02713
Water Distribution

This document provides design standards only, and is not intended for use, in whole or in part, as a specification. Do not copy this information verbatim in specifications or in notes on drawings. Refer questions and comments regarding the content and use of this document to the Yale University Project Manager.

CONTENTS

A. Summary

This section contains the design criteria for exterior water distribution systems. Section 15110: Valves contains the valve design criteria, and Section 15140: Domestic Water Piping contains the design criteria for internal water systems.

B. System Design and Performance Requirements

1. Place all water distribution piping a minimum of 10' horizontally and/or 18" vertically from sanitary sewer piping.
2. Bury water distribution piping at least 4' below grade.
3. All work performed within the City of New Haven right-of-way must conform to regional water authority design standards.

C. Submittals

Submit the following design and construction documents to Yale University.

1. Design Documents

a. Submit plan views of all design drawings. Profile views are not required.

b. Before starting construction, submit permits for exterior water main improvements to the regional water authority.

2. Construction Documents

a. Manufacturer specifications must conform to the standards in this section.

b. Before starting construction, forward manufacturer installation procedures and disinfection certificates to Yale University.

c. Provide a list of materials and the names and addresses of the organizations that can readily stock repair parts.

D. Product Standards

1. All water distribution pipe joints must conform to ANSI A21.10 and ANSI A21.11 standards for push-on-joint type, ductile iron pipe.
2. All water distribution pipes for underground use must conform to ANSI A-21.51 and AWWA Class 52 standards with a working pressure of not less than 150 psi, unless otherwise specified. Use cement mortar lining of standard thickness that conforms to ANSI A-21.4 or AWWA C205 standards.
3. Unless otherwise specified, all fittings must withstand a minimum pressure of 150 psi.
4. Fire hydrants must be UL listed and have:
   - A main valve opening of 5.5"
   - Two, 2.5" hose nozzles and one 4.5" pumper nozzle
   - Standard City of New Haven Fire Department threads
   - A left-hand opening nut
   - A working pressure of 175 psi

E. Accessories or Special Features

Install all fire hydrants with a gate valve on the hydrant service main.

F. Preparation

1. In conjunction with Yale University, prepare a shutdown procedure document, before starting construction, that outlines scheduling and notification requirements.
2. Contact the regional water authority when working within the City of New Haven right-of-way. A permit is required when connecting to the regional water authority.

G. Installation Guidelines

1. Mechanically tie all bends, tees, crosses, hydrants, and valves to the straight runs of water distribution pipe, using approved retaining glands and/or threaded rods and nuts.
2. Yale University will consider the use of thrust blocks in lieu of mechanical restraints. Review this design consideration with Yale University before completing the construction document.
3. Provide a uniform bedding for the pipe by placing a 4" of sand or fine gravel in the trench and tamping it. Using a material similar to the bedding, backfill the entire trench width evenly in 6" lifts to 6" above the top of the pipe. Compact the lifts to at least a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfill the remaining trench in lifts not to exceed 12" up to the sub-grade height for the surface condition encountered. Compact the lifts to a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfilling and compacting above the sub-grade must be determined by the soils engineer or by the recommended paving design for the project.

H. Quality Control

Work on exterior water distribution systems must conform to the following quality control standards.

1. Testing Laboratory

Yale University will retain the services of a qualified, independent testing laboratory to perform soil compaction tests, as directed, during construction.

2. Testing Methodology and Extent

After the trench is partially backfilled, hydrostatically test water distribution piping to 200 psi in accordance with AWWA C-600. Open and close all valves several times during the test. Any drop in pressure requires a visual inspection of all joints.

I. Cleaning and Adjusting

1. Disinfect all tested water distribution systems in accordance with AWWA C-601.
2. Dispose of all wastewater in a sanitary sewer, not in a storm sewer.

J. Startup and Training

The contractor must walk the site with Yale University personnel to verify the location and operation of all valves.

End of Section

02714
Chilled Water Distribution

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CONTENTS

A. Summary

This section contains the design criteria for exterior chilled water distribution systems. Section 15110: Valves contains the design criteria for valves. Section 15181: Hydronic Piping contains the design criteria for internal chilled water system piping.

B. System Design and Performance Requirements

Design all cathodic protection systems in collaboration with Yale University's corrosion protection consultant.

C. Submittals

Submit the following design and construction documents to Yale University.

1. Design Documents

- Plan and profile views of all design drawings
- Piping system analysis (The piping system manufacturer must analyze the piping system layout to determine pipe stresses and displacements.)

2. Construction Documents

- Copies of welding certificates

D. Product Standards

1. All work must conform to ASME standards.
2. Thrust blocking must conform to AWWA standards.

E. Manufacturers

Subject to compliance with the design requirements, use POLY-THERM chilled water lines manufactured by PERMA-PIPE, or chill-therm as manufactured by Thermacor Process, L.P. or an approved equivalent, when placing lines underground.

F. Materials

1. All internal piping must be standard weight, ASTM A53, Grade B, ERW carbon steel for Derm-Pipe product and SDR-25 PVC for chill-therm product.
2. All elbows, tees, reducers, anchors, field joints, and end seals must be designed and factory fabricated to prevent the ingress of moisture into the system.
3. Pipe insulation must be polyurethane foam with the following characteristics:
   - 2 lb/ft3 minimum density
   - 90% minimum closed cell content
   - 40 psi minimum compressive strength
   - 0.18 Btu-in/hr/ft2/°F initial thermal conductivity
4. All straight sections of pipe must be wrapped with a filament-wound, polyester resin or fiberglass-reinforced composite applied directly on the insulating foam.
5. Manufacturer must furnish all field joint insulation and jacketing materials.

G. Accessories or Special Features

1. Vents and drains must be ball valve type. Shut-off duty valves must be butterfly type.
2. Place identification ribbon above the centerline of the pipes at a depth of 18" below grade.

H. Special Requirements

Install manual air vents at high points in the piping and elsewhere, as required, for system air venting.

I. Preparation

1. Where possible, place straight, 40' lengths of pipe with the piping exposed at each end for field joint fabrication.
2. All fittings for insulation must be prefabricated to minimize field joints and jacketed in a chopped, spray-up plastic resin/fiberglass reinforcement composite. Apply the composite directly onto the insulating foam to a thickness related to the filament wound jacket thickness.
3. Bury piping at a depth of 4' to 8'.

J. Installation Guidelines

1. Pour insulation in place into all field joint areas.
2. Do not backfill until field joint areas, with heat-shrinkable adhesive-backed sleeves, have cooled.
3. All straight sections of insulated pipe must be filament wound, with plastic resin/fiberglass reinforcement composite applied directly on the insulating foam.
4. Where possible, provide a uniform pipe bedding of suitable on-site material. If suitable material is not available, backfill the trench with sand. Using a material similar to the bedding, backfill the entire trench width evenly in 6" lifts to 6" above the top of the pipe. Compact the lifts to at least a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfill the remaining trench in lifts not to exceed 12" up to the sub-grade height for the surface condition encountered. Compact the lifts to a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfilling and compacting above the sub-grade must be determined by the soils engineer or by the recommended paving design for the project.

K. Quality Control

Work on chilled water distribution systems must conform to the following quality control standards.

1. Testing Laboratory

Yale University will retain the services of a qualified, independent testing laboratory to x-ray 10% to 15% of all welded joints. The contractor must hire a testing agency, at their expense, to x-ray all welds.

2. Testing Methodology and Extent

Hydrostatically test piping to 150 psig or 1.5 times the design pressures, whichever is greater.

L. Cleaning and Adjusting

1. After hydrostatic testing, and before operational testing, thoroughly clean piping with a caustic soda, trisodium phosphate, or equivalent chemical cleaner. Thoroughly flush chilled water piping systems with clean water.
2. The contractor is responsible for chemical treatments using Yale University's chemical treatment provider.

M. Startup and Training

1. All water drained from the distribution system during testing and tie-ins must be drained to the sanitary sewer, not the storm sewer.
2. Before project completion, the contractor must walk the site with the design professional and Yale University staff to verify the location of all valves and air vents.

End of Section

02715
Steam Distribution

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CONTENTS

A. Summary

This section contains the design criteria for exterior steam distribution systems. Section 15110: Valves contains the design criteria for valves. Section 15182: Steam and Condensate Piping contains the design criteria for internal piping systems.

B. System Design and Performance Requirements

Design all underground, high-temperature steam and condensate piping for a minimum of 225°F and 15 psig.

C. Submittals

Submit the following design and construction documents to Yale University.

1. Design Documents

- Plan and profile views of all design drawings
- Calculations for expansion loop of joint design

2. Construction Documents

- Contractor welding and brazing certificates
- Insulation test reports (received from the manufacturer)
- A written report of hydrostatic test results

D. Product Standards

Steam, pumped condensate, and high-pressure trap return piping must conform to the standards contained in the latest edition of ANSI B 31.1.

E. Manufacturers

Subject to compliance with the design requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:

1. Underground, High-Temperature Steam and Condensate Piping

- PERMA-PIPE (Multi-Therm 500)
- THERMACOR (Duo-Therm “505)

2. Slip Joints and Ball Joints

- Yarway
- Advanced Thermal Systems

3. Steam Traps

- Armstrong International, Inc.
- Velan
- Spirax Sarco, Inc.
- Yarway

F. Materials

1. The piping insulation must be a thickness recommended by the manufacturer for different pipe thicknesses.
2. The outer layer of insulation for the PERMA PIPE System must be 1" thick polyurethane foam, bonded to the steel conduit and shall conform to ASTM C-591.
3. The outer jacket must be a minimum of 0.175" fiberglass (FRP), applied directly to the polyurethane insulation for the PERMA PIPE System for black, HDPE for the THERMACOR system.
4. Steel pipe must meet either ASTM A53 (seamless steel pipe) specifications or A106 (black steel pipe with plain ends) specifications depending the size of pipe.
5. Steel flanges and flanged fittings, including bolts, nuts, and gaskets, must meet ASME B16.5 requirements.
6. Condensate return piping shall be Schedule 30 PVC.

G. Accessories or Special Features

1. All end seals, gland seals, and anchors must be designed and factory prefabricated to prevent the ingress of moisture into the system.
2. All subassemblies must be designed to allow for complete draining and drying of the conduit system.
3. Anchors must be manufactured to minimize the heat transfer from the carrier pipe to the jackets.
4. The system shall be leak detection ready by means of a copper wire embedded in the foam insulation. An Ohm meter panel shall be included for continuous leak detection monitoring.

H. Special Requirements

Welding materials must meet ASME Boiler and Pressure Vessel Code requirements.

I. Installation Guidelines

1. Where possible, provide a uniform pipe bedding of suitable on-site material. If suitable material is not available, backfill the trench with sand. Using a material similar to the bedding, backfill the entire trench width evenly in 6" lifts to 6" above the top of the pipe. Compact the lifts to at least a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfill the remaining trench in lifts not to exceed 12" up to the sub-grade height for the surface condition encountered. Compact the lifts to a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfilling and compacting above the sub-grade must be determined by the soils engineer or by the recommended paving design for the project.
2. Support all pipes with the outer casing at intervals of not more than 14'. Design these supports to enable continuous airflow and in-place conduit drainage. The straight supports must be designed to occupy not more than 10% of the annular air space. Supports must be of the type where insulation thermally insulates the carrier pipe from the outer conduit. Protect the surface of the insulation at the support by a sleeve not less than 12" long, fitted with a traverse and, where required, with rotational arresters.
3. Conduit insulation must be spray-applied polyurethane foam, with a nominal density of 2 lbs/ft3 and minimum thickness of 1".

4. Install high-temperature isolation gaskets on all carrier pipe between the anchor plate and thrust collars.
5. On each side of any anchor plate, replace polyurethane foam insulation on the outer casing with calcium silicate insulation. To prevent corrosion, coat the portion of the anchor plate that protrudes through the jacket with fiberglass.
6. End and gland seals must have steel end plates protecting the insulation on the outer casing, as well as the insulation on the carrier pipe and air space. The outer jacket at the end and gland seals must be reinforced with a steel backing sleeve. Replace the polyurethane foam insulation on the outer casing with fiberglass insulation at the end plate.

J. Quality Control

Work on exterior steam distribution systems must conform to the following quality control standards.

1. Testing Laboratory

Yale University will retain the services of a qualified, independent testing laboratory to perform soil compaction tests, as directed, during construction.

2. Testing Methodology and Extent

a. Perform hydrostatic tests up to a pressure of 270 psig on high-pressure systems and 190 psig on low-pressure systems. Yale University will retain the services of a qualified testing agency to x-ray 10% to 15% of all welded joints.

b. Visually inspect pipe insulation before jacketing, then perform an x-ray inspection of the entire pipe length to detect any insulation voids.

3. Contractor and Manufacturer Requirements

a. Contractors must provide certification that their operators have met ASME Boiler and Pressure Vessel Code: Section IX, Welding and Brazing Qualifications.

b. The manufacturer must test polyurethane foam for mechanical and thermal properties.

K. Cleaning and Adjusting

After hydrostatic testing, and before operational testing, thoroughly clean piping with caustic soda, tri-sodium phosphate, or an equivalent chemical cleaner. Thoroughly flush the pipes with clean water.

L. Startup and Training

All water drained from the distribution system and the tie-ins during testing must be drained to the sanitary sewer, not the storm sewer.

End of Section

02721

Storm Sewerage Systems

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CONTENTS

A. Summary

This section contains the design criteria for exterior storm sewer systems. Section 15160: Storm Drainage Piping contains the design criteria for internal storm sewer piping.

B. System Design and Performance Requirements

1. Separate all combined sanitary and storm sewer systems as part of any new building project. Sanitary and storm sewer systems must be placed five feet from building walls. Sanitary and storm sewer system pipes must be separated by at least three feet.
2. All work with the City of New Haven right-of-way, including connection to public sewer mains, must meet City of New Haven requirements.
3. The minimum slope on all service pipes must be 0.5%.
4. All mains must be at least 12" in diameter.
5. Place at least two, but not more than five, 2" concrete adjusting rings on all storm manholes, before placing the manhole casting.
6. Stamp the words "Storm Sewer" on all manhole casting covers.
7. Install manholes wherever storm sewer pipe must bend. Clean-outs are not allowed for exterior storm sewerage.

8. All storm water management must meet State of Connecticut Department of Environmental Protection guidelines. Work within the critical area of Long Island Sound requires special approvals and design. Check whether the project falls within the critical area.
9. All storm water piping systems must conform to the 10-year, 1-hour design. Storm water management ponds must conform to the 100-year, 24-hour design.
10. Provide erosion control measures for construction activities that meet State of Connecticut Department of Environmental Protection guidelines.
11. During design, always consider removing, to the surface, the direct flow of runoff from pipes and discharge to reduce the time of concentration runoff. This design is consistent with EPA Phase II storm water rules, minimizes downstream impacts, and improves water quality treatment.

C. Submittals

Submit the following design and construction documents.

1. Design Documents

a. Submit plan and profile views of all design drawings to Yale University.

b. Submit storm water management calculations to the City of New Haven for review and approval.

c. All projects with construction activity encompassing more than one acre require a Non-Point Discharge Elimination System (NPDES) permit for construction activity from the State of Connecticut Department of Environmental Protection.

2. Construction Documents

Before starting construction, submit a list of materials, manufacturer specifications, and installation procedures to Yale University.

D. Manufacturers

Subject to compliance with the design requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the Campbell Foundry Co. (catch basin and manhole castings and covers).

E. Materials

1. All exterior storm sewer pipe must be:
   - Polyvinyl chloride (PVC) SDR 35, with gasket watertight joints, that meets the requirements of ASTM D3034
   - Class 5, reinforced concrete pipe (RCP), with gasket joints, that meets the requirements of ASTM C76
   - Heavy duty polyethylene (HDPE) pipe that meets AASHTO Specification M294, Type S and the requirements of ASTM D3350
2. All manholes must be pre-cast, reinforced concrete, with aluminum- or plastic-covered steel rungs.
3. Manhole and catch basin castings must be cast iron that meets ASTM A48, Class 25 B requirements for frames and 30 B requirements for covers.

F. Special Requirements

All force main pumps must be duplex pumps.

G. Preparation

1. In conjunction with Yale University, prepare a shutdown procedure document, before starting construction, that outlines scheduling and notification requirements.
2. When connecting to the public sewer main, contact the City of New Haven for approval. A permit is required from the city to connect to their public sewer main and for all work within the City of New Haven right-of-way.

H. Installation Guidelines

Where possible, provide a uniform pipe bedding of suitable on-site material. If suitable material is not available, backfill the trench with sand. Using a material similar to the bedding, backfill the entire trench width evenly in 6" lifts to 6" above the top of the pipe. Compact the lifts to at least a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfill the remaining trench in lifts not to exceed 12" up to the sub-grade height for the surface condition encountered. Compact the lifts to a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfilling and compacting above the sub-grade must be determined by the soils engineer or by the recommended paving design for the project.

I. Quality Control

Work on exterior storm sewer systems must conform to the following quality control standards.

1. Testing Laboratory

Yale University will retain the services of a qualified, independent testing laboratory to perform soil compaction tests, as directed, during construction.

2. Testing Methodology and Extent

A mandrel test must be performed on all non-concrete storm sewer piping before acceptance by Yale University.

J. Cleaning and Adjusting

With the participation of Yale University personnel, lamp all piping before acceptance by Yale University.

End of Section

02722

Sanitary Sewerage Systems

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CONTENTS

A. Summary

This section contains the design criteria for exterior sanitary sewer systems. Section 15150: Sanitary or Laboratory Waste and Vent Piping contains the design criteria for internal sanitary sewer system piping.

B. System Design and Performance Requirements

1. Separate all combined sanitary and storm sewer systems as part of any new building project. Sanitary and storm sewer systems must be placed five feet from building walls. Sanitary and storm sewer system pipes must be separated by at least three feet.
2. All work with the City of New Haven right-of-way, including connection to public sewer mains, must meet WPCA sanitary district requirements.
3. The minimum slope on all service pipes must be 0.4%.
4. All mains that collect more than one service line must be at least 8" in diameter.
5. All service lines from buildings must be at least 4" in diameter.
6. Place at least two, but not more than five, 2" concrete adjusting rings on all sanitary sewer system manholes, before placing the manhole castings.
7. Stamp the words "Sanitary Sewer" on all manhole casting covers.
8. Install manholes wherever sanitary sewer pipe must bend. Clean-outs are not allowed for exterior sanitary sewerage.
9. Place sanitary sewer piping at least 10' horizontally and/or 18" vertically from all water distribution lines.

C. Submittals

Submit the following design and construction documents to Yale University.

1. Design Documents

- Plan and profile views of all design drawings
- Pipe sizing calculations

2. Construction Documents

Before starting construction, submit:

- A list of materials
- Manufacturer specifications and installation procedures

D. Manufacturers

Subject to compliance with the design requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to the Campbell Foundry Co. (manhole castings and covers).

E. Materials

1. All exterior sanitary sewer pipe must be polyvinyl chloride (PVC) SDR 35, with gasket watertight joints, that meets the requirements of ASTM D3034.
2. All manholes must be pre-cast, reinforced concrete with aluminum- or plastic-covered steel rungs.
3. Manhole castings must be cast iron that meets ASTM A48, Class 25 B requirements for frames and 30 B requirements for covers.

F. Preparation

1. In conjunction with Yale University, prepare a shutdown procedure document, before starting construction, that outlines scheduling and notification requirements.
2. When connecting to the public sewer main, contact the WPCA for approval. A permit is required from the WPCA to connect to their public sewer main and for all work within the City of New Haven right-of-way.

G. Installation Guidelines

Where possible, provide a uniform pipe bedding of suitable on-site material. If suitable material is not available, backfill the trench with sand. Using a material similar to the bedding, backfill the entire trench width evenly in 6" lifts to 6" above the top of the pipe. Compact the lifts to at least a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfill the remaining trench in lifts not to exceed 12" up to the sub-grade height for the surface condition encountered. Compact the lifts to a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfilling and compacting above the sub-grade must be determined by the soils engineer or by the recommended paving design for the project.

H. Quality Control

Work on exterior sanitary sewer systems must conform to the following quality control standards.

1. Testing Laboratory

Yale University will retain the services of a qualified, independent testing laboratory to perform soil compaction tests, as directed, during construction.

2. Testing Methodology and Extent

Mandrel and exfiltration tests must be performed on all sanitary sewer system piping before acceptance by Yale University. Plugging the lower end of the pipe at a manhole, filling the upstream manhole to 4' with water, and checking for leaks constitutes an exfiltration test. Leakage cannot exceed 0.15 gal/inch per 100' of pipe for one hour.

End of Section

02825
Irrigation Systems

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CONTENTS

A. Summary

This section contains the design criteria for exterior irrigation systems.

B. System Design and Performance Requirements

1. For all projects, provide an automatic, electrically-and centrally-controlled irrigation system for all new planting areas, unless otherwise directed by Yale University.
2. The system should be designed to provide complete coverage and prevent over-spray on paving and adjacent structures.
3. The contractor must employ an experienced irrigation system designer to design the irrigation lines and sprinkler heads. The designer must determine the existing water pressure and flow available at each project location.
4. Drip type watering hoses are encouraged in planting beds.
5. Pop-up type sprinkler heads are required.
6. Base sprinkler selection and spacing on a wind velocity of 5 mph.
7. Provide a soil moisture sensor for all systems.
8. Before starting construction, submit a design drawing to Yale University for review and approval.

C. Submittals

Submit the following design and construction documents to Yale University.

1. Design Documents

a. Provide record drawings showing the location and type of all lines, heads, and valves. Use the site landscape drawing background as a base drawing to complete the record drawings. In addition, provide a reduced plan set to be left at the irrigation controller.

b. Before starting construction, the contractor must submit a list of irrigation systems designed by their irrigation system designer over the last five years.

2. Construction Documents

a. Before starting construction, submit:

- A list of materials
- Manufacturer specifications and installation procedures
- Flow and test reports

b. Provide the following operation and maintenance documentation:

- A watering log (left at the irrigation controller)
- A list of the closed suppliers for all heads, valves, and the irrigation system controller
- Two copies of an operational manual (submit upon project completion)

D. Product Standards

Provide Yale University with a product guarantee for the valves, heads, and drip lines used on the project.

E. Materials

1. All exterior irrigation pipe and fittings must be Class 200-DR 21 polyvinyl chloride (PVC) water pipe, extruded from virgin parent material, that conform to ASTM 2241 standards.
2. All sprinkler heads must be:
   - Industrial-grade
   - Full or adjustable, part-circle rotary pop-up, with a single or double nozzle
   - Driven by a hydraulic turbine-type motor or oscillating impact-type drive
   - Hydraulic valve-in-head model, normally closed
3. Automatic remote control valves must be electric solenoid-type, with globe screwed patterns, using 24 VAC, 60 Hz power with a running current of 2 W. The valve solenoids must be completely epoxy-encapsulated for positive waterproofing and must include a stainless steel shunt band. The valves must open and close slowly (in not less than 5 seconds) by means of a potential fluid resistor to avoid damage or surge pressures. All wiring in PVC conduits.
4. The automatic controller must be capable of 14-day programmability, with infinite timing from 0 to 60 seconds on each station, and no time lag between stations. The controller must be UL-listed, with a plug-in transformer using 115 VAC to 24 V circuit breaker protection. The cabinet must be lockable and waterproof.

F. Special Requirements

1. Booster pumps may be required when the existing water pressure and flow will not operate the irrigation system properly.
2. All irrigation systems must have a water meter from the City of New Haven installed on the water service line inside the building. The purchase of the meter must be part of the contractor's bid.
3. Provide an air connection (for blowing out the system) and a backflow preventer on all irrigation systems.

G. Preparation

1. If existing water to a building will be shut down to provide water for the irrigation system, the contractor, in conjunction with Yale University, must prepare a shutdown procedure document before starting construction that outlines scheduling and notification requirements.

H. Installation Guidelines

1. Where possible, provide a uniform pipe bedding of suitable on-site material. If suitable material is not available, backfill the trench with sand. Using a material similar to the bedding, backfill the entire trench width evenly in 6" lifts to 6" above the top of the pipe. Compact the lifts to at least a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfill the remaining trench in lifts not to exceed 12" up to the sub-grade height for the surface condition encountered. Compact the lifts to a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer). Backfilling and compacting above the sub-grade must be determined by the soils engineer or by the recommended paving design for the project.
2. Bury pressure irrigation lines at a minimum depth of 18". Bury non-pressure lines at a minimum depth of 12".

I. Quality Control

Work on exterior irrigation systems must conform to the following quality control standards.

1. Testing Laboratory

Yale University will retain the services of a qualified, independent testing laboratory to perform soil compaction tests, as directed, during construction.

2. Testing Methodology and Extent

Conduct a coverage test when the sprinkler system is completed.

J. Cleaning and Adjusting

With the participation of Yale University personnel, the system must be operated before acceptance by Yale University.

K. Startup and Training

1. The contractor must operate the irrigation system with Yale University staff present to observe its operation.
2. The contractor must adjust the system over a preventative maintenance period of 90 days and guarantee the system for one year upon acceptance of the system by Yale University.

End of Section