, the forming and bracing method shall be such that no gaps between the wrapped wire and the corewall will develop which exceed 3/8 of an inch at any place on the wall.

Z. ROOF FORMS:

- 1. The finished form surface shall be smooth, true to elevation and alignment and all joints between boards, plywood sheets or form panels shall be mortar-tight, or be made mortar-tight by taping or other means as the situation calls for, before any concrete pour may be started.
- 2. Form Removal
 - a. Removal of the forms will be permitted only when the concrete has attained the compressive strength specified in these Specifications or shown on the Drawings.
 - b. As soon as the forms have been removed, the Engineer will carefully examine the top and bottom surface of the concrete for any defects in the concrete or irregularities in the surfaces that require repair. These areas shall be repaired as required.
- 3. The Contractor shall provide either wedges under timber posts, screw jacks under shoring, or other means to adjust the forms and relieve the load.

4. Tolerance

- a. Unless stated otherwise on the Drawings, the permissible tolerance at any point for flat form-surfaces shall not exceed plus or minus 1/4 inch from the specified elevation or thickness. The finished roof surface shall be capable of completely draining. Contractor shall camber or provide necessary forming supports to prevent low spots and to insure drainage. If low spots should occur, Contractor shall submit a procedure to correct the condition to the Engineer for approval.
- b. Any transition between high and low points of the slab shall be gradual, smooth and even, and shall be to the satisfaction of the Engineer.

AA. BULKHEADS AND SCREEDS FOR FLOORS AND ROOFS:

1. Unless free-spanning vibrating and finishing screeds are used, sufficient floor and roof screeds shall be installed to insure that the finished concrete surface will conform to the slopes, elevations and tolerances specified in these documents.
2. Screeds and bulkheads shall be set to specified alignment and elevations permitting a maximum tolerance of 1/4 inch plus or minus.
3. All transitions between high and low points shall be gradual, smooth and even, and shall be to the satisfaction of the Engineer.

BB. SURFACE FINISHES:

1. Wood-Float Finish
 - a. This requires an integral finish by wood-float after screeding, to compact the surface evenly.
 - b. Any excess surface water shall be removed before floating and no mortar shall be used for leveling or absorbing surface moisture.
2. Steel Trowel Finish
 - a. This shall be an integral finish obtained by use of a steel trowel after the surface has been floated and allowed to stand until all water-sheen has disappeared.
 - b. Final trowelling shall be done after the concrete has hardened sufficiently to prevent drawing moisture and fine materials to the surface and when the concrete is sufficiently hard that no mortar accumulates on the trowel.
 - c. Cement or a mixture of cement and sand, shall not be spread on surfaces to

absorb excess water or to stiffen the concrete.

- d. Trowelling shall produce a dense, smooth, impervious surface free from defects and blemishes.
 - e. All finished top surfaces of wall, column footings and floors shall receive a smooth, even, level and hard (so called "burnt") steel trowel finish. The entire wall footing surface, particularly along each side of the circumferential waterstop in the area to receive neoprene pads, shall also receive a hard steel trowel finish.
3. Unformed surfaces not exposed in the completed work shall be brought to required finished elevations and left true and regular.
4. All flat roof surfaces, if shown on the Drawings, shall receive a steel trowel finish which is subsequently brushed with a steel or hard-bristled broom leaving a fine uniformly scratched concrete surface.
5. Screeds
- a. Sufficient screeds, unaffected by form deflections under concrete loads, shall be installed to insure an even concrete surface, true to grade and elevation, without unacceptable local depressions.
 - b. Screeds shall be set to the required levels and be approved by the Engineer before any concrete may be placed.
6. Form Tie Holes
- a. Tie holes shall be thoroughly sandblasted or roughened. After the taper tie holes have been cleaned and plugs, as specified in Section 303.03A(O)2.c., are installed in the middle third of the corewall. The tie holes shall then be coated with a water insensitive epoxy or an acceptable bonding agent and properly filled through damp-packing with a mortar of dry consistency consisting of one part cement to one part sand. The amount of water to be added to the cement-sand mix shall be such that the mortar can be driven into the voids and will tightly compacted. The outside of the tie hole shall be drypacked no sooner than 7 days after the inside has been drypacked.
 - b. Embeco or other fast-setting cements/additives shall not be used for damp--packing such cavities.
 - c. The surface of damp-packed tie hole on the interior tank wall face shall be covered with an approved water insensitive non-sag epoxy coating 10-mils thick. The epoxy shall conform to the requirements of Section 303.03A(Q). Finished surfaces shall be free from sand streaks or other voids.

7. Abrasive Blasting

- a. The exterior surface of cast-in-place concrete wall receiving strand-wrapped prestressing/shotcrete or paint, if any, shall be abrasive blasted, regardless of the forming method used, by a mechanical etching or shot blast system combined with a vacuum recovery system, or a self-contained waterblasting system.
- b. See Section 303.07(Z)- ABRASIVE BLASTING for equipment and performance requirements.
- c. All abrasive blasting shall be done to the satisfaction of the Engineer, and this work shall not be started before the completion date of the curing period or before all the tie-holes have been drypacked.

8. Honeycombed areas

- a. Defective surfaces, such as honeycomb, shall be cut out entirely until homogeneous concrete is encountered, even if it requires the removal of the entire wall, floor or roof slab thickness.
- b. The exposed area shall be coated with an approved epoxy adhesive or bonding material, which shall be applied in accordance with the manufacturer's instructions. The areas shall then be damp-packing with a mixture consisting of one part of Portland cement and two parts of sand and fine gravel; an epoxy and sand mixture; or a combination of these materials as the situation requires in the opinion of the Engineer.
- c. The water content of the repair material shall be such that a ball of the mixture squeezed by hand will not bringing free water to the surface.
- d. The repair material shall be tamped into place to remove all voids and the surface finished to match the adjacent concrete.
- e. Particular care shall be taken that material does not sag.
- f. If the repair material is required to be applied in lifts, an approved epoxy bonding agent shall be applied between lifts.
- g. Surfaces repaired shall be kept continuously damp for a period of not less than seven days after completing the repair, by the curing procedure described below in Section 303.03A(CC).
- h. Under no circumstances shall Contractor apply a plaster coat over the honeycomb areas to conceal the existence of the honeycomb in the concrete.
- i. Neither Embeco, calcium chloride or fast-setting cements/additives shall be used for filling honeycomb areas, nor shall they be mixed with repair material.

Contractor shall provide certification that any material placed on or in the corewall shall be free of chlorides and other materials corrosive to prestressing steel.

9. Miscellaneous surfaces not covered herein and not specifically designated on the Drawings shall be finished as directed by the Engineer.

CC. CURING:

1. After floor slab set-up, the floor shall be ponded with water to the perimeter of the slab for the duration of the reservoir construction.
2. All other horizontal, screeded and floated surfaces, shall be wet down and 6 mil thick polyethylene sheet shall be carefully taped and sealed to the concrete surface for as long as possible, but for at least 7 days, to minimize the loss of moisture trapped between the polyethylene and the concrete.
3. Water must be introduced under the polyethylene sheeting (after the concrete has set) whenever moist drops are not observed on the concrete side of the sheeting. Water for curing shall be generally clean and free from any elements that could cause staining or discoloration of the concrete.
4. All formed concrete surfaces shall cured as described in the Department of Water Supply Standard Specifications, Section 303.03.R. This requirement will be waived if the forms have been left in place for at least 14 days.

DD. CONCRETE TESTS:

1. Compression tests shall conform to ASTM C-39, ASTM C-670, ASTM C-683 and ASTM C-803.
2. Proportioning (or chemical analysis) tests shall conform to ASTM C-85.
3. At least one slump test and six test cylinders shall be made, under the supervision of the Engineer, by an approved testing lab for each class of ready-mixed concrete delivered to the jobsite. Each cylinder shall be coded to identify the date of delivery, the truck number, location where the concrete was placed and the slump measured upon discharge. For each tank wall section, two sets of three cylinders shall be made, at the Engineer's option.
4. The specimens shall be standard test cylinders, six inches in diameter, twelve inches in length, and they shall be prepared in accordance with ASTM Standard C-31.
5. Molds for the standard test cylinders shall be furnished at the Contractor's expense.
6. All costs for making, storing, curing and testing of concrete samples by an approved recognized reputable testing laboratory, shall be borne by the Contractor.

7. Making and testing of cylinders shall be performed by an approved testing laboratory that normally engages in the preparation of concrete mix designs and testing of concrete materials.
8. A compression test may be performed on two cylinders from each group of six after 7 and/or one cylinder after 14 days, at the Engineer's option. A strength test shall be made using three cylinders from each group of six at 28 days to evaluate the concrete strength in accordance with the current editions of the IBC and ACI 318.
9. If desired by the Engineer, proportioning tests for each class of concrete delivered to the jobsite, shall be made from test cylinders designated by the Engineer.
10. In addition to the test cylinders referred to in Section 303.03A(DD)(3), an additional 3 test cylinders shall be made for each day's pour, or for every 4,000 square feet of wall and roof surface, whichever provides the largest number of cylinders.

They shall be cured in the same manner, and in the same location of the concrete area to be investigated. Before walls may be prestressed, or before roof-forms may be stripped, at least one cylinder, of each batch of 3 cylinders, must be tested to verify whether the in-place concrete strength meets the minimum specified design strength.

11. The method of determining the standard deviation of compressive concrete strengths from previously utilized mix designs having previously recorded test results and the minimum allowable average compressive strengths of mix designs not having any previously recorded test results shall comply with the requirements of the code and commentary sections in the current edition of ACI 318.
12. The compressive test results of the cylinders referred to in Section 300.03A(DD)(8) above will be compared against the strength-versus-slump relationship curves referred to in Section 303.03A(E)(2). Proportioning tests may be made, at the discretion of the Engineer, on groups of cylinders with low readings.
13. Any concrete not meeting the minimum specified design strength and any concrete showing a cement content less than the ratio by weight established in the original mix design will be subjected to further testing of concrete cores taken from the concrete in question. Should these tests confirm that the specified requirements have not been met, the extra costs involved in such testing shall be borne by Contractor; and the concrete, at the Engineer's option, and at Contractor's sole expense, may be rejected and must then be removed from the site or may be strengthened with additional shotcrete or concrete as the situation warrants. Should the core tests indicate that the strength requirement has been met or if the low strength concrete is deemed acceptable to the Engineer, the extra costs involved in such testing shall still be borne by the Contractor. See the Water System Standards, Section 303.03(M) for additional requirements for test results not meeting specified minimum limits.

EE. PAYMENT

Payment for the work in this section shall not be made separately, but will be included with the lump sum amount for the item this is apart as stated in the Proposal.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300 SECTION 303 - STRUCTURES

SECTION 303.03B HOT WEATHER CONCRETING PROCEDURES

A. GENERAL:

1. Description: Hot weather is defined as any combination of high air temperature, low relative humidity and wind velocity that results in a rate of evaporation of 0.2 pounds per square foot per hour based upon the evaporation rate figure in ACI 305. During hot weather, any or all of the methods specified herein for temperature control of concrete shall be used as required to maintain the concrete temperature below the limits specified.
2. Related Work: Related work specified in other sections:

Section 303.03 Concrete Work

Section 303.03A Concrete Work for Strandwrapped Prestressed Concrete Tank
3. Shop Drawings: Not less than 30 days prior to expected placement of concrete under hot weather conditions, a complete procedure shall be submitted for review covering the aspects of protection of concrete and its ingredients from the detrimental effects of hot weather. Concrete placement during hot weather shall not commence prior to the return of the procedure marked "Reviewed".
4. Product Delivery, Handling and Storage
 - a. Aggregate piles, cement bins and batch plant bins shall be shaded from the direct rays of the sun.
 - b. Aggregate piles shall be cooled by wetting and evaporation. Aggregate wetting shall be performed in such a manner that it will not cause wide variations in moisture content impairing slump uniformity.
5. General Practices and Measures: The following list of practices and measures, as described in ACI 305, may be used to reduce or avoid the potential problems of hot weather concreting:
 - a. Use concrete materials and proportions with satisfactory records in field use under hot weather conditions.

- b. Use cool concrete.
- c. Use a concrete consistency that permits rapid placement and effective consolidation.
- d. Transport, place, consolidate, and finish the concrete with least delay.
- e. Plan the job to avoid adverse exposure of the concrete to the environment; schedule placing operations during times of the day or night when weather conditions are favorable.
- f. Protect the concrete against moisture loss at all times during placing and during its curing period.

B. MATERIALS

1. Batching and Mixing

- a. Concrete mix water shall be refrigerated or up to 100 percent of the water requirement may be ice added to the concrete mix. Ice, when introduced into the mixer, shall be in such form that it will completely melt and dispersed into the mix at the completion of the mixing time. The mixing time shall be held to the minimum practicable consistent with producing concrete meeting the specified requirements.
- b. All methods and equipment for cooling water and aggregate shall be subject to the approval of the Manager and shall conform to ACI 305.

C. CONSTRUCTION

- 1. Concrete Temperature: The temperature of concrete, as delivered at the time and location of placement, shall not exceed 100° F under any conditions. The temperature of concrete as delivered at the time and location of placement under the following combined ambient conditions, except concrete that will be deposited within wall or column forms, shall not exceed the following temperatures:

<u>Relative humidity</u> <u>less than %</u>	<u>Ambient temperature</u> <u>greater than F</u>	<u>Maximum concrete</u> <u>temperature F</u>
80	90	100
70	90	95
60	90	90
50	90	85
40	90	80
30	80	75
20	75	70

2. Delivery: Concrete shall be placed in the Construction within 90 minutes after the completion of mixing.
3. Preparation for Placing: Elevated forms and reinforcing steel for beams and slab members shall be cooled by fog spraying and evaporation immediately prior to placing concrete. Forms shall be free of standing water when concrete is placed herein.
4. Placing: Concrete shall be placed in shallower layers than under normal weather conditions if necessary to assure coverage of the previous layer while it is still in plastic state and will respond readily to vibration.
5. Finishing: Fog spray shall be used during finishing operations whenever necessary to avoid surface plastic-shrinkage cracking. Fog spray shall also be used after finishing and before the specified curing is commenced to avoid surface plastic-shrinkage cracking.
6. Protection and Curing: Forms shall be kept covered and continuously moist. Once forms are loosened and during form removal, concrete surfaces shall be protected from drying and shall be kept continuously wet by fog spraying or other approved means.

D. PAYMENT

There will not be any additional reimbursement made to the Contractor for costs incurred for placing concrete in hot weather. Payment for the work in this section will be included as part of the lump sum bid amount for the concrete construction item stated in the Proposal.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 303 - STRUCTURES

SECTION 303.03C EPOXY ADHESIVE INJECTION OF CONCRETE CRACKS

- A. DESCRIPTION: The Contractor or his Subcontractor shall furnish all materials, tools, equipment, appliances, transportation, labor and supervision required to repair cracks by the injection of an epoxy resin adhesive within water-retaining structures larger than 0.02-inches in width.
- B. QUALIFICATIONS
1. Epoxy injection shall be performed by a certified applicator.
 2. Contractor's/Subcontractor's operator engaged in the epoxy injection process shall have satisfactory operator experience in the methods of restoring concrete structures utilizing the specific epoxy injection process indicated. Operator's experience shall include previous repairs of cracked or damaged concrete structures, the technical knowledge of correct material selection and use, and the operation, maintenance and trouble shooting of equipment.
- C. EPOXY RESIN ADHESIVE FOR INJECTION
1. Epoxy adhesive grout shall be a 100% solids 2-part water insensitive low-viscosity epoxy resin system. Epoxy shall be suitable for grouting both dry and damp cracks. Epoxy shall develop a minimum tensile strength (ASTM D695) of 6,000 psi and a minimum compressive strength of 8,000 psi.
 2. Epoxy shall be **SELECT BOND GP-4440**, as manufactured by SPC, Costa Mesa, CA, **SIKADUR 35, HI-MOD LV** as manufactured by Sika Corp., Lyndhurst, NJ or approved equivalent.
- D. SURFACE SEAL
1. The surface seal material is used to confine the injection adhesive in the fissure during injection and cure.
 2. The surface seal material shall have adequate strength to hold injection fittings firmly in place and to resist injection pressures adequately to prevent leakage during injection.

3. The material shall be compatible and from the same manufacturer as the epoxy resin adhesive product.

E. EQUIPMENT FOR INJECTION

1. The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the crack shall be portable, positive-displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle. The pumps shall be electric or air powered and shall provide in-line metering and mixing.
2. The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi plus or minus 5 psi and shall be equipped with a manual pressure control override.
3. The injection equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 200 psi.

F. REPAIR PREPARATION

1. Surface adjacent to cracks or other areas of application shall be cleaned of dirt, dust, grease, oil, efflorescence or other foreign matter that may be detrimental to the integrity of the epoxy bond. Acids and corrosives shall not be permitted.
2. Entry ports shall be provided along the crack at intervals of not more than the thickness of the concrete section to be repaired.
3. Surface seal material shall be applied to the face of the crack between the entry ports. For through cracks, surface seal shall be applied to both faces.
4. Surface seal material shall be allowed to cure to gain adequate strength before proceeding with pressure injection.

G. EPOXY INJECTION

1. Injection of epoxy adhesive shall begin at lower entry port for vertical applications and at one end of the crack in horizontal applications and continue until epoxy adhesive appears at the next entry port along the crack.

2. Epoxy injection shall progress along the crack to the next adjacent port where epoxy adhesive has appeared.
3. Epoxy adhesive injection shall be performed continuously until cracks are completely filled.
4. If port-to-port travel of epoxy adhesive is not indicated, the work shall immediately be stopped and the Manager notified.

H. FINISHING

1. After cracks are completely filled, epoxy adhesive shall be cured to allow removal of surface seal without any draining or runback of epoxy material from cracks.
2. Surface seal material, injection ports and injection adhesive shall be removed from concrete surfaces.
3. The face of the crack shall be finished flush to the adjacent concrete surface showing no indentations or protrusions caused by the placement of entry ports.

I. PRESSURE TEST

1. The mixing head of the injection equipment shall be connected and the equipment run until clear uniformly mixed material flows into the purge pail. The Operator shall engage the equipment shut-off nozzle valve and subsequently bump the on-off switch until the pressure reaches 200 psi. If pressure is maintained between 190-200 psi for one minute, check valves shall be considered to be functioning properly and the injection may proceed. If pressure drops below 190 psi, Contractor shall be required to have new seals installed on the check valves and the equipment shall be subsequently retested.
2. The pressure test shall be run for each injection unit at the beginning and after meal breaks of every shift that the unit is used.
3. The adequacy and accuracy of the equipment shall be solely the responsibility of the Contractor.

J. RATIO TEST

1. The epoxy mixture ratio shall be monitored continuously while injecting by placing a strip of masking tape on the sides of the A & B reservoirs full height. After filling reservoirs, the A & B levels shall be marked and monitored while running injection machine into purge pail for a period of

one minute. The difference in liquid height shall then be compared to verify the correct volume ration is being dispensed.

2. If the dispensing ration is incorrect, the equipment shall be adjusted and retested.
3. The ratio test shall be run for each injection unit at the beginning and after meal breaks of every shift that the unit is used.

K. PROOF OF RATIO AND PRESSURE TEST

1. At all times during the course of the work the Contractor shall keep complete and accurate records available to the Manager of the pressure and ratio tests specified above.
2. In addition, the Manager at any time without prior notification of the Contractor, may request the Contractor to conduct the tests specified above in the presence of the Manager.

- L. PAYMENT: Payment for EPOXY ADHESIVE INJECTION FOR CONCRETE CRACKS will not be made directly but shall be included in the payment of which it is a part. Such payment shall represent full compensation for furnishing all materials, labor, tools, equipment and incidentals required to complete the work.

END OF SECTION

303.07 PRESTRESSED CONCRETE TANK

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WATER SYSTEM STANDARDS

DIVISION 300

SECTION 303 - STRUCTURES

SECTION 303.07 PRESTRESSED CONCRETE TANK

A. DESCRIPTION

1. This section shall replace Water System Standards for the County of Hawaii Department of Water Supply, Section 303.07 "PRESTRESSED CONCRETE RESERVOIR" in its entirety.
2. This section covers the qualifications for the Tank Contractor and Designer and requirements for the tank design and construction materials used in the tank. This section also covers the furnishing and installation of seven-wire strand and bars for circumferential and vertical prestressing, respectively, of concrete walls and the complete shotcreting operations.

In the event of a discrepancy between this section of the Specifications and any other section of the Specifications, this section shall govern. The words "stressing machine" may refer to either the circumferential wrapping or vertical post-tensioning machinery.

3. The Tank Contractor and Designer shall design, furnish and erect a prestressed concrete tank of the capacity shown on the Drawings, consisting of a concrete roof, concrete floor and a poured-in-place concrete core wall, post-tensioned vertically with steel rods and circumferentially with wrapped strand and protected with several coats of shotcrete and paint.
4. The tank shall conform to the dimensions and be equipped with the appurtenances shown on the Drawings and as specified herein.
5. Concrete work shall conform to the provisions of Sections 303.03A and 303.03B as supplemented and modified by this section.

B. RELATED WORK: Related work specified in other sections:

Section 303.03A – Concrete Work for Strandwrapped Prestressed Reservoir
Section 303.03B - Hot Weather Concreting Procedures
Section 303.03C - Epoxy Injection of Concrete Cracks
Section 303.07A - Earthquake Cables
Section 303.07B - Expansion and Contraction Joints
Section 303.07C - Tank Wall Base Joint
Section 303.12 – Reservoir Protection
Section 303.22A -Miscellaneous Specialties for Strandwrapped Prestressed Reservoir

Section 303.27A – Painting for Strandwrapped Prestressed Reservoir

C. WORK BY TANK CONTRACTOR, SUPERINTENDENT AND DESIGNER

1. Due to the nature of the project, it is the intent of these Specifications to obtain a first class product with emphasis on overall safety, quality and quality control, both during and after the construction process.
2. As evidenced by these Specifications and Drawings, a strong emphasis on performance has been made to assure that desired details and proven construction methods be utilized to provide the highest quality structure available. For example, the minimum design requirements listed, the minimum design and construction experience of the Tank Contractor and Designer, the stringent forming and pouring methods, the close tolerance continuously recorded circumferential and vertical prestressing and the automated shotcrete specified are only a few of many ways that will help prevent structurally deficient problems from occurring during the service life of the tank. It is imperative that the specified features of these Documents are strictly adhered to and only bids from Contractors that have a successful performance record in prestressed concrete tank construction be considered.
3. The qualified Tank Contractor shall submit with his bid the name and address of the Owner and completion dates and location of at least ten (10) tanks located within the United States that have been constructed by the Tank Contractor during the last five years. In order to meet the experience requirements, the ten (10) tanks shall be similar (i.e. freed wall base, poured-in-place corewall, externally machine strand wrapped, etc.) in design to the specified tank. Experience with tanks having fixed wall bases, mild-steel reinforced tank corewalls, shotcrete tank corewalls, precast tank corewalls or tank corewalls incorporating internal stressing systems or external wire wrapping (in lieu of strand wrapping) shall not be considered in meeting the required experience requirements.
4. The proposed Tank construction superintendent shall be currently employed by the qualified Tank Contractor and shall have been the tank construction superintendent for at least 3 strandwrapped prestressed concrete tanks during the last five years. The qualified tank superintendent shall have been in the direct employment of the qualified Tank Contractor for all three of the tanks listed and will be required to be on the project site in responsible charge, full-time, during all tank concrete construction activities.
5. A bid may not be considered responsive unless the Tank Contractor's, and associated Superintendent's, experience requirements have been submitted with the bid as specified in Section 303.07(E).
6. The Tank Contractor and Designer shall furnish the structural design for the tank, stamped by a Professional Civil or Structural Engineer registered in the State in which this tank will be built. The Professional Engineer shall have designed and be the Engineer of Record of at least five (5) tanks of the type specified in Section 303.07(C)(3) during the last five (5) years and must have worked a minimum of five (5) years in the full time employment of the qualified Tank Design firm.

7. A bid will not be considered responsive unless the Tank Contractor and Designer has submitted the name of his qualified Professional Engineer and the corresponding experience requirements of the Professional Engineer with the bid, as specified in Section 303.07(E).

D. PRESTRESSING WORK

1. No stressing system falling under any of the following requirements will be considered unless it has been successfully used on tanks of at least the same diameter, height and capacity. The Contractor shall submit with his bid the name and address of the Owner and the completion dates and location of at least ten (10) tanks located within the United States on which the proposed qualifying "stressing machine" and automated shotcrete equipment has been used within the past five (5) years. At the time of bid the qualified Tank Prestressor shall have a minimum of two operable strandwrapping and automated shotcrete machines meeting these requirements. Machines under construction shall not be considered in meeting the requirement of having two operable strandwrapping and automated shotcrete machines.

Descriptive literature shall also be submitted with the bid showing the proposed machinery with the recorders and a typical copy of an actual recording of the applied forces taken from one of the jobs on which such machinery has been used. Any stressing system that will not provide the substantial equivalent of the above requirements and experience will be rejected. This applies to the strand wrapping, tendon-stressing and automated shotcreting equipment.

2. A bid will not be considered responsive unless such data and experience record has been submitted with the bid as required in Section 303.07(E). This applies to both the wrapping as well as the tendon stressing equipment.
3. The prestressing shall be done solely by the Tank Contractor and Designer which shall be a firm or individual(s) having the equivalent of at least ten (10) years continuous experience in the installation of the type of prestressing specified. Experience with internal tendon systems or external tendon systems, not machine strand wrapped, and experience with external wire wrapping in lieu of strand wrapping shall not be considered in meeting the required experience requirements. The Tank Contractor and Designer shall not subcontract the design, forming, concrete placing, prestressing (installation or stress application) or shotcreting work. Specialty work such as rebar installation, scaffolding and concrete finishing may be subcontracted to contractors experienced in these aspects of prestressed concrete tank construction. Employees hired directly by the Tank Contractor shall perform all other tank construction activities.
4. All tanks listed for the Prestressor's experience requirements must have been prestressed in the Prestressor's own name. Experience from personnel association with the Prestressor or hired by the Prestressor will not be considered unless the Prestressor can demonstrate that the work was contracted and performed directly by the listed Prestressor in its business name.

E. BID-SUBMITTAL REQUIRED BY CONTRACTOR

As further defined in Sections 303.07(C) and 303.07(D) of these Specifications, the following

information shall be included with the Contractor's Bid Submittal:

1. The name(s) of the proposed qualified superintendent who will be in direct charge of the tank construction for the full duration of the Contract.
2. A list of at least three reservoir jobs successfully completed by each of the superintendents listed by the Tank Contractor, which shall include a tank description, the name and address of the Owner and the Project Design Consultant, and the approximate completion date of each tank.
3. The name and address of the Tank Contractor and Designer, if different than the Contractor, and a list of at least ten tanks, similar in design to the tank specified herein, successfully completed by the Tank Contractor during the last five years.
4. The name and address of the Owner and the completion dates and location of ten structures on which the proposed qualifying prestressing and automated shotcrete system, meeting the substance of these Specifications requirements, has been used during the last 5 years.
5. Descriptive literature of the wrapping, the vertical prestressing and the shotcrete machinery meeting all of these Specification requirements. Include in such data photographs or prints of the means of recording of both the circumferential and vertical prestressing applications and copies of actual photographs, print-outs or other records of applied wrapping forces (as well as force-elongation diagrams if available) taken from jobs in which the machinery has been used.
6. A written statement from the Tank Prestressor indicating that the Prestressor has a minimum of two operable strandwrapping and automated shotcrete machines meeting these specifications.
7. The name of the Professional Civil or Structural Engineer meeting the requirements of having designed five (5) tanks of the type of tank specified here-in during the last five (5) years and having been employed full time a minimum of five (5) years by the qualified tank Designer.
8. The complete tank structural design conforming to the requirements of Section 303.07(F). The submitted design shall include complete structural calculations for all major components of the tank and construction drawings detailing all major concrete reinforcing and prestressing requirements. The listed qualified Professional Engineer shall be sealed with a Civil or Structural Engineering stamp issued by the state where the tank shall be constructed, the complete tank design. The Design must be submitted with the bid to ensure compliance with the Specification requirements. Alternate tank designs or designs not in conformance to these Specifications will not be permitted and shall not be submitted.
9. The Contractor shall provide with the bid a consent of surety letter from the Tank Contractor's surety stating that the Tank Contractor's surety is prepared to provide a three (3) year maintenance bond, that the Tank Contractor's surety is Treasury listed for the contract

amount and that the Tank Contractor's surety is A.M. Best rated A12 or higher.

10. Failure to submit any of the above with the bid will cause the bid to be considered non-responsive and the bid can be rejected.

F. DESIGN

1. Minimum Requirements

These specifications reflect the mandatory minimum requirements that must be used as a basis for the tank design. The design of the tank shall meet the minimum design requirements per AWWA D110-04, Type I tank, ACI 350-06, including ACI 350.3-06, as well as, the requirements specified herein. The roof, columns, column footings and wall footing shall meet the requirements of Section 9.2.6 of ACI 350-06, which includes an environmental durability factor for flexural and tensile designs of conventionally reinforced concrete and limits the crack control value (Z) to less than 115 k/in. for one-way slab members.

2. Design Information

- a. Inside diameter: 94 FT.
- b. Water depth near wall: 20 FT. (above floor)
- c. Maximum water depth for overload: 20 FT. (above floor)
- d. Floor slope: 1.0% (high point in center of tank)
- e. Roof slope: 1.5% (high point in center of tank)
- f. Freeboard below top of wall: 2.0 FT.
- g. Live load on roof: 40 PSF.
- h. Maximum backfill height: 0 FT. (above floor)
- i. Minimum backfill height: 0 FT. (above floor)
- j. Soil bearing capacity incl. soil and liquid loads: 8,000 PSF.
- k. Seismic: 0.2 second horizontal spectral response acceleration in percent of gravity (S_s): 201 % (ACI 350.03-06)
- l. Seismic: 1.0 second horizontal spectral response acceleration in percent of gravity (S_1): 88 % (ACI 350.03-06)
- m. Seismic Site Class : B (ACI 350.03-06)

- n. Importance Factor: 1.5
3. Roof and Roof-Supports
- a. The roof will be a flat two-way slab poured-in-place reinforced concrete roof, having a minimum thickness of 9.0". The roof shall incorporate drop panels and shall be supported by round spiral-reinforced concrete columns, having a minimum diameter of 18".
 - b. The concrete cover over regular reinforcing steel in flat roof slabs and over column ties or spiral reinforcing in columns shall be 1.75 inch nominal with a plus or minus 1/4" construction tolerance.
 - c. Alternate roof designs such as post-tensioned, pretensioned, precast, dome, flat slab roofs without drop panels or waffle type roofs shall not be considered.
 - d. Flat roofs with drop panels shall be designed in accordance with ACI 350-06. Full use may be made of the design data presented in the Concrete Reinforcing Steel Institute (CRSI) handbooks.
4. Wall
- a. Wall to Wall-Footing Connection: All walls shall be supported by solid neoprene bearing pads allowing free radial movement of the wall relative to the wall-footing. The walls shall be tied circumferentially to the wall-footing with seismic cables consisting of hot-dipped galvanized strands encased in closed cell sponge rubber sleeves permitting a radial free movement of the wall of at least 3/4". A continuous 9" x 3/8" PVC or rubber waterstop connection shall be provided in wall and wall-footing joint.
 - b. Wall-Roof Connection: Flat roofs shall be supported by solid neoprene bearing pads allowing free radial movement of the wall relative to the roof or vice versa. An approved elastomeric sealant shall be provided between wall and roof when the specified backfill level is within 6 inches from the top of the wall. All radially free-floating roofs shall be tied circumferentially to the wall with special seismic connections permitting free radial movement of wall and roof.
 - c. Minimum Total Wall Thickness At Any Height*: 12.25"
 - *) Thickness includes a poured-in-place corewall and a 1.5 inch minimum shotcrete cover over the circumferential prestressing strand. The corewall is that area of the wall, interior of all circumferential prestressing.
 - d. Minimum Final Circumferential Prestressing Force for Water Load: The minimal "final" circumferential prestressing force to contain the hydrostatic load at the bottom of the wall shall be:

$$P_{cw} = 62.5 \times (R) \times (H) \quad (\text{lbs/ft of height}).$$

in which: R = inside radius of wall (feet).

H = maximum overload water height (feet).

This force shall taper uniformly to zero at the top of the maximum overload water height.

- e. Minimum Final Circumferential Prestress for Differential Temperature & Dryness Bending. (P_{cd}): The minimum total "final" circumferential compression at any height on the wall, for aboveground wall conditions (per these Specifications), shall be 200 psi over the water load and after deduction of all losses. This compression may taper to 50 psi at a distance six feet below the minimum backfill height elevation, if the tank is buried to this depth.

- f. Minimum Circumferential Backfill Force on Wall (P_{cb}):

$$P_{cb} = (h) \times (p) \times (R + 0.0833 t) \quad (\text{lbs/ft of height}).$$

in which: R = inside radius of wall (feet).

h = height of soil above wall-footing (feet).

p = equivalent liquid backfill pressure (lbs/cf) under seismic loading.

t = total wall thickness including cover over prestressing strands (inches).

- g. Minimum Final Vertical Prestress for Differential Temperatures & Dryness Bending (P_{vd})

The minimum "final" vertical compression and the vertical prestressing force (P_{vd}) for poured-in-place walls, at any point around the tank wall, shall be 200 psi minimum. Vertical prestressing shall be applied to the corewall prior to the circumferential strand wrapping operations.

- h. Maximum Final Stress in Circumferential & Vertical Prestressing Steel (f_{se}): The final stress (f_{se}) in prestressing steel shall not be less than the value determined as follows:

- 1) Start with the not-to-be-exceeded average initial steel stress. This value shall not exceed (0.70 and 0.75) M.U.S.* steel for the circumferential and vertical prestressing forces, respectively, based on a maximum stress tolerance of $\pm 1.5\%$ M.U.S. as evidenced by continuous electronic strip chart recordings taken from previous projects.

- 2) Deduct 25,000 psi for stress losses.
- 3) The balance is considered the final stress.

*) M.U.S. = Minimum Ultimate Strength.

- i. Minimum Initial-to-Final Stress Ratio (I.F. Ratio): The initial-to-final stress ratio is the value of the not-to-be-exceeded initial steel stress divided by the value of the final steel stress determined above under paragraph F(4)(h).
- j. Maximum Compressive Stress in Concrete Walls: The maximum compressive stress in concrete walls, under any combination of load conditions, at any stage during the construction and without any allowance for stress losses due to creep of steel and concrete, or due to elastic deformation of concrete, shall not exceed $0.55 f_c$.
- k. Minimum Total Overall Wall Thickness: The minimum overall wall thickness shall be no less than the minimum wall thickness shown under par. F(4)(c) or the value calculated below, whichever is greater:

$$t_{\text{overall}} = \frac{(P_{\text{cw}} + P_{\text{ctd}}) > P_{\text{cb}}}{(0.55 f_c) (12)} \text{ (inch)}$$

- l. Minimum Circumferential Prestressing Steel Requirement

$$A_{\text{cp}} = \frac{P_{\text{cw}} + P_{\text{ctd}}}{f_{\text{sc}}} \text{ (inch}^2\text{/ft of height)}$$

in which: P_{cw} = the minimum final circumferential pre-stressing force to contain the waterload (lbs/ft of height).

P_{ctd} = the minimum final circumferential pre-stressing force for differential temperature and dryness (lbs/ft of height).

f_{sc} = the final stress in the circumferential prestressing strand (psi).

- m. Minimum Vertical Prestressing Steel Requirement

$$A_{\text{vp}} = \frac{P_{\text{vtd}}}{f_{\text{se}}} \text{ (inch}^2\text{/ft of circumference)}$$

in which: P_{vtd} = the minimum final vertical prestressing force for differential temperature and dryness (lbs/ft of circumference).

f_{se} = the final stress in the vertical pre-stressing bars (psi).

- n. Bottom Edge Restraint Reinforcing for Corewalls: Cast-in-place concrete tank walls, prestressed vertically with threadbar tendons, shall be reinforced near the inside face from the bottom of the tank wall with #5 bars with a length as specified on the Drawings and spaced no further apart than 18 inch on centers.
- o. Seismic Forces: Forces and moments resulting from water sloshing and seismic accelerations of roof, wall and water loads must be calculated in accordance with Chapter 6 - Dynamic Pressure on Fluid Containers of Nuclear Reactors and Earthquakes - publication TID-7024, distributed by the National Technical Information Service of the U.S. Department of Commerce or ACI 350.3-06.
- p. Bearing Pads
 - 1) Tank walls and flat slab roofs shall be supported continuously around the circumference of the tank by neoprene bearing and closed cell neoprene sponge rubber pads.
 - 2) The hardness of neoprene bearing pads shall be 40 durometer.
 - 3) The minimum pad thickness under tank walls shall be 1 inch and under roof slab 1/2 inch.
 - 4) The minimum total neoprene bearing pad width under tank walls shall be 3 inches and under roof slabs they shall be 2 inches.
 - 5) All neoprene bearing pad areas shall take into account the total vertical force from roof, wall and backfill loads, including the downward drag on the wall when the backfill around the tank wall settles.
 - 6) All neoprene bearing pad sections shall be based on continuous loading values not to exceed those allowed in the bearing pad design manuals.
 - 7) The voids between bearing and closed cell neoprene rubber pads at wall and wall-footing and at wall and roof joints, shall be filled with soft mastic to ensure a substantially unrestrained free movement of wall and roof.

5. Wall-Footing Joint

- a. The circumferential wall-footing reinforcing, for differential dryness purposes, shall have a minimum total cross-sectional area no less than 0.5% of the wall-footing section excluding any reinforcement requirements for bursting forces due to water loads.
- b. Bursting forces caused by liquids acting on wall-footings shall be taken up fully by reinforcing steel in the radial or circumferential direction at steel stresses not exceeding 14,000 psi. No allowance shall be taken for soil passive lateral resistance effects on footings.
- c. Hinged or fixed wall to wall-footing connections shall not be considered.

- d. Radial and circumferential reinforcing bar diameter sizes shall not exceed 3/4 inch.
- e. Splices in parallel bars shall be adequately staggered to avoid more than one splice at any point around the circumference of the wall-footing.
- f. A continuous waterstop (6" x 3/8") shall be installed in all floor slab construction joints and bent upward to be welded to the bottom edge of the 9" circumferential waterstop connecting the wall to wall footing. See detail in project drawings.
- g. The minimum width of the wall-footing shall be 4.0 feet and the minimum thickness shall be 1.5 feet. The minimum embedment depth below the lowest adjacent grade shall be 1.5 feet.

6. Floor

- a. The floor slab thickness shall not be less than 6 inches nominal with a plus or minus construction tolerance of 1/4 inch, except at floor slab construction joints where the slab is thickened. See detail in project drawings.
- b. The floor reinforcing in each direction shall be no less than 1/2 percent of the nominal floor section with a maximum bar spacing of 12 inches. Floor thicknesses in excess of 8 inches shall have 2 layers of steel with the bottom mat at least 2 inches off the subgrade.
- c. Post-tensioning of floors is not required.

7. Column Footings

- a. All column footings shall be installed on top of the floor slab. The minimum size of these footings shall be as indicated on the Drawings.
- b. Reinforcing steel added to the floor steel at the columns shall be continuous without laps. The addition of such bars shall be in a way that the resulting steel distribution at the column footing is equally distributed in both directions.

8. Prestressing

- a. All vertical prestressing of tank walls shall be provided with 1.25" or 1.375" diameter steel thread-bars, with screw nut anchors, conforming to the material requirements in these Specifications. Wire or strand systems shall not be considered.
- b. All circumferential prestressing of tank walls shall be done with hot-dipped galvanized strand conforming to the material requirements in these Specifications. A prestressing system that relies on wire wrapping, including systems that pull the wire through a die to provide a tensioning force, will not be allowed.
- c. All circumferential wrapping forces shall be continuously electronically monitored

and permanently recorded on graph paper while the steel strand is being wrapped around the tank.

- d. All vertical tendon forces and elongations shall be simultaneously, permanently monitored electronically and recorded on graph paper from start to finish of each stressing operation.
- e. Tank wall designs shall not be based on wrapping tolerances less than what the wrapping machinery can factually and continuously meet based on continuous electronically recorded printouts taken from earlier projects. If none exists, the bidder is not qualified to bid this project.
- f. Tank wall designs shall not be based on stress-tolerance and stress-loss deductions less than those shown under paragraph F4(h).
- g. Prestressing wall strands shall not be spaced vertically closer than 2.5 strand diameters nor less than 3/8 inch clear between individual strands.
- h. Each intermediate strand layer shall be covered with 3/8-inch thickness of shotcrete.
- i. The minimum thickness of cover over the final strand layer shall be 1.5 inches.
- j. The center-to-center spacing of the vertical prestressing tendons shall not exceed 50 inches.
- k. Tank wall prestressing systems based on jack-operated cable or rod type tendons, involving the circumferential movement of pre-stressing steel relative to the wall surface shall not be considered. Circumferential systems relying on strand cables placed inside of ducts (cast in the corewall) or manually around the exterior, will not be accepted.

9. Waterstops

- a. Waterstops shall conform to the material requirements outlined in Section 212.09 of the Water Systems Standards and Sections 303.07B and 303.07C.
- b. All floor construction joints shall incorporate a minimum 3/8" x 6" waterstop without a centerbulb.
- c. All wall to wall-footing connections shall incorporate a minimum 3/8" x 9" waterstop and shall have a 3/4" minimum centerbulb.
- d. All vertical wall joints shall incorporate a minimum 3/8" x 6" waterstop without a centerbulb.
- e. All construction joints in the roof, if they should exist, shall incorporate a minimum 3/8" x 6" waterstop. At Contractor's option waterstop may have a 3/8" minimum

centerbulb.

- G. NON-RESPONSIVE BID: The information required in Sections 303.07(C), (D) and (E) above shall be submitted with the bid proposal. Failure to submit such information if this alternative is selected for the tank design, will be deemed a material irregularity that could cause the bid to be rejected as non-responsive.
- H. SHOP DRAWINGS: Contractor shall submit shop drawings of the circumferential prestressing wrapping schedule and the intermediate lock-off elevations for the Engineer's approval before the wall pour is made.

I. PRODUCT DELIVERY, STORAGE AND HANDLING

1. Prestressing steel shall be adequately packaged against intrusion of chemical contaminants (from the atmosphere or otherwise) for the protection of the steel against physical damage and corrosion during (and subsequently as the result of) shipping and storage.
2. Prestressing steel that has sustained physical damage through rust or other means will be rejected.
3. All materials and prestressing material delivered to the job site shall be stored off the ground on planks, supported by 4" x 4" timber, which must be covered with polyethylene or sizalkraft paper to prevent any moisture from coming up from the bottom.
4. Reels of steel strand, prestressing tendons, anchorages, etc., shall be stacked neatly and as compact as possible.
5. All materials for tendons and all fabricated tendons shall be covered with tarpaulins in such a manner that they are not exposed to water, rain, moisture or dust.

J. SEVEN-WIRE STRAND

1. Hot-dipped galvanized seven-wire strand used for prestressing shall meet the following minimum requirements unless otherwise shown on the Drawings:

<u>Item</u>		<u>Specification</u>	
		Type A	Type B
a.	Nominal strand diameter	1/2"	3/8"
b.	Nominal area after galv.	0.153 in ²	0.089 in ²
c.	Nominal weight/1000 LF	541 lbs.	303 lbs.
d.	Pitch (Strand diameters)	12-16	12-16
e.	Tensile strength (min.)	38,200 lbs.	21,400 lbs.
f.	Yield strength @ 1% extension (min)	28,500 lbs.	16,000 lbs.
g.	Elong. in 24" at fracture (min.)	4.5%	4.5%
h.	Weight of zinc coating (min.)	0.85 oz./ft. ²	0.85 oz/ft ²

2. Hot-dipped galvanized seven-wire strand shall be manufactured in accordance with ASTM

A-416 prior to galvanizing. Each wire of the strand shall be individually hot-dipped galvanized before being stranded.

3. Single wire prestressing material shall not be substituted for seven-wire strand prestressing material.

K. HIGH-STRENGTH THREADBARS

1. Deformations of the threadbars shall form a screw-thread suitable for mechanically coupling lengths of thread bar and also for positive attachment of anchor assemblies.
2. Deformations shall conform to ASTM A-722, Type II requirements and shall be uniform such that the bar may be cut at any point and the internal threads of a coupling can freely screw onto the bar. The bars and their deformations shall be hot rolled.
3. Tensile and Physical Properties shall meet the following requirements with bars being manufactured in accordance with ASTM A-722, Type II:

	<u>Item</u>	<u>Unit</u>	<u>Specifications</u>	
a.	Nominal diameter	inches	1.25	1.375
b.	Min. tensile force	kips (min.)	187	237
c.	Yield force at 0.2% offset	kips (min.)	150	190
d.	Elong. in 20 bar (diameter)	%(min.)	4	4
e.	Nom. cross-sectional area	sq. inches	1.245	1.577
f.	Nominal bar weight	lbs/ft.	4.39	5.56

Note: To provide reduced relaxation, more uniform elastic modulus and reduced residual stress in the critical thread area, only threadbars that are stress relieved after the threads are formed will be accepted. All threadbars shall be proof stressed after stress relieving and threading. Threadbars with cold rolled threads or threadbars with quenched or tempered steels will not be permitted. Threadbars shall have a maximum carbon content of 0.55 percent. Manufacturers with a minimum of 5 years of experience, under their current name, in the manufacturing of post-tensioning material meeting all the requirements of this specification will be accepted.

L. ANCHORAGES FOR VERTICAL POST-TENSIONED TENDONS

1. All post-tensioned prestressing shall be secured at the ends by means of approved permanent anchoring devices, which shall hold the prestressing steel at a force not less than 95% of the guaranteed minimum tensile strength of the prestressing steel.
2. The load from the vertical prestressing anchoring device shall be distributed to the concrete

through steel bearing plates of dimensions and details shown on the Drawings.

3. All vertical prestressing anchor plate dimensions, all dimensions relating to the conical hole in the top and bottom of the bearing plate (35° cone angle with the vertical), all steel tubing attached to the top bearing plate, and the spacing of all tendons shall strictly conform to the details shown on the Drawings.
4. Fully-threaded anchor connections that incorporate a spherical-shaped bearing surface to match the conical surface in the bearing plate shall be used at both ends of the vertical prestressing bar.
5. The contact point of the spherical-shaped vertical prestressing bearing surface to conical hole shall be approximately 1/4" to 1/2" below the bearing plate surface.
6. Wedge anchors shall not be used for permanent anchor hardware.

M. TESTING OF PRESTRESSING MATERIAL

1. Contractor shall furnish at his own expense mill test certificates showing the dimensional and physical characteristics of each heat or reel of the prestressing steel to be furnished.
2. Contractor shall furnish evidence, to the satisfaction of the Engineer, prior to the preparation of shop drawings and installation of vertical tendons, that the proposed tendon anchorage system meets the requirements of these specifications. The Engineer may order additional tests to be taken. Should such additional tests not meet the specifications, the expenses of this testing shall be paid for by Contractor; otherwise such expenses shall be borne by the Owner.
3. Before any stressing operation may be started, Contractor shall calibrate all recording equipment at an approved testing laboratory to the satisfaction of the Engineer.
4. All continuous force readings for the vertical and circumferential prestressing operations shall be developed with electronic (or the substantial equivalent) force (strain gauge method) sensing transducers, all having a maximum nonlinearity error of $\pm 0.5\%$ and a maximum hysteresis error of $\pm 0.25\%$.

N. ANCHOR POCKETS FOR VERTICAL TENDONS

1. Anchor pockets for vertical prestressing tendons shall consist of steel cans, hot-dipped galvanized after cutting (unless shown otherwise on the Drawings) and welded to the top bearing plate.
2. Anchor pockets shall be adequately sealed from moisture and concrete intrusion by wooden lids and 2-inch wide plastic adhesive tape.
3. Anchor pockets for vertical prestressing tendons must have adequate provisions for flushing of ducts with water during wall concrete placement.

O. DUCTS FOR VERTICAL TENDONS

1. Duct enclosures for vertical prestressing steel shall be standard 1.25" or 1.375" diameter PVC pipe class 160 or class 200, respectively, unless otherwise specified on the Drawings.
2. All ducts shall be provided with expandable valves at the bottom of the duct to facilitate the injection of epoxy after prestressing.
3. All connection details shall be as shown on the Drawings.

P. EPOXY GROUT FOR VERTICAL TENDONS

1. The vertical tendon system shall provide complete 2-part epoxy protection of the prestressing steel inside a PVC duct and anchors.
2. The injection of Portland Cement grout into the vertical tendon ducts will not be accepted.

Q. PORTLAND CEMENT: Portland Cement for the tank construction and shotcreting shall meet the requirements set out in Section 303.03A of these Special Provisions.

R. SHOTCRETE

1. Fine aggregates
 - a. Fine aggregates shall meet the requirements stated in Section 303.03A of these Special Provisions.
 - b. A well-graded coarse sand shall be used for all shotcrete applications.
 - c. Coarse sand shall generally consist of the following gradation:

<u>Sieve Size</u>	<u>% Passing by Weight</u>
3/8 inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10

The fineness modulus shall fall between 2.70 and 3.00.

- d. Plastersand shall be used for shotcrete finish coat if a smooth finish (as opposed to "natural") is required on the Drawings.
- e. Plastersand shall meet the following gradation:

<u>Sieve Size</u>	<u>% Passing by Weight</u>
3/8 inch	100
No. 4	97-100
No. 8	90-98
No. 16	70-85
No. 30	35-55
No. 50	15-25
No. 100	2-8

The fineness modulus shall fall between 2.40 and 2.75.

- 2. Rebound
 - a. Rebound is defined as aggregate mixed with some cements, which ricochets off the surface during the application of shotcrete because of collision with the harder surface, reinforcement, or with the aggregate particles themselves, the amount produced varies with the position of the work, air pressure, cement content, maximum size and grading of aggregate, amount of reinforcing and thickness of layer.
 - b. Rebound materials may not be reused in any form for shotcrete.
- 3. Water: Water shall meet the requirements set out in Section 303.03A of these Special Provisions.
- 4. Air-Entrainment & Admixtures: Air-entrainment and admixtures shall meet the requirements set out in Section 303.03A of these Special Provisions.
- 5. Fibrous Shotcrete Reinforcement
 - a. All shotcrete, unless otherwise specified herein, shall be fibrous reinforced. Such

material shall consist of 100 percent virgin polypropylene fibrillated fibers specifically manufactured for use as concrete/shotcrete secondary reinforcement. The required volume of fibers to be added per cubic yard of shotcrete shall be as specified below in Section 303.07(R)(6)a.

- b. Polypropylene fibers will help to provide greater control of cracking from drying shrinkage and thermal expansion/contraction, a reduction of permeability, an increased impact capacity, an improved shatter/abrasion resistance and added toughness of the shotcrete.
- c. The fibers shall be manufactured in accordance with applicable building codes and ASTM C-1116 Type III 4.1.3. and ASTM C-1116 (Ref. ASTM C-1018) Performance Level I_5 outlined in Section 21, Note 17. Fibrous concrete reinforcement shall be as manufactured by the FIBERMESH COMPANY, Chattanooga, TN [phone: (423) 892-7243], or equal.
- d. Acceptable polypropylene fibers shall have the following physical characteristics:
 - 1. Specific gravity = 0.91
 - 2. Tensile strength = 80-110 ksi
 - 3. Fiber length = graded per manufacturer

6. Shotcrete Proportioning

- a. Each cubic yard of mortar in the ready mix truck or mixer shall consist of 0.1% (1.5 lbs. per cubic yards) polypropylene fibers and a mix ratio of 3 lbs. of moist sand to 1 lb. of Portland cement. Up to 50 oz. of PRO-KRETE-R or POZZOLITH 300R may be added at the option of Contractor during warm weather conditions.
- b. Whenever night temperatures are expected to drop below 35F, "high early" Portland cement shall be used in lieu of regular Portland cement. Should "high early" Portland cement not be available, the mix design shall consist of a moist sand-Portland cement mix ratio, by weight, no greater than 2.59.
- c. If the batching procedure requires that smaller volumes of cement and sand be used, the required cement-to-sand ratio shall still be strictly maintained.
- d. Additives other than PRO-KRETE-R or POZZOLITH 300R (such as POZZOLITH 300N or others) shall not be used unless specifically approved by the Engineer, after careful consideration of its corrosive influence on prestressing steels.
- e. The total volumetric air content of the shotcrete before placement shall not exceed 7 percent (plus or minus one percent) as determined by ASTM C-173 or ASTM C-231.
- f. Unless otherwise shown on the Drawings, shotcrete cylinder strengths at 28 days shall be no less than 4,000 psi. Higher shotcrete cylinder strengths shall not permit a

reduction in the above specified cement contents. The cement content in the above mix designs may be increased should the specified 28-day strength requirement not be met.

- g. The polypropylene fibers and admixtures shall be added to the shotcrete at the time it is batched and in the amounts as required here in. Such additives shall be mixed in strict conformance to the manufacturer's instructions and recommendations for uniform and complete distribution. Each certificate of delivery supplied by the shotcrete supplier shall indicate the additive trade name, manufacturer's name and amount per cubic yard added to each batch of shotcrete.

S. CIRCUMFERENTIAL PRESTRESSING EQUIPMENT

1. The circumferential stressing system shall produce a continuously, electronically (or substantial equivalent) monitored permanent stress or force recording along its full length as it is being applied and the stress variation in any strand at any point around the circumference shall not be greater than ± 1.5 percent of the ultimate strength of the steel. In addition to this recording, any system which deflects the tensioned prestressing material between the tensioning device and the wall after it has left the tensioning device, shall provide a similar continuously monitored stress or force record along its full length as it is being applied to the wall. These recordings shall show that either before or after deflection, that the stress variation in the prestressing material at any point around the circumference shall not be greater than ± 1.5 percent of the ultimate strength of the steel. Due to prior instances of force measurement inaccuracies and the inherent problems associated with hand-held stressometers, no manual recorded force readings will be accepted. This requirement shall be strictly adhered to.
2. Any wrapping that does not meet the stress tolerances specified and/or cannot meet the requirements of Section 303.07(S)(1), will not be accepted and will be removed at Contractor's expense. Contractor shall be responsible for all costs associated with meeting the specified tolerances.
3. Since wrapping systems which utilize single solid prestressing wire will not provide the desired bond between the prestressing wire and the shotcrete and since single solid prestressing wire will not provide an adequate safety factor against failure, only machine wrapping systems which utilize seven-wire prestressing strand wrapping will be allowed.
4. Since intermittent force applications can result in an unequal stress distribution around the wall (due to friction losses), the prestressing system shall be capable of applying a continuous wrapped force at any point around the circumference within the specified tolerances. Circumferential stressing systems based on Jack-operated cable or rod-type tendons will not be allowed.

T. CIRCUMFERENTIAL PRESTRESSING APPLICATION

1. Wrapped strand shall be anchored to the wall at least once for every coil or reel.

2. Permanently anchoring one strand to a previously wrapped strand will not be permitted.
3. Wrapped strand ends shall be joined by suitable splicing methods that shall develop 90% of the full strength of the strand.
4. Use of different alloys in the splicing material will not be permitted.
5. The clear vertical spacing between adjacent prestressing strands shall be 1.5 strand diameters or 3/8 inch, whichever is larger.
6. All wrapped strands not meeting the spacing requirements shall be spread by approved methods or shall be removed.

U. VERTICAL PRESTRESSING EQUIPMENT

1. The Contractor shall provide a continuously, electronically (or substantial equivalent), monitored force-elongation record of a permanent nature from zero to full force at the final lockoff for all of the vertical prestressing work.
2. The ordinate of the permanent recording shall show the elongation in inches and the abscissa shall show the force in pounds or kips.
3. Recording force and elongation readings manually will not be accepted.
4. The vertical tendon stressing machinery shall have automatic electronic tensioning cut-off devices or equivalent means to ensure that the specified force and elongation is not exceeded at any time during any tendon stressing operation.
5. The force readings at the end of the stressed bar, immediately after lock-off, for any stressing operation, on any tendon, shall not fluctuate more than $\pm 1.5\%$ (of the minimum ultimate strength of the steel) from the desired average force setting.
6. The maximum applied force for the final stressing operation, immediately after lock-off on any tendon, shall be no greater than 75% of the minimum ultimate strength of the steel.

V. VERTICAL PRESTRESSING INSTALLATION

1. The number and spacing of threadbars, if shown on the Drawings, shall be the minimum number provided and shall not be altered under any condition.
2. High-strength threadbars shall be used for vertical prestressing which meet the requirements of Section 303.07(K) of these Specifications.
3. The anchor hardware shall have a ball-shaped threaded nut that can be screwed down on to a matching cone shaped bearing surface in the bearing plate after the desired tension on the anchor hardware and/or prestressing steel has been applied.

4. Vertical tendon components shall be assembled off the ground and as detailed on the Drawings before they are installed in the forms.
5. Particular attention shall be given to sufficient taping of damaged joint connections and holes in PVC tubing.
6. Vertical prestressing tendons shall be accurately placed at the locations shown on the reservoir design drawings, or as approved by the Engineer, and shall be securely fastened in place to reinforcing steel and form ties to prevent movement during placement of concrete.
7. Placing of vertical tendons shall be done to proper locations, elevations and alignments, with a maximum tolerance of plus or minus 1/4 inch.
8. All vertical tendons shall be securely tied at the anchor plates and shall be tied to #4 circumferential bars at 2 feet intervals between the anchor plates, unless shown otherwise on the Drawings.
9. Anchor plates must be installed at right angles to the tendon alignment near the anchor. Anchor plates must be installed with long sides, if applicable, aligned parallel with the wall forms and secured to prevent rotation while concrete is placed. The maximum permissible misalignment of anchor plate to tendon alignment is plus or minus 2.5 degrees.
10. Unless indicated otherwise on the Drawings, the minimum concrete cover around metal anchor pockets and bearing plates shall be 1.5 inches.
11. The clearance between bottom anchor plate and waterstop in tank walls shall be no less than 2 inches or more than 4 inches.
12. All vertical tendons shall be flushed with water introduced through a taped-off hole in the wooden lids on the anchor pockets from the top immediately upon completion of the wall concrete vibrating operation.
13. Flushing of ducts shall not be accomplished by introducing water through the bottom connection.
14. Upon completion of the water flushing operation of vertical tendons, the ducts shall be given a short burst of compressed air from the top only to remove any accumulations of water at the bottom of the ducts.
15. Cleaning of tendons with air only, or removal of water with air introduced from the bottom connection, will not be permitted.
16. The vertical tendon shall be stressed to the level and following the procedure described below in the next section.
17. All ducts shall be clean and free of water and deleterious materials that would impair bonding of the grout or interfere with grouting procedures.

18. Grout injection pipes shall be fitted with positive mechanical shutoff valves, which shall not be removed within the first 24 hours after grouting is complete.
19. Grouting of tendons shall be started at the lowest grout connection.
20. Each vertical tendon duct shall be pumped until the entire nut at the top anchor has been covered. Pea gravel and/or clean sand may be placed (at Prestressor's option) in the tendon can as a filler material prior to epoxy pumping.
21. In cold weather, and especially during frosts, special precautions must be taken to avoid the freezing of grout. In the event that the grouting procedure cannot be postponed, the wall temperature must be kept above the freezing point with hot blankets or by other approved means.
22. Upon completion of the vertical stressing and grouting operation, all anchor pocket areas above the anchor nuts shall be drypacked with a 1 part cement to 2 parts sand mortar mix immediately after the epoxy coating on the inside can surface has become tacky, or alternately, the metal can may filled with concrete aggregates and epoxy.
23. The drypack surface shall be finished flush with the top of the square tube.
24. The rectangular tube shall be fit over the square tube and the sides of the tubes aligned as detailed. The gaps between the tubes shall be filled with sheets of closed cell neoprene as detailed. A steel cover plate shall be seal welded to the rectangular plate prior to placing the roof slab concrete.

W. VERTICAL PRESTRESSING OPERATIONS

1. The maximum initial electronically (or substantial equivalent) recorded steel stress shall not exceed 75 percent of the guaranteed minimum ultimate strength (M.U.S.) of the steel at any time during and after stressing.
2. Each vertical tendon in the wall shall be stressed to the value shown on the reservoir design drawings prior to installation of circumferential prestressing. The stressing of the tendons may be sequential around the tank circumference if a back-up jack is provided on site. In lieu of the Contractor providing a back-up jack, the tendons may be stressed in an every-other pattern around the tank requiring two trips around the tank in order to tension all the tendons.
3. The loss in stress in post-tensioned prestressing steel due to creep and shrinkage of concrete, creep of steel and sequence stressing shall be assumed as 25,000 psi.
4. The final force in the vertical tendon is the steel section multiplied by the final stress.
5. The final force shall be no less than the force shown on the reservoir design drawings.
6. An automatic, continuously electronically (or substantial equivalent) monitored and simultaneously recorded force-elongation reading must be made for each vertical stressing

application.

7. The force-elongation reading must represent the true relationship between the elongation at any given point of the vertical stressing operation and the applied force on the prestressing steel at that same point.
8. The force-elongation relationship must be constantly maintained from the beginning, starting with the removal of the slack to the point of lock-off and complete release of the force on the vertical prestressing steel after retraction of the stressing piston or equivalent stressing device.
9. All electronically produced force-elongation readings during the vertical tendon stressing operations become the property of the Owner.
10. The ultimate initial prestressing force for vertical tendons shall not be applied until the concrete compressive strength in the wall shall have reached the specified 28-day strength.

X. CIRCUMFERENTIAL PRESTRESSING OPERATIONS

1. The maximum initial electronically (or substantial equivalent) recorded steel stress shall not exceed 70 percent of the guaranteed minimum ultimate strength (M.U.S.) of the steel at any time during or after stressing.
2. An automatic, continuously electronically (or substantial equivalent) monitored permanent recording of the applied force, at any point on the strand, at any point on and around the tank wall, must be made during the entire circumferential prestressing application. All such recordings must be based on a continuous sensing of the applied force on the strand between the tensioning drum and the wall as the strand is being wrapped and laid on the wall.
3. The force setting on wrapping and tendon stressing machinery shall be such that the applied forces fall within the specified minimum or maximum stress or force limitations; the force setting shall be corrected immediately when the applied force falls outside the required force tolerance limitations.
4. In the event that the stressing machinery is incapable of holding the applied forces within the specified stress or force limitations, the Engineer will order, at Contractor's expense, the removal and replacement of such machinery in favor of a different stressing process capable of maintaining such tolerance requirements.
5. The loss in the post-tensioned prestressing steel due to creep and shrinkage of concrete, creep of steel and sequence stressing shall be assumed as 25,000 psi.
6. The final stress is the average initial stress reduced by the assumed stress loss of 25,000 psi.
7. The final force in the prestressing strand is the steel section multiplied by the final stress.
8. The final force shall be no less than the force shown on the reservoir design drawings.

9. The continuous, electronically produced force application chart during the wrapping application becomes the property of the Owner.
10. Manual, individual or intermittent force readings taken on wrapped strand in full bodily contact with the wall will not be accepted. Force readings based on anything other than instantaneous force readings, as the strand is being tensioned, and wrapped around the tank, will not be accepted.
11. Wrapping may start when the concrete has reached a compressive strength of 3,500 psi; however, under no circumstance shall the compressive stress, under any condition, exceed 55%.
12. In the event that gaps between the corewall and the wrapped strand develop that exceed 3/8 inch, wrapping shall be discontinued and the wall shall be built up with shotcrete to provide the proper curvature. Alternately, if approved by the Engineer, the gaps may be dry-packed after wrapping is completed and before shotcreting is started.
13. Wrapping over intermediate shotcrete coats or built-up shotcrete areas may commence 12 hours after the shotcrete has been applied or when the shotcrete has reached a strength of 250 psi, whichever is later.
14. Because prestressing material exposed to excessive temperatures greatly increases the possibility of irrevocable damage, such as steel embrittlement, stress corrosion, or wire splitting, the temperature of the prestressed material during application shall not be allowed to increase by more than fifty degrees at any time during such application due to the stressing technique. No system which creates a force by pulling prestressing material through a die will be allowed.

Y. SAFETY PRECAUTIONS

1. Every precaution shall be taken to keep personnel and visitors outside the danger area of breaking strands or bars.
2. At no time shall anyone stand in the line of stressed vertical tendons or stressed strand.
3. No work shall be performed by anyone, other than the prestressing crew, within 100 feet from the wrapping operation or the application of the vertical tendon stressing operation.
4. Where access to the site by unauthorized persons is outside the Contractor's control, while prestressing work is in progress, Contractor shall erect temporary protective fencing to prevent breaking strand from endangering such persons.
5. There shall be no welding to anchor plates after the vertical tendons have been assembled, neither shall prestressing steel be used as a "ground" for welding operations.

Z. ABRASIVE BLASTING

Exterior surfaces of the concrete corewall to be strandwrapped shall be abrasive blasted by a mechanical etching or shotblast system combined with a vacuum recovery system, or a self-contained waterblasting system. Systems that have not been used successfully in the past to prepare circular tank wall surfaces for shotcreting and strandwrapping or systems relying on sandblasting or steel shot without a vacuum system will not be allowed. The surface shall be sufficiently abrasive blasted to remove all laitance, form oil or other type of coatings. The surface shall be cut to a minimum CSP5 profile, as established by the International Concrete Repair Institute (ICRI), over a minimum of 90% of the surface being prepared as measured over any one square foot area. The prestressing subcontractor who is performing the abrasive blasting shall make available to the inspector ICRI sample coupons to assist in evaluating the abrasive cut.

AA. SHOTCRETE EQUIPMENT

1. Mixing: The mixing of shotcrete material shall be done in conformance with the requirements of Section 303.03A "Concrete Work for Strandwrapped Prestressed Reservoir."
2. Delivery Equipment
 - a. The delivery equipment shall be of an approved design and size with a record of satisfactory results in similar previous work.
 - b. The equipment shall be capable of discharging mixed materials into the hose under close control and shall be able to deliver a continuous smooth stream of uniformly mixed material at the proper velocity to the discharge nozzle, free of any kind of slugs.
 - c. The equipment shall permit concrete, water and air to be distributed to the automated shotcrete tower through a swivel pin located at the center of the tank.
 - d. The nozzle shall be of a design and size that will ensure a smooth and uninterrupted flow of materials.
 - e. Delivery equipment shall be thoroughly cleaned at the end of each shift.
 - f. Equipment parts shall be regularly inspected and replaced as required.
3. Air Supply: The air capacity of the compressor shall be large enough that the minimum amount of air to be available at the nozzle shall be no less than 400 CFM, irrespective of whether or not air from the same air supply is used for other purposes.

BB. SHOTCRETE APPLICATION PROCESS

1. Shotcrete shall be applied under the wet mix process only.
2. Nozzles shall be mounted on power driven machinery enabling the nozzle to travel parallel to the surface to be sprayed at a uniform linear or bi-directional speed.
3. The nozzle shall be kept at a uniform constant distance from the surface, always insuring a right angle spray of the material to the surface.
4. Hand operated nozzles and shotcreting operations dependent on the performance of the nozzleman will not be accepted except where additional shotcrete is needed to correct flat areas or for architectural surface treatments.
5. Grout materials shall be delivered to the jobsite in ready-mix trucks from approved batching plants. However, job mixing will be accepted provided automatic weigh batch plants are used.
6. The sand, cement and water shall be premixed before being pumped through a 2" minimum hose by specially designed mortar pumps.
7. The high velocity impact of the shotcrete shall be developed pneumatically by injecting compressed air at the nozzle.

CC. SHOTCRETE PLACING AND FINISHING

1. General
 - a. Shotcrete shall be applied in a steady, uninterrupted flow.
 - b. Should the flow become intermittent for any cause, the machine operator shall direct the nozzle away from the work until it again becomes constant, or shut off the flow of materials.
2. Position of Pneumatic Nozzles: The nozzle shall be held at approximately right angles to the surface and shall be kept at a constant and proper distance, as dictated by good practice standards for the type of application, type of nozzle and air pressure employed.
3. Shotcreting More Than One Layer
 - a. Sufficient time shall be allowed for each layer of shotcrete to set up to prevent the next layer from sagging.
 - b. The shotcrete shall be started at the bottom of the wall and proceed upward until all wrapped strand has been covered. Subsequent shotcrete layers may be applied from the top down or from the bottom up at the discretion of the Contractor.

- c. While the nozzle travels around the wall, the nozzle shall be raised or lowered at a uniform rate in such a manner that an adequate overlapping of coatings and a uniform finish develops.
 - d. The nozzle shall be spiralled up or down around the tank to either the top or the bottom of the wall or to the termination of the strand layer being covered.
- 4. Application of Shotcrete
 - a. To ensure proper penetration around the strand and proper conveyance of the material through the hose, a 5" to 7" slump of the mortar at the pump is recommended.
 - b. The application of the shotcrete in the number and thickness of layers specified in design drawings by Contractor is mandatory for proper penetration of shotcrete behind prestressing steel and to reduce shrinkage due to more uniform in-depth drying of the shotcrete. The moisture absorption by earlier applied layers is relied upon to improve the bond and strength of the material and to reduce drying shrinkage of the applied shotcrete.
- 5. Shotcrete Covercoats Over Wrapped Strand
 - a. Each layer of wrapped prestressing steel shall be covered with shotcrete until a minimum cover of 3/8" over the steel has been obtained.
 - b. The final covercoat, to make up for the full thickness of shotcrete over the outermost strand layer, shall be applied in at least 3 layers of equal thickness.
 - c. Each layer of shotcrete shall be completed for the full circumference of the tank and substantially the full height of that layer before the next layer of shotcrete may be applied.
- 6. Coating Thickness
 - a. All shotcrete coatings shall be built up in layers of approximately 3/8 inch in thickness until the final required thickness has been obtained.
 - b. Unless otherwise shown on the Drawings, the minimum shotcrete cover over all wrapped steel shall be 1.5 inch.
- 7. Finish Coat
 - a. After the minimum shotcrete cover specified over the wrapped prestressing strand has been completed by the automated shotcrete procedure, and only if such finish requirements are shown on the Drawings, the exterior surface shall be given an acceptable float finish true to line and curvature and to details shown on the Drawings.

- b. If a float finish is required on the Drawings, plaster or hand-applied shotcrete may be used to build up and level the surface and to obtain the desired surface finish and projections.
- c. The finish coat mix (if a smooth float finish is required on the Drawings), shall consist of a minimum of one sack of cement for every 3-1/2 cubic feet of moist plaster sand.
- d. If no finish requirements are shown on the Drawings, it is intended to have a natural original gun finish of the shotcrete covercoat.

8. Protection of Adjacent Buildings and Surface

- a. Contractor shall take every possible precaution to protect adjacent buildings, concrete surfaces, vehicles, equipment, etc., from being damaged by overshooting shotcrete and by materials carried away by the wind.
- b. Overshot shotcrete and rebound materials deposited on the roof shall be removed before it adheres to the concrete surface.
- c. Contractor shall pay for all damages caused by his operations under this contract.

DD. SHOTCRETE TESTS: Testing of shotcrete shall conform to Section 303.03A(DD) "Concrete Tests" of these Special Provisions.

EE. NOZZLEMAN REQUIREMENTS FOR HAND PLACED SHOTCRETE

- 1. To ensure a high quality shotcrete, the Contractor shall satisfy the Engineer that the nozzleman has had sufficient and acceptable experience in the application of structural shotcrete.
- 2. Experience gained on shotcrete pool and ditch construction will not be considered as experience for qualifying the nozzleman, unless approved by the Engineer.
- 3. The nozzleman shall be capable of applying thin coats of even and uniform thickness.
- 4. The nozzleman's skill will be tested and approved by the Engineer before he may start any work.

FF. RESTRICTIONS ON SHOTCRETE OPERATION

- 1. Shotcrete shall not be applied under such strong wind conditions that a considerable amount of cement and moisture will be removed by the wind from the mortar spray between the nozzle and the surface intended to have shotcrete applied.

2. The Contractor may apply shotcrete under the conditions specified herein solely at his own risk.
3. Whenever rain or frost has damaged shotcrete that has not had a chance to set up, such shotcrete shall be removed and replaced.
4. Contractor shall consult with the Engineer to determine whether or not the shotcrete damaged by rain or frost will be accepted before applying any additional layers of shotcrete.

GG. SHOTCRETE WATERCURING

1. Intermediate layers of shotcrete shall be kept damp by hand curing or other means no sooner than 12 hours after the shotcrete has been applied.
2. This watercuring is not required should additional shotcrete be applied on the entire wall surface within the following 12 hours.
3. An indiscriminate use of continuous watercure for intermediate layers shall be avoided.
4. Complete shotcrete surfaces, which do not receive any additional coatings, shall be watercured for a period of at least seven (7) days by encapsulating the shotcrete with plastic sheeting. Such plastic sheeting shall be lapped and sealed as necessary to properly cure the shotcrete. Membrane curing methods utilizing curing compounds or wax-based residuals will not be permitted.
5. Wall coatings, as specified in Section 303.27A, shall be applied no later than five (5) days after completion of the watercuring. If conditions make it impossible to apply coatings within the five (5) day period, shotcrete shall be watercured for a period of ten (10) days instead of the seven (7) days specified here-in.

HH. CLEANING AND WATERPROOFING

1. After construction is completed, the interior of the tank shall be completely hosed out and cleaned of all dirt and loose material.
2. Cracks in the floor slab, wall, footings, columns or roof slab, which may have developed from drying shrinkage, shall not be taped or chipped out and caulked. All cracks shall be pumped and sealed with a two-part water insensitive epoxy.

II. DISINFECTING AND FILLING

1. Disinfection of the tank shall only proceed after the tank has been leak tested and the interior pipe coating per the construction documents.
2. The disinfection of the tank shall be performed as described in the Water System Standards, Section 303.10 "Reservoir Leakage Test and Disinfection".

JJ. LEAK TESTING AND REPAIRS

1. Testing

- a. Leak testing of the tank shall be conducted prior to disinfection and shall follow the procedures described in the Water System Standards, Section 303.10 "Reservoir Leakage Test and Disinfection".
- b. Testing shall be completed before the tank is backfilled, if applicable.

2. Leak Detection Methods

- a. Leaks in floor construction joints may be detected with the aid of a diver.
- b. Mud or cement deposits on the floor, when stirred up, would flow to the leak and may indicate the leak locations.
- c. Honeycomb and cracks around waterstops may be detected through tapping with a hammer along the joint.
- d. The Engineer may require any of these procedures when cement seeding has not stopped the leaks.
- e. Leakage through joints, which may have resulted from bent over waterstops or honeycomb under or around waterstops may require the removal of concrete around the waterstops in suspected areas.
- f. Chipped out concrete areas shall be properly drypacked as specified in Section 303.03A(BB)(8) of these Special Provisions.

3. Acceptance

- a. Any cracks, voids, honeycomb or cold joints showing or causing running leaks of water, shall be epoxy pumped by qualified operators until such cracks and voids have been completely sealed. If requested by the Contractor to stop floor leakage and if allowed by the Owner, the floor may be covered with a minimum of two inches of water and pure cement shall then be spread evenly over the entire floor area at the rate of one sack of cement to every 1000 square feet of floor area. The floor shall not be allowed to dry after the application of cement. If the tank has been cement seeded and if the tank is drained during the warranty period, Contractor shall be given fourteen (14) days advance notice and Contractor shall promptly remove all cement residue from the tank floor and clean the tank to the Owner's satisfaction. The Owner shall pay for the subsequent tank disinfection and chlorination.
- b. The tank shall not be backfilled until and unless the Engineer has accepted the tests.
- c. This section shall be applicable during the entire specified warranty period of the

tank.

- d. After the completion of the reservoir leakage test, the reservoir shall remain filled until the reservoir is chlorinated and placed in service.

KK. PAYMENT

Payment for the work in this section shall not be made separately, but will be included with the lump sum amount for the item this is apart as stated in the Proposal.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300 SECTION 303 - STRUCTURES

SECTION 303.07A EARTHQUAKE CABLES

A. GENERAL

1. This item of work shall include the furnishing of all labor, materials, tools and equipment necessary to complete the tank earthquake cables work.
2. The Contractor shall submit five copies of the quantity, location and details for the Manager's approval before the earthquake cables are fabricated.

B. EARTHQUAKE CABLE STRANDS

1. Where called for on the Drawings, earthquake cables consisting of 7-wire galvanized strands, meeting the minimum physical and strength requirements on the Drawings and Section 303.07 of these Special Provisions, shall be installed to connect wall and wall footing. If no strength requirements are shown on the Drawings, the minimum ultimate strength for 3/8" and 1/2" strand shall be 21,400 lbs. and 38,200 lbs., respectively.
2. The strands shall be hot-dipped galvanized before stranding with a minimum zinc coating of 0.85 oz./ft².
3. Galvanized strands for earthquake cables shall meet the quantity and spacing specified on the Drawings.

C. CLOSED CELL NEOPRENE SEISMIC CABLE SLEEVES

1. Neoprene sleeves for seismic cables, which encase the galvanized strands, shall conform to the minimum dimensions shown on the Drawings to permit unrestrained flexing of the strands inside the sleeves under the maximum projected radial wall movements.
2. The material shall be medium grade closed cell neoprene conforming to 2A3 of ASTM D 1056-85 and as further specified here-in and on the Drawings.

- | | | |
|----|----------------------------|---------------------------|
| a. | Compression deflection | : 9-13 PSI |
| b. | Density | : 18-28 PCF |
| c. | Water absorption by weight | : 0.5 lbs/ft ² |

- d. Temperature range:
 - 1) low (flex without cracking) : -30° F
 - 2) high continuous : 150° F
 - 3) high intermittent : 200° F
- e. Heat aging (7 days @ 158° F)
lineal shrinkage (max.) : 5%
- f. Tensile strength : 115 PSI min.
- g. Elongation : 170% min.
- h. Resilience (bayshore-% rebound average
1/2" thickness @ 72° F) : 20%-40%

- 3. **RUBATEX R431N or R423N or CYPRESS SPONGE 431N or 423N,**
or approved equal, are acceptable materials.

D. MILD STEEL REINFORCING BARS: The mild steel reinforcing bars for the support of the earthquake cable anchors shall conform to the requirements of Water System Standards, Section 303.04, REINFORCING STEEL and as amended herein these technical provisions as they apply to this project.

E. EARTHQUAKE CABLE INSTALLATION

- 1. Cable sets shall be installed equally spaced and in equal number in each wall section. The spacing shown on the Drawings is only approximate and the number of cable sets specified is the governing criteria for placement.
- 2. The cables may be cut to length with a burning torch.
- 3. Where necessary, the strands shall be pre-bent before placing into wall and wall footing forms, as called for on the Drawings.
- 4. The strands shall be separated and tied to circumferential wall reinforcing as required and shown on the Drawings.
- 5. At wall construction joints, the strands may be arched away from the joints or pass through the joints if the length of strand beyond the joint is at least 30 inches.
- 6. In the footing, the strands shall be fanned out and tied to the top of the radial bars at the bottom of the footing.

F. PAYMENT: No separate payment for EARTHQUAKE CABLES will be made; compensation for such work shall be deemed to be included in the Lump Sum Bid for the item of which it is a part.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300 SECTION 303 - STRUCTURES

SECTION 303.07B TANK EXPANSION AND CONSTRUCTION JOINTS

- A. **DESCRIPTION:** This item of work shall include the furnishing of all labor, materials, tools and equipment necessary complete the tank expansion and construction joints.
- B. **SUBMITTALS:** Furnish certified mill certificates showing that the material meets all of the requirements specified here-in. The Manager, at his option, may take samples of any materials and have them tested by an independent testing laboratory to verify their compliance with these Specifications. All such costs shall be borne by the Department of Water Supply. If any materials should fail to meet these Specifications, all costs for further testing of the replacement material shall be borne by the Contractor.
- C. **OBSTRUCTIONS:** Contractor shall pay particular attention to removing all obstructions such as concrete, nails, etc., from joints when movements of floor, wall and roof sections can be expected under prestressing, temperature and other conditions.
- D. **WATERSTOPS:**
1. Waterstops shall meet the requirements of Water Systems Standards, Section 212.09, with the following revisions and additions.
 2. No reclaimed PVC shall be used in the compound.
 3. The finished waterstop material shall meet the following minimum requirements:

a.	Tensile strength	2,200 psi	(ASTM D-412)
b.	Ultimate elongation	450%	(ASTM D-412)
c.	Shore hardness	80 + 10	(ASTM D-2240)
d.	Specific gravity	0.95 min.	(ASTM D-792)
e.	Stiffness in flexure	600 psi	(ASTM D-747)
f.	Cold brittleness point	-35° F max.	(ASTM D-746)
g.	Water absorption (48 hrs.)	0.320% max.	(ASTM D-570)
h.	Tear resistance	275 lb./in.	(ASTM D-624)
 4. **JP SPECIALTIES, INC., (Earth Shield)** 551 Birch Street, Lake Elsinore, CA 92530 (Phone 800-821-3859) and **GREENSTREAK PLASTIC PRODUCTS**, Box 7139, St. Louis, MO 63177 (phone

314-225-9400) are two of several suppliers who can furnish waterstops meeting these requirements. Approved equal materials may also be used.

5. Waterstop intersection joints shall be prefabricated with a 12 inch minimum length from the joint.

E. JOINT SEALERS

1. Joints, not requiring waterstops or when so indicated on the Drawings, shall be sealed with a mastic joint sealer material of uniform, stiff consistency that does not contain solvents.
2. The mastic shall tenaciously adhere to primed concrete surfaces, shall remain permanently mastic and shall not contaminate potable water.
3. The material shall be of a type that will effectively and permanently seal joints subject to movements in concrete.
4. The mastic joint sealer shall be an acceptable two-part, self-leveling (or gun grade), non-staining, polyurethane elastomeric sealant that cures at ambient temperature. Acceptable sealants shall conform to ASTM C-920 or Federal Specification TT-S-00227E.
5. For sloping joints, vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used; all such compounds shall conform to the requirements of ANSI/ASTM C 920 Class 12-1/2, or Federal Specification TT-S-0027 E(3), Type II.
6. For plane horizontal joints, the self-leveling compounds which meet the requirements of ANSI/ASTM C 920 Class 25, or Federal Specification TT-S-0027 E(3), Type I shall be used. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics, and having a Shore "A" hardness range of 25 to 35, shall be used.
7. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the sealant manufacturer.
8. Acceptable polyurethane materials are **PSI-270 RESERVOIR SEALANT**, as manufactured by POLYMERIC SYSTEMS, INC., Phoenixville, PA (610-935-1170), **SIKAFLEX/2C POLYURETHANE ELASTOMERIC SEALANT**, as manufactured by SIKA CHEMICAL CORP., Santa Fe Springs, CA (310-941-0231) and **SELECT SEAL U-227 RESERVOIR GRADE**, as manufactured by SELECT PRODUCTS CORP., Costa Mesa, CA (714-429-0808), or approved equal.

- F. PREFORMED JOINT FILLER: Preformed joint filler material shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be

permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 for Type I, except as otherwise specified herein.

G. BACKING ROD: Backing rod shall be an extruded closed-cell, polyethylene foam rod. The material shall be compatible with the joint sealant material used and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi. The rod shall be 1/8-inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

H. BOND BREAKER: Bond breaker shall be **SUPER BOND BREAKER WATER BASE** as manufactured by Burke Company, San Mateo, California; **SELECT EMULSION CURE 309**, as distributed by Select Products Co., Costa Mesa, CA (clear or white pigmented) or equivalent. Fugitive dye may be used in bondbreakers if recommended by manufacturer.

I. INSTALLATION OF WATERSTOPS

1. The waterstop shall be correctly positioned in the forms with the center of the waterstop centered on the joint.
2. In cases where preformed expansion joint material is used in conjunction with the waterstop, allowance shall be made for equal waterstop embedment on each side in the concrete.
3. Waterstop shall be held in place in the forms by use of a split form or other approved method that will positively hold the waterstop in the correct position and to the correct alignment.
4. All waterstop intersection joints shall be welded in the shop and shipped to the project site.
5. Field Joints
 - a. Field joints shall be restricted to properly aligned, straight butt joints only.
 - b. Use only recommended splicing tool for field joints of waterstop.
 - c. Centerbulbs shall be compressed or closed when welding to non-centerbulb type or edge.
6. Horizontal waterstops shall be bent up during placing of concrete until the concrete has been brought to the level of the waterstop; additional concrete shall then be placed over the waterstop, after which the concrete shall be thoroughly vibrated.

7. All horizontal and vertical waterstops, which are not accessible during pouring, shall be tied off in two directions every 12 inches to prevent bending over during concrete placement or consolidation.
8. A hog-ring or nail may be driven through both ends of the waterstop to facilitate placing and tying of waterstops to reinforcing steel forms or form-ties.
9. All waterstops shall be properly spliced and joints shall be checked for strength and pinholes after splicing.
10. Splices shall be strong enough to develop a pulling force of 75 percent of the waterstop strength, and shall be watertight.
11. Ends of the radial waterstop in the floor slab joints shall be connected to the circumferential waterstop in the floor to wall-footing joint.

J. JOINT SEALERS

1. Joint sealed areas shall be sandblasted or roughened and blown clean of dust and sand with compressed air before the material may be applied.
2. Joints shall be primed (if required) prior to installing the joint sealer, install bond breaker tape to bottom of joint. Sealant shall be applied in accordance with the manufacturer's recommendations.

- K. PAYMENT: No separate payment for TANK EXPANSION AND CONSTRUCTION JOINTS will be made; compensation for such work shall be deemed to be included in the Lump Sum Bid for the item of which it is a part.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300 SECTION 303 - STRUCTURES

SECTION 303.07C TANK WALL, BASE AND TOP JOINT

- A. DESCRIPTION: This section covers the work necessary for the tank wall base and top joint (if shown on the Drawings), complete.
- B. SUBMITTALS
1. The Contractor shall provide the Manager a 2-foot minimum length of each of the closed cell neoprene pads and the neoprene bearing pads in order that the Manager can test the pads for compliance with these Specifications.
 2. Furnish certified mill certificates showing that the material meets all of the requirements specified here-in. The Manager, at his option, may take samples of any materials and have them tested by an independent testing laboratory to verify their compliance with these Specifications. All such costs shall be borne by the Department of Water Supply. If any materials should fail to meet these Specifications, all costs for further testing of the replacement material shall be borne by the Contractor.
- C. WATERSTOPS: Waterstops shall conform to requirements in Section 303.07B, EXPANSION AND CONSTRUCTION JOINTS. The size and location of the waterstop shall be as shown.
- D. NEOPRENE BEARING PADS
1. Neoprene pads shall be of dimensions and hardness shown on the Drawings and shall be made by an approved manufacturer.
 2. The material for 40 durometer neoprene pads shall conform to ASTM D-2000 M2BC414A14C12F17 and the material for 30 durometer neoprene pads shall conform to ASTM D-2000 M2BC310A14C12F17.
 3. Unless otherwise specified on the Drawings, neoprene pads shall be of 40 durometer.
 4. **DACOM INDUSTRIES CO.**, 10661 N. Lombard, Portland, OR 97203 (Phone 503-978-0801 and **WEST AMERICAN RUBBER COMPANY, INC.** (Phone: 714-532-3355) are two of several suppliers who can furnish

neoprene pads meeting these requirements. Approved equal materials may be used.

E. CLOSED CELL NEOPRENE FILLER PADS

1. Closed cell neoprene pads, shall be used as a filler material in the flexible joints between the wall and wall-footing and between the wall and roof connection in the areas not taken up by the solid neoprene bearing pads and waterstops.
2. The materials shall be medium grade closed cell neoprene conforming to 2A3 of ASTM D 1056-85 and as further specified here-in and on the Drawings.
 - a. Compression deflection : 9-13 PSI
 - b. Density : 18-28 PCF
 - c. Water absorption by weight : 5%
 - d. Temperature range:
 - low (flex without cracking) : -30° F
 - high continuous : 150° F
 - high intermittent : 200° F
 - e. Heat aging (7 days @ 158° F) lineal shrinkage : 5% max.
 - f. Tensile strength : 115 PSI min.
 - g. Elongation : 170% min.
 - h. Resilience (bayshore-% rebound average
1/2" thickness @ 72° F) : 20%-40%
3. **RUBATEX R431N or R423N, or CYPRESS SPONGE 431N or 423N**, or approved equal, are acceptable materials.

F. SOFT MASTIC

1. Self-leveling soft mastic shall be installed in all voids and cavities around bearing pads, waterstops and seismic cable sleeves. Such material shall be installed with a consistency that will not adversely affect the quality of rubber or neoprene materials.
2. **SIKAFLEX 1A**, as manufactured by Sika Corporation or **SELECT SEAL U-230**, as manufactured by Select Products Company, or approved equal, are acceptable materials.

G. INSTALLATION OF WATERSTOP: Waterstops shall be continuous and shall be installed where shown. The method of installation shall be as specified in Section 303.07B(I).

H. BEARING AND NEOPRENE FILLER PADS

1. Bearing and filler pads shall be installed as indicated on the Drawings.
2. Bearing and filler pads shall be glued to the concrete with an approved rubber cement material to prevent uplift of the pads during placement of concrete.
3. In addition, all pads shall be held down with approved plastic shim plates or 'adobes' placed under the reinforcing steel as shown.
4. Nailing down pads will not be permitted
5. All voids and cavities between bearing and filler pads, waterstop and seismic cable sleeves, irrespective of whether these voids are large or small, shall be filled with a soft mastic.
6. Closed-cell neoprene shall be ordered at least 1/4-inch wider than theoretically required to facilitate placing and to reduce development of voids between filler pads, bearing pads and waterstops.
7. Contractor's workmanship shall be such that no cement grout or concrete seepage will occur through the bearing and filler pad area resulting in a restraint of radial wall-movements.
8. Neoprene bearing pads and one or more closed cell neoprene pads are required between the top of the wall and the underside of the roof. Secure pads as described above in item #2. Trim closed cell neoprene pads as required to fit around seismic tubes at top of wall. Any void areas between such pads shall be filled with soft mastic to prevent any mortar from the roof pour to come in contact with the wall top.

- I. PAYMENT: No separate payment for TANK WALL, BASE AND TOP JOINT will be made; compensation for such work shall be deemed to be included in the Lump Sum Bid for the item of which it is a part.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300
SECTION 303 - STRUCTURES

303.12 PROTECTION OF STRANDWRAPPED PRESTRESSED RESERVOIR

Replace entire section with the following:

A. GENERAL

The reservoir concrete shall be properly protected from “drying out” during construction. Upon completion of the floor slab, the floor shall be cured as specified in Special Provision section 303.03A.CC.

After the completion of the reservoir leakage test, the reservoir shall remain filled up to the time when the reservoir is chlorinated and placed in service.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300 SECTION 303 - STRUCTURES

SECTION 303.13 UNIT MASONRY

E. MORTAR AND GROUT:

Add the following to item 1. "Mortar"

"Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a pre-blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site."

F. REINFORCING:

Item 2: Delete second paragraph and replace with the following:

"Splices shall be lapped as indicated but not less than 32 diameters or 24 inches, whichever is longer. See typical details or drawings for reinforcing at jambs of doors windows and other openings, corners, junctions and ends of walls.

H. STORAGE AND HANDLING:

Add the following to this subsection:

2. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
3. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
4. Deliver pre-blended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store pre-blended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
5. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

I. WORKMANSHIP

Add the following to the end of the fourth paragraph of this subsection:

“Bed unit webs in starter course mortar bed on footings and where adjacent to cells or cavities to be filled with grout.”

Add the following to the end of this Section:

N. SUBMITTALS:

1. Product Data: For each different masonry unit, accessory, and other manufactured products specified. Submit manufacturer's certification materials provided meet requirements specified.
2. Reinforcing Steel Shop Drawings: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."

O. PROJECT CONDITIONS:

1. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress. Extend cover a minimum of 24 inches down both sides and secure in place.
2. Do not apply uniform roof loads for at least 12 hours and concentrated loads for at least 3 days after completion of masonry walls.
3. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
4. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.
 - a. When ambient temperature exceeds 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

P. ADDITIONAL GROUTING REQUIREMENTS:

1. A ready mix producer shall provide grout in conformance with the approved mix design, unless Manager has given written permission site mix the grout.
2. All reinforcing, inserts and ties shall be placed and secured prior to starting the grouting process.

3. After cleanout holes have been inspected and the grout space cleaned out of any loose material, the cleanout holes shall be sealed with a face shell or a form board braced to resist the pressure of the poured grout.
4. Mortar in wall sections to be grouted shall be sufficiently cured to resist the pressure of the fluid grout prior to grouting.
5. Consolidated grout with a mechanical vibrator to produce a dense grout.
6. Re-consolidated grout 3-5 minutes after initial consolidation to eliminate voids created by absorption of water by the masonry units.
7. Finish consolidated grout flush with the top of the wall.

Q. CONTROL AND EXPANSION JOINTS:

1. General: Install control and expansion joints in unit masonry where indicated on the Drawings.
2. Form control joints in concrete block masonry as follows:
 - a. Omit head joint for full height of wall, except at chord bar bond beam at top of wall.
 - b. Install preformed backer rod in each face of joint and seal with joint sealant as detailed.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 303 - STRUCTURES

SECTION 303.16 BUILT-UP ROOFING

Delete and replace subsection D. PRODUCTS; 1. ROOFING SYSTEM with the following:

1. ROOFING SYSTEM: Atactic Polypropylene (APP) modified asphalt membrane consisting of a durable, non-woven polyester mat saturated with APP and surfaced with mineral granules, in conformance with ASTM D6222, Type I, Grade 'G', such as 'Brai Supreme – APP Granule FR'. Color of granular finish to be selected by Department. Apply to roof deck with coat of asphalt primer designed for use on cast-in-place concrete.

Delete item D.2 "SUMMARY OF MATERIALS PER 100 SQ. FT."

Delete and replace subsection G. "APPLICATION" with the following:

- G. APPLICATION: Apply roofing materials as specified and as recommended by manufacturer's printed application instruction. Roofing sheets to be continuously torch welded at seams.

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 303 - STRUCTURES

303.16A FLUID APPLIED ROOFING MEMBRANE

- A. GENERAL DESCRIPTION: This item of work shall include the furnishing of all labor, materials, tools and equipment necessary for the complete installation a fluid-applied roofing system where indicated on the drawings. A specific manufacturer is described to establish the level of quality required, but an approved equivalent system is acceptable.
- B. SECTION INCLUDES:
1. Adhered cold fluid-applied reinforced unsaturated polyester waterproofing system including, membrane, penetration flashings, base flashings, expansion joints, and non-skid finish.
 2. Substrate preparation, cleaning, leveling and patching
 3. Temporary waterproofing
 4. Alkalinity protection
 5. Waterproofing membrane installation
 6. Flashing installation and finish work installation
- C. REFERENCES:
1. American Society for Testing and Materials (ASTM) C 836 Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane.
 2. National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual.
 3. ACI-308 - Recommended Practice for Curing Concrete
 4. ASTM - D638 - Test Methods for Tensile Properties of Plastics
 5. ASTM - D4258 - Standard Practice for Surface Cleaning Concrete for Coatings
 6. ASTM - D4259 - Standard Practice for Abrading Concrete
 7. ASTM - D4541 - Method for Pull-Off Strength of Coatings using Portable Adhesion Tester

8. ASTM - E96(A) - Test Methods of Moisture Transmission of Material
9. ASTM E-108, ANSI/UL 790 for fire resistance.
10. Steel Structures Painting Council (SSPC)

D. SUBMITTALS FOR REVIEW:

1. Membrane System Product Data: Provide current standard printed product literature indicating characteristics of membrane materials, flashing materials, components, and accessories, product specification, and installation.
2. Product Samples: Submit product samples of membrane and flashing materials showing color, texture, thickness and surfacing representative of the proposed system for review and approval by the DWS Representative. Sample shall be 1 ft. square.
3. Submit sample copies of both the Manufacturer and Applicator warranties for the periods stipulated. Each specimen must be a preprinted representative sample of the issuing company's standard warranty for the system specified.
4. Submit copies of current Material Safety Data Sheets (MSDS) for all components of the work.
5. Membrane Shop Drawings: Submit shop drawings of cold fluid-applied reinforced unsaturated polyester showing a project plan, size, flashing details, and method of attachment for review and approval by the DWS Representative and Membrane Manufacturer.

E. QUALITY ASSURANCE:

1. Membrane Manufacturer: Company specializing in manufacturing the products specified in this section with ten (10) years documented experience.
2. Applicator: Company specializing in performing the work of this section with (3) years documented experience and approved by system manufacturer for warranted membrane installation. Applicator shall submit the following certification for review:
 - a. Applicator shall submit documentation from the membrane manufacturer verifying contractor's status as an approved applicator for warranted installations.
3. Calculate moisture content of substrate materials. Contractor shall determine substrate moisture content through-out the work and record the measured value in Daily Inspection Reports or other form of reporting acceptable to the Engineer or designated Representative, and Membrane Manufacturer.
4. Random tests to determine tensile bond strength of membrane to substrate shall be conducted by the Contractor at the job site using an Elcometer Adhesion

Tester Model 106 or similar device. Contractor shall perform a minimum of three (3) tests. Test results shall be submitted to DWS or designated Representative and the Membrane Manufacturer. Contractor shall immediately notify the DWS Representative and Membrane Manufacturer in the event tensile bond test results are below specified values.

- a. Adequate surface preparation will be indicated by tensile bond strength of membrane to substrate greater than or equal to 116 psi.
 - b. In the event the tensile bond strengths are lower than the minimum specified, additional substrate preparation is required. Repeat testing to verify suitability of substrate preparation.
5. Monitor quantities of installed materials. Monitor application of resin mixture, reinforcing fleece and flashing. Perform Work in accordance with manufacturer's instructions.
 6. Conduct tests to verify that substrate preparation meets specified requirements by the membrane manufacturer. Tests shall include, but are not limited to, tensile bond strength and moisture content of substrate.
 - a. Prepare and clean a three (3) foot by three (3) foot area of each substrate material type.
 - b. Submit findings in writing to DWS Representative and Membrane Manufacturer.
 - c. Test areas shall be maintained for quality control for the entire project.

F. REGULATORY REQUIREMENTS:

1. Conform to applicable building and jurisdictional codes for roofing/waterproofing assembly and fire resistance requirements.
2. Comply with requirements of OSHA, NIOSH or local governing authority for work place safety.

G. PRE-INSTALLATION MEETING:

1. Convene a pre-installation meeting at the job site one (1) week before starting work of this section. Require attendance of parties directly affecting work of this section, including but not limited to, Engineer, DWS Representative, Roofing Contractor, and Membrane Manufacturer's Representative. Review roofing /waterproofing preparation and installation procedures, coordination and scheduling required with related work, and condition and structural loading limitations of roof deck.

H. DELIVERY, STORAGE, AND PROTECTION:

1. The Contractor together with the DWS Representative shall define a storage area for all components. The area shall be cool, dry, out of direct sunlight, and in accordance with manufacturer's recommendations and relevant regulatory agencies. Materials shall not be stored in quantities that will exceed design loads,

damage substrate materials, or hinder installation or drainage.

2. Store solvent-bearing solutions, resins, additives, inhibitors or adhesives in accordance with the MSDS and/or local fire authority. After partial use of materials replace lids promptly and tightly to prevent contamination or spillage.
3. Rolled materials shall be stored horizontally on platforms sufficiently elevated to prevent contact with water and other contaminants. DO NOT use rolls of material that are wet, dirty or have damaged ends.
4. Roofing/waterproofing materials must be kept dry at all times. If stored outside, keep materials above ground or roof level on pallets and cover with a tarpaulin or other waterproof material. Plastic wrapping installed at the factory should **not** be used as outside storage covers.
5. Follow manufacturer's directions for protection of materials prior to and during installation. Do not use materials that have been damaged to the point that they will not perform as specified. Fleece reinforcing materials must be clean, dry and free of all contaminants.
6. Copies of all current MSDS for all components shall be kept on site. Provide any and all installation crew members with appropriate safety data information and training as it relates to the specific chemical compound he or she may be expected to encounter. Each crew member shall be fully aware of first-aid measures to be undertaken in case of incidents. Comply with requirements of OSHA, NIOSH or local governing authority for work place safety.

I. ENVIRONMENTAL REQUIREMENTS:

1. Do not apply roofing/waterproofing membrane during or with the threat of inclement weather.
2. Application of cold fluid-applied reinforced unsaturated polyester roofing/waterproofing membrane may proceed while air temperature is lower than 95°F providing the substrate is a minimum of 5°F above the dew point.
3. Ensure that substrate materials are dry and free of contaminants. DO NOT commence with the application unless substrate conditions are suitable. Contractor shall demonstrate that substrate conditions are suitable for the application of the materials.

J. COORDINATION & PROTECTION:

1. Coordinate the work with the installation of associated metal flashings, accessories, appurtenances, etc. as the work of this section proceeds.

2. Building components shall be protected adequately (with tarp or other suitable material) from soil, stains, or spills at all hoisting points and areas of application. Contractor shall be responsible for preventing damage from any operation under its Contract. Any such damage shall be repaired at Contractor's expense to Owner's satisfaction or be restored to original condition.
3. Provide barricades, retaining ropes, safety elements (active/passive) and any appropriate signage required by OSHA, NIOSH, and NSC and/or the DWS Representative.
4. Protect finished roofing/waterproofing membrane from damage by other trades. Do not allow waste products containing petroleum, grease, acid, solvents, vegetable or mineral oil, animal oil, animal fat, etc. or come into direct contact with the membrane.

K. WARRANTY:

1. Manufacturer's Premier Warranty: Provide twenty (20) year manufacturer's premier warranty under provisions of this section. This warranty provides for cost of labor and materials for loss of watertightness, limited to amounts necessary to effect repairs necessitated by either defective material or defects in related installation workmanship, with no dollar limitation ("NDL").
2. Waterproofing Contractor's Warranty: Provide 2 year "Applicator Maintenance Warranty" covering workmanship for all work of this section including installation of membrane, flashings, metal work, and waterproofing accessories.
3. Submit two (2) executed copies of both the manufacturer and applicator warranties for the periods stipulated above, effective from the date of substantial completion. An authorized representative of the issuing company must sign each submitted warranty.

L. SYSTEM REQUIREMENTS:

1. The products herein specified are totally pre-engineered products of the listed manufacturer and establish criteria for the approval of substitutions. Products must be part of a pre-engineered system, equivalent in function, quality, composition and method of application to be considered for approval as an "Approved Substitute".

M. MANUFACTURER'S MEMBRANE:

1. Membrane: Cold fluid-applied reinforced unsaturated polyester waterproofing membrane with a 360 degree needle punched non-woven 200 polyester reinforcing fleece, for a finished dry film membrane thickness of .080 inch (80 mils) nominal per ply; colored aggregate topcoat surfacing as selected by DWS from manufacturer's standard palette of colors; conforming to ASTM C 836. Subject to compliance with requirements, provide products manufactured and supplied by the following:
 - a. Kemperol BR resin for use in an adhered membrane assembly.

N. FLASHINGS:

1. Membrane Flashings: A composite of the same resin material as field membrane with 200 fleece reinforcement; colored aggregate topcoat surfacing or aliphatic polyester polyurethane coating to match field membrane.

O. ACCESSORIES:

1. Emulsified Epoxy Primer (Protection from Substrate Wetness): Two-component, solvent-free epoxy coating for use in improving adhesion of membrane to cementitious/masonry substrate surfaces. Monitor application rate and adjust depending on substrate absorbency.
2. Inhibitor: Additive specifically designed to slow resin catalyzation process at ambient temperatures above 75°F. Do not use inhibitor at ambient temperatures of 75°F or less. Inhibitor to be used with white resin prior to mixing of multi-component resin. Continuously monitor substrate surface temperatures.
3. Tools, Accessories, and Cleaners: Supplied and/or approved by membrane manufacturer for product installation.
4. Topcoat Surfacing Aggregate: Kiln-dried Surfacing Silica Sand shall be washed, kiln-dried, and dust-free with the following size specification:
 - a. Entire Roof: 0.45 - 0.55 mm
5. Leveling and Patching Aggregate: Silica sand shall be washed, kiln-dried, and dust-free, suitable for troweling or pourable self-leveling, round grain or angular with the following size specification:
 - a. For voids less than ¼" in depth: 0.45 - 0.55 mm
 - b. For voids ¼" to 2" in depth: 0.7 - 1.2 mm

Mixing Proportions shall be a ratio of resin to sand at 1:2 by volume or as approved by membrane manufacturer.

6. Backer Rod: Expanded, closed-cell polyethylene foam designed for use with cold-applied joint sealant.
7. Miscellaneous Fasteners: Appropriate for purpose intended and approved by membrane system manufacturer; length required for thickness of material; as supplied by membrane manufacturer.
8. Caulking: Single component, non-sag elastomeric polyurethane sealant, as recommended or supplied by membrane manufacturer for use in making airtight and watertight seals where required.
9. Temporary and Night Sealant: As recommended or required by membrane manufacturer.
10. Anti-Skid Surfacing: Colored aggregate topcoat surfacing in additional layer of

membrane material as selected by DWS from manufacturer's standard palette of colors; as supplied or approved by membrane manufacturer.

P. EXAMINATION:

1. Verify that surfaces and site conditions are ready to receive work.
2. Verify deck/substrate openings, curbs, and protrusions through deck/substrate, and reglets are in place and solidly set.
3. Verify deck/substrate is structurally supported, secure and sound.

R. PREPARATION OF SUBSTRATE:

1. General

- a. All substrates must be free from gross irregularities, loose, unsound or foreign material such as dirt, water, grease, oil, release agents, lacquers, or any other condition that would be detrimental to adhesion of the primer and/or resin to the substrate. Fill all surface cracks or voids greater than 1/8 inch wide with an acceptable fill material. Surfaces may require scarifying, sandblasting or grinding in some cases to achieve a suitable substrate. Remove any ponded water prior to installing roofing system.
- b. Substrate shall have a maximum moisture content of five (5) percent and 75% relative humidity, and be prepared as required to provide adhesion of the membrane to substrate with a minimum bond strength of 116 psi. The Contractor shall periodically determine if the surface preparation and moisture content are acceptable throughout the course of work. Test results shall be submitted in writing to the DWS Representative and Membrane Manufacturer for acceptance.
- c. The final substrate shall be clean, dry, and free of contaminants.

2. Concrete:

- a. New concrete shall have cured a minimum of 28 days in accordance with ACI-308.
- b. Concrete shall be free of oil, grease, curing compounds, loose particles, moss, algae growth, laitance, friable matter, dirt, bituminous products and previous waterproofing materials.
- c. Concrete shall be dry with a maximum moisture content of five (5) percent. Contractor shall measure and record moisture content of substrate as described above.

- d. Where required, concrete shall be abrasively cleaned in accordance with ASTM D4259 to provide a sound substrate free from laitance with an open concrete surface. When using mechanical methods to remove existing waterproofing products or surface deterioration, the surface profile is not to exceed 1/8 inch (peak to valley).
 - e. The substrate shall be sound and all spalls, voids and bug holes on surfaces must be repaired prior to placement of the primer coat. Spalls and other deterioration shall be repaired in accordance with the Engineer's requirements and Membrane manufacturer.
 - f. Areas of surface deterioration of 0.50" or greater in depth shall be repaired to prevent possible ponding of the system.
 - g. Extent and location of thin surface patching shall require approval of the Engineer and Waterproofing Manufacturer prior to the application of any system component.
3. Steel/Metal:
- a. Clean and prepare metal surfaces to near white metal in accordance with SSPC - SP3 (power tool clean) or as required by membrane manufacturer. Extend preparation a minimum of three (3) inches beyond the termination of the membrane flashing materials. Notch steel surfaces to provide a rust-stop.
 - b. Stainless steel (series 400, 300) shall be abraded to provide a rough open surface.
4. Other Surfaces:
- a. Remove all contaminants as required by membrane manufacturer. Surface preparation shall be performed by means approved by Owner or his designated Representative.
5. Finish Leveling, Patching and Crack Preparation:
- a. General: Resin/sand mix is the preferred material for all substrate finish leveling, crack and deck preparation and patching. Resin/sand patching mix provides a fast-set time of approximately 25 minutes and does not require surface grinding.

Primer/sand mix is an alternative substrate leveling and patching material. Primer/sand patching mix provides a set time of approximately 12 hours, and does not require surface grinding. Kemperol primer/sand mix is typically applied in conjunction with general surface priming.
 - b. Substrate Leveling & Patching: Substrate conditions are to be evaluated by the Contractor, the DWS Representative, and Membrane manufacturer. Perform leveling and patching operations as follows:
 - 1) Level uneven surfaces with a leveling mixture of unsaturated polyester resin/primer and approved kiln-dried silica sand in a 1:2

resin/primer to sand ratio by volume. Spread and plane compound with a squeegee and trowel to achieve a flat surface.

- 2) Fill cavities with a patching mixture of polyester resin/primer and approved kiln-dried sand in a 1:3 to 1:3.5 resin/primer to sand ratio by volume.
 - 3) Silica sand must be kept absolutely dry during storage and handling.
 - 4) Any surface to be leveled or filled must first be primed with an appropriate primer.
- c. Joint and Crack Preparation: Joints, cracks and fractures in the structural deck/substrate shall be prepared as defined below prior to installation of the waterproofing membrane. Note: Joints, cracks, and fractures may telegraph through the waterproofing membrane.
- 1) Non-Moving Cracks: Determine that crack is non-moving. Clean out crack by brushing and oil-free compressed air. Fill crack with polyurethane sealant. Allow for a minimum of twelve (12) hours cure or as required by sealant Manufacturer.
 - 2) Moving Cracks: Determine that crack is moving. Clean out crack by brushing and oil-free compressed air. Fill crack with polyurethane sealant. Allow for a minimum of twelve (12) hours cure or as required by sealant Manufacturer. Apply resin and 4 inch wide strip of membrane (resin and fleece) in strict accordance with Membrane manufacturer's written instructions.

S. PRIMER APPLICATION:

1. General:

- a. Mix and apply two-component primer in strict accordance with written instructions of Membrane Manufacturer. Use only proprietary materials, as supplied by the membrane manufacturer.
- b. The substrate surface must be dry, with any remaining dust or loose particles removed using clean, dry, oil-free compressed air, industrial vacuum, cloth wipe or a combination of methods.
- c. Do not install primer on any substrate containing newly applied and/or active asphalt, coal-tar pitch, creosote or penta-based materials unless approved in writing by Membrane Manufacturer. Some substrates may require additional preparation before applying primer.

2. Mixing of Primer:

- a. Premix primer Component A thoroughly with a 6" spiral agitator or stir stick. Pour primer Component B into Component A and mix the components for approximately 2 minutes with a clean 6" spiral agitator on slow speed or stir stick without creating any bubbles or streaks. DO NOT

AERATE. The Primer solution should be a uniform color, with no light or dark streaks present.

- b. Do not thin primer. Determine required primer coverage for each substrate material/condition and apply in strict accordance with written instructions of Membrane Manufacturer.
- c. Mix only that amount of primer components A & B that can be used in 30 minutes.

3. Application of Primer:

- a. Apply primer at the rate of approximately 0.6 gallons per 100 square feet.
- b. Roll or brush the primer evenly onto the surface to fully saturate the substrate in one application. Do not allow primer to pond or collect in low areas.
- c. Apply primer only up to the edge of the membrane flashing terminations. Primer application past the membrane terminations requires surfacing with an approved material.
- d. For EP primer applications over cementitious substrates where protection from substrate wetness is required, apply second primer coat following a minimum of twelve (12) hours cure time.
- e. Allow primer to cure for a minimum of twelve (12) hours before membrane application. Membrane must be applied to primer only when completely dry and without tack.
- f. Exposure of the primer in excess of five (5) days or premature exposure to moisture may require removal and application of new primer. DO NOT apply new primer over exposed primer older than five (5) days, primer prematurely exposed to moisture, or primer used as temporary waterproofing, unless approved in writing by the Membrane Manufacturer.

4. Disposal of Primer:

- a. Cured primer may be disposed of in standard landfills. This is accomplished by thoroughly mixing all components.
- b. Uncured primer is considered a hazardous material and must be handled as such, in accordance with local, state and federal regulation. Do not through uncured resin away.

T. MEMBRANE APPLICATION:

1. General:

- a. Mix and apply cold fluid-applied reinforced unsaturated polyester waterproofing membrane in strict accordance with written instructions of Membrane Manufacturer. Use only proprietary membrane resins and materials, as supplied by the membrane manufacturer.
- b. The primed substrate surface shall be dry, with any remaining dust or loose particles removed using clean, dry, oil-free compressed air, industrial vacuum, cloth-wipe or a combination.
- c. Two-part polyester resins contain a photo-curing additive for proper surface curing. Therefore, exposure to natural UV light is necessary. For concealed and/or interior applications where exposure to natural UV light cannot be obtained, exposure to UV radiation is required. Maintain UV radiation exposure in strict accordance with written instructions of UV light source Manufacturer and Membrane manufacturer.
- d. Protect all areas where membrane has been installed. Do not work off installed membrane during application of remaining work before forty-eight (48) hours of curing. Movement of materials and equipment across installed membrane is not acceptable. If movement is necessary, provide complete protection of affected areas.
- e. Closely follow the Membrane Manufacturer's recommendation for hot and cold weather application. Monitor surface and ambient temperatures, including the effects of wind chill.

2. Mixing of Resin:

- a. Mix resin Component A (black formulation) with a 6" spiral agitator until the liquid is a uniform black color.
- b. Add the Catalyst Powder to resin Component A and mix with the same 6" agitator for 5 minutes or until the powder is completely mixed. The dissolving time is 20 minutes to 2 hours, depending on the ambient temperature. The catalyst is completely dissolved when there are no white specks remaining.
- c. Mix resin Component B (white formulation) with a separate spiral agitator until the color is a uniform white. If the ambient temperature is below 50°F or above 75°F, then a weather related additive should be combined and mixed into the Component B.
 - 1) Inhibitor should be added to resin Component B when the temperature is 75°F and above. The inhibitor should be mixed with the 6" spiral agitator for 5 minutes or until both liquids are thoroughly blended.
- d. Pour resin Component A and Component B into a third clean bucket at a 1:1 ratio (equal parts) and thoroughly mix the components with a clean 6" spiral agitator. The Resin solution should be a uniform color, with no light

or dark streaks present.

- e. Mix only that amount of resin components A & B that can be used in 20 minutes.

3. Application of Resin/Fleece

- a. Apply mixed resin to the prepared surface at the approximate rate of 4.5 gallons per 100 square feet. The resin should be rolled or brushed liberally and evenly onto the surface using a broad, even stroke. Cover one working area at a time, between 15 – 20 square feet.
- b. Roll out dry polyester fleece onto the liquid resin mix, making sure the SMOOTH SIDE IS FACING UP (natural unrolling procedure), avoiding any folds and wrinkles. The fleece will begin to rapidly saturate with the liquid resin mix. Use a medium nap roller or brush to work the resin into the fleece, saturating from the bottom up, and eliminating air bubbles, wrinkles, etc. The appearance of the saturated fleece should be light opaque amber with no white spots. White spots are indications of unsaturated fleece or lack of adhesion.
- c. Apply additional liquid resin mix on top of fleece at the approximate rate of 2 gallons per 100 square feet to finish the saturation of the fleece. Roll this final coating into the fleece, which will result in a glossy appearance. The fleece can only hold so much resin and all excess should be rolled forward to the unsaturated fleece, eliminating ponding or excessive build-up of the resin. The final resin coating should be smooth and uniform.
- d. Prevent contact between mixed/unmixed resin and new/existing membrane. If any unmixed resin contacts membrane surface remove immediately and clean thoroughly with a cloth rag.
- e. At all fleece seams, allow a 2" overlap for all side joints and a 4" overlap for all end joints.
- f. At membrane tie-offs, clean in-place membrane with acetone once resin has cured. Allow solvents to fully evaporate before application of new resin.

4. Disposal of Resin:

- a. Cured resin may be disposed of in standard landfills. This is accomplished by thoroughly mixing all components.
- b. Uncured resin is considered a hazardous material and must be handled as such, in accordance with local, state and federal regulation. Do not throw uncured resin away.

U. FLASHING APPLICATION:

1. General:

- a. Install flashing system in accordance with the requirements/recommendations of the Membrane manufacturer and as depicted on standard drawings and details. Provide system with base flashing, edge flashing, penetration flashing, counter flashing, and all other flashings required for a complete watertight system.
- b. Wherever possible, install the flashings before installing the field membrane to minimize foot traffic over newly installed field membrane.
- c. All membrane flashings shall be installed concurrently with the waterproofing membrane as the job progresses. Temporary flashings are not allowed without prior written approval from the Membrane manufacturer. Should any water penetrate the new waterproofing membrane because of incomplete flashings, the affected area shall be removed and replaced at the contractor's expense.
- d. Provide a minimum vertical height of 8" for all flashing terminations. Flashing height shall be at least as high as the potential water level that could be reached as a result of a deluging rain and/or poor slope.
- e. All flashings shall be terminated as required by the Membrane Manufacturer.

2. Metal Flashing – General:

- a. Metal flashings shall be fabricated in accordance with the current recommendations of SMACNA and in accordance with standard drawings and project details.
- b. Metal flashing flanges to which membrane is to be bonded shall be a minimum of four (4) inches in width, and secured to the substrate six (6) inches on center staggered with fasteners appropriate to the substrate type. The flanges shall be provided with a roughened surface that has been cleaned of all oil and other residue.
- c. Metal edges that will be overlaid with membrane shall be provided with a 1/4" min. hemmed edge.
- d. Apply primer, resin and fleece to metal flange, extending membrane to outside face of metal edging, and to vertical face of metal base/curb flashing.

3. Membrane Flashing – General:

- a. Membrane flashings shall be fabricated with primer appropriate for the substrate surface, resin of the same base chemical type as the field

membrane, and fleece of the same weight as the field membrane unless specified otherwise.

- b. Primer, resin, and fleece mixing and application methods as specified for field membranes are also suitable for membrane flashing.
 - c. Fleece shall overlap 2" minimum for all joints. Fleece shall be cut neatly to fit all flashing conditions without a build-up of multiple fleece layers. Work wet membrane with a brush or roller to eliminate blisters, openings, or lifting at corners, junctions, and transitions.
4. Pipes, Conduits, and Unusually Shaped Penetrations:
- a. Flash all penetrations using cold fluid-applied reinforced unsaturated polyester roof membrane with approved broadcast mineral aggregate surfacing or aliphatic polyester polyurethane coating. Flashing material shall be the same resin used in the field membrane with 165 fleece reinforcement.
 - b. Flashing is typically constructed as a two-part assembly consisting of a vertical wrap and a horizontal target patch. There must be a minimum of a two (2) inch overlap between vertical and horizontal flashing components.
5. Curbs and Base Flashings:
- a. Curb and base flashings shall be installed to solid substrate surfaces only.
 - b. Flash all curbs and base flashings using cold fluid-applied reinforced unsaturated polyester roof membrane with approved broadcast mineral aggregate surfacing or aliphatic polyester polyurethane coating. Flashing material shall be the same resin used in the field membrane with 165 fleece reinforcement.
 - c. Reinforce all transition locations and other potential wear areas with a four (4) inch wide 200 polyester fleece bottom layer evenly positioned over the transition prior to installing the exposed flashing layer.
 - d. Reinforce all inside and outside corners with a four (4) inch diameter conical piece of 165 fleece prior to installing the exposed flashing layer.
 - e. All pins, dowels and other fixation elements shall be flashed separately with a vertical flashing component prior to installing the exposed flashing layer.
 - f. Alkalinity surface protection consisting of two applications of EP primer and one application of approved broadcast mineral aggregate surfacing

shall be applied wherever stone, concrete, or masonry elements will be placed directly over the flashing.

- g. Extend flashing a minimum of four (4) inches onto the field substrate surface.

V. SURFACING AND FINISHES:

1. Kiln-Dried Sand Finish Surfacing:

- a. Provide and install approved kiln-dried silica sand, or other approved mineral surfacing with dry roller to achieve non-skid surface. Note: sand surfacing is considered a non-warranty maintenance item, and will require re-application periodically.
- b. Broadcast specified and approved mineral aggregate into a fresh application of EP primer applied over cured and prepared resin membrane. Apply primer at a rate of approximately 0.6 gallons per 100 square feet. Obtain uniform and full coverage.
- c. Immediately after broadcasting aggregate, back roll with a dry sand roller using pressure of the roller to ensure full embedment of sand into primer, sealer, or resin.
- d. Following minimum 48 hour cure time remove loose/un-embedded mineral aggregate. Re-broadcast clean mineral aggregate as required to provide full embedment and coverage of membrane.
- e. After completion of mineral aggregate broadcasting, avoid any traffic for a minimum of three (3) days to allow for surfacing to cure. After cure, remove any loose mineral aggregate by blowing with oil-free compressed air or with a vacuum.
- f. As specified, seal sand surfacing with Membrane Manufacturer's approved sealer. Agitate sealer in sealed container prior to use. Apply sealer at an approximate rate of 1.0 gallon per 100 square feet. The sealer should be rolled or brushed evenly onto the surface. Allow sealer to set approximately 12 hours before walking on the treated surface. Allow 3 days for full cure before applying additional coats of sealer or resuming normal traffic.

W. TEMPORARY CLOSURES & WATERSTOPS:

- 1. Contractor shall be responsible to ensure that moisture does not damage any completed section of the new waterproofing system. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition. All temporary closures shall be made as recommended or required by the membrane manufacturer.

X. PROTECTION:

1. Upon completion of waterproofing and flashings (including all associated work), institute appropriate procedures for surveillance and protection of roofing during remainder of construction period. Protect all areas where membrane has been installed.

Y. CLOSEOUT:

1. Correction of Work: Work that does not conform to specified requirements including tolerances, slopes, and finishes shall be corrected and/or replaced. Any deficiencies of membrane application, termination and/or protection as noted during the Membrane Manufacturer's inspections shall be corrected and/or replaced at Contractor's expense.
2. Clean-Up: Site clean-up, including both interior and exterior building areas that have been affected by construction, shall be restored to pre-construction condition.

Z. PAYMENT: Payment for furnishing and installation roofing will be made at the lump sum price bid of which the item is a part and shall be full compensation for all work under this Section, complete and finished in accordance with the drawings and specifications.

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 303 - STRUCTURES

SECTION 303.21 CAULKING

Add the following to this section.

F. GENERAL REQUIREMENTS:

Completely close with caulking compound or sealant all joints around frames of doors, windows, or other openings in exterior walls, joints where masonry abuts other surface finishes, and other joints indicated or specified to be caulked or sealed.

G. SUBMITTALS:

1. Manufacturer's Data, Joint Sealants:

Submit to the Manager six copies of manufacturer's specifications, recommendations and installation instructions for each type of material required. Include manufacturer's published data, or letter of certification, or certified test laboratory report indicating that each material complies with specified standards and other requirements, and is intended generally for applications shown.

2. Samples, Joint Sealants:

Submit to the Manager samples of available colors for selection (except black) for each type of joint sealer exposed to view. Install samples between two strips of material similar to or representative of typical surfaces where sealer will be used, held apart to represent typical joint widths, and for approval.

H. JOB CONDITIONS:

1. Examine joint surfaces and backing, and their anchorage to the structure, and conditions under which joint sealer is to be applied, and notify General Contractor in writing of conditions detrimental to proper completion of the work and performance of sealers. Do not proceed with joint sealing work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

2. Weather Conditions:

Do not proceed with the installation of sealants under adverse weather conditions, or when temperatures are above manufacturer's recommended temperature range for installation.

Proceed with the work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength. Where joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in lower third of manufacturer's recommended installation temperature range.

- I. PRODUCT HANDLING: Deliver caulking compounds and sealants to the job site in sealed containers labeled to show the designated name, formula, or specification number, lot number, color, date of manufacture, shelf life, curing time, manufacturer's directions, and name of manufacturer.
- J. GUARANTEE: The Contractor shall jointly execute with the General Contractor a two-year written guarantee to the Department that the installation will be watertight and that any leaks which develop during this period which are not due to improper use or willful damage will be repaired at no cost to the Department.
- K. MATERIALS: Products shall conform to the reference documents listed for each use. Color of sealant and caulking shall match adjacent surface color unless specified otherwise. For ASTM C 920 sealants, use a sealant that has been tested on the type(s) of substrate to which it will be applied.
 - 1. Interior Caulking or Sealant: ASTM C 920, Type S or M, Grade NS, Class 12.5, Use NT. Color of caulking or sealant shall match adjacent surface color unless specified otherwise.
 - 2. Exterior Sealant: For joints in vertical surfaces, provide ASTM C 920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C 920, Type S or M, Grade P, Class 25, Use T. Color of sealant shall match adjacent surface color unless specified otherwise .
 - 3. Primer for Sealant: Use a non-staining, quick-drying type and consistency recommended by the sealant manufacturer for the particular application.
 - 4. Primer for Oil and Resin-Base Caulking: Use ready-mixed aluminum paint, Fed. Spec. TT-P-38.

5. Bond Breakers: Use the type and consistency recommended by the sealant manufacturer for the particular application.
 6. Backstops: Use glass fiber roving or neoprene, butyl, or polyurethane, or polyethylene foams free from oil or other staining elements as recommended by the sealant manufacturer. Backstop material shall be compatible with the sealant. Do not use oakum and other types of absorptive materials as backstops.
- L. SURFACE PREPARATION: Surfaces shall be clean, dry to the touch, and free from frost, moisture, grease, oil, wax, lacquer, paint or other foreign matter that would tend to destroy or impair adhesion. Where adequate grooves have not been provided, clean out grooves to a depth of 1/2 inch and grind to a minimum width of 1/4 inch without damage to the adjoining work. No grinding shall be required on metal surfaces.
- M. SEALANT PREPARATION: Do not modify the sealant by addition of liquids, solvents, or powders. Mix multi-component elastomeric sealants in accordance with manufacturer's printed instructions.
- N. APPLICATION:
1. Backstops: Where joint cavities are constructed deeper than indicated, tightly pack the back or bottom with backstop material to provide a joint of the depth indicated. Install backstops dry and free of tears or holes.
 2. Primer: Just prior to application of the sealant or caulking compound, clean out all loose particles from joints. Apply primer in accordance with compound manufacturer's directions. Do not apply primer to exposed finish surfaces.
 3. Bond Breaker: Provide bond breakers as recommended by the sealant manufacturer for each type of joint and sealant used.
 4. Sealant and Caulking Compounds: Use a compound that is compatible with the material to and against which it is applied. Do not use a compound that has exceeded its shelf life or has become too jelled to be discharged in a continuous flow from the gun. Apply the compound in accordance with the manufacturer's printed instructions. Force the compound into joints with sufficient pressure to fill the joints solidly. Compound shall be uniformly smooth and free of wrinkles.
 - a. Interior Sealant and Caulking: Provide sealant or caulking at all exposed joints in the building and at all joints indicated to receive sealant or caulking.

- b. Exterior Sealant: Provide sealant at all joints around the perimeter of openings and at all exposed joints on the building and at all joints indicated to receive sealant.

O. PROTECTION AND CLEANING:

- 1. Protection: Protect areas adjacent to joints from compound smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled.
- 2. Cleaning: Immediately scrape off fresh compound that has been smeared on masonry and rub clean with a solvent as recommended by the compound manufacturer. Upon completion of compound application, remove all remaining smears and stains resulting therefrom and leave the work in a clean and neat condition.

P. INTERIOR CAULKING: Interior areas and items that may require caulking include, but are not limited to the following:

- 1. Opening 1/4 inch and less between walls or partitions and casework, shelving, door frames, built-in or surface-mounted equipment and fixtures, and similar items.
- 2. Perimeter of frames at doors and access panels which adjoin exposed interior concrete and masonry surfaces.
- 3. Joints of interior masonry walls and partitions which adjoin exterior walls unless otherwise detailed.
- 4. Joints between edge members for drywall ceiling and adjoining vertical surfaces.
- 5. Other interior locations where small voids between materials require filling for first-class workmanship and painting.

Q. EXTERIOR CAULKING: Exterior areas and items that may require caulking include, but are not limited to the following:

- 1. Joints and recesses formed where frames and subsills of doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations.
- 2. Expansion and control joints.

3. Interior face of expansion joint in exterior concrete or masonry walls where no metal expansion joint covers are required.
4. Openings where items pass through exterior walls.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300 SECTION 303 - STRUCTURES

SECTION 303.22 MISCELLANEOUS IRON AND METAL WORK

Add the following paragraphs to item D.2. Workmanship.

- d. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use only welded connections for steel member connections. Clearly mark units for reassembly and coordinated installation.
- e. Fabricate metal items to comply with indicated dimensions, member sizes and spacing, details, finish, and anchorage.
- f. Welded Connections: Fabricate railing by welding members. For all welded connections, cope components at perpendicular and skew connections to provide a close fit. Weld connections continuously to comply with the following:
 - 1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2) Obtain fusion without undercut or overlap.
 - 3) Remove welding flux immediately.
 - 4) At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
 - 5) Fabricate joints in a watertight manner.
 - 6) Form work true to line and level with accurate angles and surfaces and straight sharp edges.
 - 7) Remove sharp or rough areas on exposed traffic surfaces. Close exposed ends of railing members with fitted and welded ends.
 - 8) Railing connections shall not require any field welding or rivets for assembly.

Add the following paragraphs to item G. Interior Access Ladder.

- 1. Stainless-Steel Bars and Shapes: ASTM A 276, Type 316, unless noted otherwise.
- 2. Stainless Steel Sheet, Strip, and Plate: ASTM A 666, Type 316, unless noted otherwise.

3. Stainless Steel threaded rod: ASTM F 593 (AISI 304/316).
4. Welding Rods and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items. Select according to AWS specifications for metal alloy welded.
5. Fabricate ladders for locations shown, with dimensions, spacing, details, and anchorages as indicated and in accordance with DWS Standards, Section 303.22.G.
6. Siderails: Continuous pipe or flat bar sections, material, size and spaced as indicated on Drawings.
7. Bar Rungs: 3/4-inch minimum diameter solid steel bars, spaced 12 inches on center.
8. Fit rungs in centerline of side rail members; insert rung 1 inch minimum into pipe section and to outside face of flat bar; fillet weld circumference of rung.
9. Support each ladder at top and bottom as detailed.
10. Provide non-slip knurled surface on top of each rung.
11. Measure existing conditions to provide connection members and ladder of proper length and orientation to fit the completed construction. Verify fit-up before installing epoxy anchors.
12. After ladder position is plumb and straight, the drilled and epoxy anchors shall be installed to anchor the ladder as shown in the Drawings.
13. Form and cast concrete interior ladder base pad onto roughened surface coated with concrete bonding agent after the ladder has been secured to the structure at the top. Finish base pad surface level.
14. The concrete pad shall properly cure before utilizing the ladder.
15. Interior access ladder shall be equipped with a fall protection system as described below.

Add the following sections:

K. RESERVOIR ACCESS HATCH

Furnish and install where shown on the plans, reservoir access hatches. The roof hatches shown shall be "Hawaii" Style Light Duty Aluminum Hatch by SYRACUSE

CASTINGS SALES CORP., as distributed by B.K., Inc, Hilo, Hawaii Phone: 808-961-2125

1. Top Mount – Single or double leaf hatch, see Drawings. Frame opening width and opening length as indicated on the Drawings.
2. Material shall be 6061-T6 aluminum for bars, angles and extrusions, 1/4" diamond plate shall be 5086 aluminum.
3. Unit to be constructed per AWWA Standard for tank openings stating, "Hatches should be constructed as to prevent leakage into the tank and locked to resist unauthorized entry and vandalism." Shall be constructed to eliminate infiltration of pests into water storage tanks.
4. Covers shall be turn down 2" over curb (4" tall angle frame). Angle Frame shall be of extruded aluminum with an integral seat. Angle frame shall be a minimum 4" tall and 1/4" thick. Unit shall be designed for a minimum of 300 lbs/sq. ft.
5. Covers shall be equipped with a hold open arm. Door shall lock open in the 90 degree position. Each hold open arm shall be fastened to the frame with a 1/2" grade 316 stainless steel bolt.
6. All hardware shall be stainless steel. Each hatch shall be supplied with an exposed padlock clip for owner's padlock.
7. Unit supplied with "Rimseal" gasket on vertical leg of angle. "Rimseal" to be pressed tightly against cover by aluminum pressure locks (swing bolts)
8. Doors balanced to require less than 30 lbs opening force.
9. Install graphite pad and silicone gasket between frame and concrete.

L. FALL PROTECTION SYSTEM

1. The fall prevention system to be mounted on ladders where specified on the Drawings, shall be a manufactured item. The manufacturer shall have a minimum of 10 years experience in manufacturing the product provided for this project. The system shall meet the requirements of OSHA requirements of Standards 29 CFR, Part 1910.27(d)(5).
2. The fall prevention system shall be constructed from the same material as the ladder.

3. The fall prevention system shall consist of a vertical guide rod special notched to prevent a climber's climbing sleeve from slipping down if the climber where to fall, brackets to connect the system to a vertical ladder.
4. Three (3) woven nylon safety harnesses with an integrated belt design to attach to the climbing sleeve and three (3) climbing sleeves shall be provided as part of this contract. The harness shall be adjustable and include front and back "D" rings and padded straps and three climbing sleeves.
5. The installed system shall include a removable extension at the top of the rail to a height of 42 inches above the ladder's top rung to assist the climber in safely disconnecting the sleeve from the rail after reaching the top of the ladder.
6. Product information describing the components of the proposed system shall be provided to the Engineer for review.
7. Product and Manufacturer:
 - a. 'Saf-T-Climb' by North Safety Products, Cranston, Rhode Island (800) 430-4110
 - b. 'Miller Sure-Track' by Gravitec Systems, Inc., Brainbridge Island, Washington (800) 755-8455
 - c. Approved equal

M. EXTERIOR RESERVOIR GALVANIZED STEEL STAIRS AND RAILING

1. Steel pipes shall conform to ASTM A53, Grade B
2. Welded steel grating shall be prefabricated by a manufacturer routinely involved in providing this product.
3. Prefabricated fully welded bar grating shall be galvanized steel with banded edges. The grating shall be the depth specified with a 3/16" bearing bar, 1 3/16" spacing by 4" spacing of bars and cross bars with a serrated top surface.
4. Prefabricated stair treads shall be fabricated with the same bar grate spacing and bar as the grating section described above. The treads shall be provided with connection end plate for bolting to the stringers.
5. Grating and treads shall be designed to support 100 pounds per square foot with a maximum deflection of 1/4-inch for the required spans.
6. Grating clips shall be provided by the grating manufacturer with a galvanized finish and designed for the grating style provided.

7. Provide stairs and railing in a timely manner, not to delay progress of construction.
8. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
9. Railing to be installed on leveling grout (if required), after railing is properly located for installation, it shall be secured with specified anchors – see Drawings.
10. Railing to be bolted into place with drilled and epoxy anchors shall be plumbed and leveled and secured in place prior to installation of anchors. Anchors shall be installed per installation requirements of product's ICC Research Report. All epoxy anchors require special inspection by deputy inspector during installation.
11. For stairs fabricate connections that do not require any field welding or rivets for assembly.
12. The rise and run slope of the strings shall be consistent for the entire length of the stair. The risers shall be set within a tolerance of 3/8-inch for the entire run of stairs.
13. Support each stair stringer at top and bottom as detailed.
14. Determine location of stair assembly concrete footing and construct per Drawings and Section 303.03A. The concrete landing at base of the stairs shall be set at the elevation that results in the finished surface level with the top of the adjacent reservoir footing.
15. The stair strings and landing framing shall be set plumb and the landings level. Construct connections as detailed on approved shop drawings.
16. Position the stair string to maintain the specified clearance from the exterior face of the reservoir wall.
17. Adhesive anchors installed in the exterior face of the reservoir wall must take precautions not to touch the installed prestressing strands beneath the surface shotcrete.
18. Fasten stair treads into a level position and as indicated on the Drawings and shop drawings.
19. Provide paint finish on galvanized steel of stairs, hand rails, railing, and grating per Water System Standards, Section 303.27 PAINTING.

N. BAR GRATING INSTALLATION

1. Grating shall be galvanized steel bar grating as described on the Drawings and oriented to span the shortest span with grating joints level and flush.
2. The grating shall be an item manufactured by a company that has been manufacturing bar grating for a minimum of 10 years.
2. Each section of grating shall be secured to the support members with a minimum of 4 clips or as recommended by the manufacturer. The clips shall be manufactured specifically for the grating and compatible with the type of support member used.

O. SECURITY FENCING AND GATE

1. The security fencing located at the edge of the reservoir roof at the top of the stair shall be provided with the features and to the dimensions shown and detailed on the Drawings.
2. Fence posts and horizontal rail members shall be the size specified in the Drawings and in conformance with ASTM A153 or ASTM A500, Grade B. The posts and rails shall be galvanized in accordance with ASTM A123.
3. The fence fabric shall be an expanded metal fence fabric specifically designed to be anti-climb and cutting fence fabric. The fencing fabric shall be a 9 gauge expanded metal mesh with a 3/4-inch hole size. The mesh shall have a powder-coating consisting of a preparation media blast of the metal prior to one coat of polyester powder. The color of the powder coating shall be the standard green. The fence posts and horizontal rails shall be painted in a similar manner as the stairs and railing.
4. An example of a product that meet these requirements is Secuex Diamond Expanded Metal Fence System: by Niles Fence & Security Products, LLC, Niles, OH (800) 321-7464 [www.nilesfence.com] or approved equal.
5. Provide and install all necessary clips, bracing members, post caps, tension rods, anchors or other accessories for a complete fence installation directly to the reservoir roof slab, as specified by the fencing manufacturer. Install fence fabric taut and in accordance with manufacturer's installation instructions.
6. The access gate shall be constructed of the same or similar materials as the security fence. The gate lock hasp shall be fabricated and installed on the access gate frame and fence post as shown on the Drawings to provide smooth operation of the gate without rubbing, binding or scraping of elements.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 303 - STRUCTURES

SECTION 303.24 FINISH HARDWARE

Add the following to this section:

B. GENERAL REQUIREMENTS:

11. Locks and latches shall conform to ADAAG Section 4.13.9 and 4.27.4.

D. SUBMITTALS:

1. Schedule: Furnish six copies to the Manager of hardware schedule list in compliance with the specifications and drawings. List each opening and hardware to be supplied. State material, finish and manufacturer's number for each item. Schedule of hardware shall be approved by the Manager before any item is fabricated or ordered.
2. Manufacturer's Instructions: Templates and installation and adjustment instructions. Submit templates to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.

E. SCHEDULE OF FINISHING HARDWARE

1. Pre-Qualified Manufacturers: The following is a list of pre-qualified manufacturers for the supplying of door hardware. The Contractor may substitute hardware of equivalent quality upon approval of the Manager. Submit verifying documents for all substitutions.

<u>CATEGORY</u>	<u>VENDOR NAME</u>	<u>ABBREVIATION</u>
OVERHEAD HOLDER	ABH MANUFACTURING	ABH
D. P. STRIKE	H.B. IVES	IVE
FLUSH BOLT	H.B. IVES	IVE
WALL STOP	H.B. IVES	IVE
HINGE	McKINNEY PRODUCTS CO	MCK
ADJ DOOR GASKETING	PEMCO	PEM
ASTRAGAL	PEMCO	PEM
DOOR BOTTOM	PEMCO	PEM
DOOR SEAL	PEMCO	PEM
MORTISE AUTO DR BTM	PEMCO	PEM

CYLINDER	CORBIN RUSSWIN, INC.	RUS
LOCKSET	CORBIN RUSSWIN, INC.	RUS
PRIVATE SET	SARGENT MANUFACTURING CO.	SAR
SS SPRING HINGE	STANLEY HARDWARE	STA

2. Door Hardware Schedule:

The following is a schedule of door hardware for this project.

<u>CATEGORY</u>	<u>VENDOR NAME</u>	<u>ABBREVIATION</u>
<u>HW GROUP – 001 (Doors D/1)</u>		
8.0 EA HINGE	TA2314 4.5 X 4.5 US26D-NRP	MCK
2.0 EA OVERHEAD HOLDER	3500 US26D	ABH
1.0 EA LOCKSET*	CL 3851 NZD 626	RUS
1.0 EA FLUSH BOLT	458B26D-24 - TOP ROD	IVE
1.0 EA FLUSH BOLT	458B26D-12 - BOTTOM ROD	IVE
1.0 EA D.P. STRIKE	489B26D	IVE
1.0 EA DOOR SEAL	S88W25	PEM
2.0 EA DOOR BOTTOM	210AV 36"	PEM
2.0 EA ASTRAGAL	29310 CS 94"	PEM
<u>HW GROUP – 002 (Door D/2)</u>		
4.0 EA HINGE	TA2314 4.5 X 4.5 US26D	MCK
1.0 EA LOCKSET*	CL 3851 NZD 626	RUS
1.0 EA DOOR SEAL	S88W20	PEM
1.0 EA DOOR BOTTOM	210AV 36"	PEM
1.0 EA OVERHEAD HOLDER	N9014 US32D	ABH
<u>HW GROUP – 003 (Door D/4)</u>		
3.0 EA HINGE	TA2314 4.5 X 4.5 US26D	MCK
1.0 EA PRIVACY SET	8265 LNL WBX US26D	SAR
1.0 EA DOOR SEAL	S88W20	PEM
1.0 EA WALL STOP	407B26D	IVE
<u>HW GROUP – 004 (Doors D/3)</u>		
3.0 EA SS SPRING HINGE	2060R 4.5 X 4.5 US32D	STA
1.0 EA LOCKSET*	CL 3851 NZD 626	RUS
1.0 EA OVERHEAD HOLDER	N9014 US32D	ABH
1.0 EA DOOR SEAL	S88W17	PEM
1.0 SET ADJ DOOR GASKETING	379CR	PEM
1.0 EA MORTISE AUTO DR BTM	434ARL 36"	PEM

* - DWS to furnish to Contractor for installation

F. MATERIALS

1. Template Hardware: Hardware to be applied to aluminum doors shall be made to template. Promptly furnish template information or templates to door and frame manufacturers. Template hinges shall conform to BHMA A156.7. Coordinate hardware items to prevent interference with other hardware.
2. Fasteners: Provide fasteners of proper type, quality, size, quantity, and finish with hardware. Fasteners exposed to weather shall be stainless steel. Do not use aluminum screws to attach hardware. Provide fasteners of type necessary to accomplish a permanent installation.

G. INSTALLATION

1. Field Quality Control: After installation, protect hardware from paint, stains, blemishes, and other damages until acceptance of work. Adjust hinges, locks, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give key to the Manager. Correct, repair, and finish, as directed, all errors in cutting and fitting and damage to adjoining work.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 303 - STRUCTURES

303.27A PAINTING OF STRANDWRAPPED PRESTRESSED CONCRETE RESERVOIR

A GENERAL

1. This section covers furnishing and applying paint to the exterior wall, tank exterior, roof area and elastomeric urethane coatings for the tank interior piping.
2. Protection of Materials: All material shall be delivered to the jobsite in their original unopened containers bearing the manufacturer's name, brand and batch number. All coatings and paints shall be stored in enclosed structures to protect them from weather and excessive heat and cold. Flammable coatings or paints must be stored to conform with city, county and state safety codes for flammable coating or paint materials.
3. Substitutions: Requests for material substitutions must be made and approved in writing.

B. SUBMITTALS

1. Submit product data in accordance with these Specifications. Unless otherwise specified here-in, submit manufacturer's data sheets showing the following information:
 - a. Percent solids by volume.
 - b. Minimum recommended dry-film thickness per coat for prime, intermediate and finish coats.
 - c. Recommended surface preparation.
 - d. Recommended thinners.
 - e. Statement verifying that the specified prime coat is recommended by the manufacturer for use with the specified intermediate and finish coats.
 - f. Application instructions including recommended equipment and temperature limitations.
 - g. Verification from the manufacturer that the product meets current California VOC requirements.
 - h. Color chips for alkyd enamel and exterior tank coatings.
2. Painting Contractor experience documentation as described in Section 303.27A.C below.
3. A letter from the coating manufacturer or its distributor stating that the Coating Contractors is a certified applicator of the elastomeric urethane coating system.

C. PAINING CONTRACTOR QUALIFICATIONS

1. The Painting Contractor must be capable of performing the various items of work as specified. If required by the Engineer, the Painting Contractor shall furnish a statement covering experience on similar work, a list of machinery, plan and other equipment available for the proposed work, and a financial statement, including a complete statement of the Paint Contractor's financial ability and experience in performing similar painting and coating work. The Painting Contractor shall have a minimum of five (5) years practical experience and a successful history in the application of the specified products to concrete surfaces. Upon request, the Painting Contractor shall substantiate this requirement by furnishing a list of references, which shall include jobs of similar nature.
2. The pipe coating contractor shall have had specific training for the specified coating application to be installed.

D. MATERIALS

1. Aboveground Exterior Wall, Roof Soffit and Roof Areas:
 - a. Prime Coat - (1) coat, ICI Devoe Coatings 4030 TRU-GLAZE-WB Waterborne Epoxy Primer at 4.0-8.0 mils wet; 2.0-4.0 mils DFT. (200-270 sf/gal.) or approved equal.
 - b. Finish Coat- (2) coats, ICI DULUX Coatings 2406 Exterior 100% Acrylic Semi-Gloss at 4.1-5.4 mils wet; 1.5-2.0 mils DFT. (300-400 sf/gal) or approved equal.
 - c. Roof Finish Coat - (2) coats, ICI Devoe Coatings 4308 DEVGUARD Alkyd Industrial Gloss Enamel at 4.5-5.5 mils wet; 2.0-2.5 mils DFT (280-350 sf/gal) or approved equal.
2. Interior Miscellaneous Metals (Piping); (All Interior coatings shall be NSF approved for drinking water.)
 - a. Prime Coat (1), - CIM 61BG Epoxy Primer at 5-10 mils wet or approved equal.
 - b. Finish coat - (2) coats, CIM 1061 at 30 mils wet per coat or approved equal.

E. EXECUTION

1. Equipment: The Contractor's coating and painting equipment shall be designed for application of materials specified and shall be maintained in first class working condition. Compressors shall have suitable traps and filters to remove water and oils from the air. Contractor's equipment shall be subject to approval of the Engineer.
2. General Surface Preparation
 - a. All concrete surfaces shall be prepared in accordance with the recommendations of the coating manufacturer.

- b. The surfaces shall be thoroughly cleaned, if they are not free of grease, curing compounds or other deleterious matter, as recommended by the coating manufacturer.

3. Paint Application

- a. Contractor shall comply with manufacturer's recommended application rates, methods, and instructions.
- b. Each coat shall be free of runs, skips or "holidays".
- c. All work shall be done in accordance with the manufacturer's safety recommendations, adequate ventilation shall be provided within the tank by the contractor during the course of interior painting work.
- d. The application of the coatings shall commence within 5 days after completion of the watercuring of the shotcrete.

4. Interior Piping Preparation

- a. Clean surface of all contaminates, including all dirt, oil, grease spots, rust, or rust residue.
- b. Abrasive blast the pipe surface to be coated to a "Near White Metal Blast, SSPC-SP-10 or NACE No. 2 blast.

5. Interior Pipe Coating System Application

- a. Before flash rusting of freshly blasted pipe surface occurs, apply one coat of CIM 61BG Primer.
- b. At penetration or material joint transitions, apply CIM 1000 Trowel Grade at least 60 wet mils thick, 2-inches onto and 2-inches beyond the joint.
- c. Apply the first of the two finish coats of CIM 1061 within 48 hours of applying the primer. Do not apply second coat until first coat can be touched lightly without coming off on a finger (about 1 hour at 70 degrees F), but no longer than 4 hours after the application of the first coat.
- d. See manufacturer's recommended instructions for additional requirements for installation.

Surfaces Not To Be Coated

The following surfaces shall not be painted and shall be protected during the surface preparation and painting of adjacent areas:

- a. Mortar-coated pipe and fittings.
- b. Stainless steel.
- c. Metal letters.
- d. Nameplates.
- e. Grease fittings.

- f. Brass and copper.
- g. Buried pipe, unless specifically required in the piping specifications.
- h. Reservoir interior walls, columns, ceiling, floor and concrete pedestals or footings

F. PROTECTION OF SURFACES NOT TO BE PAINTED

- 1. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.
- 2. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- 3. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- 4. Mask openings in motors to prevent paint and other materials from entering the motors.

G. THINNING

The Contractor shall not add thinner to any paint product without prior approval of the Engineer and the paint manufacturer. Only thinner manufactured by the paint manufacturer will be allowed if thinning is approved.

H. WEATHER CONDITIONS

- 1. No painting shall be done under unfavorable weather conditions unless the work is well-protected from such conditions, and then only with the specific approval of the Engineer.
- 2. No painting shall be done when the air temperature is less than 50 degrees Fahrenheit (F), when the relative humidity is greater than 70 percent, or when the surface temperature is less than 5 degrees F above the dew-point, unless otherwise approved by the Engineer. If dew or moisture condensation should be anticipated and if such conditions are prevalent, painting should be delayed until surfaces are dry. Further, the day's painting should be completed in advance of the problem time when condensation will occur, in order to permit the film sufficient drying time prior to the formation of moisture.
- 3. No painting shall be applied on any surface whose temperature is less than 50 degrees F or more than 120 degrees F or in conflict with the manufacturer's recommendations, unless otherwise approved by the Engineer.

I. SAFETY

- 1. In accordance with requirements of the latest revision of the OSHA Regulations for Construction, the Contractor shall provide and require use of personal protective life-saving equipment for persons working in or about the project site.

2. Head and Face Protection and Respiratory Devices: Equipment shall include protective helmets conforming to the requirements of ANSI Standard Z89.2, and shall be worn by all persons while in the vicinity of the work. In addition, workers engaged in or near the work during sandblasting shall wear eye and face protection devices meeting the requirements of ANSI Standard Z87.1 and OSHA Regulations for Sandblasting Operations, and air-purifying half-mask or mouthpiece respirator with appropriate filter.
3. Ventilation: Where ventilation is used to control potential exposure as set forth in section 1910.924 of the OSHA Regulations for Construction, ventilation shall reduce the concentration of air contaminant to the degree a hazard does not exist.
4. Sound Levels: Whenever the occupational noise exposure exceeds the maximum allowable sound levels as set forth in Table D-2 of Subpart C, Section 1926.52 of the OSHA Regulations for Construction, the Contractor shall provide and require the use of approved ear protection devices.
5. Illumination: Adequate illumination shall be provided while work is in progress. Whenever required by the Engineer, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the Engineer.
6. Temporary Ladders and Scaffolding: All temporary ladders and scaffolding shall conform to the applicable requirements of Subpart L, Sections 1926.45 and 1926.451 of the OSHA Regulations for Construction. They shall be erected where requested by the Engineer to facilitate inspection and be removed by the Contractor to locations requested by the Engineer.

J. PAYMENT

Payment for the work in this section will be included as part of the lump sum bid item of which it is a part as described in the Proposal.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 303 - STRUCTURES

SECTION 303.28 ARCHITECTURAL SPECIALTIES

Delete items B and C, and replace with the following:

B. TOILET ACCESSORIES:

1. DESCRIPTION:

This item of work shall include the furnishing of all material, labor and equipment necessary to install the following toilet accessories.

2. GENERAL REQUIREMENTS:

- a. The type of toilet accessories required include the following:
 - 1. Toilet tissue dispensers.
 - 2. Grab bars.
 - 3. Paper towel dispenser.
 - 4. Framed mirror.
- b. Furnish inserts and anchoring devices for toilet accessories. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.
- c. Provide products of the same manufacturer for each type of accessory unit and for units exposed in the same areas, wherever possible.
- d. Accessibility: Mount accessories for accessible toilets in accordance with Americans with Disabilities Act Accessibility Guidelines (ADAAG), State of Hawaii, Architectural Access Committee, Section 4.27 Controls and Operating Mechanisms.

3. SUBMITTALS:

- a. Manufacturer's Data: For review by the Manager, submit six copies of manufacturer's specifications and installation instructions for each toilet accessory.

- b. Samples: When requested, submit full-size samples of units to Manager for review of finishes. Acceptable samples will be returned and may be used in the work. Compliance with all other requirements is the exclusive responsibility of the Contractor.

4. PRODUCTS:

a. MATERIALS:

- 1. Stainless Steel: AISI, Type 302/304. Provide satin finish, unless otherwise specified.
- 2. Galvanized Steel Mounting Devices: Hot-dip galvanized after fabrication ASTM A 386.

b. LIST OF TOILET ACCESSORIES (Refer to drawings for locations)

- 1. For convenience and to establish standards of quality and design, the following list indicates items manufactured by Bobrick Washroom Equipment Co., equal products of the following manufacturers will be accepted:
 - a) Bradley Corp., Washroom Accessories Division.
 - b) McKinney Parker Products Co.
- 2. Toilet Paper Dispenser (TPD): B-6857, surface mounted, 1 roll, stainless steel unit for accessible toilets.

c. Grab Bars (GB): B-550 Series, with concealed mounting and flange covers, 1-1/4" o.d., extra heavy stainless steel grab bar, peened gripping finish surface. Anchor plate with vandal-proof set screws. Provide sizes and arrangements indicated. Provide manufacturer's metal backer plates series 256 and 257 as applicable and appropriate stainless steel mounting kits of substrate.

d. Paper Towel Dispenser (PTD): B-262 surface mounted for 400 C-fold or 525 multi-fold towels.

e. Framed Mirror: B-2906 Series with polished stainless steel mirror, stainless steel frame, 18 x 36 inches.

5. INSTALLATION:

- a. Installer must examine the areas and conditions under which toilet accessories are to be installed. Notify the Contractor in writing of

conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

- b. Use concealed fastening wherever possible.
- c. Provide anchors, bolts and other necessary fasteners, and attach accessories securely to walls and partitions in locations as shown or directed. The structural strength of all grab bars and all fasteners and mounting devices shall meet or exceed the accessibility requirements of ADAAG Section 4.26.3 Structural Strength.
- d. Install concealed mounting devices and fasteners fabricated of the same material as the accessories or of galvanized steel.
- e. Install exposed mounting devices and fasteners finished to match the accessories.
- f. Secure toilet room accessories to adjacent walls in compliance with the manufacturer's instructions for each item and each type of substrate construction.

6. PAYMENT:

Payment for the furnishing and installation of toilet accessories will not be made separately but shall be included in the Lump Sum Bid Price for the Control Building structure.

F. SIGNS:

1. WARNING SIGNS:

- a. Shape, dimension, wording and lettering shall be as shown on the drawings.
- b. Sign shall be made of white aluminum sheet material; the minimum thickness shall be 10 gage. Aluminum sheet shall conform to ASTM B 209, alloy and temper 6061-T6 flat sheet.
- c. Lettering shall be silk screened on the face of the white aluminum.
- d. Fasteners shall be one-way, tamper-proof stainless steel.

2. STATION NAME PLATE:

- a. Station name plate shall be cast bronze tablet with raised edge border and pebble textured field. Lettering shall be upper case Helvetica Medium style, 1-inch high by 5/32-inch stroke.
- b. Mounting of the sign shall be with one 1/2-inch diameter stainless steel post-installed wedge anchor at each corner of the sign. The exposed nut and bolt shall be painted to blend with the color of the sign.

3. PAYMENT:

Payment for the furnishing and installation of building signs and plaque will not be made separately but shall be included in the Lump Sum Bid Price for the Control Building structure.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300- CONSTRUCTION

SECTION 303.30 – PLUMBING

G. FIXTURES:

The following shall modify and supplement DIVISION 300- PLUMBING- FIXTURES in the Water System Standards, 2002

Paragraph G. Fixture shall be added to and supplemented as follows:

GENERAL SCOPE:

Furnish and install all fixtures indicated on the plans. Upon completion of the plumbing work, the entire plumbing system shall be tested for acceptable operating conditions. The fixtures specified below may be substituted with fixtures of equal quality from different manufacturer subject to pre-bid approval from the Manager. If fixtures are supplied with hot water supply openings when not required, such openings are to be closed permanently with chrome plated faucet hole covers. Fixtures shall be as follows:

1. Handicap Water Closet:

American Standard	3043.102 "Cadet" Siphon Bowl, floor mounted vitreous china water closet with 1-1/2" top spud, and 17-1/4" bowl height.
Sloan	111-YO-ADA "Royal" flush valve with vacuum breaker bumper, and screwdriver stop. Valve shall comply with ADA requirements. 1.6 gallons per flush.
Beneke	523. SS/NCH white solid plastic open front seat with self-sustaining hinge less cover.

2. Handicap Lavatory Wall Hung

American Standard	9141.011 vitreous china
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wall hung wheel chair
lavatory, 27" x 20",
with faucet holes 4"
on center.

7400.172H "Heritage"
gooseneck faucet with
aerator and 4" wrist
handles. 2 gpm flow
restrictor.

7223.018 offset grid drain.

J.R.Smith

720-27 concealed
lavatory support

Brasscraft

CR1912-A 1/2-inch angle
supplies

CalTuPCo

503-601 17 ga. 1-1/4" x
1-1/2" chrome plated
P-trap.

Plumberex

3010 black drain lever

3020 black valve & supply
cover.

3040 black offset tail-
piece cover.

3. Emergency Shower/Eye Wash Basin:

See Section 304.04 (Chlorination Section) for a full description of this assembly.

4. Fire Extinguisher:

Potter-Roemer

3005 5 lb. ABC Multi-
Purpose dry chemical
fire extinguisher

5. Floor Drain:

Smith	2220, coated cast iron body, flashing collar with cast iron grate and sediment bucket, deep seal trap with primer connection.
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6. Interior Hose Bibb:

Dick Brothers	2524-LK ½-inch interior sill faucet with loose key.
Watts	#8 vacuum breaker
Price-Pfister	13-041 ½-inch screw-driver stop.
7. Exterior Hose Bibb:

Dick Brothers	3501-MLK ¾-inch exterior hose bibb with loose key.
Watts	#8 vacuum breaker
Price-Pfister	807-39 ¾-inch square head service cock.
8. Floor Cleanout:

Smith	4031, or equal
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9. Cleanout to Grade (COTG): Smith Fig. 4280 Duco cast iron body with counter sunk cleanout plug.
10. Underground Soil, Waste and Vent Pipes: Service weight cast iron with "No-Hub" fittings conforming to Cast Iron Pipe Institute Standards 301-85, 2-1/8 inches wide stainless steel sleeve, bands (2 each) and screws, with neoprene rubber gasket. Anaheim Foundry A 300 coupling or approved equal.
11. Trap Seal Primer Valve: Bronze body automatic trap primer with integral vacuum breaker, solder female union connection, Zurn Z-1022 and access door.

12. Toilet Paper Dispenser:
Bradley 5084, or equal
13. Tower Dispenser:
Bradley 50-15, or equal
14. Mirror:
Bradley 710-24x36, or equal
15. Grab Bar:
Bradley -001, or equal

The following shall supplement section 303.29, Miscellaneous Specialties:

This item of work consists of furnishing all labor, materials, tools, and equipment required to install the items listed, herein, in place complete, ready for use.

WALL EXHAUST FAN-CHLORINE SAFETY SYSTEM:

1. Design Conditions:
 - a. Exhaust Fan: Two(2) wall mounted units
 - b. Capacity Required: 440 cfm @ 1/8 SP
2. Centrifugal Wall Exhausters:

The Centrifugal Wall Exhausters shall be Cook Model ACW-B, 100W2B, belt drive, manufactured by Loren Cook Co., or approved equal. Ventilator housing shall be of heavy gauge spun aluminum construction and shall be weatherproof.

 - a. Fan wheels shall be backward-inclined, non-overloading centrifugal design, statically and dynamically balanced. Tip speed, rpm and motor horsepower shall not exceed listing in manufacturer's catalog for unit specified.
 - b. Housing shall be provided with rubber grommetted internal wiring passage and shall be designed to discharge air in a 360 degree pattern, away from the building.
 - c. Fan shall be equipped with the following accessories: wheel guard, grille and explosion proof motor with gas tight wiring.

3. Installation:

Install fan in accordance with manufacturer's requirements and recommended procedures.

PAYMENT:

Payment for MISCELLANEOUS SPECIALTIES will not be made directly but shall be a part of the Unit Price Bid or the Lump Sum Bid, whichever is specified for the item of which this item is a part.

INSTALLATION INSTRUCTIONS AND MAINTENANCE MANUAL

- A. The manufacturer shall also provide at least five copies of the instructions for the installation and proper maintenance of the plumbing equipment in bound folders. Included in the folders shall be drawings of the individual components and its accompanying material list.
- B. Installation shall be performed in accordance with the manufacturer's instructions.

GUARANTEE

- A. The equipment covered by these specifications shall be guaranteed against defective parts due to faulty material or workmanship for one year after date of acceptance of project. The Contractor shall guarantee to replace all defective parts within the period of time specified. The Contractor shall pay for all costs for the replacement of defective parts at no cost to the Department of Water Supply. The guarantee shall be in writing and shall be given to the Department of Water Supply prior to the completion of the project.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 304 – MECHANICAL AND ELECTRICAL

The following shall supplement Section 304.01 of the Water System Standards.

A. SUBMERSIBLE PUMPS:

The following requirements are for the furnishing and installation of the pump, motor, and appurtenances of the Deep Well Pump Station.

A.1 WELL PUMPING UNIT:

This section of the specification covers the furnishing and installing of one new vertical, motor-driven, submersible deep well turbine pumping unit. The pump shall conform to AWWA E 101-88 specifications.

A. Pump Characteristics:

Number Required: One (1)

Pump Rated Capacity and Head: 1000 gpm at 850 ft. head
(Pump efficiency not less than 85%)

Example of pump performance characteristics desired:

1. 0 gpm at 1071 ft. head maximum (shutoff head)
2. 900 gpm at 900 ft. head
(Pump efficiency not less than 83.0%)
3. 1000 gpm at 850 ft. head
(Pump efficiency not less than 85.0%)
4. 1100 gpm at 790 ft. head
(Pump efficiency not less than 84.0%)

Pump used to dimension plans and specify pump performance characteristics:

Goulds Pumps 1770 rpm (12 CMC, 12 Stages)

B. Motor Characteristics:

Number Required: One (1)

Electric Motor Rating: 300 HP

Power: 3-Phase, 60 Hertz, 2300 Volts

Minimum Full Load Motor Efficiency: 87%

C. Surface Plate Assembly:

Surface Plate: 2 in. thick x 27.50 in outside diameter x 25.00 in bolt circle

Discharge Elbow: 10 in – 90 degrees, long radius, schedule 40 steel reducing elbow reduced to 8 in dia. down hole as shown in the plans.

Discharge Flange: 10 in – 150 lb ASA flat face

D. Discharge Column:

Minimum Inside Diameter: 8 inches

Minimum Pipe Wall Thickness: .322 inches (Schedule 40)

E. Pumping Unit Efficiency Test Requirements:

Minimum guaranteed overall efficiency of pump unit at rated capacity and head: 73%

F. Well Data:

All elevations refer to mean sea level.

Well Casing Inside Diameter: 16 inches

Length of Solid Steel: 797.5 feet

Length of Perforated Steel Casing: 100 feet

Elevation of Bottom of Solid Steel Casing: +26.49 feet

Elevation of Bottom of Perforated Steel Casing: -73.51 feet

Elevation of Bottom of Pump Submersible Motor: -28.33 feet (estimated)

Elevation of Pump Suction Inlet: -18.2 feet

Elevation of Bottom of Pump Discharge Head/Surface Plate: +824.0 feet

Length of Pump Column as measured from Pump Discharge Elev./Surface Plate to top of Pump Bowl Assy: 833.0 ft (Approximately)

Elevation of Estimated Static Water Level in Well: +16.77 ft, MSL

Estimated Drawdown: 0.5 foot + or – at 1050 gpm

G. Deep Well Pump Description:

The pump shall be as manufactured by Goulds Pumps, or approved equal and meet “Quality Management Standards”, ISO 9001:1994 and NSF 61.

Bowls:

The pump bowls shall be ductile iron having a minimum tensile strength of 30,000 pounds per square inch, free from blow holes, sand holes and all other faults; accurately machined and fitted to close dimensions. Bowls shall be porcelain enamel lined. Porcelain enameled finish shall be smooth, nominal 8 mils thick, and shall be free of defects such as thin spots, blister, chipping, spray sagging, air bubbles, fish scaling and pinholes. The manufacturer shall provide the Engineer with pressure ratings of bowls at one and one-half (1-1/2) times shut-off conditions as well as at full load.

Pump Shaft:

The pump shaft shall be of polished ASTM A 582, Grade 416 stainless steel and shall be supported by suitable non-corrosive bearings on both sides of each impeller and positive means must be provided for water lubricating each bearing. The shaft shall be provided with a means to accurately locate the shaft with respect to the bowls during assembly of the bowl unit. The case bearings shall be bronze or other approved material.

Impellers:

Impellers shall be the fully enclosed type of bronze cast from new ingot material of heavy construction, finished all over, accurately fitted and perfectly balanced both statically and dynamically. (Hydraulic "balanced thrust" impellers shall not be permitted.) They shall be locked securely to the impeller shaft with a tapered collet lock bushing or other means.

The bowls and impellers shall be designed with open and smooth passages to secure efficient operation and to prevent air locking or sand locking. The impellers shall be so designed as to permit axial adjustment to compensate for wear. The clearance calculations shall be submitted to the Engineer before the pump is installed.

Surface Plate Assembly:

The surface plate assembly shall consist of a heavy steel base plate with a steel coupling of required strength to carry the weight of the complete pumping unit. The coupling shall be screwed onto the upper end of the column pipe and shall have a long radius steel flanged reducing elbow. The surface plate shall be round with 8 bolt holes. A 1-inch NPT tapped hole shall be provided in the surface plate for connection to the air relief line which will allow the relief of air in the space between the casing and the pump column. Three additional 1-1/4 NPT inch tapped holes shall be provided in the pump base to allow the soundings tubes for water level determination to pass through the base into the area between the column and casing. A suitable opening shall also be provided to pass the power cable from the junction box through the surface plate into the area between the column and casing. Provide suitable lifting lugs of required strength to lift the entire pump unit into or out of the well for installation or maintenance purposes.

Discharge Column Assembly:

The discharge column assembly shall conform to the following requirements:

1. Discharge Column Pipe Size

The pipe for the discharge column shall have a nominal inside diameter of not less than that specified.

2. Discharge Column Pipe Description

The discharge column pipe shall be Schedule 40 steel pipe conforming to ASTM specification A 53, Grade B and shall be coated with zinc inside and outside by the hot-dip process. Each section of the column shall be NPT threads. The pipe shall be furnished in interchangeable sections of 20 feet nominal length. The

Schedule 40 pipe specified is the minimum weight to be furnished. The Contractor shall furnish and install a heavier weight of pipe should same be required to satisfy pressure or structural requirements for his proposed pump installation.

3. Certification of Discharge Column Pipe

A certificate must be submitted to the Engineer before the pump is installed verifying the following:

- a. The thickness of the discharge column pipe furnished is as specified.
- b. The pipe supplied conforms to ASTM Specification A 53, Grade B.
- c. The pipe has been coated with zinc inside and outside by the hot-dip process.

4. Steel Column Couplings

The pipe shall be fastened with threaded-sleeve type galvanized steel couplings.

Column Check Valve:

A column check valve(s) shall be furnished and installed to prevent surging the well due to rapid column drain. The check valve shall be 8 inch nominal size. The location shall be as shown on the plans. The check valve(s) shall be a Lakewood Check Valve, or approved equal with double flapper disk and a round neoprene upper crossbar to absorb seat opening shock. Hinge openings shall be provided to allow water to bleed back into the well when valve seats are closed. The check valve(s) shall be threaded on both ends to attach the valve to the column pipe and shall be capable of supporting a maximum load of 85,000 pounds.

Strainer:

The strainer screen shall be 416 stainless steel. The net area of the screen openings shall be not less than twice the area of the pump suction opening and shall be fastened with stainless steel bolted connections. The pump shaft shall extend through the strainer and shall be supported by adequate bronze, extra long, sleeve type bearings integrally constructed with the strainer body and shall be provided with a sand cap for protecting the bearings against sand and grit.

Full Face Gasket:

Provide a full face gasket between the leveling plate and surface plate assembly.

Motor and Pump Connection:

Different manufacturers were used to specify the motor and pump assembly. It shall be the responsibility of the pump contractor to supply suitable adaption/mechanical connection between the motor and the pump assembly. The warranty provisions shall cover the full resultant assembly.

Centering Guides:

Centering guides shall be strapped/installed on the column assembly just above the discharge end of the pump and motor assembly and spaced at 120-degree intervals around the column for the length of that 20-foot column pipe.

Motor Description:

The motor shall be a new and unused of the vertical, submersible type capable of continuous operation at nameplate rating submerged under water at a maximum temperature of 77 degrees F and suitable for "across the line" starting. It shall be provided by the pump contractor to be installed in the existing well with ample clearance for water to flow pass the motor into the pump and shall be rated at 300 HP, 3 phase, 60 Hz, 2300 volts, 1800 RPM with a minimum service factor of 1.15. Minimum Efficiency at full load shall be 87% with a minimum power factor of 77%. The maximum actual motor diameter shall not exceed 8.00 inches in diameter at its widest point.

The motor shall be the oil-filled type and filled with a high dielectric strength FDA approved food grade mineral oil that meets NSF 61.

The motor shall be equipped with a double mechanical seal design which will incorporate a chamber between the two seals to collect and return seal leakage to the bottom end of the motor. The motor design shall automatically balance internal pressure in the motor with the well pressure (submergence pressure) outside the motor without the use of diaphragms or springs.

The motor design shall include the capability to carry continuously, the total sum of the weight of the rotating components of the pump and motor, and the hydraulic thrust that the pump might apply in both the up and down direction. The motor thrust bearings are to be designed to carry not less than 16,700 lbs. down thrust and 10,600 lbs. of up thrust.

The motor windings shall be a minimum of Class F insulation utilizing a VPI process and be of the form wound design on all voltages 4000 volt and above.

The motor rotor will be squirrel cage with copper bars for maximum efficiency and be dynamically to ISO grade G2.5.

The motor shall be equipped with a factory hot-injection molded plug at the motor terminal end. The plug design shall incorporate a sealing plug-in design, which can be removed without disassembling any part of the motor. The cable plug design shall be capable of withstanding full submergence pressure without failure. The submersible motor shall be a Byron-Jackson, 2300 volts, 4 pole submersible, 300 HP motor or an approved equal.

Manufacturer's certified copies of tests run on a motor of the same type, size and model as being furnished shall be forwarded from the Contractor for inclusion in bound sets for submittal to the Engineer. Test data shall include:

1. A.C. Winding resistance
2. No load current
3. Full load current
4. Locked Rotor current
5. Starting Torque
6. Motor efficiency at 50, 75 and 100% full load
7. Power factor at 50, 75, and 100% full load
8. Power factor at full load with 90 and 110% rated voltage

H. Power Cable:

Provide a sufficient amount of power cable of proper size and voltage rating to reach from the motor terminal connection cable to the junction box above the surface plate and adjacent to the discharge elbow. The cable shall comply in every respect to the National Electrical Code, latest edition. The cable shall have three conductors and sized to confirm for 125% of motor full amps at the conductor temperature rating of 75 degrees C and a voltage drop at the motor not to exceed 3%. The individual conductors shall be class "B" stranding or better, with synthetic rubber or thermoplastic insulation. The cable shall be supported on the pump column by suitable stainless steel straps at intervals not exceeding 10 feet. The cable shall have suitable provisions to take care of any stretching of the pump column.

Type: Cross-linked thermosetting polyethylene insulated cable in conformance with IPCEA (Insulated Power Cable Engineers Association) S-66-524 and NEMA WC-7 (latest issue).

Construction: Three conductors, concentric lay or side by side (to suit clearance requirement of existing well casing), no ground wires. Synthetic insulated, and jacketed.

Size: AWG No. 4

Voltage: 2300 volts rated (volt usage)

- Usage:
- 1) Vertical submersible turbine well unit power conductor from surface to driver in well.
 - 2) Environment
 - in air (-20 degrees F to +130 degrees F)
 - in water (60 degrees F to 190 degrees F)
 - variable external pressure from 0 to 50 psig
 - 3) Powering a submersible three-phase, squirrel cage induction motor
 - 4) Vertical suspension, supported every 10 feet with bands or clamps to the pump discharge column.

Testing: In conformance with IPCEA S-66-524 and NEMA WC-7, latest issue.

Certification of Compliance: The Contractor shall submit three copies of certificate of compliance that the power cable fabrication, materials and testing complies with IPCEA S-66-524 and NEMA WC-7, latest issue.

A.2 KEONEPOKO-NUI NEW BOOSTER PUMPING UNITS:

This section of the specifications covers the furnishing and installing of two (2) new vertical, motor-driven, booster turbine pumping units. The pumps shall conform to AWWA E 101-88 specifications.

A. Booster Pump Characteristics:

Number Required: Two (2)

Pump Rated Capacity and Head: 400 gpm at 290 ft. head
(Pump efficiency not less than 85.0 %)

Example of pump performance characteristics desired:

1. 0 gpm at 384 ft. head maximum (shut-off head)
2. 320 gpm at 316 ft. head
(bowl efficiency not less than 81.2%)
3. 400 gpm at 290 ft. head
(bowl efficiency not less than 85.0%)
4. 480 gpm at 251 ft. head
(bowl efficiency not less than 83.9%)

Pump used to dimension plans and specify pump performance characteristics:

Goulds Pumps, 1770 rpm (9 RCLC, 7 stages)

B. Motor Characteristics:

1. Number Required: Two(2) Premium Efficient
2. Electrical Motor Horsepower Rating: 40 hp
3. Power: 3 phase, 60 cycle, 240/460 volts
4. Minimum Full Load Motor Efficiency: 93.0%
5. Minimum Motor Speed: 1775 rpm
6. Service Factor: 1.15
7. KVA Code Letter: G
8. Totally Enclosed Fan Cooled (TEFC)
9. NEMA Design Code: B
10. Internal Space Heaters: 115 Volts
11. Maximum Sound Pressure at 3 feet: 70 dBA

C. Discharge Head Characteristics:

1. Number Required: Two (2)
2. Size and Class of Discharge Flange:
4 inches, 300 lbs., ASA
3. Size and Class of Suction Flange:
8 inches, 150 lbs., ASA
4. Height of Centerline of Discharge/Suction Flanges from Baseplate:
12 inches.

D. Suction Barrel Characteristics:

1. Minimum Nominal Diameter: 12 inches
2. Minimum Length of Suction Barrel: 9' – 0" long.
3. Minimum Barrel Thickness: 0.375 inches.
4. Minimum Pressure Rating of Barrel: 150 psig.

E. Line Shafting:

1. Minimum Shaft Size: 1-3/16 inches.
2. Shaft Material: High chrome stainless steel ASTM A 582, Grade 416.
3. Coupling Material: High chrome stainless steel ASTM A 582, Grade 416.

F. Pumping Unit Requirements:

Minimum Guaranteed Overall Efficiency of Pumping Units at Rated Capacity and Head: 76%

G. Pump Bowls:

The pump bowls shall be of close-grained cast iron having a minimum tensile strength of 30,000 pounds per square inch, free from blowholes, sand holes, and all other faults; accurately machined and fitted to close dimensions. The bowl shall be porcelain enamel lined, nominal 8 mils thick, finished smooth, and free of defects. Bowls shall conform to ASTM 48, Class 30. Bowl shall be able to withstand the shut-off head. Provide stainless steel bowl cap screws.

H. Impeller Shaft:

The impeller shaft shall be of polished ASTM 582, Grade 416 stainless steel and shall be supported by suitable noncorrosive bearings on both side of each impeller, and positive means shall be provided for water lubricating each bearing. The shaft shall be threaded at the lower end to receive an assembly nut to accurately locate the shaft with respect to the bowls during assembly of the unit. The bottom base bearing shall be bronze or other approved material. All shaft couplings, head shaft adjusting nuts, shaft pins and all nut exposed to the elements shall be stainless steel of the same composition as the impeller shaft.

I. Impellers:

Impeller shall be the fully enclosed type of ASTM 954 aluminum bronze cast from new ingot material of heavy construction, finished all over, accurately fitted and perfectly balanced both statically and dynamically. (Hydraulic "balanced thrust" impellers shall not be permitted.). They shall be locked securely to the impeller shaft with a tapered collet lock bushing or other means. The bowls and impellers shall be designed with open and smooth passages to secure efficient operation and to prevent air locking or sand locking. The impeller shall be so designed as to permit axial adjustment to compensate for wear. The manufacturer of the pump must provide sufficient clearance in the bowl of the pump he supplies to take care of any stretching of the shaft under shut-off head conditions without the impeller making contact with bottom surface of the bowl.

J. Motor Description:

The motor shall be a normal premium efficient torque, low starting current, vertical, hollow shaft, Totally Enclosed Fan Cooled (TEFC), squirrel cage induction motor or approved equal and shall conform to the standards of the National Electrical Manufacturers Association, American National Standards Institute and the Institute of Electrical and Electronics Engineers. The motor shall be designed for full voltage starting and shall have a horsepower rating of not less than specified, and shall be a U.S. Vertical Hollow Shaft Induction Motor, or approved equal. The motor shall have adequate capacity to drive the pump continuously under the head specified with a temperature rise of not more than 40 degrees C. The maximum starting current shall not exceed that of a motor having a locked rotor current of that specified.

Modifications to the motor shall include 120-volt internal space heaters.

Motors shall have an efficiency of not less than that specified when operating under full load conditions. The bearings of the motor shall be oil or grease lubricated. The motor thrust bearing shall have ample capacity for the thrust loads of the pump thrust and weights of the pump shaft and pump rotating element with pump operating at shut-off head conditions. The thrust bearing shall be of such size that the average life rating is base on five years of continuous operation. It shall also have ample capacity to permit the pump to operate for 10-minute periods with the discharge valve closed.

The selection of the motor shall be the responsibility of the Contractor and Pump Manufacturer and must meet the approval of the Manager before it is ordered.

Manufacturer's certified copies of tests run on a motor of the same type, size and model as the one being furnished shall be forwarded to the pump supplier for inclusion in the bound sets for submittal to the Engineer. Test data shall include:

1. A.C. winding resistance

2. No load current
3. Full load current
4. Locked rotor current
5. Starting torque
6. Motor efficiency at 50, 75 and 100% full load
7. Power factor at 50, 75 and 100% full load
8. Power factor at full load with 90 and 110% rated voltage

K. Discharge head and Suction Barrel:

The discharge head shall be fabricated steel with suction and discharge flanges located above the ground. The mechanical seal in the discharge head shall be Chesterton "Balanced Type" or approved equal. All discharge heads shall be furnished by the pump manufacturer. The pump nameplate shall be securely fastened in a conspicuous place showing the manufacturer's name, serial number, capacity in gpm at rated head in feet, speed in rpm and the number of stages for each pump.

The suction barrel with combination flange and foundation mounting plate shall be fabricated steel with a minimum thickness of 3/4-inch drilled to match the discharge head and shall be furnished with gaskets and bolts for mounting the discharge head. The suction barrel shall be designed for a minimum pressure rating of 150 psi, with a minimum wall thickness of 0.375 inch and guide vanes at the bottom to reduce vortices. The discharge head and suction barrel assemblies must be approved by the Engineer before they are ordered by the Contractor. Discharge head shall have a bronze bushing just before the mechanical seal to support the pump shaft.

L. Spare Parts:

1 set mechanical seals for the pump. Chesterton 155 or approved equal.

B.1 SUBSTITUTION OF SPECIFIED PUMP UNIT

The pumping unit to be furnished is that used to specify pump unit performance characteristics or their approved equal. This specific model has been used to dimension plans. Substitute pump units can be used only if the following conditions are met:

- A. All changes in dimensions resulting from the substitution of the specified pump and motor shall be the responsibility of the Contractor and such changes must be approved by the Engineer ten days prior to bid opening date.
- B. The substitute pump and motor must have performance characteristics equal to or better than the specified pump unit. Specific performance characteristics that shall be compared are the required horsepower, efficiency and head capacity curve. The pump and motor shall be OEM unit and be provided with manufacturer's data and actual working applications of a similar pump unit.

B.2 PRELIMINARY PUMP CHARACTERISTIC CURVE

The Contractor shall submit three copies of the preliminary pump characteristic curve to the Engineer for approval prior to ordering and shipping the unit. The curve shall show the proposed head, efficiency and brake horsepower versus capacity characteristics of the pump to be furnished. The Contractor shall furnish the pump shaft size, pump requirements, number of stages, bowl dimensions, and specifications.

B.3 FACTORY PUMP TESTS

The Contractor shall submit three copies of a certified performance curve for the pump and string test which he proposes to furnish, based on a factory witnessed running test for the pump unit and motor made in accordance with the recommended practices of the Hydraulic Institute and the American Waterworks Association to show that the specified conditions can be met by his equipment. The test shall also be certified and witnessed by an independent registered professional engineer. The curve and data sheet must be approved by the Engineer. The performance curve shall show the head capacity at rated speed, efficiency capacity, and required brake horsepower capacity curves for the pump. The pump shall be operated by shut-off condition and at a minimum of five capacity points, including one within ± 2 percent of the design speed. The Contractor shall provide a complete pump string test with overall efficiencies in addition to pump and motor efficiency test data. The Contractor shall submit three copies of the data sheet used to plot the curves to the Engineer.

B.4 INSTALLATION INSTRUCTIONS AND MAINTENANCE MANUAL

The pump manufacturer shall also provide at least four copies of the instructions for the installation of the pumping unit and proper maintenance of the same in bound folders.

B.5 EQUIPMENT ASSEMBLY

Installation of the pumping unit shall be made for the Contractor by a DWS-approved subcontractor possessing current C-57 Well Drilling Contractor License and/or a C-57a Pump Installation Contractor License or a C-68 Pump Specialty License at the time of bidding and throughout the project and shall be under the direction of the supplier of the pumping unit. The unit shall be installed in the presence of the Engineer or his designated representative. The Contractor installing the pump unit shall have at least five years experience in installing deep well pumps.

Immediately after the Contractor is given the notice to proceed and prior to ordering the submersible deep well pump, the Contractor shall provide a "gage" of the same length and diameter as the combined pump and motor assembly to test the plumbness and alignment of the well. In the presence of the Engineer or his designated representative, the Contractor shall lower the "gage" into the well to the elevation at which the motor and pump are to be placed. If the "gage" can be lowered to this point without binding and to the satisfaction of the Engineer, the Contractor may proceed in ordering the pump.

All equipment shall be located, leveled and aligned to accurately maintain all lines and grades shown on the applicable drawings. Where assembly tolerances are established by written instructions provided by the equipment manufacturer, such tolerances shall govern. If the equipment manufacturer does not provide assembly tolerances, such

tolerance shall be normal for the class of fit and the type of work involved. Alignment of rotating shaft centers at couplings shall not exceed proper allowance for the expansions of the driving and driven units when operating; and faces of coupling halves, with coupling square on their shafts, shall be parallel. In any case, tolerances and alignments must be approved and witnessed by the Engineer or his designated representative.

Grouting of equipment bases and supports shall be performed after final positioning at proper elevation, with all plumbing, leveling and aligning completed and with anchors tightened. Grouting of equipment bases and supports shall be in accordance with Article GROUTING of Section 2.2. Once grouted, the item shall not be operated or subjected to other vibration or stresses until the group has reached an age of seven days minimum.

Shimming of equipment bases and supports shall be performed after final positioning at proper elevation, with all plumbing, leveling and aligning completed and with anchors tightened.

The Contractor shall do lubrication of all moving parts with the lubricants recommended by the manufacturer. Rotating equipment, which has been shipped dismantled for assembly in the field or is not shipped with lubricants, shall have the bearings flushed clean and lubricated when assembly is complete.

The following requirements and instructions of equipment manufacturers shall be followed precisely regarding lubrications.

All surfaces of equipment shall be cleaned prior to assembling and erecting. All internal surfaces shall be maintained clean and free of dirt, water, loose scale and all other foreign materials during assembling and erecting, and shall subsequently be thoroughly cleaned prior to initial operation or use.

B.6 PAINTING

Paintings of new deep well pump unit, all exposed pipes, fittings, and valves associated with the new pump stations shall be as specified herein and in Section 2.26 – “Painting”. Paint shall be delivered to the site in factory-sealed containers and applied in accordance with the manufacturer’s instructions. All surfaces to be painted shall be thoroughly cleaned of dirt, dust, oil or grease with clean, dry rags and solvents. Rust, mill scale, stain and any other injurious materials shall be removed by scraping, chipping, wire brushing or sand blasting. Drop cloths and other suitable covering shall be used to eliminate paint drips or overspray beyond the painted surfaces.

B.7 LAYOUT DRAWINGS

Three sets of the pump and piping layout drawings shall be submitted for approval to the Engineer prior to construction. All dimensions of the pump, valves, piping, fittings, well dimensions (static water level), solid casing info, bottom hole, sounding tube location and appurtenances shall be shown.

B.8 FIELD TESTING OF PUMP UNIT

After installation of all equipment and before any field tests are conducted, the pump shall be operated continuously for a period as determined by the Engineer or as required by the pump installation permit. The Contractor shall make his own arrangements and pay for power and other costs.

Throughout the operating test, the pumping unit shall run smoothly without vibration or heating of the bearings. If, during or as a result of this test, any structural or mechanical defect or weakness develops, or if the equipment fails to deliver its required discharge at the respective head under required conditions, the Engineer reserves the right to reject any part or all of the equipment and demand reconstruction or replacement to meet the requirements of these specifications at no cost to the DWS.

After the operating test has been completed to the satisfaction of the Engineer, an efficiency test shall be made for the pumping unit covering a period of not less than two hours. This efficiency test shall be made by the Contractor in the presence of the Engineer and in accordance with the recommended practices of the Hydraulic Institute and American Waterworks Association. The capacity of the pumping unit will be tested under the head capacity conditions specified.

All gages and equipment required for tests, which are not available in the permanent equipment, will be furnished, installed and tested by the Contractor. All gages shall be calibrated and calibration curves shall be submitted.

The overall efficiency of the pumping unit shall be the ratio of the water horsepower delivered by the pumping units as measured at the pump discharge head to the total electrical power consumed by the unit. Overall efficiency shall include all pump, motor, and power cable losses.

The quantity of water delivered shall be based on the readings of the flow meter. No special calibration will be made. Tests shall be made with the electric current normally furnished by Hawaii Electric Light Company, Ltd. No adjustment of the electrical power will be allowed.

Should the test for efficiency for the pumping unit result in an overall efficiency of less than that specified in the guaranteed capacity and head point, the Contractor shall make the necessary changes and replacements. The Contractor shall pay all such changes and replacements and any additional tests required. During the period between the first test and the final acceptance of the pumping unit by the Owner, the unit shall be left in place and in good working condition for use by the Owner in order to provide service, if required, at no additional cost to the Owner.

The pump contractor shall also provide at least three copies of the field-testing that the pump is accepted at.

B.9 AS-BUILT DRAWINGS

The Contractor at no additional cost shall return one set of red marked as-built drawings to the Engineer.

B.10 PACKING AND SHIPMENT

Pump equipment shall be packed in substantial containers to protect them adequately from damages during normal handling in transit.

B.11 STORAGE

The Contractor shall, as a minimum, comply with the following requirements for protection of all equipment during storage.

Equipment shall be stored off the ground, properly supported on skids, blocking, cribbing or other suitable support. Equipment having saddle or dollies shall be supported mainly from these supports. Equipment supports shall be leveled and aligned on wedges or shims as necessary to prevent any twisting or bending stresses on the supported equipment.

At the time of delivery, the factory-installed closures on nozzles and equipment openings shall be inspected for weather-tightness. Any closures, which are punctured, or missing shall be replaced with temporary closures and made weather-tight. All closures shall be maintained weather-tight and left in place until the Engineer or his representative authorizes removal.

Motor and controls shall be stored only in an enclosed cover, except that if outdoor storage of a short duration is necessary, these items may, for that period, be stored off the ground and fully covered with a suitable waterproof covering free from punctures or tears and secured against displacement. The protective measure for all such outdoor storage will be provisional upon approval by the Engineer.

B.12 COORDINATION OF WORK

The Contractor's work and installation of equipment and materials shall be closely coordinated with the Engineer and other contractors working on the project to avoid all possible interferences, delays, omissions, and overlapping of responsibilities.

B.13 WARRANTY

The Contractor shall guarantee the equipment covered by these specifications against any defective material and workmanship for two years after the date of acceptance of the installed pump unit. The Contractor shall replace and correct all defective parts within this period and pay for all costs thereof including shipping, removal and reinstallation of the necessary parts. It shall be understood that any shipping damages shall be corrected and paid for by the Contractor, and final acceptance and payment will be subject to satisfactory delivery of the equipment.

B.14 PAYMENT

The pumping unit, which includes motor, measured as provided above, will be paid for at the applicable contract unit price at the well site:

“One only vertical turbine submersible deep well pump and motor unit, inclusive of discharge column, Lakewood check valves, surface plate assembly, power cable, 1-1/4-inch Sounding Tubes, pump discharge piping, valves, fittings, silent check valve, air and vacuum valve assembly, pump control valve assembly, electromagnetic flow meter, flow transmitter, flow switch, air relief valve assembly, sand sampler assembly, and pressure gage assemblies, inclusive of painting and testing, fully operational per plans and specifications.”

Which price shall be full compensation for furnishing, handling, installing, and testing pumping unit; and for all equipment, tools, labor, materials, including drawings and instruction books, and incidentals necessary to complete the work.

Payment for the item shall be made as follows:

Forty percent of the total cost for the item will be paid when the complete pumping unit is acceptably delivered at the job site.

An additional 40 percent of the total cost for the item will be paid after the pumping unit has been installed.

The remaining 20 percent of the total cost for the item will be paid after the pumping unit has been tested and accepted.

The Contractor shall make payment for the inspection and testing of the pumping unit within 30 days after receipt of invoices. The Engineer shall have the right to withhold from monies due the Contractor, a sufficient amount to cover such invoices. The right to withhold money from the Contractor will be at the discretion of the Engineer and shall be without recourse by the Contractor.

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 304 - MECHANICAL AND ELECTRICAL

The following shall supplement Section 304 "Mechanical and Electrical", in the Water System Standards, 2002.

SECTION 304.03 ELECTRICAL WORK

A. GENERAL:

1. The Detailed Specifications of the Special Provisions for each project shall be added and made a part of this section for electrical work.

B. SCOPE OF WORK: Furnish all labor, supervision, and tools, and provide all materials and equipment necessary for a complete installation as shown on the drawings and specified herein, and as required for its correct and proper operation. It is the intent and purpose of these specifications and the related drawings that, upon completion of the project, the electrical installation shall be complete in all respects. The work includes but is not limited to:

1. Providing a complete electrical system as indicated on the drawings and in accordance with the true intent and meaning of the drawings and these specifications.
2. Confirming and coordinating electrical service requirements with serving utilities, complying with their requirements. Paying for any service related connection work, fees, and costs to serving utility company. (Provide for a total allowance of \$850,000.)
3. Procuring all permits, paying for same, and arranging for the necessary inspections required by the County of Hawaii ordinances.
4. Furnishing submittals per specification requirements for review and acceptance by the Department. Furnishing reproducible shop drawings.
5. Coordinating materials and equipment delivery to insure satisfactory completion of the Contract in the scheduled time.
6. Testing complete installation and correcting all defects and malfunctions of material and workmanship at no additional costs.

E. MATERIALS AND WORKMANSHIP

2. Rules, Standards, and Specifications

All electrical work shall comply with the applicable portions of the following current editions which are also to be considered a part of these specifications:

NEC – National Electrical Code

NEIS – National Electrical Installation Standards

NECA – National Electrical Contractors Association

County of Hawaii Ordinances

Serving Utility Company's Service Installation Manual Requirements and Rules and Regulations.

G. EQUIPMENT AND SHOP DRAWINGS

1. Materials and Equipment Data

- a. Submit a complete list of all materials and equipment proposed to be furnished and installed under this Section. For each item, submit manufacturer's shop drawings, specifications and/or catalog cuts as required to demonstrate compliance with the specified requirements. Shop drawings shall include complete dimensioned general arrangement, wiring, schematic, and connection diagrams.
- b. Any item installed without a review and/or written signature of acceptance from the Department shall be subject to rejection and disqualification. Replacement shall be provided by the Contractor as acceptable to the Department at no additional costs to the Department.
- c. Submit manufacturer's recommended installation procedures for applicable items, which, when accepted by the Department, will become the basis for inspecting and accepting or rejecting actual installation procedures used by the Contractor.
- d. Submittals shall be submitted all together at one time in order to demonstrate that all items of electrical work have been properly coordinated and will function properly with each other. Partial or incomplete submittals will be returned to the Contractor without a review by the Department.
- e. Submittals shall be submitted in form that folds-out to right in folders or binders. Top fold-over submittals will not be acceptable and will be returned without review.
- f. Submittals shall be certified by the Contractor that all submittals have been reviewed by the Contractor prior to submittal to the Department and that the submittals are in compliance with the Contract requirements and can be installed in the designated spaces indicated on the drawings. Submittals without certification by the Contractor shall be returned to the Contractor without a review by the Department.
- g. Reproducibles: Upon acceptance of the Contractor's submittals by the Department, the Contractor shall submit a set of reproducible shop drawings to the Department. Drawings shall be the original or mylar sepia. Drawings shall be erasable and correctable.

H. SUBMITTALS

1. As-built Drawings. Submit a clearly and legible red-marked complete set of Electrical Drawings and submittal shop drawing showing all deviations in conduit routing,

equipment locations, circuiting, detail revisions, and any other changes done during construction affecting the electrical work. Drawings shall be submitted within five working days after acceptance of the electrical work by the Department as a condition for release of final payment to the Contractor.

2. Manuals. Four sets of bound instruction, installation, maintenance, and parts list manuals shall be furnished for all electrical apparatus and control items. The Contractor shall submit a list of proposed manuals for review and acceptance by the Department.

I. DEFINITIONS

1. Provide – Furnish and install.
2. Replace – Remove existing and provide new.
3. Restore – Match existing types, rating, functions at existing or new location as applicable. Re-use existing wiring if can be relocated without splicing. Provide additional new wiring and splice to existing and extend to new location where applicable.
4. Relocate – Disconnect, remove, store, re-install, re-connect, and place into correct operation all without causing any damage to affected items.
5. Reattach – Replace mounting attachment methods. Replace all mounting hardware, screws, bolts, washers, nuts. Match existing types, sizes, and quantities. Replace all wiring splices, terminations, connections. Match existing types, sizes, and quantities.
6. Wiring – Provide all conduits, conductors, fittings, devices, protective equipment, and any other material as necessary for a completed, working electrical circuit or system.
7. Outlet – In addition to definition in the NEC, outlet shall mean the required outlet boxes, conductors, terminations, wiring devices, and cover plates, to provide for the intended use, application, or utilization equipment.
8. Interior – Within imaginary lines formed by outer surface of building walls and roof.
9. Exterior – Beyond imaginary lines formed by outer surface of building walls and roof, including all projections thereof such as roof eaves and overhangs.
10. Field Locate: Final location adjusted to suit field conditions to accommodate Contractor's construction methods, while complying with minimum requirements of NEC and as acceptable to the Department. Allow for minimum 10 feet horizontal adjustment without additional costs and/or provide for the additional adjustments where noted.
11. Field Route: Final conduit routing selected by Contractor with acceptance by the Department to suit site conditions avoiding interferences with other equipment, piping, structural steel, structural walls, etc., and to match construction methods desired by Contractor.
12. AHJ: Authority Having Jurisdiction

J. GENERAL REQUIREMENTS

1. Specifications and Drawings. Drawings show approximate locations for all electrical items. The drawings are diagrammatic and shall not be scaled for dimensions. The drawings are intended to be complete as to specific intent and requirements but not to actual details of construction, installation, and locations.
2. Coordinating of Work. Contractor's work and installation of electrical items of work shall be closely coordinated to avoid all interferences, omissions, and overlapping of responsibilities. Contractor shall study and review all drawings and specifications and coordinate all electrical requirements. Failure by Contractor to propose and provide wiring for electrical requirements due to lack of coordination shall not be grounds for additional costs. Advise the Department of and resolve any discrepancy before performing any work.
3. Quality Assurance. For actual fabrication, installation and testing of work of this Section, use only licensed, thoroughly trained, and experienced workmen completely familiar with the items required and with the manufacturer's recommended methods of installation. In accepting or rejecting installed work, no allowance will be made for lack of skill or experience on the part of workmen.

Good workmanship and appearance shall be considered of equal importance with electrical and mechanical operation. Carefully lay-out all work in advance and install in a neat and workmanlike manner and in accordance with recognized good practices and standards. All electrical work shall conform to the methods or standards described in NECA 1-2006, Standard For Good Workmanship In Electrical Construction.

Installation shall be complete in every detail as specified and ready for use. Any item supplied developing defects of design, construction, or quality within one year of final acceptance by the Department shall be replaced at no cost to the Department by such materials, apparatus, or parts to make such defective portion of complete system conform to the true intent and meaning of the drawings and these specifications.

4. Defective Materials and Equipment. Defective materials and equipment or materials and equipment damaged in the course of installation or testing shall be replaced or repaired in a manner meeting with the approval of the Department and at no additional costs to the Department.
5. Nameplates. Each major component of equipment shall have as a minimum the manufacturer's name, address, catalog number, model, style, or type on a plate securely and conspicuously attached to the item or equipment. Nameplates for electrical apparatus shall conform to the referenced NEMA publication.
6. Prevention of Corrosion. Exposed metallic parts of outdoor apparatus shall be Type 316 stainless steel where available as a catalog standard product or Type 304 if not available. All such parts as boxes, bodies, fittings, guards, and miscellaneous parts made of ferrous metals but not of stainless steel, shall be hot-dipped galvanized after fabrication. The Contractor shall not join dissimilar metals that will result in deterioration due to galvanic corrosion. All screws, machine screws, nuts, bolts, washers, and similar hardware and mounting brackets/hardware shall be stainless steel, Type 316. Conduits at exposed

exterior locations including those continuing from underground shall be Type 316 stainless steel.

7. Verification of Dimensions and Available Spaces. The Contractor shall be responsible for the coordination of the proper relation of his work to the site and to the work of all trades. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, shall verify all dimensions in the field, and advise the Department of and resolve all discrepancies before performing any work. The electrical plans are diagrammatic and shall not be scaled for dimensions. Use dimensions and measurements from detailed drawings, as obtained from actual field measurements, and from shop drawings of the equipment to be installed.
 8. Cutting and Repairing. Provide all cutting, patching, channeling, drilling, etc., in building structure or areas only as necessary for electrical work. Locate holes to be drilled, etc., coordinate work with all other trades on the job, and make arrangements for necessary openings and chases, and for stub-ups. Make necessary repairs where patching or refinishing is necessary for electrical work. Actual work involved in these repairs shall be done by skilled craftsmen in the trades involved, but paid for under this Section of the specifications.
- K. REMOVED ELECTRICAL ITEMS OR WIRING: Any item of electrical work which is to be removed by the Contractor shall remain the property of the Department, unless otherwise indicated. The Contractor shall consult the Department for delivery, storage, and/or disposal instructions. When so instructed by the Department, the Contractor shall dispose of removed items at no additional costs to the Department. Unless instructed otherwise, all removed items shall be delivered to the Department of Water Supply's baseyard on Leilani Street, Hilo, Hawaii.
- L. SERVICE INTERRUPTIONS
1. All work requiring electrical outages, system shutdowns, or interruptions of existing utility lines shall be scheduled with the Department a minimum of three working days in advance. The number of outages and shutdowns and the duration of each outage shutdown shall be subject to the approval of the Department. All work shall be expedited to shorten the shutdown time as much as possible.
 2. The Contractor shall plan and schedule his work to allow continued operation of the existing water system as required. Normal flows shall not be disrupted except as approved by the Department. Existing water system shall remain in the "AUTO" operating mode during the non-working hours. During normal working hours, the existing water system may be operated in the "HAND" operating mode as allowed by the Department.
- M. PRODUCTS
1. General
 - a. Unless indicated or specified otherwise, materials and equipment shall conform to the National Electrical Code and to the standards, codes, regulations and specifications referenced herein. All materials and equipment shall be new and shall not have been stored unprotected in the outdoors.

- b. Materials and equipment shall be essentially the standard catalog product of a manufacturer regularly engaged in the manufacture of the produce, shall meet the requirements of the specifications, duplicate materials and equipment that have been in satisfactory use for the past two years on the Island of Hawaii, and be acceptable to the Department.
 - c. Brand names, manufacturer's names and catalog numbers, where indicated establish standards of design and quality desired. Substitutions will not be accepted unless specifically accepted in writing by the Department. No substitutions will be allowed after acceptance of Contractor's proposal by the Department, unless otherwise allowed in writing by the Department.
2. Conduits. Rigid metal (steel) conduit, stainless steel rigid metal conduit, electrical metal tubing, rigid non-metallic conduit, liquid tight flexible steel conduit, and flexible steel conduit shall conform to U.L. Standards.
 3. Fittings. Threaded fittings only for use with rigid metal conduit, compression and set screw type for use with electrical metal tubing, and solvent welding for non-metallic conduit. Fittings for liquid tight flexible metal conduit shall be cadmium or zinc-coated. End fittings for conduit shall be insulated throats or bushings. All hardware shall be Type 316 stainless steel.
 4. Conductors. Conductors shall be copper, stranded, 600 VAC, Type MTW for all control wiring systems, Type THWN-2 for connections to control devices at exterior locations, and Type THWN-2 for all power wiring circuits. Type THHN for lighting fixture wiring where 90 degree C. conductors are required.
 5. Connectors and Terminals. Connectors and terminals conforming to UL Standard 486 shall be designed for use with the specific associated conductor material and shall provide a uniform compression over the entire contact surface of both the connector or terminal and the conductor.
 6. Wireways. Fabricate from NEC code gauge Type 316 stainless steel, square or rectangular cross-section. Manufacture according to applicable NEC requirements. Enclosure classification as indicated or as required for the location and application.
 7. Pull and Junction Boxes. Boxes shall be code gauge Type 316 stainless steel with screwed-on covers. Sizes as indicated on the drawings. Where no size is indicated, size per the NEC. Enclosure classification as indicated or as required for the location and application.
 8. Lighting Fixtures. Lighting fixtures shall be furnished as indicated and specified on the drawings and shall be complete with lamps, ballasts, and all necessary accessories and shall be in accordance with NEC Article 410.

Lighting fixtures located at exterior walls of building shall be "Dark Sky Compliant".

Fluorescent lighting ballasts shall be electronic-type, solid state, energy efficient, high power factor. Total harmonic distortion shall not exceed 20 percent. Ballasts shall be designed to prevent overheating of lamps at end of lamp life or if lamp malfunctions. Magna-Tek, Advance, or approved equivalents.

Furnish tube guards for exposed lamps or any lamp not totally enclosed within housing or diffuser.

Tube guards shall have temperature ratings suitable for use with lamps having increased temperatures at end of lamp life or lamps used with electronic-type, solid state, energy efficient ballasts.

9. Wiring Devices (Furnish Specification Grades). Duplex Receptacle: Rated 2 pole, 3 wire, grounding, 20 amperes, 125 volts, unless otherwise indicated. Bodies shall be brown molded phenolic compound mounted on a corrosion resistant metal mounting strap. Switches shall be as indicated for the functions required.

Lighting Switches: Rated quiet type, AC only, 20 amperes, 125 volts. Bodies shall be brown molded phenolic compound mounted on a corrosion resistant metal mounting strap. Switches shall be as indicated for the functions required.

10. Device Plates. Device plates of the one piece type shall be provided for all outlets and fittings to suit the devices installed. Plates on unfinished wall and on fittings shall be of zinc-coated steel or cast metal having round or beveled edges. Plates on finished walls shall be stainless steel. Plates for outdoor receptacles shall be weatherproof, gasketed, cast metal, with a spring-hinged cap over each receptacle opening.
11. Outlet and Small Pull and Junction Boxes. Outlet boxes may be pressed galvanized steel boxes for interior concealed or recessed locations, sized per the NEC, suitable for the application intended. Device outlet boxes shall be minimum 2-1/4 inches deep. Furnish with raised ring as required to suit the application intended.

Outlet boxes at exposed or surface mounted locations shall be cast metal or cast aluminum, sized per the NEC, suitable for the application intended.

Pull or junction boxes shall be Type 316 stainless steel where indicated, with screwed on covers, sized as indicated on the drawings and suitable for the application and location intended. Where no size is indicated, size per the NEC.

12. Grounding and Bonding. Grounding and bonding equipment shall conform to UL Standard 467. Ground rods shall be copper-clad steel not less than 5/8 inch in diameter, 10 feet long.
13. Circuit Breakers for Service Disconnect. Thermal magnetic, insulated case, ambient compensated, adjustable instantaneous trip, ratings as indicated. UL labeled for service disconnect. Enclosure type and classification as indicated or as required for the location and application. Enclosure material Type 316 stainless steel. General Electric, Westinghouse/Cutler-Hammer.
14. Electrical Metering Equipment. As indicated on the drawings. Comply with utility company requirements. Enclosure material Type 316 stainless steel.
15. Motor Control Equipment. Motortronics Medium Voltage Solid State Type MVC Plus Series with all required options, accessories, and related items as indicated on the drawings.

16. Safety Disconnect Switches. Switches shall be heavy duty type with rating as indicated on the drawings. Enclosure types shall be as indicated or as required for the application. Enclosure material Type 316 stainless steel. General Electric, Westinghouse/Cutler-Hammer.
17. Control Equipment and Devices
- a. General: Control equipment and devices shall be of rating and type as indicated on the drawings. Enclosures and mountings shall be suitable for and fit into the intended spaces and locations. Specifications apply to all items of control work, whether furnished individually or part of other equipment such as motor control equipment, control panels, and other panels or equipment.
 - b. Enclosures: Type 316 stainless steel, classification, size, and mounting as indicated on the drawings. Furnish Hoffman brand unless otherwise indicated. Enclosures shall be sized adequately to provide a minimum of 5 inches of wiring space between terminal block and side or bottom of enclosure.
 - c. Terminal Blocks: General Use: Control type, one piece, 600 volt, 30 amperes, phenolic marking strip, screw with wire saddle-type clamps on both sides, total number of points as indicated, end-to-end mounting as required. General Electric CR151B series.
 - d. Control Relays: Cutler-Hammer Type M. Relays shall be equipped with a neon indicating light mounted on the relay to indicate the state of the magnet coil. Number of contacts and types as indicated on the drawings. Furnish with mounting channels. Furnish mounting channels in place for future relays where indicated.
 - e. Selector Switches: Cutler-Hammer Type T., oiltight, with knob operator and maintained contacts unless otherwise indicated. Operation, contact arrangements, and legend plates as indicated on the drawings.
 - f. Pushbuttons: Cutler-Hammer Type T, oiltight, with flush button operator, black color unless otherwise indicated. Operation, contact arrangement, and legend plates as indicated on the drawings.
 - g. Emergency Stop Pushbutton: Cutler-Hammer Type T, maintained contact with separate reset pushbutton, large mushroom red pushbutton with wording "EMERGENCY STOP".
 - h. Indicating Lights: Cutler-Hammer Type T, oiltight, press-to-test, transformer type, glass lens, color and legend plates as indicated on the drawings.
 - i. Time Delay Relays: Cutler-Hammer Type PN, for pneumatic type, 0-3 minutes adjustable. Agastat Series 7000 for timing ranges longer than 3 minutes. Operation, contacts, and timing range as indicated on the drawings.
 - j. Sequence Timer: Siemens LOGO. Contacts, operation, and timing range as indicated.
 - k. Control Relay, Plug-in Type: Potter and Brumfield Type KRP Series with mounting socket, hold-down spring, 8-pin or 11-pin as applicable.

- l. Legend Plates: Standard size, aluminum black field, engraved.
 - m. Wire Markers: Slip-thru type, white bands with black numbers, compression type or heat shrink, identification numbers as indicated on the drawings.
 - n. Nameplates: Laminated plastic, engraved lettering, 5/16 inch high lettering minimum, white on black, durable and legible. Attach with self tapping screws. Lettering as indicated on the drawings.
18. Secondary Surge Arrestor. Eaton Secondary Surge Arrestor suitable for indicated voltage application.
 19. Line Protection Units (LPU). Furnish as indicated on the drawings. Furnish Poly Phaser Impulse Suppressor IS-SPXL as standardized by the Department. Mount in readily accessible location for ease of maintenance and replacement. Where an enclosure is required, furnish with type NEMA 12, size as indicated or as required for the application.
 20. Communications Surge Arrestor. Furnish as indicated on the drawings. Furnish one spare unit. Mount in readily accessible location for ease of maintenance and replacement. Where an enclosure is required, furnish with type NEMA 12, size as indicated or as required for the application.
 21. 120 VAC Power Surge Arrestor. Furnish as indicated on the drawings. Furnish base mounted metal oxide varistors, 150 VAC RMS, 200 VDC, 220 Joules at .01 microseconds, 20,000 peak pulse current for .4 microseconds.
 22. Panelboard. Dead front, copper bussed, neutral and ground busses, with ratings and branch circuit breakers as indicated. Galvanized sheet steel enclosure with hinged door, latch, lock, and 2 keys. General Electric, Westinghouse/Cutler-Hammer.
 23. Tank Level Transmitter (XMTR _____). Pressure transmitter, static water pressure application, indicating type, Foxboro IGP10 series with silicon strain gauge microsensor. Electronic solid-state circuitry. 0 to 20 feet scaled indicator, 4-20 milliampere output. Maximum working pressure 30 PSI. Power source from remote loop-type current power supply, 22 milliampere minimum. Furnish with weatherproof enclosure complete with mounting bracket for 2-inch pipe mounting and with bleeder block assembly.
 24. Tank Level Recorder (RCDR _____). Circular chart recorder and controller, Chessel 392 Recorder series, single input, electric drive, 120 VAC with OFF-ON switch, 4-20 milliampere input, 10-inch circular chart, 0-20 feet scaled, 7-day per revolution, minimum 6 output control contacts, all independently adjustable. Marking by disposable colored markers. Furnish with power supply for tank level transmitter with voltage output matching measured loop resistance. Furnish isolated scaled 4-20 milliampere retransmission signal. Configuration shall be by integral keypad with logical menu driven steps displayed in English. Furnish with 200 7-day charts and 48 extra colored markers.
 25. Well Level Transmitter (XMTR _____). Furnish transducer type with recorders as specified under Mechanical work.

26. Well Level Recorder (RCDR _____). Circular chart recorder and controller, Chessel 392 Recorder series, single input, electric drive, 120 VAC with OFF-ON switch, 4-20 milliamperes input, 10-inch circular chart, 0-20 feet scaled, 7-day per revolution, minimum 6 output control contacts, all independently adjustable. Marking by disposable colored markers. Furnish with power supply for tank level transmitter with voltage output matching measured loop resistance. Furnish isolated scaled 4-20 milliamperes retransmission signal. Configuration shall be by integral keypad with logical menu driven steps displayed in English. Furnish with 200 7-day charts and 48 extra colored markers.
27. Flow Transmitters. Furnished/installed with Mechanical Work. (Mag-Flo 5100W series as specified by the Department sized to match piping served. Furnished complete with all required accessories including signal converter, cabling, remote mounted transmitter.) Furnish all electrical wiring and testing.
28. SCADA Cabinet. The Contractor's SCADA work shall include providing a SCADA cabinet and terminating all inputs to terminal blocks within a SCADA cabinet. Termination shall be maintained tight to top, front of the enclosure's left side. Terminal blocks shall be neatly aligned in a single column and arranged in the following sequence from top to bottom: Power (Line), Power (Neutral), Power (Ground), Power Distribution, Digital Inputs, Digital Outputs, Analog Inputs, and Analog Outputs. Terminal blocks shall be color coordinated in the following patterns:

TERMINAL BLOCK SCHEDULE

DESCRIPTION	COLOR	PART #
POWER (LINE)	BLACK	PHOENIX CONTACT UT4, 3045143
POWER (NEUTRAL)	WHITE	PHOENIX CONTACT UT4, 3045130
POWER (GROUND)	GREEN	PHOENIX CONTACT UT4, 3045156
POWER DISTRIBUTION	ALTERNATING RED/BLACK	PHOENIX CONTACT UT4, 3045127, 3045143
DIGITAL INPUT	YELLOW	PHOENIX CONTACT UTTB4, 3035467
DIGITAL OUTPUT	BLUE	PHOENIX CONTACT UTTB4, 3044791
ANALOG INPUT	GRAY	PHOENIX CONTACT UTTB4, 3044814
ANALOG OUTPUT	BLACK	PHOENIX CONTACT UTTB4, 3074282

Terminal blocks shall maintain one block spacing between groups, with exception for Power (Line), Power (Neutral) and Power (Ground) which shall be grouped together. Further, Digital Input, Digital Output, Analog Input and Analog Output shall be segmented into groupings of eight (8) blocks with one block spacing between groupings.

Contractor's wiring shall be terminated to left side of terminal blocks, with negative on the base tier and positive on the top tier for multi-level terminal blocks. Wiring shall be marked with wire tags at both ends and color coordinated as follows:

WIRING SCHEDULE

<u>DESCRIPTION</u>	<u>COLOR</u>
POWER (LINE)	BLACK
POWER (NEUTRAL)	WHITE
POWER (GROUND)	GREEN
POWER DISTRIBUTION	RED
DIGITAL INPUT	YELLOW
DIGITAL OUTPUT	BLUE
ANALOG INPUT	GRAY
ANALOG OUTPUT	BLACK

The SCADA enclosure shall also include grounding strip, 120V AC power for use by the DWS. Enclosure shall be free standing, NEMA 4X, 316 stainless steel, single door dual access, 72" x 24" x 24" in dimensions. Front door shall be left handed and back door shall be right handed. Enclosure shall include L-style rack mounting angles for standard 19" equipment which provides for 35U rack units of space. Enclosure shall be Hoffman A722424SSFSDAN4.

Any and all references to "SCADA READY" are for references only to indicate work by DWS.

29. Supervisory Control and Data Acquisition (SCADA) System

General

- a. General Conditions: This section covers the supervisory control and data acquisition (SCADA) system including equipment and wiring as indicated on the plans and specified herein.
 - 1) As specified in Section 304.03 Electrical Work. The provisions of these related sections apply to this section and work described in this section shall comply with them.
- b. Scope of Work: Provide all articles, materials, equipment, operations, and services herein or on Drawings, include all labor, materials, taxes, fees, insurance, and incidentals required to insure completion.
 - 1) System Overview – These specifications are for a distributed supervisory control and data acquisition (SCADA) system for a water system, including Intelligent Remote Telemetry Units (RTUs). Initially, this system shall require the furnishing of all RTU hardware and installation of a SCADA ready enclosure at the Makuu Offsite Water System Site.

- (a) The contractor shall furnish all RTU and hardware as required at the Makuu Offsite Water System Site with all appurtenances, whether specifically referenced herein or not, but which may be required for operation. Communications between the Makuu Offsite Water System Site and the Department of Water Supply baseyard in Hilo shall be by radio telemetry.
 - (b) The contractor shall furnish and install a SCADA ready enclosure as indicated on the plans and specified herein.
 - (c) The Department of Water Supply shall provide all installation and programming required for the RTU hardware and software.
- 2) During bidding and construction, Contractor shall coordinate his work with other trades to avoid omissions and overlapping responsibilities. Electrical contractor shall notify other trades and suppliers of project voltages, including control voltages.
- 3) Work by Others: Instrument transmitters shall be provided by respective sections of this contract. Installation of equipment complete with power wiring and electric controls and interlock wiring shall be part of Electrical Work.
- c. Submittals: Submittals shall be made for approval and resubmitted until approval is received for the following:
 - 1) Catalog Cuts – Submit for approval six (6) copies of catalog cuts of following equipment:
 - (a) SCADA system components and equipment.
 - (b) Conductors and Wiring.
 - (c) Wiring and functional or block diagrams.
 - (d) Manufacturer's recommendations for installation.
 - (e) Manufacturer's recommended list of spare parts for a one-year period of operation.
 - 2) Electrical Installation Drawings – At least 10 days prior to any testing the Contractor shall submit three (3) sets of approved completed electrical installation drawings. The installation drawings shall include the manufacturer's wiring diagrams for the SCADA ready enclosure and any built-to-order equipment.
 - 3) As-Built Drawings: Upon completion of the final inspection and testing, the Contractor shall provide six (6) copies of as-built installation drawings and manufacturer's wiring diagrams for the SCADA ready enclosure and any built-to-order equipment.
- d. Local Support: The manufacturer of the SCADA system supplied shall be represented by a company with offices in the State of Hawaii. This local office shall be capable of responding to request for maintenance and repair to the system by having a technician skilled in the repair, maintenance and operation of the system at the job site within 24 hours of being notified. This local representative shall carry all

spare parts which are recommended by the manufacturer.

Products

- a. General: Unless otherwise indicated, provide all first quality, new materials, free from defects, in first class condition, and suitable for the space provided. New old stock materials shall not be furnished as new material and shall not be accepted. Provide materials approved by UL wherever standards have been established by that agency. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.
- b. Standard Products: Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design which conforms to these specifications.
- c. Equipment Finish: Electrical equipment may be installed with manufacturer's standard finish color, except where specific color, finish, or choice is indicated. If the manufacturer has no standard color, equipment shall be painted ANSI G1, Light Gray.
- d. SCADA Ready Enclosure: The Contractor's SCADA work shall include terminating all telemetry inputs and outputs to terminal blocks within a SCADA enclosure. Termination shall be maintained tight to top, front of the enclosure's left side. Terminal blocks shall be neatly aligned in a single column and arranged in the following sequence from top to bottom: Power (Line), Power (Neutral), Power (Ground), Power Distribution, Digital Inputs, Digital Outputs, Analog Inputs, and Analog Outputs. Terminal blocks shall be color coordinated in the following patterns:

TERMINAL BLOCK SCHEDULE

DESCRIPTION	COLOR	PART#
POWER (LINE)	BLACK	PHOENIX CONTACT UT4, 3045143
POWER (NEUTRAL)	WHITE	PHOENIX CONTACT UT4, 3045130
POWER (GROUND)	GREEN	PHOENIX CONTACT UT4, 3045156
POWER DISTRIBUTION	ALTERNATING RED/BLACK	PHOENIX CONTACT UT 4, 3045127, 3045143
DIGITAL INPUT	YELLOW	PHOENIX CONTACT UTTB4, 3035467
DIGITAL OUTPUT	BLUE	PHOENIX CONTACT UTTB4, 3044791
ANALOG INPUT	GRAY	PHOENIX CONTACT UTTB4, 3044814
ANALOG OUTPUT	BLACK	PHOENIX CONTACT UTTB4, 3074282

Terminal blocks shall maintain one block spacing between groups, with exception for Power (Line), Power (Neutral) and Power (Ground) which shall be grouped together. Further, Digital Input, Digital Output, Analog Input and Analog Output shall be segmented into groupings of eight (8) blocks with one block spacing between groupings.

Wiring shall be terminated to left side of terminal blocks, with negative on the base tier and positive on the top tier for multi-level terminal blocks. Wiring shall be marked with wire tags at both ends and color coordinated as follows:

WIRING SCHEDULE

<u>DESCRIPTION</u>	<u>COLOR</u>
POWER (LINE)	BLACK
POWER (NEUTRAL)	WHITE
POWER (GROUND)	GREEN
POWER DISTRIBUTION	RED
DIGITAL INPUT	YELLOW
DIGITAL OUTPUT	BLUE
ANALOG INPUT	GRAY
ANALOG OUTPUT	BLACK

The SCADA enclosure shall also include grounding strip, 120V AC power for connection to 24 V DC power supply, and UPS with 4 back-up batteries installed and ready for "drop-in" installation of pre-fabricated RTU panel by DWS. Enclosure shall be free standing, NEMA 4X, 316 stainless steel, single door dual access, 72"x24"x24" in dimensions. Front door shall be left handed and back door shall be right handed. Enclosure shall include U-style rack mounting angles for standard 19" equipment which provides for 35U rack units of space. Enclosure shall be Hoffman A722424SSFSDAN4. UPS and four (4) back-up batteries shall occupy the bottom 10U of rack space. UPS shall be APC Smart-UPS RT 1500, SURTA1500RMXL2U. Back-up batteries shall be APC, SURTA48RMXLBP2U.

- e. SCADA Hardware: The Contractor shall furnish the following list of RTU hardware and an equal quantity of spare equipment to the Department of Water Supply.

- 1) (3) Siemens S7-1200, CPU, PN# 6ES7 214-1AE30-0XB0
- 2) (1) Siemens SB1221, Digital Input Signal Board, PN# 6ES7 221-3BD30-0XB0
- 3) (2) Siemens SM1221, Digital Input, PN# 6ES7 221-1BH30-0XB0
- 4) (1) Siemens SB1222, Digital Output Signal Board, PN# 6ES7 222-1BD30-0XB0

- 5) (1) Siemens SM1222, Digital Output, PN# 6ES7 222-1BH30-0XB0
- 6) (12) Siemens SM1231, Analog Input 8AI, PN# 6ES7 231-4HF30-0XB0
- 7) (1) Siemens SM1232, Analog Output, PN# 6ES7 232-4HB30-0XB0
- 8) (1) Siemens PM1207, Power Switch, PN# 6EP1 332-1SH71
- 9) (1) Siemens CSM1277, Unmanaged Communications Switch, PN# 6GK7 277-1AA00-0AA0
- 10) (3) Siemens KTP1000, 10" Panel, PN# 6AV6 647-0AF11-3AX0
- 11) (6) DIN Rails, 35mm x 7.5mm x 2000mm, Phoenix Contact PN# 0801733
- 12) (50) Terminal Block, Black, Phoenix Contact UT4, PN# 3045143
- 13) (150) Terminal Block, White, Phoenix Contact UT4, PN# 3045130
- 14) (100) Terminal Block, Gray, Phoenix Contact UT4, PN# 3044102
- 15) (50) Terminal Block, Red, Phoenix Contact UT4, PN# 3045127
- 16) (100) Terminal Block, Yellow, Phoenix Contact UT4, PN# 3045114
- 17) (50) Terminal Block, Green, Phoenix Contact UT4, PN# 3045156
- 18) (50) Terminal Block, Blue, Phoenix Contact UT4, PN# 3044115
- 19) (34) Fuse Holder, Phoenix Contact, PN# UK63-HESI
- 20) (34) 2PDT, 24VDC Coil, 10A, Rockwell PN# 700-HC22Z24-3-4
- 21) (34) Screw Terminal Base Socket, Rockwell PN# 700-HN104
- 22) (34) Relay Retainer Clips, Rockwell PN# 700-HN114

- f. Desktop Workstation: Provide one (1) desktop workstation with the following minimum configuration:

Catalog Number/Description	Product Code	Qty	SKU	Id
Dell Precision T3500:				
Dell Precision T3500, CMT, Standard Power Supply, C2 Motherboard	T3500W	1	[224-8671]	1
Operating System:				
Genuine Windows® 7 Ultimate, w XP Mode, No Media, 64-bit, English	7UN61XE	1	[330-6228] [421-2262] [421-5335] [421-5652]	11
Processor:				
Quad Core Intel™ Xeon W3550 3.0GHz, 8M L3, 4.8GT/s, Turbo	W3550	1	[317-2539]	2
Memory:				
4GB, 1333MHz, DDR3 SDRAM, ECC (4 DIMMS)	4G3E334	1	[317-0117]	3
Graphics:				
512MB NVIDIA® Quadro® NVS420, Quad Monitor, 4DP	NVS420	1	[320-8136]	6
Keyboard:				
Dell Multimedia Pro Keyboard, with Palmrest	USBMPRO	1	[330-1990]	4

Hard Drive Configuration:				
C1 All SATA drives, No RAID For 2 Hard Drive	SATA1A	1	[341-8562]	9
Boot Hard Drive:				
1TB SATA 3.0Gb/s, 7200 RPM Hard Drive with 32 MB DataBurst Cache™	1TBST	1	[341-8997]	8
2nd Hard Drive:				
1 TB SATA 3.0Gb/s, 7200 RPM Hard Drive with 32 MB DataBurst Cache™	1TBSTA	1	[341-9001]	23
Hard Drive Controller:				
Integrated Intel chipset SATA 3.0Gb/s controller	NSASCTL	1	[341-9289]	24
CD-ROM, DVD and Read-Write Devices:				
16X DVD+/-RW w/Cyberlink PowerDVD™/Roxio Creator™, No Media	DVRW16N	1	[313-7457] [421-4370] [421-4539]	16
Floppy Drive and Media Card Reader Options:				
Internal 19:1 USB Media Card Reader	MCR19	1	[341-8560]	10
Productivity Software:				
Microsoft® Office Professional 2010 with Adobe Acrobat X Standard, English	10HPADE	1	[410-0560] [421-3950] [421-3957]	22
Security Software:				
Trend Micro Worry-Free Business Security Services, 30-days	TMWF30	1	[410-0329]	37
Monitor:				
Dell UltraSharp™ U2410 24in HAS Wide Monitor, VGA/DVI/DP/HDMI	U2410	2	[320-8276]	5
Mouse:				
Dell® USB 6-Button Laser Mouse	USBLDT	1	[330-1170]	12
Speakers:				
Speakers on Monitor	(TO BE DETERMINED)			
System Recovery:				
Resource DVD – contains Diagnostics and Drivers	RDVD	1	[330-4025]	47

Quick Reference Guide:

Quick Reference Guide, English	REFE	1	[330-4020]	39
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Chassis Configuration:

Mini-Tower Chassis Configuration	MT	1	[311-7463]	15
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Resource DVD:

No Resource DVD	NORCD	1	[330-4024]	27
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Energy Efficiency Option:

No Energy Star	NOESTAR	1	[330-3201]	25
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Hardware Support Services:

3 Year Basic Limited Warranty and 3 Year NBD Onsite Service	U3OS	1	[992-8982] [993-3080] [993-9018] [993-9027]	29
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Documentation:

Documentation, English, with 125V Power Cord	DOCENG	1	[330-3156] [330-3157]	21
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Shipping Packaging Options:

Shipping Material for System	SHIP	1	[330-3209]	40
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- g. Laptop Computer: Provide one (1) laptop computer with the following minimum configuration:

Catalog Number/Description	Product Code	Qty	SKU	Id
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Dell Precision M6500:

Dell Precision M6500, Mobile Workstation	M6500	1	[224-7095]	1
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Operating System:

Genuine Windows® 7 Professional, No Media, 64-bit, English	W7PN61E	1	[330-6322] [421-8099]	11
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Processor:

Intel® Core™ i7-840QM Quad Core 1.86GHz 8 MB	840QM	1	[317-4995] [330-9154]	2
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Memory:

8.0GB, DDR3-1333MHz SDRAM, 2 DIMMS	8G2D3	1	[317-2588]	3
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Graphics:

1.0GB NVIDIA® Quadro® FX 2800M Graphics	FX2800M	1	[320-1126]	6
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Internal Keyboard:				
Internal English Backlit Keyboard	ENGBL	1	[330-1652] [330-5876]	4
Fingerprint Reader Options:				
No Fingerprint Reader	NOFR	1	[313-8680]	9
Primary Storage:				
256GB Mobility Solid State Drive	256SSDM	1	[341-8492]	8
Secondary Hard Drive:				
256GB Mobility Solid State Drive	256SSD2	1	[341-8493]	23
Media Bay Devices:				
8X DVD+/-RW Slot Load w/Roxio and Cyberlink PowerDVD™, no media	8XDVRSN	1	[313-8694] [421-4370] [421-4539]	16
LCD Options:				
17" Wide Screen WXGA+ LCD Panel w/microphone	WXGMIC	1	[313-8684] [313-8685] [320-1130]	10
Productivity Software:				
Microsoft® Office Professional 2010, English	HPRO10E	1	[421-3950] [421-3957]	22
Contactless Smartcard:				
Contactless Smart Card Reader	SMART	1	[313-8936]	17
AC Adapter:				
210W/240W switchable Slim 3P A/C Adapter	210ACS	1	[330-1838] [330-4127]	15
Primary Battery:				
9 Cell Battery	9C	1	[312-0222]	27
Hardware Support Services:				
3 Year Basic Limited Warranty and 3 Year NBD Onsite Service	U3OS	1	[905-9378] [905-9407] [906-7342] [907-7080]	29
System Documentation:				
No System Documentation	NODOCS	1	[313-3673]	25
Additional Power Options:				
Additional 9 Cell Battery	9C2	1	[312-0211]	147
Wireless LAN (802.11):				
Dell Wireless™ 1397 802.11b/g	DW1397	1	[430-3085]	19

Mini Card

RAID Configuration:

All Hard Drives, Non-RAID,
1 or 2 drive total configuration

NORAID 1 [341-7876] 26

Modem:

Add Modem

(TO BE DETERMINED)

Serial Port:

1 Required

(TO BE DETERMINED)

h. Radio and Communications:

1) Communications: The Contractor shall take complete responsibility for the system communications. The initial investigation has determined that the radio frequency in the VHF range to transmit from the remote site to the central computer would be the most efficient method of communication. The Contractor shall take the responsibility of checking out and verifying this mode of communication.

(a) Communication Path Survey: Based on the coordinates and elevations of the various remote sites, the Contractor shall perform and furnish a computerized paper path survey to determine the gain margin for each proposed transmission path. The survey should stimulate use of actual frequency and proposed equipment.

(1) The survey shall include but not be limited to: a printout graph for each communications path which shall show the path profile, site elevations, site name, frequency, ERP, antenna type, distance between sites, and predicted losses versus desired losses. The Contractor shall design the radio and communications system for at least 99.9% reliability.

(2) Radio Path Study: A representative of DWS shall be present for any radio path study field work.

(b) Licensing: The Contractor shall prepare all paperwork required for FCC coordination and FCC licensing in accordance with the FCC Rules and Regulations governing the licensing of the proposed channels. One VHF frequency shall be required to accommodate the RTU reception and transmission to the central computer. The Contractor shall submit all FCC coordination requirements to the FCC for frequency approval. The Contractor shall be responsible for the payment of FCC license fees.

(c) FCC Type Acceptance: All equipment related to the radio communication shall be FCC type accepted, indication authorization by the FCC to allow the equipment to be used by the licensee.

2) Radio Equipment: The Contractor shall furnish and install latest edition CalAmp DataRadio Viper SC Ethernet radios as required by the Makuu Offsite Water System project.

- 3) Antenna and Accessories: All antenna hardware shall comply with FCC rules and governing the design characteristics and mounting requirements for licensed frequencies used in the SCADA system. In general, the remote stations shall employ directional gain antennas. The central computer site will use an omni-directional gain antenna. Feedlines between antenna and SCADA ready enclosure shall be solid, shielded coax (minimum 7/8" in diameter), low density, foam heliax. Each coax run shall be continuous and shall terminate with factory-installed connectors which are specifically designed for use with the above-described cable. The coax shall be run through conduit between the SCADA ready enclosure and the antenna. The conduit shall be a minimum of 3" nominal diameter, with no more than two (2) 90 degree bends with a minimum bend radius on 36 inches. The SCADA ready enclosure shall be equipped with a combination lightning arrestor and bulkhead fitting to allow coax termination through the enclosure. The feedline signal loss shall not exceed 1.55 dB (VHF) for each one hundred feed of run. The total connector loss at each site shall not exceed 1.0 dB.

- (a) Ground hardware kits specifically designed for use with the cable selected shall be furnished and installed by the Contractor.

(1) Antenna Specifications:

Frequency Range: Match licensed channels
Nominal Impedance: 50 Ohms
Forward Gain: 6 - 10 dB
Polarization: Vertical
Power Rating (min): 200 Watts
Materials: Anodized Aluminum/Stainless Steel
Construction: Welded
Mounting Clamps: 2" O.D. Galvanized Pipe
Wind Rating: 125 mph, 90 mph w/1/2" ice
Termination: Captive Type N
Lightning Protection: Direct ground connection

- i. Radio Hardware: The Contractor shall furnish and install the following list of telecommunication hardware and provide an equal quantity of spare equipment to the Department of Water Supply.

- 1) (1) VHF Licensed Ethernet Router, Dual Port, CalAmp DataRadio Viper SC
- 2) (1) VHF Licensed Ethernet Router, Single Port, CalAmp DataRadio Viper SC
- 3) (1) VHF Omni Antenna, 167-174 MHz, 6.0 dB, Telewave ANT150F6-7
- 4) (2) VHF Yagi Antenna, 167-174 MHz, 9.5 dB, 6 element, Sinclair SY206-SF5SNM
- 5) (3) Lightning Arrestor, PolyPhaser VHF50HN

N. INSTALLATION

1. General

- a. Electrical installation shall conform to the NEC and to the requirements specified herein. All equipment and materials shall be new unless indicated specified

otherwise. The Contractor shall provide all equipment and materials specified, required, or implied herein, and incidentals in compliance with the NEC and Standards referenced herein and any local rules and regulations.

- b. The Contractor shall advise the Department by written notification of any required modifications to the design with regard to installation or specified equipment to suit the actual equipment to be furnished, or to suit field conditions, or to comply with applicable local codes and regulations.
- c. Where applicable, materials and equipment shall be installed and connected in accordance with the manufacturer's instructions and drawings. Contractor shall have available at the job site for the Department's inspection and use a complete file of manufacturer's instructions and drawings for the materials and equipment being installed.

O. DUCTLINE CONSTRUCTION

- 1. Excavation and Trenching: All excavating, trenching, and backfilling shall be done in conformity with the applicable sections of the specifications. Additionally, trenchings for all underground conduits shall be excavated to required depths indicated on the drawings. Depth of trenches shall be measured from finished grade and shall not exceed indicated depth by one foot unless approved by the University. Bottom of trenches shall be tamped hard. Rocks, where encountered, shall be excavated to depth of 6 inches below bottom of conduit jacket and before conduit is laid, space between bottom of duct jacket and rock surfaces shall be filled with gravel to the satisfaction of the University. Any existing underground piping or conduit that is encountered shall be properly shored and protected from damage. Any damage resulting from the Contractor's operations shall be repaired by him at his own expense.
- 2. Backfilling: After conduits have been inspected and approved by the University and prior to backfilling, forms shall be removed and excavation shall be cleaned of trash and debris. Material for backfilling shall consist of excavated, or borrow of sand or gravel, and shall be free of trash, lumber or other debris. Backfill shall be placed in horizontal layers, not exceeding 8 inches in thickness and properly moistened. Each layer shall be compacted to density equal to that adjacent undisturbed material that will prevent excessive settlement or shrinkage.
- 3. Ductlines: Ducts and/or conduits shall be laid in trenches on plastic saddles or on concrete spacers. Spacing between ducts shall be 3 inches minimum. After cables have been installed, seal all ducts with mastic compound to prevent entry of water. All spare ducts shall be plugged.

P. CONDUITS

- 1. Conceal all conduits in wall or ceiling spaces unless specifically otherwise indicated on the drawings.
- 2. Conduits shall be installed as follows:
 - a. Exterior and exposed where subject to physical damage: Stainless steel rigid metal conduit.

- b. Exterior exposed where not subject to physical damage: Rigid non-metallic conduit, SCH 80.
 - c. Interior, concealed from view but exposed in ceiling spaces: EMT.
 - d. Interior, concealed in wall vertical spaces: EMT.
 - e. Interior, concealed in wall spaces, horizontal runs: EMT or FMC.
 - f. Interior, exposed: EMT, painted.
 - g. Below exterior grade: Rigid non-metallic conduit, SCH 40, concrete encased. (Except as indicated.)
 - h. In ground floor concrete slab or passing through for branch circuits and feeders: Stainless steel rigid metal conduit.
 - i. Below ground floor concrete slab for branch circuits: Stainless steel rigid metal conduit, or SCH 80 rigid non-metallic conduit in approved cushion material.
 - j. Below ground floor concrete slab for feeders: Stainless steel rigid metal conduit or SCH 80 rigid non-metallic conduit in approved cushion material.
3. Conduit size shall be minimum 3/4 inch except that 1/2 inch may be used with 3-No.12 plus 1-No.12 ground.
 4. Provide conduit support directly from building structure in spaces above removable ceilings. Contractor shall not attach conduits to suspended ceiling grid framing or to the supporting wires.
 5. Where required and allowed and approved, exposed conduit shall be installed parallel with or at right angles to the building walls and ceiling and shall be supported by straps, wall brackets, hangers or ceiling trapeze.
 6. Fastening of conduit supports and clamps shall be by wood screws or screw type nails to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; by machine screws, welded threaded studs, or spring-tension clamps on steel work. All mounting hardware shall be Type 316 stainless steel.
 7. Provide UV rated nylon pull cords in all empty conduits, regardless of use or length.
 8. Outlet, Pull and Junction Boxes. Boxes shall be provided in the wiring or conduit systems wherever required for pulling of wires, making connections, and mounting of devices or lighting fixtures.
 9. Conductors (Other Than Control Work)
 - a. Color code in accordance with the NEC.

- b. Form neatly in enclosures for minimum of cross-overs and for adequate ventilation and air spaces around conductors.
 - c. Splices shall be in accessible locations. Splices in wires No. 10 AWG and smaller shall be made with an insulated pressure type connector. Splices for wires No. 8 and larger shall be made with solderless connectors and shall be covered with an insulation material equivalent to the conductor insulation. Splices shall not be pulled into or through conduits or wireways or other raceways.
 - d. Provide types of insulation as follows:
 - 1) Type THWN-2 for service, feeder, and branch circuits.
 - 2) Type THHN where required for 90 degree C. rated conductors in dry applications.
 - 3) Type MTW for control circuits.
 - e. Unless otherwise indicated on the drawings, install no conductors smaller than No. 12 AWG.
 - f. Conductors in conduit shall be stranded only.
 - g. Provide stranded conductors only for control circuits.
 - h. Install conductors continuous from terminal point to terminal point, from outlet to outlet or junction box. Keep splices to a minimum, but where necessary, make them in a readily accessible outlet box or junction box.
10. Equipment Supports. All electrical equipment shall be properly supported and securely mounted by approved methods for static loads and for earthquake loads of seismic Design Category F.
11. Grounding and Bonding. All exposed noncurrent carrying metallic parts of electrical equipment, conduits, control equipment and devices, grounding conductors in non-metallic conduits, and neutral conductor of wiring systems shall be grounded. Unless otherwise indicated, a grounding conductor with Type THWN insulation and sized according to the NEC shall be provided in all motor circuits and branch circuit conduit systems.
12. Equipment Connections. All wiring for the connection of control equipment as indicated on the drawings shall be provided under this Section of the specifications. Flexible connections of short length shall be provided for all equipment subject to vibration, noise transmission, or movement. Liquid-tight flexible conduit shall be used. A separate grounding conductor shall be provided across all flexible connections.
13. Lighting Fixtures and Lamps. No wiring other than the branch circuit as defined in the NEC supplying a continuous line of fixtures shall be installed in the fixture wiring channels. All fixtures shall be securely supported with approved seismic hangers for Seismic Zone 4. They shall be set in perfect alignment and elevation. All splices shall

be carefully placed in outlet boxes or wiring gutters with no crowding. Fixtures shall be supported from structural ceiling or structural supports.

Connections to recessed fixtures shall be with 1/2 inch minimum flexible metal conduit 6 feet in length from fixture to outlet box. Provide grounding conductor in flexible conduit.

Surface mounted fixtures shall mount directly to the outlet box. Boxes shall be securely supported for Seismic Zone 4. Flexible conduit between fixture and outlet box is not allowed.

All fixtures, lamps, and tube guards must be thoroughly cleaned as a requirement for acceptance by the Department.

14. Painting and Finishing. All exposed surfaces of electrical equipment, conduits, supports, and other items shall be field painted. Refer to the applicable Painting Section for paint requirements. The basic intent is to have all electrical items of work painted the same color as the wall or other mounting support to which it is attached. All threaded portions of conduits shall be cleaned with solvent and painted with corrosion resistant paint.

Patch, repair, and restore to approval of the Department all structural and architectural elements cut or drilled for installation of electrical work. Paint with primer and finish coat of paint.

15. Control Work

- a. Unless otherwise indicated, control wiring shall be No. 14, Type MTW, copper, stranded, 19 strands, 600 volts.
- b. All control wiring shall be installed without splices and shall be terminated "point-to-point". No splices will be allowed.
- c. All control wiring shall be neatly loomed, laced, and bundled by the indicated groupings and properly identified.
- d. Control wire bundle routings in equipment spaces shall be subject to approval by the Department.
- e. All control items and devices shall be correctly and properly labeled as indicated. Labeling shall follow nameplate specifications.
- f. The Contractor shall follow the color coding indicated on the drawings for all control work wiring. No exceptions will be allowed.
- g. The terminal block numbers and wire number indicated on the drawings shall be used on all shop drawings and for the actual installation. Any approved deviation shall be properly noted on the as-built drawings.

16. Tank Level Transmitter: Install per manufacturer's requirements and installation drawings. Comply with all start-up, testing, and calibration requirements of manufacturer and the Department.

17. Flow Transmitter: Install per manufacturer's requirements and installation drawings. Comply with all start-up, testing, and calibration requirements of manufacturer and the Department.
18. Supervisory Control and Data Acquisition (SCADA) System
 - a. SCADA Cabinets: Install all components, hardware, and accessories as indicated and/or specified.
 - b. Configuration, set-up, and programming of the new SCADA system and the existing SCADA system at the Department's Hilo Baseyard to incorporate the new SCADA site into the existing system will be by DWS. Coordinate and schedule this work.
 - c. Provide start-up and testing prior to work by DWS. Coordinate and schedule with DWS.

Q. EQUIPMENT CALIBRATIONS: The Contractor shall calibrate all equipment furnished by him in the field to the satisfaction and acceptance of the Department. Any required testing and calibrating equipment shall be provided by the Contractor. Settings shall be furnished by the Department to the Contractor. All calibrations shall be done to the satisfaction of the Department.

R. INSPECTION AND TESTS

1. Poor workmanship or unacceptable workmanship as determined by the Department shall be repaired and/or corrected to acceptable standards at no additional costs to the Department.
2. After the installation is completed and at such time as the Department may direct, the Contractor shall conduct an operating test for approval and acceptance. The complete electrical system shall be demonstrated to operate in accordance with the requirements of these specifications. All tests shall be performed in the presence of the Department.
3. Wiring systems shall be tested for insulation resistance after all wiring is completed and ready for connections to equipment. Tests shall be made with an approved instrument capable of measuring resistance at 500 volts potential. The insulation resistance between conductors and also between each conductor and ground shall be measured. These tests shall insure that all wiring and equipment are free from short circuits and from grounds other than the required grounds. These tests shall not cause any damage to any existing or new equipment. All readings shall be recorded on the as-built drawings and shall be subject to acceptance by the Department.
4. Ground system shall be tested with an approved ground testing system. Readings shall be recorded on the as-built drawings and shall be subject to acceptance by the Department.
5. Test each device outlet for the correct and proper connections, voltages, neutrals, and grounds.

6. Any deficiencies found shall be corrected and work affected by such deficiencies shall be completely retested at Contractor's expense and in the presence of the Department.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300- CONSTRUCTION

SECTION 304.04 – PUMP STATION MECHANICAL EQUIPMENT

D. CHLORINATORS

The following shall modify and supplement DIVISION 300- PUMP STATION MECHANICAL EQUIPMENT in the Water System Standards, 2002

Paragraph D. Mechanical Work shall be added to and supplemented as follows:

CHLORINATION SYSTEM AND APPURTENANCES

SCOPE:

Section Includes: All labor, materials, appliances, tools, equipment, facilities, transportation, and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this section, complete, as specified herein. The work includes, but is not limited to the following:

- a) Examine all other sections for work related to those specifications and required to be included as work under this section.
- b) Furnishing and installing a gas-fed chlorination system as indicated. The installation shall include equipment, pipes, fittings, electrical connections, and all appurtenances to affect a complete operational and functioning chlorination system.

CHLORINATION SYSTEM DESCRIPTION:

A. CHLORINE AUTOMATIC SWITCHOVER MODULE:

The automatic switchover gas feeder shall be Capital Control ADVANCE Series 200 Gas Feeders, or an approved equal, and shall be of the vacuum operated, solution feed type and shall automatically switch the gas supply from an empty source to a full source. The system shall have automatic reset and shall not permit return to the initial source until the second is empty. The gas feeder shall have a maximum capacity of 25 pounds per day of chlorine gas feed and shall be equipped with a remote mounted gas flow meter of 0 to 25 pounds of gas feed per day.

The gas feeders shall mount directly on the gas cylinder valve by means of a positive yoke type, gasket connection and shall be provided with a gas valve direction indicator.

B. CHLORINE GAS FEEDER DESIGN:

The gas feeder design shall provide for conveying the gas under vacuum from the vacuum regulator to the ejector-check valve assembly to insure complete system safety. The gas feeder design shall permit the entire system to be vacuum checked in the field without using special tools or manometers. The gas feeder shall be constructed of

materials specially selected for wet or dry gas services. All springs used in the gas feeder shall be of a tantalum alloy for chlorine gas service. The rate valve and seat shall be constructed of fine silver for chlorine. A double thickness diaphragm shall be provided for vacuum regulation.

The rate of gas feed shall be set manually and shall remain constant until manually changed. A differential pressure regulator shall not be required for gas flow control.

C. CHLORINE GAS FEEDER ASSEMBLY:

The gas feeder shall be comprised of the following: vacuum regulators, gas flow meter with manual rate valve, pressure relief valve, ejector-diffuser assemblies, gas supply indicator, and automatic switchover module:

1. Vacuum Regulators:

Each vacuum regulator shall mount directly on the gas valve by means of a positive yoke type, gasket connection. Vacuum shall be controlled by a spring-opposed diaphragm regulator which shall close tight upon loss of vacuum. Each regulator shall be equipped with a gravity-actuated loss-of-gas indicator, and gas flow-meter.

2. Yoke Assembly:

The corrosion-resistant yoke assembly shall be fitted with a metallic inlet valve and filter capsule which is field replaceable using only a screwdriver. The coating on the corrosion-resistant yoke assembly shall be fusion-bonded epoxy.

3. Gas Flow Meter and Rate Valve:

The gas flow-meter with solid silver rate valves and solid silver seats for chlorine shall be mounted on a chemical resistant panel for mounting. The gas flow-meters shall indicate the flow of gas to a minimum of 1/20 maximum feed.

4. Relief Valve:

Pressure will be prevented from building up in the system by means of a spring-loaded, diaphragm-actuated pressure relief valve located at the vacuum regulator. The gas shall vent at the vacuum regulator.

5. Ejector-Diffuser Diaphragm Type:

The ejector-diffuser assemblies shall receive all gas and ejector water and discharge the resulting solution to the point of application. The ejector shall be equipped with a check valve which will prevent water from backing up into the vacuum regulators. A loss of water supply shall automatically shut-off the gas flow. The diffuser shall be a universal type providing a open-end outlet and a one-inch NPT threaded connection for ease of field installation.

6. Supply Indicator:

Each gas feeder shall be equipped with gravity actuated device, directly connected to the main control diaphragm, to indicate when gas supply is exhausted.

7. Valve Direction Indicator:

A gas valve direction indicator shall be provided with each gas feeder.

8. Automatic Switchover Module:

The automatic switchover module shall be vacuum operated, switching from an empty gas source to a full gas source. There shall be no manual reset required when switchover has been made and the empty container replaced with a full container. The module shall be wall mounted and operated on a spring loaded toggle. The switchover module shall be factory set and shall not require field adjustment.

D. CHLORINE DIFFUSER ASSEMBLY:

The diffuser shall fit a one-inch (1") NPT tap and accommodate a chlorine flow rate of 0 to 25 pounds per day. The diffuser shall protrude into the ten-inch(10") main discharge line as recommended by the manufacturer. The assembly shall also include a corporation cock, with a one-inch(1") hose connection as indicated on the drawings. Assembly shall be manufactured by Chlorinator's Inc. Capital Controls Company, Inc., Penwalt, or approved equal. Installation shall be per manufacturer's recommendation.

E. CHLORINE CYLINDERS:

Furnish two(2) full chlorine cylinders with a net weight of 150 pounds for each cylinder. The contractor shall be licensed to furnish chlorine cylinders or if not, make the necessary arrangements with a licensed provider for their delivery.

SUBMITTALS

Submit manufacturer's information and descriptive literature.

CHLORINATION SYSTEM ACCESSORIES:

A. CHLORINE CYLINDER SCALES:

Chlorine cylinder scales shall be of the hydraulic type. Scale platform shall be constructed of non-corrosive PVC plastic and sized to accept one(1) 150 lb. chlorine cylinder each, a total of two(2) chlorine shall be weighed.

Cell shall be of the temperature stable, rolling diaphragm type. Flexible PVC coated copper tubing shall lead from the cell to allow easy wall mounting of the dial and shall be 6 feet in length. Cylinder chaining bracket shall be wall mounted and use a double coil chain and a spring loaded snap hook to secure cylinder.

Dial diameter shall be at least 4-1/2" and read to 150 lbs. net with provision for tare adjustment. Dial accuracy shall be better than 1% full scale.

Scale platform shall carry a minimum Five(5) Year Warranty and all other components a Two(2) Year Warranty. Scale shall be **SCALETRON Model 2310** with 3-1/2 Digital Controller as manufactured by Scaleton Industries Ltd., Plumsteadville, Lafayette, PA 18949, or approved equal.

B. RESIDUAL CHLORINE MONITOR:

1. General:

- a. This section includes the Chlorine Analyzer for monitoring free residual chlorine.
- b. The method of measuring free or total chlorine will be with colorimetric chemistry.
 - 1) The chemistry will be USEPA accepted N, N-diethyl-p-phenylenediamine (DPD) method.
- c. Other methods of chlorine measurement, such as amperometric, potentiometric and iodometric with electrodes are not acceptable.
- d. Performance Requirements:
 - 1) Measurement range: 0 to 5 mg/L free or total residual chlorine.
 - 2) Accuracy: ± 5 percent of reading or ± 0.035 mg/L, whichever is greater.
 - 3) Precision: ± 5 percent of reading or ± 0.005 mg/L, whichever is greater.
 - 4) Minimum detection limit: 0.035 mg/L.
 - 5) Resolution: 0.01 mg/L
 - 6) Repeatability: 0.05 mg/L.
 - 7) Cycle time: 2.5 minutes.
- e. Certifications:
 - 1) CE approved
 - 2) ETL listed to UL 1262
 - 3) ETL certified to CSA 22.2 No. 142
- f. Operational Criteria:
 - 1) Sample flow rate: 200 to 500 mL/minute
 - 2) Sample pressure: 1 to 5 psig
 - a) The supplied conditioning kit allows for up to 120 psig.
 - 3) Sample temperature: 5 to 40 degrees C
 - 4) Operating temperature: 0 to 40 degrees C
 - 5) Operating humidity: 90 percent at 40 degrees C maximum
- g. Warranty:
 - 1) The product includes a one-year warranty from the date of shipment.
- h. Scheduled Maintenance
 - 1) Reagent replenishment: monthly, approximately 15 minutes per month
 - 2) Pump tubing replacement: operating temperature dependent
 - a) Below 80 degrees F: six-month intervals
 - b) Above 80 degrees F: three-month intervals
 - 3) Analyzer tubing replacement: annually

2. Products:

- a. Model CL17 Chlorine Analyzer, Free Residual, PN 5440001, by Hach Company, Loveland, CO.
- b. The CL17 Chlorine Analyzer consists of a sample valve, flow cell and buffer and indicator solutions.
- c. The CL17 is housed in a NEMA 12 enclosure, IP62-rated with the gasketed door latched.
- d. Equipment:
 - 1) The CL17 operates using 115 or 230 volt selectable AC power.
 - 2) Between analysis points, the CL17 performs a self-test auto-blanking to eliminate potential drift.
 - 3) The CL17 operates unattended 30 days between chemical reagent changes and sample cell cleaning.
 - 4) The CL 17 has two feed control operation modes to operate chemical feed pumps.
 - a) On/off control where the concentration alarm outputs turn the pump on or off when chlorine levels fall below or exceeds acceptable levels.
 - b) Proportional control where the 4-20 milli-amp output current is scaled to pace the feed pump proportional to the output.
 - 5) Output:
 - a) Standard optically isolated analog output, selectable as 0 to 20 milli-amp or 4 to 20 milli-amp, field programmable over any portion of the analyzer range.
 - b) Standard two internal alarms, each are SPDT relays with contacts rated for 5 amp resistive load at 230 volt AC power. Alarms include:
 - (1) Concentration set point
 - (2) Analyzer system warning
 - (3) Analyzer system shut down
- e. Components
 - 1) Standard equipment:
 - a) Analyzer
 - b) One-month supply reagents
 - c) Spare pump tubing
 - d) Wall mount kit
 - e) Sample conditioning kit
 - f) Manual
 - 2) Dimensions:
 - a) 13.5 inches wide (343 mm)
 - b) 17.9 inches high (455 mm)
 - c) 7 inches deep (178 mm)

- 3) Weight: 25 pounds (11.3 kg)
- 4) The CL17 includes a standard sample conditioning element consisting of a pressure regulator, strainer and shut-off valve.
- 5) Connectors:
 - a) Sample inlet quick-connect 0.25-inch O.D. polyethylene tubing
 - b) Sample drain 0.50-inch I.D. flexible tubing
 - c) Overflow drain 0.50-inch I.D. flexible tubing
 - d) Air purge quick-connect 0.25-inch O.D. polyethylene tubing (optional).

f. Accessories:

- 1) Power cord (PN 5448800)
- 2) Maintenance kit with pre-assembled tubing (PN 5444301)
- 3) 1 year reagent supply (PN 2556900 qty 11)
- 4) Pocket Colorimeter II for free and total chlorine, low and high range combination unit (PN 5870000)

3. Execution:

a. Preparation:

- 1) Wall mount
- 2) Clearances
 - a) Horizontal: 15.2 inches (386 mm) minimum, 27 inches (686 mm) ideal
 - b) Vertical: 19 inches (483 mm)
 - c) Depth: 20 inches (508 mm)
- 3) Power connection is made by three-wire barrier terminal block through 0.5-inch conduit hole in case using 12 to 18 AWG.

b. Installation:

- 1) Contractor will install the analyzer in strict accordance with the manufacturer's instructions and recommendation.
- 2) Manufacturer's representative will include a half-day of start-up service by a factory-trained technician, if requested.
 - a) Contractor will schedule a date and time for start-up.
 - b) Contractor will require the following people to be present during the start-up procedure.
 - (1) General Contractor
 - (2) Electrical Contractor
 - (3) Hach Company factory trained representative
 - (4) Owner's personnel
 - (5) Engineer

C. GAS DETECTOR ALARM UNIT:

1. The chlorine gas detector unit shall consist of a wall mounted receiver and remotes sensor. The gas detector shall have a range of 0-10 parts per million (ppm).
2. The receiver shall provide a LED bar graph display. The LED bar graph display shall be color-coded to indicate sensor status, gas concentration and alarm set point. Additionally, LEDs shall provide for indication of set point alarm, sensor malfunction, power ON and sensor ready. The receiver shall be housed in a NEMA 4X enclosure.
3. The sensor shall be an electrochemical type requiring no chemical addition with a response time of 30 seconds maximum for 80% of full range at 20 degrees C. The sensor shall be wall mounted and housed a NEMA 4X enclosure.
4. The alarm and malfunction contacts shall be SPDT rated at 10 amps at 240 VAC or 28 VDC maximum resistive or inductive loads. The alarm and malfunction contact shall be field configurable for manual reset (latching) or automatic reset (non-latching).
5. Communications between the sensor and receiver shall be 3-wire, shielded, 22 gauge cable. The maximum distance between the receiver and sensor shall be 1000 feet/305 meters.
6. The gas detector shall operate from a 120 VAC, 50/60 Hz, 1 phase power supply. The receiver and sensor electronics shall have provisions for protection against radio frequency/electromagnetic interference.
7. Weatherproof visual and audible alarms shall be provided.
8. A sensor test kit shall be provided; BM-4709.
9. The gas detector unit shall be a Severn Trent Services, ADVANCE 610B or an approved equal.
10. This gas detector shall be provided with a power back-up unit for continuous monitoring as provided by the supplier of the gas detector unit.

D. PAYMENT:

Payment for Chlorination System will be made at the Lump Sum Price Bid. Payment shall represent full compensation for furnishing and placing all materials and for all labor, tools, equipment and incidentals required to complete the work as shown on the drawing and as specified, in place complete ready for use.

STANDARDS AND CODES:

Installation shall conform to all applicable provisions of the latest editions of the following, as well as to specific standards listed elsewhere in these Specifications:

- a) Uniform Plumbing, 1991 Code with County of Hawaii Amendments.
- b) State of Hawaii, Title 11 Administrative Rules, Department of Health.
- c) American Society for Testing and Materials (ASTM):

A74-75 Cast Iron Soil Pipe and Fittings

A120-78 Black and Hot-Dipped Zinc Coated (Galvanized) Welded
and Seamless Steel Pipe for Ordinary Uses

B88-78 Seamless Copper Water Tube

- d) American National Standards Institute (ANSI):

B16.18-78 Cast Bronze Solder Joint Pressure
Fittings

B16.22-73 Wrought Copper and Bronze Solder Joint Pressure
Fittings

REQUIRED SUBMITTALS

- A. Shop drawings and brochures and catalog cuts of fixtures and equipment. Show all layout and locating dimensions, clearances for fittings, and fixture centerline dimensions. Show construction details of pipe hangers and anchors.
- B. Certificate of compliance by the test laboratory analyzing the water samples following the pipeline disinfection and flushing.

PIPING MATERIALS

Potable Water:

- 1. Water Lines Above Grade: Copper Type L, hard temper, with wrought copper or cast bronze fittings made up with 95-5 solder.
- 2. Water Lines Below Grade: Copper Type K, soft temper, with silver-solder brazed joints.
- 3. Service Valves: 2" and smaller, Nibco "U" valve No. T-22. Larger than 2", Nibco 113 bronze gate valve.

VALVES

- A. General: Model and number listed in these specifications are the basis for type and quality. Pressure ratings indicated are "working steam pressure" (WSP).

- B. Gate Valves: 2-1/2" and smaller: bronze body, 125 psig, non-rising stem Nibco 113.

VALVE BOX

Dimensions and locations are shown on the drawings. Box frame shall be concrete or approved hard fiberglass material. Plate cover shall be cast iron and similar to Type III Standard Detail 43 for Board of Water Supply, City and County of Honolulu. Plate cover shall be flush to the box frame.

UNIONS

- A. Copper: bronze body, 200 psig. For pipes 2" and smaller use ground joint, for pipes 2-1/2" and larger use flanged face.
- B. Dielectric Unions shall separate all ferrous and nonferrous metals in all piping systems. Unions shall match those above, except that of metal-to-metal contact shall be avoided. Where flanges are used, the bolts shall be electrically insulated from the body of the flange.

ROUGH-IN PIPING SPECIALTIES

Floor Drains (FD): Smith Fig. 2010-A Duco, epoxy coated, cast iron body, adjustable strainer, secured square hole grate, nickel-bronze strainer with trap primer connection.

ESCUTCHEONS

Brass body, chrome-plated finish. Of sizes sufficient to cover pipe openings through the floor, wall, or ceiling. Escutcheons shall be secured in place by either spring clips or setscrews.

PIPE SLEEVES

Schedule 40 galvanized steel pipe sleeves in concrete, 18 gage galvanized sheet metal sleeves in other construction. Sleeves shall be sized to provide a minimum of 1/4" clearance around bare or insulated piping or as otherwise required by Code.

PIPE HANGERS AND SUPPORTS

- A. General: Elcen, Fee and Mason, Globe, Grinnell, Superstrut, and Unistrut are approved. Fee and Mason figure numbers indicate type and quality. Provide concrete insert at all pre-stressed planks for pipe and equipment installation and coordinate with pre-stressed plank contractor.
- B. For Uninsulated Copper Tubing: Fee and Mason No. 307, 364, or 365.
- C. For Insulated Copper Tubing: Fee and Mason No. 800.

D. Riser Clamps: Black steel, Fee and Mason No. 241. Copper coated, Fee and Mason No. 368.

E. Hanger Spacing:

<u>Pipe</u>	<u>Maximum Spacing</u>
Copper tubing, 1-1/2" and smaller	6 feet
Copper tubing, 2" and larger	10 feet
Cast iron soil pipe	At each joint and at intervals not to exceed 8 feet.

F. Hanger Rods: Continuous-threaded rod conforming to ASTM A-107. Eye rods shall be Fee and Mason Figure No. 228 and 228 WL. Sizes shall be as follows:

<u>Pipe Size</u>	<u>Rod Size</u>
1/2" to 2"	3/8"
2-1/2" to 3"	1/2"
4" to 6"	5/8"

EMERGENCY EYE-WASH/DRENCH SHOWER

A. Floor-mounted, emergency eye-wash basin/drench shower HAWS stainless steel Model 8330 WC with stainless steel shower head with barrier-free-combination eye/face wash stainless steel receptor/basin or approved equal. Stainless steel pull rod activates shower and a push flag activates eye/face wash basin. One pieces solid 1-1/4-inch Type 304 Stainless Steel construction to be protected by an inline strainer. Supply and Waste: 1-1/4-inch IPS. Complete assembly must be certified by the CSA to meet ANSI Z358.1-2004 Standard for Emergency Eyewash and Shower equipment to be considered as an approved equal and requires the approval of the Engineer before being ordered.

Required: One (1) Unit Complete

B. Water pressure reducing valve shall be installed in the supply line as shown on the plans before this emergency eye-wash basin/drench shower to prevent any surges to occur. Valve shall be a Watts Regulator Co. Series 223 or an approved equal.

Required: One (1)

Size: 1-1/2 inch

Rating: 125 lb, down-stream adjustable from 50 psi and lower.

HOSE BIBB

Chicago No. 952 with vacuum breaker, 3/4" hose thread outlet, removable key handle, chrome finish with square head cock.

BOOSTER/EMERGENCY SHOWER/EYEWASH/WATER LUBE LINE PUMP:

GRUNDFOS Pump Company BoosterPaQ Model no. HYDRO MPC-CUE-20CR5-7, One-Phase 240 VAC, Variable-Speed drive unit featuring Two(2) centrifugal multi-stage vertical turbine pump installed in parallel, a Hydro-Pneumatic Tank as described below, a self-contained Motor Control Center pre-wired to all control components and elements or an approved equal. This pump shall be 3500 RPM, 2-horsepower, Single phase, 240 VAC with TEFC motors. Capacity of this pump shall be 30 GPM at 150 feet TDH and shall contain 7 stages. Pump shall be outfitted for operation with potable water having a temperature range of 50°F to 80°F. Provide with a packaged control system to include but not limited to: a motor starter and all required controls and relays and additionally; two (2) pressure switches: one to start the pump to sustain the water pressure in the hydro-pneumatic tank and the other to serve as a low pressure cutoff and alarm.

Required: One (1) Complete Unit Assembly

HYDRO-PNEUMATIC TANK:

- A. Hydro-Pneumatic Pressurized Storage Tank, a free standing model, shall be a Amtrol Model No. ST-210V or an approved equal. It shall be ANSI Certified, NSF approved, rated for a maximum pressure of 125 psig and a volume of 86.0 gallons. It shall be durable seamless full-size blow molded interior replaceable air-cell of heavy gauge polyether urethane (PEU).

Required: One (1)

- B. Pressure Relief/Sustaining Valve shall be used to protect the hydro-pneumatic storage tank from water pressures higher than tank rated pressures. It shall be hydraulically operated, pilot-controlled, modulating valve designed to maintain upstream pressure within close limits. In operation, this valve is actuated from water pressure within the tank, opening fast at a pre-set pressure below the maximum pressure rating of the tank preventing damage to it. Operation is completely automatic and pressure setting may be easily changed. The valve shall be a Clayton Model 50-01 or an approved equal.

Required: One (1)

Size: 1-1/2 inch, screwed ends

Minimum Pressure rating of valve: 150 psi

Class: 125 lb

PACKING AND SHIPMENT

The Contractor shall be responsible for inspecting equipment and acceptance thereof prior to delivery to the site. Immediately upon the arrival of the pumping unit at the job site, the Contractor shall make a careful inspection of the pumping unit and all incidental items that go with the unit and shall submit a certified check list describing all items checked. All defects and or parts not conforming to these specifications shall be replaced without delay.

INSTALLATION INSTRUCTIONS AND MAINTENANCE MANUAL

- A. The manufacturer shall also provide at least five copies of the instructions for the installation and proper maintenance of the plumbing equipment in bound folders. Included in the folders shall be drawings of the individual components and its accompanying material list.
- B. Installation shall be performed in accordance with the manufacturer's instructions.

GUARANTEE

- A. The equipment covered by these specifications shall be guaranteed against defective parts due to faulty material or workmanship for one year after date of acceptance of project. The Contractor shall guarantee to replace all defective parts within the period of time specified. The Contractor shall pay for all costs for the replacement of defective parts at no cost to the Department of Water Supply. The guarantee shall be in writing and shall be given to the Department of Water Supply prior to the completion of the project.

DUCT WORK:

All duct work shall be constructed and installed per SMACNA Guidelines.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 304 -- MECHANICAL AND ELECTRICAL

The following shall supplement Section 304 "Mechanical and Electrical" in the Water System Standards, 2002.

SECTION 304.07 PUMP DISCHARGE PIPING AND VALVE SYSTEM

GENERAL DESCRIPTION

MAKUU OFF-SITE PRODUCTION WELL:

- A. Pump Discharge Piping and Valve System: A pump discharge piping and valve system, consisting of a pump silent check valve, a pump gate valve, a pump control valve, a pump combination air and vacuum release check valve, a pump combination air release valve, a Electro-Magnetic flow meter and transmitter, a pump flow switch, a well lever sensor and transmitter, a Tank Level Pressure Transmitter, a "Duckbill" Elastomeric Check Valve, a Rossum Sand Tester, and all necessary appurtenances and piping shall be furnished as shown on the plans.

1. Pump Control Valve:
 - a) Number required: One (1) pump control valve with external pressure source.
 - b) Size of valve: 8 inches
 - c) Minimum pressure rating of valve: 150 psi
 - d) Class of flanges valve shall be mounted between: ANSI B16.42, Class 150 psi
2. Pump Discharge Silent Check Valve:
 - a) Number required: One (1)
 - b) Size of valve: 10 inches
 - c) Minimum pressure rating of valve: 150 psi
 - d) Class of valve flange: 125 lb., ANSI B16.1
3. Pump Combination Air and Vacuum Release Check Valve:
 - a) Number required: One (1)
 - b) Size of valve: 3 inches
 - c) Minimum pressure rating of valve: 150 psi
 - d) Class of valve flange: 125 lb., ANSI B16.1

4. Surge Check Valve:
 - a) Number required: One (1)
 - b) Size of valve: 3 inches
5. "Duckbill" Elastomeric Check Valve
 - a) Number required: One (1)
 - b) Size of valve: 8-inch
 - c) Location: End of Pump Waste Bi-charge Pipe

B. PLAN OF OPERATION OF PUMP CONTROL VALVE UNIT

The pump control valve unit shall be designed to (1) release air in the pump discharge column on starting up, (2) break the vacuum in the pump discharge column as the water drops back when shutting down, and (3) eliminate objectionable pipeline water pressure surges by controlling the opening and closing speeds of the pump control valve whenever the unit is started and stopped.

The pump control valve shall be open with pumping unit stopped. After the pump is started, the solenoid valve (a part of the pump control valve) shall be energized which will slowly close the control valve. The air and initial inrush of water from the pump column shall be expelled through the pump control valve. As the pump control valve moves from its open position, the silent check valve will open to permit the flow of water into the main line.

When the pump is to be shut off, the pump control valve solenoid valve is de-energized causing the pump control valve to slowly start opening. As the control valve nears the open position, the silent check valve will close and a limit switch on the pump control valve shall shut down the pumping unit. Should the water, on falling back into the well, create a vacuum in the pump discharge column, the combination air and vacuum release valve opens and breaks the vacuum.

This valve shall be a modified globe-type, hydraulically operated by a double-acting diaphragm. An externally mounted, four-way, rotating disc-type, solenoid-operated pilot valve shall control the valve operation. High-pressure water from the existing high-pressure waterline shall be used for pilot valve operation. When the solenoid is energized, the pilot valve shall close the main valve. When it is de-energized, the pilot valve shall open the main valve. Two flow control valves shall permit separate regulation of both valve opening and closing rate. The control valve body and cover shall be ductile iron; stem shall be stainless steel; seat shall be bronze and removable; disc shall be synthetic rubber and the diaphragm shall be nylon fabric, bonded with synthetic rubber. Two (2) limit switches shall be installed on the valve stem to detect separately when the valve is fully open and when it is fully closed and shall be adjustable over the entire valve travel. The valve unit shall be Clayton Valve No. 661-02 Pump Control

Valve, or approved equal. The valve shall be epoxy coated internally and be equipped with silicon bronze or stainless steel nuts and bolts.

C. PUMP SILENT CHECK VALVE

The pump discharge silent check valve shall be flanged, center-guided check valve, APCO Globe Style Series 600, Valmatic Series 1800 or approved equal. The valve body shall be semi-steel or cast iron with bronze trim, stainless steel spring and bronze-bushed center-guides. The valve shall be installed on the discharge line of the pump.

D. PUMP COMBINATION AIR AND VACUUM RELEASE CHECK VALVE SYSTEM:

The Deep Well pump air and vacuum release check valve shall vent large quantities of air through the discharge orifice when the pump starts, close tight when liquid enters and permit large quantities of air to re-enter through the orifice when the pump stops to prevent vacuum forming in the pump suction column.

The main valve parts shall be a body, cover, baffle, float and seat. The baffle shall shield the float from direct impact of air and water to prevent premature float closure. The seat shall slip fit in the baffle or cover and lock in place without any distortion. The entire float and baffle assembly must be shrouded with a water diffuser to prevent water from slamming the float shut. Outlets to be threaded.

The float shall be stainless steel, center guided for positive shut-off into the seat.

Valve exterior to be painted with universal metal primer paint as accepted by the EPA for use with potable water.

Materials of construction shall be certified conforming to following ASTM specifications:

Body and cover	Ductile iron	ASTM A536 Gr. 65-45-12
Baffle, size 3"	Cast iron	ASTM D2133
Float	Stainless steel	ASTM A240
Seat	Buna – N	
Water diffuser	Stainless steel	ASTM B16

Valve System to be manufactured to AWWA C-512.

Air Release Valve No. 50 shall also be attached to this valve to port any remaining air in the pump line.

- a) Number required: One (1)
- b) Size of valve: Three (3) inches
- c) Minimum pressure rating of valve: 150 psi
- d) Class of valve flange: 125 lb, ANSI B16.1

Valve to be APCO Series 146 Air/Vacuum valve with Water Diffuser manufactured by DeZurik Corp. or an approved equal.

E. SURGE CHECK VALVE:

The Surge Check Valve shall have integral flanges for the installation to the inlet of the above specified Pump Combination Air and Vacuum Release Valve System on the line. It shall consist of a body, seat, flow disc and compression spring. The surge check unit shall operate on the interphase between the kinetic energy and relative velocity flows of air and water. After air passes through and water rushed into the surge check, the disc start to close, reducing the rate of flow of water into the air valve by means of throttling orifices in the disc to prevent water hammer in the air valves. The surge check orifices must be adjustable for regulation in the field to suite operating conditions.

The Surge Check Valve shall fit to the inlet of the above air/vacuum system.

The Surge Check Valve shall have been flow tested and the test data submitted to the Engineer to verify surge pressure reduction in the valve.

Valve exterior to be painted by Universal Primer for high resistance to corrosion.

All materials of construction shall be certified in writing to conform to ASTM specifications as follows:

Body	Cast iron	ASTM 1265, Gr. B
Seat & disc	Bronze	ASTM B584
Spring	Stainless steel	T302

Valve shall be APCO Series 1600 Surge Check Valve, as manufactured by Valve & Primer Corporation, Schaumburg, Illinois, USA or an approved equal. Note: Entire Pump Combination Air and Vacuum Release Valve System include this Surge Check Valve must as a system be an approved equal.

F. COMBINATION AIR RELEASE VALVE

Combination air valve, (single-body, double orifice) allows large volumes of air to escape out the large orifice when filling a pipeline and closes when liquid enters the valve. During large orifice closure, the small air release orifice will open to allow small pockets of air to escape automatically and independently of the large orifice.

The large orifice shall also allow large volumes of air to enter during pipeline drainage to break the vacuum. The body inlet must be baffled to protect the lower float from direct forces of rushing air and water to prevent premature valve shut-off. The top large orifice plug or float must be protected in similar manner for the same purpose.

The Buna-N seat must be fastened to the valve cover, without distortion, for droplight shut-off. The floats shall be heavy stainless steel, hermetically sealed; designed to withstand 1000 psi. The top plug or float shall be center-guided through hex bushings for positive shut-off.

All materials of construction shall be certified in writing to conform to ASTM specifications as follows:

Body and Cover	Cast Iron	ASTM A48, Class 30
Float	Stainless Steel	ASTM A240
Needle and Seat	Buna-N	
Plug	Bronze	ASTM B124
Leverage Frame	Delrin/Cast Iron	ASTM D2133/ASTM A48, Class 30

- a) Number required: One (1)
- b) Size of valve: 1 inches
- c) Minimum pressure rating of valve: 150 psi
- d) Class of valve flange: 125 lb., ANSI B16.1

Valve to be APCO Series 140C combination air valve as manufactured by Valve & Primer Corp. or approved equal.

G.. “DUCKBILL” ELASTOMERIC CHECK VALVES:

1. Check valves are to be all rubber and the flow operated check type with an integral flanged end connection. The port area shall contour down to a duckbill. This shall allow passage of flow in one direction while preventing reverse flow. The flange and flexible duckbill sleeve shall be one-piece rubber construction with nylon reinforcement. The top and bottom of the valve shall flare out to form the duckbill shape. The bill portion shall be thinner and more flexible than the valve body.
2. The flange drilling shall conform to ANSI B16.5 and ANSI B16.47 Class 150 standards. The valve shall be furnished with galvanized or stainless steel back-up rings for installation.
3. Manufacturer must have available flow test data from an accredited hydraulics laboratory to confirm pressure drop data. Company name, plant location, valve size and serial number shall be bonded to the check valve. Valve shall be manufactured in the USA.
4. Function: When the line pressure inside the valve exceeds the backpressure outside the valve, the line pressure forces the bill of the valve to open, allowing flow to pass. When backpressure exceeds the line pressure, the bill of the valve is forced closed preventing backflow.

5. Manufacturer: All valves shall be of the Series 35 as manufactured by Tideflex Technologies Inc. of Pittsburgh, PA 15205 or approved equal.

H. GATE VALVE

The gate valve supplied shall be of the size indicated on the drawings. It shall be equipped with a hand wheel, outside stem and yoke, and shall conform to the Department of Water Supply's Water System Standards.

I. FLANGED COUPLING ADAPTERS

The flanged coupling adapters shall be Series 2100 MEGAFLANGE adapter as produced by EBAA Iron, Inc. or an approved equal.

1. Restrained flange adapter shall be used in lieu of threaded welded flanged spool places. Flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circle that are compatible with ANSI/AWWA C110/A21.10.
2. Restraint for the flange adapter shall consist of a plurality individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.
3. The flange adapters shall be capable of deflection during an assembly or permit lengths of pipe to be field cut to allow a minimum 0.6-in gap between the end of the pipe and the mating flange without affecting the integrity of the seal.
4. For PVC pipe, the flange adapter will have a pressure rating equal to the pipe.
5. For Ductile iron pipe, the flange adapter shall have a safety factor of 2:1 minimum.

J. PUMP FLOW SWITCH

1. Flow Switch

This section of the specifications covers the furnishing and installing of the flow switch and appurtenant equipment for deep well pump unit.

- a. Total Number Required: One (1)
- b. Pipe Size: 10 inches (discharge line)
- c. Flow Rate: 1000 GPM
- d. Location: As shown on plans

2. Flow Switch

The flow switch shall be an OMEGA Model FSW 42A-SS, with an internal screw adjustment which provides continuous switch adjustment while in operation. Multiple drag disks and strips shall be provided with each unit to provide incremental switch point adjustment to match flow condition. Spare drag disks or strips shall be delivered to Owner as spare parts. The flow switch shall be a

single pole double-throw snap switch, 15 Amp, 120 volts, 60 Hz power. "Duct Seal" is to be used to seal the flow switch chamber from the incoming conduit and packed tightly around the leads.

- a. Number Required: One (1)
- b. Vane Area: As req'd for 4.1 feet per second flow
- c. Location: As shown on plans

K. PUMP SAMPLING CONNECTION AND ROSSUM SAND TESTER

The single (1) sampling connection and rossum sand tester assembly shall be installed in-line to the horizontal centerline of the 10-inch discharge line. The assembly shall be located as close as possible to the discharge flange without causing hindrances to the removal process of the adjacent flanged coupling adapter. Sand sampler shall be fixed in place by a support bracket shown in the plans.

1. Sampling Connection.

Assembly shall be of size and material as indicated on the drawing and capable of operating under 150 psi working pressure. Installation shall be per manufacturer's recommendation.

2. Rossum Sand Tester.

The above shall be the system manufactured and supplied by Beylik Drilling & Pump Service Hawaii of Honolulu, or approved equal. Installation shall be per manufacturer's recommendation.

Manufacturer of the system shall also provide at least five copies of the instructions for operation of the rossum sand tester and proper maintenance of the same in bound folders. Included in the folders shall be drawings of the tester describing its individual components and its accompanying material list.

L. ELECTROMAGNETIC FLOWMETER:

The Siemens SITRANS FM MAGFLO 5100W electromagnetic flow meter or an approved equal shall consist of a flow sensor based on Faraday's Law of Electromagnetic Induction and Microprocessor-based signal converter, remote type MAG 6000 (SCADA ready) mounted within the Control Building or an approved equal.

Sensor:

Operating principle: Utilizing Faraday's Law of Electromagnetic Induction, the flow of liquid through the sensor induces an electrical voltage that is proportional to the velocity of flow.

Construction:

- a. The sensor flow tube and liner material shall be constructed of an EPDM liner, subject to the approval of the Engineer, surrounded by two integral coils. Measurements and grounding electrodes shall be 316 stainless steel.
- b. Connecting flanges shall be carbon steel. Wetted materials shall be NSF approved for drinking water service.

Installation:

- a. A minimum of five (5) pipe diameters upstream and three(3) pipe diameters downstream are recommended. (Factory shall be consulted for any variations).
 - b. Operating Temp: -20 to +200 degrees F.
 - c. Size: 10-inch for Makuu Well Site.
8-inch for Keonepoko-Nui Site.
 - d. Submergence: The sensor shall be pedestal sealed against accidental submersion to 3 feet for 30 minutes standard, permanently submerged to 30 feet when the terminal box is backfilled with a non-setting, transparent potting material.
1. Signal converter: Remote Type MAG 6000 (SCADA ready) or an approved equal compatible with the rest of the assembly.
 - a. Enclosure: NEMA 4X enclosure
 - b. Display: Background illumination with alphanumeric 3-line, 20-character display to indicate flow rate, totalized values, settings, and faults (a blind version of the MAG 6000 signal converter is available).
 - c. Power supply: 115/230 VAC or 11-24 VAC.
 - d. Operating temperatures: -4 to +140 degrees F.
 - e. Outputs: 0-20 mA or 4-20 mA into 800 Ohms max. One relay rated at 42 VAC/2A, 24 DC/1A. Digital (frequency or pulse) for external display of flow rate or totalizer.
 - f. Communications: Optional HART available.
 2. Sensor and signal converter performance:
 - a. Flow range: 1.5 fps to 33 fps for accuracies stated below.
 - b. Accuracy: 0.25% of actual flow rate.
 - c. Separation: Maximum distance of 900 feet between signal converter and sensor without the use of any additional equipment.
 - d. Bi-directional flow capabilities shall be standard.
 3. Totalizer:

Two eight-digit counters for forward, net or reverse flow.
 4. Calibration:
 - a. Each flow sensor shall be wet calibrated and all of the calibration information and factory setting matching the sensor shall be stored in an integrally mounted SENSOR-PROM memory unit. The SENSOR-PROM

shall store calibration data and signal converter settings for the lifetime of the product. At initial commissioning, the flow meter commences measurement without any initial programming. Any customer specified settings are downloaded to the SENSOR-PROM. Should the signal converter need to be replaced, the new signal converter will upload all previous settings and resume measurement without any need for reprogramming or rewiring.

- b. A certificate of calibration shall accompany each flow sensor.

5. Signal Converter Function Details:

The following functions shall be provided:

- a. All programming shall be accomplished through an integral keypad and all programming shall be protected by a user-defined pass word.
- b. The signal converter shall be integrally mounted or remotely mounted using a remotely-mount kit provided by the manufacturer.
- c. The signal converter shall provide a 4-20 mA DC signal proportional to the flow rate into 800 ohms max. Output selectable as unidirectional or bi-directional.
- d. The relay shall be programmable as error indicator, limit alarm or pulsed output.
- e. The signal converter system shall be equipped with an error and status log with 4 groups of information.
 - 1) Information without a functional error involved.
 - 2) Warnings which may cause malfunctions in the application.
 - 3) Permanent errors, which may cause malfunction in the application.
 - 4) Fatal error, which is essential for the operation of the flow meter.
- f. A system error shall be indicated by a flashing icon on the display or activation of the relay when set as an error alarm.

The first nine standing errors shall be stored in the error pending log. A corrected error pending log. A corrected error is removed from the error pending log. A status log shall be provided to store the last 9 error messages received for 180 days regardless of correction.

6. Reverification:

- a. Verification using a stand-alone Siemens MAGFLO Vericator to measure a number of selected parameter in the flow sensor and signal converter, which affects the integrity of the flow measurement, shall be available through a factory verification service.

Verification of the Flow Meter shall consist of the following test routines:

- 1) Insulation test of the entire flow meter system and cables. Test of sensor magnetic properties.
- 2) Digital output test.
 - a) Analog output test.
 - b) A certificate of verification shall be issued if flow meter passes all of the tests with-in 1% of the original factory test parameters.

7. Installation:
 - a. Follow manufacturer's recommendation for the minimum upstream and downstream installation requirements.
 - b. Wiring between flow sensors and remote mounted signal converters shall use cable type and procedures as per manufacturers' recommendation.
8. Warranty:
 - a. The manufacturer of the electromagnetic flow meter shall for one year of operation, warrant that the equipment shall be free from defects in design, workmanship, or materials.
 - b. In the event a component fails to perform as specified, or is proven defective in service during the guarantee period, the manufacturer shall promptly repair or replace the defective part at no cost to the owner.
9. Spare Parts:
 - a. One set of manufacturer's recommended spare parts.
 - b. Extra operations manuals as required.
10. The electromagnetic flow meter shall be a Siemens Model SITRANS FM MAGFLO 5100W flow sensor with a Siemens Remote Model MAG 6000 (SCADA ready) signal converter or an approved assembly. Insertion type flow meters will not be accepted.
11. Project Requirements: Makuu Off-Site Deep Well:
 - a. Siemens 10-in MAG 5100W Carbon Steel Flanges, EPDM liner (subject to approval of the Engineer), Hastelloy-C measuring and grounding electrodes, Part No. 7ME6520-4VJ12-2AA2 or an approved equal compatible with the Transmitter. Quantity: One(1).
 - b. Siemens Remote MAG 6000 Transmitter, 115/230 VAC, Part no. 7ME6920-1AA10-1AA0. Quantity: One(1).

KEONEPOKO-NUI BOOSTER PUMP UNITS:

- A. Pump Suction/Discharge Piping and Valve System: A pump suction/discharge piping and valve system, consisting of Booster Pump Control Valves, Combination air release valves, Pressure relief valves, Pump flow switches, Electro-Magnetic Flow Meters and all necessary appurtenances and piping shall be furnished on the plans.
 1. Booster Pump Control Valves:
 - a. Number required: Two(2)
 - b. Size of valve: 4 inches
 - c. Minimum pressure rating of valve: 250 psi
 - d. Class of flanges valve shall be mounted between 300 psi, class

2. Combination Air Release Valve
 - a. Number required: Two(2)
 - b. Size of valve: 1 inch
 - c. Minimum pressure rating of valve: 250 psi
3. Pressure Relief Valves:
 - a. Number required; Two(2)
 - b. Size of Valves: 1-1/2 inch
 - c. Minimum pressure rating of valve: 250 psi
 - d. Valve shall have screwed ends

B. PLAN OF OPERATION OF BOOSTER PUMP CONTROL VALVE UNITS:

Valves shall be diaphragm actuated, single seated, and hydraulically operated globe-type valve. It shall have two operating chambers sealed from each other by a flexible synthetic rubber fully supported diaphragm. The valve disc shall be resilient with a rectangular cross-section and shall be retained on three sides. Control of valve operation shall be by means of an externally mounted, four-way, and solenoid pilot valve. Self-cleaning strainer shall be used to protect the control system. Valve shall utilize line pressure for operation. Limit switches must be installed to be adjustable over the entire valve travel to indicate full closing and full opening of the valve. Valve shall be equipped with a built-in lift type check feature to prevent reverse flow. It shall operate independently of the solenoid control. Valve shall be similar in all respects the Clayton 60-11 Booster Pump Control Valve or an approved equal.

C. PRESSURE RELIEF/PRESSURE SUSTAINING (BACK PRESSURE UNIT):

Pressure relief valve shall be a diaphragm type, pilot controlled, cast iron body, Clayton No. 50 G-01 or an approved equal. Valve shall have bronze trim and be equipped with "Delrin" stem sleeves. Valves shall be designed for maximum operating pressure of at least 1.5 times the pump design pressure or 1.2 times shut-off head of the pump whichever is greater. Valve shall be epoxy coated internally. Pilot control shall be factory set to open at 15% over the pump head design. Provide adjustment range of 20 to 350 psig.

D. DIGITAL PRESSURE GAUGES:

This digital pressure gauge offers a menu-driven display for easy customization. User selectable features include 12 units of measurement, password protected calibration and disable functions, adjustable bar graph and update rate. The readout shall be a five digit display for maximum resolution with a 4-20mA output with the range printed on the keypad and shall meet ASME B40.7 specifications and manufactured in the USA.

Number required: 4 (four)

The digital pressure gauge shall be an Ashcroft Model No. 30-2274-SD-02L-200 psig as manufactured by Ashcroft Inc., 250 East Main Street, Stratford, CT 06614, USA or approved equal.

E. PUMP FLOW SWITCH:

1. Flow Switch:

This section of the specification covers the furnishing and installing of the switch and appurtenant equipment for the new booster pump units:

- a. Total Number required: Two(2)
- b. Pipe Size: 8 inches (Suction Line)
- c. Flow Rate: 400 GPM
- d. Location: As shown on the plans

2. Flow Switch:

The flow switch shall be an OMEGA Model FSW 42A-SS, with an internal screw adjustment which provides continuous switch adjustment while in operation. Multiple drag disks and strips shall be provided with each unit to provide incremental switch point adjustment to match flow conditions. Spare drag disks or strips shall be delivered to the DWS as spare parts. The flow switch shall be a single pole double-throw snap switch, 15 amp, 120 volts, and 60 Hz power. "Duct Seal" is to be used to seal the flow switch chamber from the incoming conduit and packed tightly around the leads.

- a. Number required: Two(2)
- b. Vane area: As required for flow velocity of 2.55 ft/sec

3. ELECTRO-MAGNETIC FLOWMETER (MAGMETER):

The Siemens Electro-Magnetic SITRANS FM MAGFLO 5100 W Flow Meter shall be similar to the flow meter specified earlier in the specifications for the well complete with all connected appurtenances including the Siemens Remote MAG 6000 (SCADA ready) Transmitter 115/230 VAC. Part No. 7ME6920-1AA10-1AA0 mounted within existing control building or an approved equal.

Keonepoko-Nui Booster Pump Site:

- a. Siemens 8-in SITRANS FM MAGFLO 5100W
Carbon Steel Flanges, EPDM liner,
Hastelloy-C measuring and grounding electrodes,
Part No. 7ME6520-4PJ12-2AA2 or an approved equal
compatible with the below transmitters.

- b. Siemens Remote MAG 6000 (SCADA ready) Transmitter, 115/230 VAC,
Part No.
7ME6920-1AA10-1AA0.

- 1) Number required: Two(2)
- 2) Flow range: 0-600 gpm
- 3) Size: 8-inch
- 4) Minimum pressure rating of the meter: 150 psiG
- 5) Class of meter flange: 125 lbs, ANSI B16.1

F. TEST OF PUMPING UNIT

After installation of all pump discharge piping components and other equipment, a complete operating test of the pumping unit and other equipment shall be made as specified elsewhere in this specification listed under Section 304.01 subsection C.9 for Makuu Deep Well Production Pump, new Booster Units at Keonepoko-Nui Pump Site.

G. PUMP DISCHARGE PIPING AND VALVE SYSTEM PAYMENT

1. General.

No separate payments will be made for the work covered by this section of the specifications. All costs in connection with furnishing and installing of the various items shall be included in the Lump Sum Price Bid of which the item is a part.

H. COMPENSATION

Payment for the furnishing and installing of equipment will be made at the Lump Sum Price Bid of which the item is a part and shall be full compensation for all work in connection therewith, complete and finished in accordance with the drawings and specifications.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 304 -- MECHANICAL AND ELECTRICAL

The following shall supplement Section 304 "Mechanical and Electrical", in the Water System Standards, 2002.

SECTION 304.08 WELL LEVEL RECORDER SYSTEM

GENERAL DESCRIPTION:

This section of the specification describes the well level transmitter system required. The well level system will be based on a submersible water level transmitter to be installed in one of the sounding tubes provided to the depth shown on the plans.

This transmitter senses the hydrostatic head pressure in the well and provides a two-wire 4-20 mA D.C. output signal directly proportional to that pressure and utilizes a solid state piezoresistive pressure sensor housed in a 316 stainless steel body with its associative electronics. A stainless steel diaphragm isolates the sensor from the well water.

A SCADA system specified elsewhere in these specifications should provide this well level data at a remote site as required by the DWS.

WELL LEVEL TRANSMITTER:

The Contractor shall furnish and install a submersible water level transmitter sensor into one of the sounding tubes to measure well water level. The sensor shall be directly powered by the SCADA system.

1. Number Required: One (1)
2. Pressure Range: 0-50 psig or 1-115 ft. W.C.
3. Accuracy: $\pm 1\%$ of span
4. Input: 15/45 Volts DC
5. Output: 4-20 mA
6. Body: 316 stainless steel
7. Sensor Fill Fluid: Silicone 200

The submersible water sensors shall be specially designed transducers to meet the harsh environments encountered in industrial, municipal, and pressure and/or depth measurements. The electronic sensor shall be enclosed in a 316 SS housing, isolated from the process liquid by a 316 SS diaphragm. These sensors incorporate an isolated solid state piezo-resistive pressure transducer, which provides excellent linearity, repeatability and low hysteresis. The cable for the sensor shall be 20 GA polyethylene jackets, insulated and shielded cable unspliced for the full length from the well to the well level recorder. The Contractor shall install the well sensor cable

without kinks to insure the air breather passage is not closed. The sensor shall be calibrated and factory certified prior to shipping. The Contractor shall provide the sensor certification to the Engineer and the DWS. The sensor shall be similar in all respects to the SIGMA CONTROL INC. Series 5000 submersible level sensor or approved equal.

WELL LEVEL TRANSMITTER CABLE:

A. At Well Pad:

Provide ducts and cable connection according to the plans and details. The sensor cable shall not be kinked. Provide long radius bends to the junction box on the pad. Leave a coil of cable in the junction box before pulling cable to the control building.

Storage Reel and Reel Jack Stands shall be furnished complete with SS support cable and support cable bracket for ease of removal for this assembly.

B. Outside of Well:

The cable shall be installed between the well and the Motor Control Center Building in a 1-1/4 inch PVC conduit pipe as shown on the drawings. The Contractor shall use long radius bends to prevent cable kinks.

C. In the Well:

The sensor and cable shall be suspended within a 1-1/4 inch PVC, Schedule 40, sounding tube, which shall be strapped to the pump pipe column. A portion, as shown on the drawing, shall be 1 1/4" 304 Stainless Steel Pipe capped at the bottom with a stainless steel cap of the same material and constructed as shown on the plan. The sensor and cable shall have sufficient tensile strength to not only support its weight but also, withstand any vertical and horizontal movements within the sounding tube and have sufficient counterweight to overcome any buoyant forces. The sensor shall terminate at the elevation as shown on the plans which is the bottom of the sounding tube. There shall be an identical 1 1/4" sounding tube strapped to the pump pipe column to be used by the Department of Health. Additional 3/8" HDPE tubing, NSF Certified (Hudson Extrusion or equal) shall be run parallel to PVC sounding tube with 20' length at surface. Bottom of tubing shall be terminated with 6" length of 316 S.S. tubing with bevel cut end.

INSTALLATION:

Install well level recorder system in accordance with manufacturer's requirements and recommended procedures.

PAYMENT:

Payment for well level recorder system will be made at the lump Sum Price Bid. Payment shall represent full compensation for furnishing and placing all materials and for all labor.

END OF SECTION

WATER SYSTEM STANDARDS

DIVISION 300

SECTION 304 -- MECHANICAL AND ELECTRICAL

The following shall supplement Section 304 "Mechanical and Electrical", in the Water System Standards, 2002.

SECTION 304.11 TANK LEVEL RECORDING SYSTEM

GENERAL DESCRIPTION

This tank level pressure transmitter measures gauge pressure by applying the pressure to a silicon strain gage microsensor. This microsensor converts the pressure to a change in resistance, and the resistance change is converted to a 4 to 20 mA signal proportional to the pressure. This measurement signal is transmitted to remote receivers over the same two wires that supply power to the transmitter.

Provide a Foxboro Model IGP10-A20C1F-M2V2 Intelligent Electronics Direct Connect Gauge Pressure Transmitter or an approved equal.

It shall be an electronic version calibrated from 0 to 30 psig with 4 to 20 mA signal including an explosion-proof rating and LCD indicator with pushbuttons for Calibration, Configuration, Standard Pressure Units. It shall have a 316L stainless steel Process Connection, C0-Ni-Cr Diaphragm, Silicone Fill Fluid, 1/2-inch NPT External & 1/4-inch internal thread connection type. Unit shall be mounted on the top on the pump discharge line into the storage tank and plumb with the centerline of the line. There shall be 1/2-inch NPT conduit connections on both sides and housed in an aluminum housing. Unit shall be provided with stainless steel mounting brackets with stainless steel bolts with carbon steel block and bleed valve.

PRESSURE GAGE

Provide two (2) pressure gages for the deep well pump discharge piping. Pressure gage shall be provided with snubber and petcock union. Gage, snubber and petcock union shall be supplied as a unit and shall be located as shown on the plans.

A. Gage.

The diameter of the dial shall be 3-1/2 inches with a standard pressure range specified on the plans, liquid filled, 1 percent full scale accuracy, and a minimum ASME Grade 1A rating. The gage shall be made with an all welded stainless steel construction. Process connection shall be 1/4-inch NPT with a brass snubber and petcock, union between gage

and pipe. Pressure snubbers shall be furnished with all gages and pressure instruments and shall be RAY or approved equal.

B. Pressure Range.

Pressure range shall be as indicated below. Accuracy shall be in accordance with ASME, Grade 1A.

Pump Discharge at Test Gage: 0-30 psi (Figure mark shall be every 5 psi)

Pump High Pressure Switch: 0-60 psi (Figure mark shall be every 5 psi)

END OF SECTION