

SECTION 616 - SPRINKLER SYSTEM

616.01 Description. This work includes installing underground irrigation systems, a complete system of highway landscape irrigation, or relocating existing sprinkler systems such as piping, sprinkler heads, valves, automatic controllers, remote control valves, booster pumps, valve assembly units, power and control wiring, pullboxes, and related equipment and materials at locations shown in the contract or as ordered by the Engineer. *

616.02 Materials. Materials shall conform to the following:

Trench Backfill Material	703.21
Polyvinyl Chloride (PVC) Pipe	706.13
Polyethylene Pipe	706.14
Zinc-coated Pipe and Fittings	707.10
Copper Service Pipe and Appurtenances	707.11
Dark Green Enamel Paint	708.03
Pullboxes	712.06(B)
Frames and Covers	712.07(A)
Sprinkler Heads	712.12
Valves	712.13
Pressure Regulators	712.14
Backflow Preventers	712.15
Precast Concrete Meter and Valve Boxes and Covers	712.23
Conduits	712.27
Cables, Conductors and Wires for Irrigation System	712.34(C)
Automatic Controller	712.42(A)
Pump, Motor and Motor Controller	712.43
Springs for Sprinkler Risers	712.47
Electrical Appurtenances	712.48
Valve Boxes and Covers (Plastic and Concrete)	712.49

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Switching Tensiometer	712.50
Rain Sensor Switch	712.52

Materials and equipment incorporated in the irrigation system shall be new and shall be of recognized standard quality. The Engineer will inspect and test the materials according to the contract. *| *

Electrical equipment shall conform to the NEMA Standards. Electrical work shall conform to the National Electrical Code (the Code), General Order No. 6 of the Hawaii Public Utilities Agreement, local power company rules, and local ordinances that may apply. *|

Sprinkler water lines under the roadway shall be copper or PVC pipe, Schedule 80 with threaded connections. |

Concrete for reaction blocks, pump foundations and jackets shall be Class B conforming to Section 601 - Structural Concrete. |

Within ten (10) days following the award of contract, the Contractor shall submit a list of the irrigation equipment that the Contractor will use on the project. The list shall be by name of manufacturer and catalog number. The list of irrigation equipment shall include sprinkler heads, valves, irrigation control equipment, booster pump units, and pump controls as required for the irrigation system. *| *

Materials will be subject to inspection. Failure of the Engineer to note faulty material or workmanship during construction will not relieve responsibility by the Contractor for removing or replacing such materials and redoing the work at no cost to the State. *|

616.03 Construction Requirements.

(A) Installation.

(1) **General.** The irrigation system shown in the contract is diagrammatic only. The Contractor shall provide the pipe fittings or substitute other pipe fittings necessary to complete the connections shown in the contract. Alterations and changes in the layout may occur to conform to the ground conditions and to obtain full and adequate coverage of water. The Contractor shall not change or alter the system as planned without prior acceptance by the Engineer. *| *

The Contractor shall ream the pipes after being cut and shall clean and free the pipes from dirt or other foreign matter. The Contractor shall make the metal to metal screwed joints with an accepted non-soluble and nontoxic lubricant on the male thread only. *|

The Contractor shall excavate the necessary trenches and other openings a minimum of eighteen (18) inches of depth or to the required depth shown in the contract. The Contractor shall excavate *| *

the additional depth and width where required, to ease valves, reaction blocks, concrete jackets, rock removal, connections to other mains or to clear subsurface obstructions. Trenches shall be of sufficient width to permit snaking of plastic pipe not connected by rubber ring-type fittings. The Contractor need not snake the pipe connected with rubber ring-type fittings.

Trenches for plastic pipe shall be smooth and free of jagged rubble or sharp objects that will cause abrupt bending stresses and uneven weight distribution during backfilling operations. Before the Contractor backfills the pipe line trenches in an area that the Contractor will water, the Contractor shall:

(a) pressure test that unit of the irrigation system and

(b) modify the sprinkler locations if necessary to get complete and uniform coverage or flow.

Supply line trenches located next to curbs, dikes and paved shoulders shall be at least four (4) feet from said curbs, dikes and paved shoulders.

The Contractor shall install reaction blocks according to the manufacturer's instructions and as ordered by the Engineer. The Contractor shall furnish a copy of the manufacturer's instructions to the Engineer before the Contractor installs pipes.

If the Contractor installs supply lines through existing paved areas, the Contractor shall replace the subbase, base and paving removed with material of equal quality.

The Contractor shall set the risers for sprinklers on slopes approximately perpendicular to the plane of the slope or half-way between perpendicular to slope and vertical for best coverage. The Contractor shall install each series of sprinklers and adjust and test operate the nozzles to establish the location on the slope and proper angle of the risers.

If the location of a supply line interferes with the drilling of plant holes, the Contractor shall locate the plant holes to clear the supply lines. The Contractor shall not install supply lines through plant holes except in the installation of emitters or bubble heads.

The Contractor shall install the vertical spring action check valves on the sprinkler risers or swing joints shown in the contract or ordered by the Engineer.

Before the Contractor removes or disturbs markers showing the location of existing cross-over conduits, the Contractor shall mark the conduit location on the pavement.

The Contractor shall connect the underground metallic pipes, valves or fittings made of dissimilar metals through a dielectric coupling or bushing. The Contractor shall separate these pipes physically from other metal objects a minimum of one-eighth (1/8) inch. The Contractor may require non-conducting spacers that will insure physical separation of pipe from foreign objects as decided by the Engineer. *

Before the Contractor backfills the pipeline, the Contractor shall expel the air from the line. The Contractor shall then turn the water and maintain at full pressure for not less than eight (8) consecutive hours. Also, the Contractor shall do a similar test except the test shall be for a duration of one (1) hour. The Contractor shall repair leaks that develop in the portion of the system installed by the Contractor and replace defective materials at no cost to the State. The Contractor shall plug or cap the pipe where the Contractor will install sprinklers while making this test. The Contractor shall then check the entire system for uniform and complete coverage after installing sprinklers. *

After the Contractor has installed the pipe and tested properly according to the contract, the Contractor shall backfill and compact the trench in six (6) inch layers according to Section 206 - Excavation and Backfill for Conduits and Structures. The Contractor shall dispose of the remaining material. *

In planting areas, the Contractor may compact the backfill material by ponding or jetting with water until the backfill material, after settlement, is level with the surrounding soil. The Contractor shall fill the pipeline with water before the compaction of the backfill material. *

The Contractor shall backfill the pipe trenches so that sharp objects will not damage the pipe. The Contractor shall not place rocks directly on the pipe. *

When backfilled area has settled, the Contractor shall refill and compact said area including furnishing, applying and compacting the fill material. *

When the Contractor meets solid rock, the Contractor shall excavate the rock: *

(a) to a depth six (6) inches below the invert grade and *

(b) to a width four (4) inch on each side of the pipe. *

The Contractor shall backfill the space up to the invert with trench backfill material. The Contractor shall compact the trench backfill material firmly. *

The Contractor shall install the pressure regulators and backflow preventers according to the Plumbing Code of the respective County. *

(2) Copper Pipe. When installing copper pipe, the Contractor shall excavate the trench to a depth of six (6) inches below the invert grade. The Contractor shall backfill the space up to the invert with trench backfill material. After installing and testing the copper pipe, the Contractor shall place an additional six (6) inch thickness of trench backfill material before commencing structure backfill operations. The Contractor shall compact the trench backfill material firmly. *

The Contractor shall connect the copper to the zinc-coated pipe with a brass adapter. *

(3) PVC Pipe. The Contractor shall join the plastic pipe and fittings by solvent cementing, slip seat joints, or threaded joints. Cuts shall be square-end and clean. When the Contractor clamps the pipe, the Contractor shall protect the pipe from nicks and scouring by wrapping in canvas, emery paper or other accepted materials. *

The Contractor shall install the plastic pipes and fittings according to the manufacturer's instructions and procedures. The Contractor shall furnish a copy of the printed instructions to the Engineer before the Contractor installs the pipe. The Contractor shall be responsible for making arrangements with the pipe manufacturer for field assistance. *

In making solvent cement joints, the Contractor shall not apply pressure until the joints cure for an adequate time. *

The Contractor shall screw the threaded joints and apply an accepted non-hardening, putty-type joint compound. The Contractor shall avoid undue strain on plastic material. On plastic to steel connections, the Contractor shall make the steel connections first. The Contractor shall tighten the threaded joints about one (1) turn past hand-tight with a strap wrench. *

The Contractor shall install the plastic pipes to allow for expansion and contraction as recommended by the manufacturer's instructions and procedures. *

(4) Polyethylene Pipe. The Contractor shall install the polyethylene pipe according to the manufacturer's instructions and procedures. *

The Contractor shall furnish a copy of the instructions to the Engineer before the Contractor installs the pipes. *

(5) Valves and Valve Boxes. The Contractor shall construct the valve manifolds shown in the contract. *|
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If the contract shows multiple installations of valves in a large single valve box, the Contractor may, at its option, install the valve in individual valve boxes. The Contractor shall install the valves with a two (2) inch clearance from valve box walls. *|
*|

The Contractor shall install the valve boxes with their tops one (1) inch above the surface of surrounding grade. In concrete walks or traffic islands, the Contractor shall flush the top of the valve boxes with the surrounding grade. *|
*|

The Contractor may substitute plastic valve boxes for portland cement concrete valve boxes. *|

(6) Valve Keys. The Contractor shall furnish to the Engineer upon completion of the project: *|
*|

(a) two (2) long shank keys or wrenches for flow adjustment of manual control valves and *|
*|

(b) two (2) valve keys for four (4) inch or larger gate valves. *|
*|

(7) Electric Automatic Controllers. The Contractor shall house each controller in a pedestal type enclosure. The Contractor shall install the controller on a portland cement concrete foundation or wall mounted shown in the contract. The concrete for the foundation shall be Class B and shall conform to Section 601 - Structural Concrete. The Engineer will permit hand mixing of foundation concrete. *|
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Each controller shall have an individual neutral conductor to its respective valves.

The Contractor shall submit a complete maintenance and operations manual for each type of controller to the Engineer before the plant establishment period. *|
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A complete schematic wiring diagram for each controller shall be a part of the maintenance manual. The diagram shall show in detail the circuits and parts. Also, the Contractor shall one (1) copy of said diagram in a heavy plastic envelope and attached to the inner portion of each controller cabinet door. *|
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Electrical equipment requiring modifications to conform to the contract shall have such modifications made at the factory before shipment to the project. |

(8) Valve Assembly Unit. The valve assembly unit shall be of the same size as the pipeline that said unit serves. |

(B) **Connection Details for Copper Pipe Joints.** The Contractor shall *|
make the connection details for copper pipe joints for copper water pipe *|
according to Subsection 624.03(G) - Installation of Copper Pipes, Copper *|
Service Laterals and Service Connections, Including Appurtenances.

(C) **Water Service Connection.** The Contractor shall install the water *|
service connection according to the requirements of the appropriate *|
County Water Supply or governing agency. The Contractor shall furnish *|
and install the service lateral, service connection, meter, meter box,
shut-off valve, valve box and miscellaneous items necessary to complete
the connection. This includes excavation, backfilling and tapping into *|
the water main.

(D) **Relocation of Existing Sprinkler Lines.** The Contractor shall *|
reinstall the indicated sprinkler lines at the new locations according *|
to Subsection 616.03(A) - Installation. If the Contractor cannot reuse *|
the existing lines, the Contractor shall install new material. *|

The Contractor may use compression type fittings to connect new *|
lines to existing lines.

The Contractor shall furnish and install a valve box at each *|
relocated valve or multiple valve installations.

(E) **Electric Service.** The electric company will provide electric *|
services to the irrigation system from its facilities or existing *|
facilities shown in the contract. The electric services includes the *|
equipment and features shown in the contract. The Contractor shall apply *|
to the electric company for the required services under the applicable
rate schedule. The Engineer will pay such charges the electric company *|
levies. The Contractor shall pay energy charges up to the time of final *|
acceptance of the project.

(F) **Field Test.** Before the acceptance of the work, the Contractor *|
shall conduct the following tests on the automatic sprinkler system *|
circuits in the presence of the Engineer:

(1) Test for continuity of each circuit.

(2) Test for grounds in each circuit.

(3) A megger test on each circuit between the circuit ground. The
insulation resistance shall not be less than the values specified
in Section 110-20 of the Code.

(4) A functional test to show that the system functions as *|
specified or as intended herein.

The Contractor shall replace or repair faulty material or *|
installation revealed by these tests according to the contract. The *|
Contractor shall repeat the same tests until no fault appears. *|

(G) **Sprinkler Heads.** The Contractor shall install the several kinds and types of sprinkler heads at the locations shown in the contract or as modified and accepted by the Engineer. *

The Contractor shall locate: *

(1) lawn spray heads or lawn pop-up spray heads four (4) inches away from curbs, sidewalks and pavements; *

(2) shrubbery spray heads shall be located twelve (12) inches away from curbs, sidewalks and pavement; and *

(3) jet sprinkler heads or rotary pop-up jet sprinkler heads shall be located five (5) feet away from curbs, sidewalks, edge of shoulder or pavement or *

(4) as ordered. *

The Contractor shall install lawn pop-up spray heads and rotary pop-up jet sprinkler heads on swing joints or flexible swing joints. *

(H) **Installation of Electrical Materials.**

(1) **Equipment List and Drawings.** Within thirty (30) days following the award of the contract, the Contractor shall submit for acceptance six (6) copies of a list of materials and equipment that the Contractor will incorporate in the work. The list shall include the name of the manufacturer, data and catalog number of equipment, detailed scale drawings and wiring diagrams of the systems and proposed deviations from the contract. If required, the Contractor shall submit for acceptance samples of the materials that the Contractor will use at no cost to the State. *

(2) **Excavation and Backfill.** Excavation and backfill shall conform to Section 206-Excavation and Backfill for Conduits and Structures. *

(3) **Concrete for Transformer and Equipment Cabinet Pads, Cabinet Bases, and Conduit Encasement.** Concrete for transformer and equipment cabinet pads, cabinet bases, and conduit encasement shall be Class B. They shall conform to Section 601 - Structural Concrete. Reinforcing steel shall conform to Section 602 - Reinforcing Steel. Welded wire fabric reinforcement shall conform to Subsection 709.01(C). Forms shall be true to the lines and grades as accepted. Forms shall be rigid. The Contractor shall brace the forms securely in place. The Contractor shall place the conduits and anchor bolts in the proper position and to the proper height. The Contractor shall hold the conduits and anchor bolts in place with a template until the concrete sets. The Contractor shall allow: *

(a) concrete pads to cure for seven (7) days, and *

(b) concrete for conduit encasement to cure for seventy-two (72) hours. *

Concrete pads shall be level and have a steel trowel finish. The Contractor shall notify the electric company twenty-four (24) hours before placement of concrete for transformer pads or conduit encasement. *

(4) Circuits.

(a) **Buried Conductors.** The Contractor may bury or install circuits operating at a nominal potential of thirty (30) volts directly or in conduit. The Contractor shall unreel direct burial wires and cables alongside the trench and place carefully on the bottom of the trench. The Engineer will not permit unreeling and pulling the cable into the trench from one end. Before backfilling, the Contractor shall verify that the cable is free of kinks and sharp bends. *

The Engineer will permit splices only in electrical pullboxes marked "Electric" or valve boxes housing electric control valves. The Contractor shall make the splices to provide a watertight joint of dielectric value at least equal to the conductor insulation. *

The Contractor shall leave the at least two (2) feet of slack in each conductor at each splice and at each remote control valve. The Contractor shall bundle directly buried wires with nylon straps at five (5) foot intervals. *

(b) **Conductors in Conduits.** The Contractor shall install circuits operating at a potential above thirty (30) volts nominal in conduit. Before installation of wire or cable in conduit, the Contractor shall pull a suitable wire brush, swab and mandrel through the conduit to remove extraneous matter. The Contractor shall verify that the conduit system is free of obstructions. The Contractor shall pull the cable directly into the conduit from the shipping coil or reel before installation. The Contractor shall not uncoil and lay the cable on the ground. The Contractor shall make the pulls in one (1) direction. The Contractor shall use only lubricants recommended by the manufacturer of the wire or cable, or accepted by the Engineer. The Contractor shall not leave the wires and cables under tension nor tight against bushings or fittings. If the Contractor uses pulling grips, the Contractor shall remove the damaged ends when the Contractor pulls the wire or cable. The Contractor shall not pull the cable with its end open. The Contractor shall maintain the seal. Cables shall be continuous from pulling point to pulling point. The Engineer will not permit splices elsewhere. The Contractor *

shall make splices and taps with standard splicing kits of type *|
recommended by the cable manufacturer. Splices shall be |
waterproof and of dielectric value at least equal to that of
the insulation of the conductors joined.

(c) **Conductors.** Conductors shall be of the size shown in the |
contract or larger as recommended by the manufacturer of the |
controllers furnished for this project.

The Contractor shall tag each conductor in each pullbox *|
and each conductor terminal at each controller and remote
control valve with a small permanent identification tag or |
band. The tags or bands shall be embossed, non-ferrous metal,
or rigid plastic. The embossed symbols shall contrast with the
background color. Identification on each tag or band shall
include the controller station, and number or letter
designation of the controller serving the remote control valve.

(d) **Bonding and Grounding.** The Contractor shall ground *|
noncurrent-carrying parts of the electrical system, including
metallic portions of conduit systems, equipment and device |
enclosures, and equipment frames. *|

(e) **Conduits.** Metallic conduit shall be rigid zinc-coated
steel. Non-metallic conduit shall be PVC conduit or
bituminous-fiber duct (BFD). Non-metallic conduit encased in |
concrete shall be PVC Schedule 40, thin wall type for the BFD |
kinds. Non-metallic conduit directly buried shall be PVC |
Schedule 80, heavy wall type for the BFD kind. The Contractor *|
shall apply the conduit types shown in the contract. *|

The Contractor shall install the rigid metal conduit *|
according to Article 346 of the Code. The Contractor shall use *|
white and tinted ready-mix paint on the threads of joints. The *|
Contractor shall repair the zinc-coated surfaces according to *|
Subsection 501.03(G)(2) - Repairing of Damaged Zinc-Coated |
Surfaces.

The Contractor shall cut rigid PVC conduit with a hack- *|
saw. The Contractor shall square and trim the cut ends to *|
remove rough edges. Construction shall be of the solvent-weld
type. The Contractor shall make the solvent-weld joints *|
according to the conduit manufacturer's recommendations and as *|
accepted by the Engineer. The Engineer will permit *|
preassemblying sections of conduits. *|

The Contractor shall cut the bituminous-fiber lengths with *|
tapering tools accepted by the manufacturer. Couplings shall be
of the same material as the conduit that the couplings join. |

The Contractor shall not use such force as to damage the coupling. The Contractor shall install the ducts to drain toward either one (1) or both pullboxes or manhole. *

The Contractor shall make directional changes in non-metallic conduit runs with curved equipment using accepted deflection couplings or with short lengths of straight ducts and couplings. The deflection angle between two (2) adjacent lengths of duct shall not exceed six (6) degrees nor shall the bends give a radius of less than twelve (12) times the nominal size of the conduit unless the Contractor uses factory-made ells. *

The Contractor shall use only hand shovels in compacting the concrete jacket unless the Engineer authorizes other methods. The Contractor shall cure the concrete for at least seventy-two (72) hours before permitting vehicular traffic to run over the concrete. *

(5) **Pullbox.** The Contractor shall space the pullboxes shown in the contract or at a maximum spacing of two hundred fifty (250) feet. The Contractor shall install pullboxes with their tops one (1) inch above the surface of the surrounding grade. In concrete walks or traffic islands, the Contractor shall flush the top of the pullboxes with the surrounding grade. *

(I) **Water Service.** The Contractor shall arrange with the appropriate County Water Department for the water service. The Contractor shall pay for the water and service charges during the period of use of the sprinkler system. For water service from existing State water system, the Contractor shall install a water meter to establish the Contractor's prorated usage and cost. *

(J) **Acceptance.** The Engineer will not accept the sprinkler system until the end of the plant establishment period. The sprinkler system shall be operating according to the contract for the section the Engineer is accepting. *

The Contractor shall operate the automatic type sprinkler system in the automatic mode for at least three (3) weeks before acceptance. The Contractor shall repair the breakdowns in the system occurring during this period at no cost to the State. *

(K) **Workmanship.** The Contractor shall install materials and equipment according to the contract. The Contractor shall remove and replace material when ordered in writing at no cost to the State. *

A licensed plumbing Contractor or an experienced journeyman plumber shall do the irrigation pipe work. A Licensed Electrical Contractor or an experienced journeyman electrician shall do the electrical work. The *

616.03

contract defines plumbing and electrical work and the Contractor shall conform to "Title 16, Chapter 80, Rules Relating to Electricians and Plumbers, Chapter 448E, H.R.S.", and "Chapter 448E, H.R.S., Electricians and Plumbers".

The Contractor shall install sprinkler systems and automatic sprinkler control systems according to the contract.

616.04 Method of Measurement. The Engineer will measure the various components of said system per each or by the linear foot.

The Engineer will not measure the sprinkler system when contracted on a lump sum basis.

616.05 Basis of Payment. The Engineer will pay for the accepted sprinkler system or components of the sprinkler system at the contract unit price per each, per linear foot, or lump sum price specified in the proposal.

The Engineer will pay for the copper service laterals and copper service connections under Section 624 - Water System. The Engineer will consider the furnishing and installing of corporation stops incidental to the copper service lateral and copper service connection.

The Engineer will pay for work done by the respective County Water Supply according to Section 624 - Water System.

The Contractor shall pay for the water used before the acceptance of the project or until the termination of the maintenance period for the plantings, whichever is later.

The price shall be full compensation for furnishing and installing the sprinkler system; excavating; backfilling; installing concrete and reinforcing steel for reaction blocks, pipe sleeves in catch basins and retaining walls; connecting to existing sprinkler systems; installing pipe fittings, valve and pressure regulator boxes, service connections; making the required tests; and furnishing labors, materials, equipment, tools and incidentals necessary to complete the work.

The unit price for sprinkler head includes the riser, swing joint, fittings and other necessary items to connect to the lateral line.

The Engineer will pay for the high voltage work above thirty (30) volts on a contract lump sum basis. The price shall be full compensation for work from the electric company facilities up to the controller(s) or the State distribution panel, hookup, furnishing labors, materials, equipment, tools and incidentals necessary to complete the work.

The Engineer will pay for the low voltage work up to thirty (30) volts on a contract lump sum basis. The price shall be full compensation for work from the sprinkler control valves to the controller(s) or State distribution panel, hookup, furnishing labors, materials, equipment, tools, and incidentals necessary to complete the work.

616.05

The Engineer will make payment under:

*j

Pay Item	Pay Unit
Sprinkler System	Lump Sum
(Components of the System)	Each
(Components of the System)	Linear Foot
High Voltage Work	Lump Sum
Low Voltage Work	Lump Sum