

## CM CLARIFICATION #005

April 16, 2018

### PROJECT: CNE Tahlequah Casino

Foreman Manhattan Team has added and/or revised the following CM Manual documents for review and inclusion by all contractors within their Scope Package Proposal:

1. **00 01 10 – Table of Contents**
  - a. Revised to include Revised Bid Forms
2. **00 50 00 – The following Bid Forms have been revised and re-issued with this CM Clarification #005:**
  - a. 22.01 REV1 – Underslab Mechanical and Plumbing
  - b. 26.01 REV1 – Underslab Electrical
  - c. 33.01 REV1 – Site Utilities
3. **00 60 00 – Exhibit D – Documents Listing**
  - a. Revised to include current CM Clarifications and Addendums
4. **Request for Information Response(s):**
  - a. Project RFI #001 attached.

Please Contact Tina Jones, Buyer IV with any questions:

Tina Jones

(918) 384-7802

[Tina.Jones@cnet.com](mailto:Tina.Jones@cnet.com)

- END OF CM CLARIFICATION -

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**BID PACKAGE – CNE Tahlequah Casino: SCOPE PACKAGE 22.01: – UNDERSLAB MECHANICAL AND PLUMBING**

Submitted by (Company Name per W-9 Form): \_\_\_\_\_

Provide the following *Lump Sum Proposal* as requested in accordance with all scope items listed in Scope of Work.

**1. BASE BID – UNDERSLAB MECHANICAL AND PLUMBING:** \$ \_\_\_\_\_  
- Water  
- Sanitary  
- Roof Drains  
- Beer and Beverage Lines

**2. GAS SERVICE LINE** \$ \_\_\_\_\_  
-Sheet C2.02b, Utility Plan Keynotes, Items 2.20b through 2.20h

**3. ALLOWANCE #1 - Fire Service Underslab Rough In** \$ 7,500.00

- Provide all underground fire entrance piping to main fire service riser work from a point 5'-0" outside the building line to 1' above finish floor with bolted flange complete. Inspections and pressure test to be performed by this contractor.

**TOTAL BID PLUS (1+2+3)** \$ \_\_\_\_\_

**Other Comments:**

**Contact Name:** \_\_\_\_\_

**Address:** \_\_\_\_\_  
\_\_\_\_\_

**Phone/Fax:** \_\_\_\_\_

**Email:** \_\_\_\_\_

**Signature:** \_\_\_\_\_

By acknowledging items below, bidder certifies acceptance of these documents and that all associated costs have been included in the proposal amount. Any and all exceptions/comments to these documents must be attached to this proposal. Comments or requested revisions to these documents will not be accepted after this proposal date.

TERO bidders must supply a copy of TERO Certificate, front of back

Non-Collusion Affidavit

Business Relationship Affidavit

Acknowledge all scope of work items listed under scope of work (See Exhibit A)

Acknowledge Exhibits B, C, D, E, F, G, H

Addenda Included

MCC Clarifications Included

Acknowledge and agree to Foreman Manhattan Standard Subcontract Agreement/Special Terms and Conditions as per Exhibit E

Acknowledge and agree to Manhattan General Provisions as Included in the Bid Documents

**SCHEDULE/EXPEDITING/SUBMITTALS**  
Foreman Manhattan Construction Target Schedule is attached. Please verify supplier is able to meet Foreman Manhattan required installation dates.

***\* PROJECT SCHEDULE TO BE ISSUED BY CLARIFICATION***

**Sales Tax**

All bids must be submitted exclusive of Federal Excise Tax and Oklahoma State Sales Tax. The Cherokee Nation is exempt from Oklahoma State Sales Tax and Federal Excise Tax under authority of § Okla. Stat. Supp. 1994 Section 1356. Bidder is to include and pay all other applicable sales tax and use taxes as required. Applications for payment shall be broken down as required by the Owner or Construction Manager.

Specific Project Requirements for the process, approval, and payment of Owner-Direct Payment Items (ODPI) are identified in section 00 60 09:

**EXHIBIT “G” Tax Exempt / Owner Direct Paid Invoice (ODPI) Payment Process**

**Tribal Employment Rights Office.**

SUBCONTRACTOR IS TO COMPLY WITH ALL CHEROKEE NATION, TRIBAL EMPLOYMENT RIGHTS OFFICE (TERO), NATIONAL INDIAN GAMING ASSOCIATION (NIGA), AND ALL BUREAU OF INDIAN AFFAIR'S (BIA) RULES, REGULATIONS, AND LICENSING REQUIREMENTS INCLUDING ALL FEES AND ASSESSMENTS, ASSESSMENT, APPLICABLE TO THIS PROJECT.

11.1.1 - TERO document “An Act” Legislative Act 01-14 dated February 10, 2014.  
This Document is ACT AMENDING LA 30-12, "CHEROKEE NATION EMPLOYMENT RIGHTS ACT"

11.1.2 - Subcontractors are to EXCLUDE the cost for Section; Title 40, § 1011; T.  
To assess an Employee Rights Fee of one-half (1/2) of one percent (1%) on all covered contracts. This cost will be paid by the Construction Manager.

11.1.3 - The Work Permits paragraph of the Tribal Employment Rights Office (TERO) Project Labor Agreement - Master Agreement LA 01-14 states: No person who is not a member of a federally recognized tribe shall be employed by a covered employer until he or she has obtained a work permit from the TERO at a cost of twenty-five dollars (\$25) per day, per permit. Subcontractors are to INCLUDE in their proposed price for the work, all costs associated with the twenty-five (\$25) per day work permit for every non-Indian individual employed on this project.

**Performance and Payment Bond Requirements: (Subcontractor contracts Only)**

Costs for performance and payment bonds **shall be included in your base bid and any applicable alternates or unit prices.** All exterior envelope Bid Packages (Trades) will be required to bond. In addition, all base bids, combination base Bid and including all alternates of \$100,000 or above will require Performance and Payment Bond equal to one hundred percent (100%) of the contract amount. Reference Section 00 60 04 – Exhibit B of the C.M. Bid Manual.

No obligation shall be incurred by the Owner or Foreman Manhattan Construction Team to any Bidder by reason of the issuance of these written instructions, by any notification relating to this bid, or by any act other than the execution of a written Subcontract Agreement between Foreman Manhattan Construction Team and the Bidder.

**APPLICABLE SPECIFICATIONS:**

**DIVISION 00 – Foreman Manhattan’s Construction Manager’s Bid Manual**

**Complete**

**BID PACKAGE 01 (March 6, 2018)**

DIVISION 00 – Procurement Requirements and Contracting Requirements	
00 0102 – Project Information	As Applicable
00 0105 – Geotechnical Data	As Applicable
<b>DIVISION 01 – General Requirements</b>	<b>As Applicable</b>
DIVISION 03 – CONCRETE	
03 3000 – Cast in Place Concrete	As Applicable
DIVISION 31 – EARTHWORK	
31 2000 – Earthwork	As Applicable
31 2319 – Dewatering	As Applicable
31 2500 – Erosion and Sedimentation Control	As Applicable
31 5000 – Excavation Support and Protection	As Applicable
31 6329 – Drilled Concrete Piers and Shafts	As Applicable
DIVISION 32 – SITE IMPROVEMENTS	
32 9200 – Turf and Grasses	As Applicable
DIVISION 33 – UTILITIES	
Section 33 5100 – Private Storm Sewer	As Applicable

Legends, Notes and Schedules per Plans and Specifications  
Geotechnical Engineering Report by Building & Earth Sciences, Inc. dated January 17, 2018

As Applicable  
As Applicable

**BID PACKAGE 02 (March 27, 2018)**

DIVISION 07 – THERMAL AND MOISTURE PROTECTION	
07 1300 – Sheet Waterproofing	As Applicable
07 2100 – Thermal Insulation	As Applicable
DIVISION 22 – PLUMBING	
22 1113 – Water Distribution	As Applicable
22 1313 – Private Sanitary Sewerage	As Applicable
<b>22 1316 – Sanitary Waste and Vent Piping</b>	<b>COMPLETE</b>
DIVISION 23 – HEATING, VENTING, AND AIR CONDITIONING	
23 1123 – Facility Natural Gas Piping	As Applicable
23 6500 – Closed Circuit Cooling Tower	As Applicable
23 7313 – Central Station Air Handling Units	As Applicable
23 7313.1 – Central Station Air Handling Units	As Applicable
DIVISION 26 – ELECTRICAL	
26 0519 – Low Voltage Electrical Power Conductors and Cables	As Applicable
26 0526 – Grounding and Bonding for Electrical Systems	As Applicable
26 0529 – Hangers and Supports for Electrical Systems	As Applicable
26 0533 – Raceways and Boxes for Electrical Systems	As Applicable
26 0543 – Underground Ducts and Raceways for Electrical Systems	As Applicable
26 0544 – Sleeves and Sleeve Seals for Electrical Raceways and Cabling	As Applicable
26 4113 – Lighting Protection for Structures	As Applicable
DIVISION 31 – EARTHWORK	
31 3116 – Termite Control	As Applicable

**Terminology:**

Contractor and/or Subcontractor shall mean Scope Package Bidder.  
Construction Manager (CM) shall mean Foreman Manhattan Construction Team.

**SCOPE OF WORK:**

Includes, but is not limited to, providing all the necessary labor, materials, tools, supplies, supervision, insurance, equipment, scaffolding, hoisting, fees, etc. necessary to provide the **Under Slab Mechanical and Plumbing** for the **CNE Tahlequah Casino**, Tahlequah, Oklahoma in accordance with the Contract Documents. It is further understood and agreed that this Subcontract also includes the furnishing and installation of the below listed items regardless of whether or not they are in the listed specification section(s) or any other specification section(s), or shown on the plans. This scope listing is to be used as a guideline and should not be considered as an all-inclusive list of items required to provide a complete scope of work under this proposal. Drawing and detail references are provided for reference only and are not to be considered as all inclusive of Contract Documents for the particular items referenced. (Please note: The word "provide" when used herein shall mean furnish and install completely, including all costs for labor, materials, equipment, hoisting, layout, scaffolding, ladders, staging, tools, rigging and any other appurtenances necessary to complete the Work".) Subcontractor has familiarized himself with the documents and has included those items of work shown and noted on the documents and all other equipment, devices and components that are not shown or noted, but required to provide a complete, functional and working system that is in compliance with all local codes.

1. This bid package is intended to be all inclusive of labor, material, and equipment required for the Under Slab Mechanical and Plumbing only, as required by the contract documents for a complete project.
2. Provide complete related Division 22 PLUMBING systems work complete, including but not limited to all sanitary, gas, domestic cold and hot water systems, venting, and appurtenances as required for all areas designated for construction.
3. Provide, relocate and remove upon completion, all temporary power (generators) and all required temporary light plants for work performance, safety and convenience for the work of this subcontractor, and as required to maintain required schedule.
4. Provide all survey, layout, and staking from established benchmarks as required for the performance of this subcontractor's work. The initial site control / coordinates will be provided by Manhattan Construction Company.
5. Comply with all notes on plumbing drawings.
6. Provide all building domestic water services complete including requirements on the civil documents
7. Provide all building sanitary and waste vent systems complete including requirements on the civil documents
8. Provide all building storm drainage systems / **Roof Drains** complete from +/- 5'-0" outside building and connections to site Storm Drainage system as provided by others (including any necessary reducers, fittings, couplings and / or other adapters). **Stub up at 8" AFF.**
9. Provide as may be required, any related earthwork including excavation, backfill materials, backfill, handwork, pipe bedding and compaction in accordance with Division 31 specifications and geotechnical reports. Remove and legally dispose; all excess soil, spoil, or rock from Plumbing work,

offsite. Restore all building and site sub-grades rutted or disturbed during work performance to **+/-1/2"** balanced to zero of required sub-grade elevations.

10. Provide flowable fill at any excavations under foundations, footings, or grade beams.
11. Provide all required clean-outs and architectural cover plates as required for plumbing work.
12. Provide any required seismic provisions for plumbing work.
13. Provide all required sleeves or block-outs in slabs required for this scope of work.
14. Review all drawings for any plumbing work identified therein. (E.G. Food Service troughs, floor sinks, floor drains, etc.)
15. Provide all performance and acceptance testing. Subcontractor to provide all labor, materials, supervision and equipment to facilitate the testing of all work of this subcontract.
16. Provide all necessary local and state trade permits, test and inspection fees as required for the performance of this subcontractor's work.
17. **Provide all under slab PVC carbonated beverage lines.**
18. **Provide all under slab PVC duct for Beer Lines, Carbonated Beverage Lines, as shown on Food Service Drawings.**
19. **Provide Gas Line complete by this subcontractor, coordinate with Gas Service Provider.**  
**Note: Gas Meter to be provided and installed by Gas Service Provider.**
  - a. All gas line, bends, tees, reducers required for a complete operational system.
  - b. Provide all connections and testing as required for a complete operational system.

#### GENERAL ITEMS

1. Include separate mobilizations / demobilizations as required by the Project Schedule and Phasing Plans.
2. Provide all shop drawings, product data, sample and other pertinent submittals for the work of this Subcontract. Provide engineering and printing costs for all shop drawings, coordination drawings, and product submittals for architect approval as required to properly coordinate the work included in this Subcontract with other trades. Include costs for revising and resubmitting shop/ coordination drawings as needed.
3. Subcontractor will assist Foreman Manhattan with providing material quantities and cost breakdowns as required for the Owner's and Foreman Manhattan's budget requirements. All breakouts specified in this subcontract will be used for accounting purposes and tracking only.
4. Contractor shall provide a complete installation that complies with all applicable codes, ordinances and satisfying all Authorities Having Jurisdiction.
5. Provide all field engineering and layout from benchmarks and base building control (benchmarks and baseline control is furnished by others). This Subcontractor is responsible for replacement of any damaged benchmarks, base line control or layout work of other trades/packages damaged or destroyed by the work of this work package.
6. Provide all required pedestrian protection, traffic control and protection including flagman, barricades, signage, etc. as required for the work, and as may be required for protection for equipment access, deliveries and loading.
7. Subcontractor is required to comply with requirements to control Dust and Airborne Contaminants. No waste materials or debris shall be allowed to accumulate.
8. Provide coordination, assistance, and necessary access for the Owner's furnished Testing Laboratory, including notification, obtaining samples and data gathering as required for scope of work. Costs for retesting due to failed tests and/or for Subcontractor's unpreparedness, will be paid by this Subcontractor.
9. It is mutually understood and agreed that this subcontractor will coordinate all of the scheduled deliveries of these items being furnished by others with the Foreman Manhattan designated representative. This includes the on or off site storage, staging, inventory control, and shipping to the site. All damages or shortages are to be reported within 24 hours of delivery.
10. Subcontractor agrees to be bound by the Welcome Package issued by the Foreman Manhattan Field staff.
11. **Revise paragraph 1.2.3 of section 00 60 02A Manhattan General Provisions as contained in the Construction Manager's Bid manual as follows:**  
***Until Subcontractor's obligations under this Subcontract are completely fulfilled, Subcontractor agrees not to perform any changes to the work directly for Owner or any of its tenants, or deal directly with Owner's representatives with respect to the work and/or changes to the work, in connection with the Project, unless approved in writing by Foreman Manhattan. Foreman Manhattan understands that the Owner and specifically TERO shall communicate directly with the subcontractor to maintain a spirit of cooperation and also to utilize the TERO Job Bank to the fullest extent giving first hire priority rights to Cherokee Citizens.***
12. **The Owner requirements for funding for work in progress is to provide payment less retainage of ten percent (10%), which shall be withheld and paid, without interest, upon final completion of the entire project.**



13. The terms and conditions contained in the following documents including General Provisions, Article 2.5, "Indemnification" as included within the contract documents; are incorporated herein by reference as if fully written out;
- Foreman Manhattan General Provisions 2012
  - Exhibit A – (Scope of Work)
  - Exhibit B – (Bond Forms)
  - Exhibit C – (Insurance Requirements / Sample)
  - Exhibit D – (Contract Documents)
  - Exhibit E – (Special Conditions)
  - Exhibit F – (Project Schedule)
  - Exhibit G – Tax Exempt – O.D.P.I.
  - Exhibit H – (Foreman Manhattan Additional Safety Requirements)

**SCOPE OF WORK EXCLUSIONS:**

The following items are excluded from this Subcontract:

1. Concrete housekeeping pads and bases.
2. Maintenance Building
3. Grease Interceptors
4. Painting
5. Prefabricated PVC Inlets (1 and 2/C9.25b)

**BID PACKAGE – CNE Tahlequah Casino: SCOPE PACKAGE 26.01: – UNDERSLAB ELECTRICAL**

Submitted by (Company Name per W-9 Form): \_\_\_\_\_

Provide the following *Lump Sum Proposal* as requested in accordance with all scope items listed in Scope of Work.

- |  |          |
|--|----------|
| <b>1. BASE BID – UNDERSLAB ELECTRICAL:</b>                     | \$ _____ |
| - Underslab Electrical Conduits                                |          |
| - Underslab Low Voltage Conduits                               |          |
| - Underslab Future Expansion Conduits                          |          |
| - Underslab Site Conduits                                      |          |
| <br>   |          |
| <b>2. Secondary Electric Line</b>                              | \$ _____ |
| - Sheet C2.02b, Utility Plan Keynotes, Item 2.10e              |          |
| <br>   |          |
| <b>3. Communication Line</b>                                   | \$ _____ |
| -Sheet 2.02b, Utility Plan Keynotes, Items 2.80a through 2.80e |          |
| <br>   |          |
| <b>TOTAL BID (1+2+3)</b>                                       | \$ _____ |

**Other Comments:**

Empty box for other comments.

**Contact Name:** \_\_\_\_\_

**Address:** \_\_\_\_\_

\_\_\_\_\_

**Phone/Fax:** \_\_\_\_\_

**Email:** \_\_\_\_\_

**Signature:** \_\_\_\_\_

By acknowledging items below, bidder certifies acceptance of these documents and that all associated costs have been included in the proposal amount. Any and all exceptions/comments to these documents must be attached to this proposal. Comments or requested revisions to these documents will not be accepted after this proposal date.

TERO bidders must supply a copy of TERO Certificate, front of back

**Initial:**

Non-Collusion Affidavit

**Initial:**

Business Relationship Affidavit

**Initial:**

Acknowledge all scope of work items listed under scope of work (See Exhibit A)

**Initial:**

Acknowledge Exhibits B, C, D, E, F, G, H

**Initial:**

Addenda Included

**#'s:**

MCC Clarifications Included

**#'s:**

Acknowledge and agree to Foreman Manhattan Standard Subcontract Agreement/Special Terms and Conditions as per Exhibit E

**Initial:**

Acknowledge and agree to Manhattan General Provisions as Included in the Bid Documents

**Initial:**

**SCHEDULE/EXPEDITING/SUBMITTALS**

Foreman Manhattan Construction Target Schedule is attached. Please verify supplier is able to meet Foreman Manhattan required installation dates.

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**\* PROJECT SCHEDULE TO BE ISSUED BY CLARIFICATION**

**Sales Tax**

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SUBCONTRACTOR IS TO COMPLY WITH ALL CHEROKEE NATION, TRIBAL EMPLOYMENT RIGHTS OFFICE (TERO), NATIONAL INDIAN GAMING ASSOCIATION (NIGA), AND ALL BUREAU OF INDIAN AFFAIR'S (BIA) RULES, REGULATIONS, AND LICENSING REQUIREMENTS INCLUDING ALL FEES AND ASSESSMENTS, ASSESSMENT, APPLICABLE TO THIS PROJECT.

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**Performance and Payment Bond Requirements: (Subcontractor contracts Only)**

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No obligation shall be incurred by the Owner or Foreman Manhattan Construction Team to any Bidder by reason of the issuance of these written instructions, by any notification relating to this bid, or by any act other than the execution of a written Subcontract Agreement between Foreman Manhattan Construction Team and the Bidder.

**APPLICABLE SPECIFICATIONS:**

**DIVISION 00 – Foreman Manhattan’s Construction Manager’s Bid Manual**

**Complete**

**BID PACKAGE 01 (March 6, 2018)**

DIVISION 00 – Procurement Requirements and Contracting Requirements	
00 0102 – Project Information	As Applicable
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31 2319 – Dewatering	As Applicable
31 2500 – Erosion and Sedimentation Control	As Applicable
31 5000 – Excavation Support and Protection	As Applicable
31 6329 – Drilled Concrete Piers and Shafts	As Applicable
DIVISION 32 – SITE IMPROVEMENTS	
32 9200 – Turf and Grasses	As Applicable
DIVISION 33 – UTILITIES	
Section 33 5100 – Private Storm Sewer	As Applicable

Legends, Notes and Schedules per Plans and Specifications  
Geotechnical Engineering Report by Building & Earth Sciences, Inc. dated January 17, 2018

As Applicable  
As Applicable

**BID PACKAGE 02 (March 27, 2018)**

DIVISION 07 – THERMAL AND MOISTURE PROTECTION	
07 1300 – Sheet Waterproofing	As Applicable
07 2100 – Thermal Insulation	As Applicable
DIVISION 22 – PLUMBING	
22 1113 – Water Distribution	As Applicable
22 1313 – Private Sanitary Sewerage	As Applicable
22 1316 – Sanitary Waste and Vent Piping	As Applicable
DIVISION 23 – HEATING, VENTING, AND AIR CONDITIONING	
23 1123 – Facility Natural Gas Piping	As Applicable
23 6500 – Closed Circuit Cooling Tower	As Applicable
23 7313 – Central Station Air Handling Units	As Applicable
23 7313.1 – Central Station Air Handling Units	As Applicable
DIVISION 26 – ELECTRICAL	
26 0519 – Low Voltage Electrical Power Conductors and Cables	As Applicable
26 0526 – Grounding and Bonding for Electrical Systems	As Applicable
26 0529 – Hangers and Supports for Electrical Systems	As Applicable
26 0533 – Raceways and Boxes for Electrical Systems	As Applicable
<b>26 0543 – Underground Ducts and Raceways for Electrical Systems</b>	<b>COMPLETE</b>
26 0544 – Sleeves and Sleeve Seals for Electrical Raceways and Cabling	As Applicable
26 4113 – Lighting Protection for Structures	As Applicable
DIVISION 31 – EARTHWORK	
31 3116 – Termite Control	As Applicable

**Terminology:**

Contractor and/or Subcontractor shall mean Scope Package Bidder.  
Construction Manager (CM) shall mean Foreman Manhattan Construction Team.

**SCOPE OF WORK:**

Includes, but is not limited to, providing all the necessary labor, materials, tools, supplies, supervision, insurance, equipment, scaffolding, hoisting, fees, etc. necessary to provide the **Under Slab Electrical** for the **CNE Tahlequah Casino**, Tahlequah, Oklahoma in accordance with the Contract Documents. It is further understood and agreed that this Subcontract also includes the furnishing and installation of the below listed items regardless of whether or not they are in the listed specification section(s) or any other specification section(s), or shown on the plans. This scope listing is to be used as a guideline and should not be considered as an all-inclusive list of items required to provide a complete scope of work under this proposal. Drawing and detail references are provided for reference only and are not to be considered as all inclusive of Contract Documents for the particular items referenced. (Please note: The word “provide” when used herein shall mean furnish and install completely, including all costs for labor, materials, equipment, hoisting, layout, scaffolding, ladders, staging, tools, rigging and any other appurtenances necessary to complete the Work’.) Subcontractor has familiarized himself with the documents and has included those items of work shown and noted on the documents and all other equipment, devices and components that are not shown or noted, but required to provide a complete, functional and working system that is in compliance with all local codes.

1. This bid package is intended to be all inclusive of labor, material, and equipment required for the Under Slab Electrical only, as required by the contract documents for a complete project.
2. Provide all required local, State and Federal trade permits and pay required fees as required for the performance of this subcontractor’s work.
3. Provide all underground and under-floor ducts and raceways, complete.
4. Provide, relocate and remove upon completion, all temporary power (generators) and all required temporary light plants for work performance, safety and convenience for the work of this subcontractor, and as required to maintain required schedule.
5. Provide all taping, flashings, etc. protection, etc. as required around perimeter of electrical rough-in components for air, moisture, weather, acoustical, fire resistance, etc., as required.
6. Comply with all notes and details on electrical drawings.
7. Provide all survey, layout, and staking from established benchmarks as required for the performance of this subcontractor’s work. The initial site control / coordinates will be provided by Foreman Manhattan.
8. Review Food Service drawings for any required in-slab electrical rough in required for Food Service equipment and items.
9. Provide under slab empty electrical conduits with 6” stub ups at each end as shown on electrical drawings; **including but not limited to:**
  - a) E 1.1: 1-1/4” under slab conduit from Service Station 18 to panel ‘TCSP5’ (Room 36 Electrical)
  - b) E 1.1: 1” under slab conduit at Lounge 16.

- c) EFS112: Sheet Notes 1 and 2, under slab conduits as noted in the Kitchen
  - d) EFS113: Sheet Notes 1 and 2, under slab conduits as noted in the Kitchen
  - e) EFS115: Sheet Notes 1, under slab conduits as noted in the Kitchen
  - f) ES1.0A: 4 inch under slab conduit from 5' outside the building IMF Room, stub up 8" AFF
10. Provide under slab conduits shown on ITS101 and ITS 102 Low Voltage Conduit Plans.
  11. Provide required underground / under slab sleeves, Raceways, and conduits required at the Fire Riser Room 34, Emergency Electrical 35, Electrical Room 36 and outdoor equipment yard.
  12. Provide Two (2ea) conduits, plus Two (2ea) Spare Conduits, for a total of Four (4ea) 2 inch conduits from Main Service Switchboard 'TCMSA' location, straight West under the building slab, to stub up 5' outside the building on the west face, near the circle drive. These conduits will serve the entry signs (not in this bid package), and other exterior building components. Ref Sheet ES1.0.
  13. Provide Secondary Electrical Extension from the main service switchboard location to the Maintenance Building, complete by this subcontractor. Ref C2.02b, Utility Plan Keynotes, Item 2.10e. Provide all raceways, conductors for a complete system.  
Note: Primary Electric Extension to be completed by Electrical Service Provider (not in this Contractor's Scope).

#### GENERAL ITEMS

1. Include separate mobilizations / demobilizations as required by the Project Schedule and Phasing Plans.
2. Provide all shop drawings, product data, sample and other pertinent submittals for the work of this Subcontract. Provide engineering and printing costs for all shop drawings, coordination drawings, and product submittals for architect approval as required to properly coordinate the work included in this Subcontract with other trades. Include costs for revising and resubmitting shop/ coordination drawings as needed.
3. Subcontractor will assist Foreman Manhattan with providing material quantities and cost breakdowns as required for the Owner's and Foreman Manhattan's budget requirements. All breakouts specified in this subcontract will be used for accounting purposes and tracking only.
4. Contractor shall provide a complete installation that complies with all applicable codes, ordinances and satisfying all Authorities Having Jurisdiction.
5. Provide all field engineering and layout from benchmarks and base building control (benchmarks and baseline control is furnished by others). This Subcontractor is responsible for replacement of any damaged benchmarks, base line control or layout work of other trades/packages damaged or destroyed by the work of this work package.
6. Provide all required pedestrian protection, traffic control and protection including flagman, barricades, signage, etc. as required for the work, and as may be required for protection for equipment access, deliveries and loading.
7. Subcontractor is required to comply with requirements to control Dust and Airborne Contaminants. No waste materials or debris shall be allowed to accumulate.
8. Provide coordination, assistance, and necessary access for the Owner's furnished Testing Laboratory, including notification, obtaining samples and data gathering as required for scope of work. Costs for retesting due to failed tests and/or for Subcontractor's unpreparedness, will be paid by this Subcontractor.
9. It is mutually understood and agreed that this subcontractor will coordinate all of the scheduled deliveries of these items being furnished by others with the Foreman Manhattan designated representative. This includes the on or off site storage, staging, inventory control, and shipping to the site. All damages or shortages are to be reported within 24 hours of delivery.
10. Subcontractor agrees to be bound by the Welcome Package issued by the Foreman Manhattan Field staff.
11. **Revise paragraph 1.2.3 of section 00 60 02A Manhattan General Provisions as contained in the Construction Manager's Bid manual as follows:**  
**Until Subcontractor's obligations under this Subcontract are completely fulfilled, Subcontractor agrees not to perform any changes to the work directly for Owner or any of its tenants, or deal directly with Owner's representatives with respect to the work and/or changes to the work, in connection with the Project, unless approved in writing by Foreman Manhattan. Foreman Manhattan understands that the Owner and specifically TERO shall communicate directly with the subcontractor to maintain a spirit of cooperation and also to utilize the TERO Job Bank to the fullest extent giving first hire priority rights to Cherokee Citizens.**
12. **The Owner requirements for funding for work in progress is to provide payment less retainage of ten percent (10%), which shall be withheld and paid, without interest, upon final completion of the entire project.**
13. The terms and conditions contained in the following documents including General Provisions, Article 2.5, "Indemnification" as included within the contract documents; are incorporated herein by reference as if fully written out;
  - Foreman Manhattan General Provisions 2012
  - Exhibit A – (Scope of Work)
  - Exhibit B – (Bond Forms)
  - Exhibit C – (Insurance Requirements / Sample)
  - Exhibit D – (Contract Documents)
  - Exhibit E – (Special Conditions)
  - Exhibit F – (Project Schedule)
  - Exhibit G – Tax Exempt – O.D.P.I.
  - Exhibit H – (Foreman Manhattan Additional Safety Requirements)

**SCOPE OF WORK EXCLUSIONS:**

The following items are excluded from this Subcontract:

1. Concrete housekeeping pads and bases.
2. Maintenance Building
3. Painting
4. Site Electrical / Site Lighting
5. Site CCTV
6. Electrical Equipment, such as Distribution Panels, Switchboards, UPS, Generators, Transformers,
7. Conductors
8. Casino Floor Junction Boxes

**BID PACKAGE – CNE Tahlequah Casino: SCOPE PACKAGE 33.01: – SITE UTILITIES**

Submitted by (Company Name per W-9 Form): \_\_\_\_\_

Provide the following *Lump Sum Proposal* as requested in accordance with all scope items listed in Scope of Work.

**1. Bid Package 02 Storm Sewer System** \$ \_\_\_\_\_

-Sheet 2.02b, Utility Plan Keynotes, Item 2.50b, Sheet 5.02b Storm Sewer Index

**2. Sanitary Sewer Line** \$ \_\_\_\_\_

-Sheet 2.02b, Utility Plan Keynotes, Items 2.60a and 2.60b, Sheet 6.02b Sanitary Sewer Index

**3. Water Line** \$ \_\_\_\_\_

-Sheet 2.02b, Utility Plan Keynotes, Items 2.70a through 2.70e, Sheet 7.02b Water Index

**TOTAL (1+2+3):** \$ \_\_\_\_\_

**UNIT PRICING:**

**UP-001:** Provide additional mobilization unit price (base bid assumes 2ea):

\$ \_\_\_\_\_ / per Mobilization

**UP-002:** Provide select fill including delivery and compaction in-place:

\$ \_\_\_\_\_ / Cubic Yard

**UP-003:** Over excavate, remove, haul off and legally dispose, replace sub grade with approved materials, scarify, moisture condition and compact in accordance with specification and soils report for any inadequate sub-grade surfaces:

\$ \_\_\_\_\_ / Cubic Yard

**UP-004:** Provide aggregate base in-place for all adjustments including delivery and compaction in-place:

\$ \_\_\_\_\_ / Cubic Yard



**UP-006:** - Provide the following Unit Rates to be used during the project for any Additional Changes, Scope Changes or Time and Material Work. Rates Shall be guaranteed through February 28, 2019 and shall include all required tools/equipment (Valued < \$5,000). Transportation, jobsite trucks, burden and any other required items.

<b>Classification</b>	<b>Straight Time (\$Hour)</b>	<b>Overtime (\$Hour)</b>
Operator		
Labor – Foreman		
Labor – Journeyman		
Labor- Apprentice		
Equipment – Bobcat or Skid Steer		
Equipment – Small Excavator < 2500 lbs		
Equipment - Medium Excavator between 2,500 lbs and 4,500 lbs		
Equipment – Large Excavator > 4,500 lbs		
Equipment – Medium Bull Dozer		
Equipment – Large Bull Dozer		

**Other Comments:**

**Contact Name:** \_\_\_\_\_

**Address:** \_\_\_\_\_

\_\_\_\_\_

**Phone/Fax:** \_\_\_\_\_

**Email:** \_\_\_\_\_

**Signature:** \_\_\_\_\_

By acknowledging items below, bidder certifies acceptance of these documents and that all associated costs have been included in the proposal amount. Any and all exceptions/comments to these documents must be attached to this proposal. Comments or requested revisions to these documents will not be accepted after this proposal date.

TERO bidders must supply a copy of TERO Certificate, front of back

**Initial:**

Non-Collusion Affidavit

**Initial:**

Business Relationship Affidavit

**Initial:**

Acknowledge all scope of work items listed under scope of work (See Exhibit A)

**Initial:**

Acknowledge Exhibits B, C, D, E, F, G, H

**Initial:**

Addenda Included

**#'s:**

MCC Clarifications Included

**#'s:**

Acknowledge and agree to Foreman Manhattan Standard Subcontract Agreement/Special Terms and Conditions as per Exhibit E

**Initial:**

Acknowledge and agree to Manhattan General Provisions as Included in the Bid Documents

**Initial:**

**SCHEDULE/EXPEDITING/SUBMITTALS**

Foreman Manhattan Construction Target Schedule is attached. Please verify supplier is able to meet Foreman Manhattan required installation dates.

**Initial:**

**\*PROJECT SCHEDULE TO BE ISSUED BY CLARIFICATION**

**Sales Tax**

All bids must be submitted exclusive of Federal Excise Tax and Oklahoma State Sales Tax. The Cherokee Nation is exempt from Oklahoma State Sales Tax and Federal Excise Tax under authority of § Okla. Stat. Supp. 1994 Section 1356. Bidder is to include and pay all other applicable sales tax and use taxes as required. Applications for payment shall be broken down as required by the Owner or Construction Manager.

Specific Project Requirements for the process, approval, and payment of Owner-Direct Payment Items (ODPI) are identified in section 00 60 09:

**EXHIBIT “G” Tax Exempt / Owner Direct Paid Invoice (ODPI) Payment Process**

**Tribal Employment Rights Office.**

SUBCONTRACTOR IS TO COMPLY WITH ALL CHEROKEE NATION, TRIBAL EMPLOYMENT RIGHTS OFFICE (TERO), NATIONAL INDIAN GAMING ASSOCIATION (NIGA), AND ALL BUREAU OF INDIAN AFFAIRS (BIA) RULES, REGULATIONS, AND LICENSING REQUIREMENTS INCLUDING ALL FEES AND ASSESSMENTS, ASSESSMENT, APPLICABLE TO THIS PROJECT.

11.1.1 - TERO document “An Act” Legislative Act 01-14 dated February 10, 2014.  
This Document is ACT AMENDING LA 30-12, "CHEROKEE NATION EMPLOYMENT RIGHTS ACT"

11.1.2 - Subcontractors are to EXCLUDE the cost for Section; Title 40, § 1011; T.  
To assess an Employee Rights Fee of one-half (1/2) of one percent (1%) on all covered contracts. This cost will be paid by the Construction Manager.

11.1.3 - The Work Permits paragraph of the Tribal Employment Rights Office (TERO) Project Labor Agreement - Master Agreement LA 01-14 states: No person who is not a member of a federally recognized tribe shall be employed by a covered employer until he or she has obtained a work permit from the TERO at a cost of twenty-five dollars (\$25) per day, per permit. Subcontractors are to INCLUDE in their proposed price for the work, all costs associated with the twenty-five (\$25) per day work permit for every non-Indian individual employed on this project.

**Performance and Payment Bond Requirements: (Subcontractor contracts Only)**

Costs for performance and payment bonds **shall be included in your base bid and any applicable alternates or unit prices.** All exterior envelope Bid Packages (Trades) will be required to bond. In addition, all base bids, combination base Bid and including all alternates of \$100,000 or above will require Performance and Payment Bond equal to one hundred percent (100%) of the contract amount. Reference Section 00 60 04 – Exhibit B of the C.M. Bid Manual.

No obligation shall be incurred by the Owner or Foreman Manhattan Construction Team to any Bidder by reason of the issuance of these written instructions, by any notification relating to this bid, or by any act other than the execution of a written Subcontract Agreement between Foreman Manhattan Construction Team and the Bidder.

**APPLICABLE SPECIFICATIONS:**

**DIVISION 00 – Foreman Manhattan’s Construction Manager’s Bid Manual**

**Complete**

**BID PACKAGE 01 (March 6, 2018)**

DIVISION 00 – Procurement Requirements and Contracting Requirements	
00 0102 – Project Information	As Applicable
00 0105 – Geotechnical Data	As Applicable
<b>DIVISION 01 – General Requirements</b>	<b>As Applicable</b>
DIVISION 03 – CONCRETE	
03 3000 – Cast in Place Concrete	As Applicable
DIVISION 31 – EARTHWORK	
31 2000 – Earthwork	As Applicable
31 2319 – Dewatering	As Applicable
31 2500 – Erosion and Sedimentation Control	As Applicable
31 5000 – Excavation Support and Protection	As Applicable
31 6329 – Drilled Concrete Piers and Shafts	As Applicable
DIVISION 32 – SITE IMPROVEMENTS	
32 9200 – Turf and Grasses	As Applicable
DIVISION 33 – UTILITIES	
Section 33 5100 – Private Storm Sewer	As Applicable

Legends, Notes and Schedules per Plans and Specifications  
Geotechnical Engineering Report by Building & Earth Sciences, Inc. dated January 17, 2018

As Applicable  
As Applicable

**BID PACKAGE 02 (March 27, 2018)**

DIVISION 07 – THERMAL AND MOISTURE PROTECTION	
07 1300 – Sheet Waterproofing	As Applicable
07 2100 – Thermal Insulation	As Applicable
DIVISION 22 – PLUMBING	
<b>22 1113 – Water Distribution</b>	<b>COMPLETE</b>
<b>22 1313 – Private Sanitary Sewerage</b>	<b>COMPLETE</b>
22 1316 – Sanitary Waste and Vent Piping	As Applicable
DIVISION 23 – HEATING, VENTING, AND AIR CONDITIONING	
<b>23 1123 – Facility Natural Gas Piping</b>	<b>As Applicable</b>
23 6500 – Closed Circuit Cooling Tower	As Applicable
23 7313 – Central Station Air Handling Units	As Applicable
23 7313.1 – Central Station Air Handling Units	As Applicable
DIVISION 26 – ELECTRICAL	
26 0519 – Low Voltage Electrical Power Conductors and Cables	As Applicable
26 0526 – Grounding and Bonding for Electrical Systems	As Applicable
26 0529 – Hangers and Supports for Electrical Systems	As Applicable
26 0533 – Raceways and Boxes for Electrical Systems	As Applicable
26 0543 – Underground Ducts and Raceways for Electrical Systems	As Applicable
26 0544 – Sleeves and Sleeve Seals for Electrical Raceways and Cabling	As Applicable
26 4113 – Lighting Protection for Structures	As Applicable
DIVISION 31 – EARTHWORK	
31 3116 – Termite Control	As Applicable

Terminology:

Contractor and/or Subcontractor shall mean Scope Package Bidder.  
Construction Manager (CM) shall mean Foreman Manhattan Construction Team.

**SCOPE OF WORK:**

Includes, but is not limited to, providing all the necessary labor, materials, tools, supplies, supervision, insurance, equipment, scaffolding, hoisting, fees, etc. necessary to provide the **Site Utilities** for the **CNE Tahlequah Casino**, Tahlequah, Oklahoma in accordance with the Contract Documents. It is further understood and agreed that this Subcontract also includes the furnishing and installation of the below listed items regardless of whether or not they are in the listed specification section(s) or any other specification section(s), or shown on the plans. This scope listing is to be used as a guideline and should not be considered as an all-inclusive list of items required to provide a complete scope of work under this proposal. Drawing and detail references are provided for reference only and are not to be considered as all inclusive of Contract Documents for the particular items referenced. (Please note: The word “provide” when used herein shall mean furnish and install completely, including all costs for labor, materials, equipment, hoisting, layout, scaffolding, ladders, staging, tools, rigging and any other appurtenances necessary to complete the Work.”) Subcontractor has familiarized himself with the documents and has included those items of work shown and noted on the documents and all other equipment, devices and components that are not shown or noted, but required to provide a complete, functional and working system that is in compliance with all local codes.

1. This bid package is intended to be all inclusive of labor, material, and equipment required for the Site Utilities as required by the contract documents for a complete project.
2. Provide all **BID PACKAGE 2 ONLY Site Storm Water Utility System** work including all connections complete as indicated and required to make complete and operable systems. Work is to include all systems to within 5'-0" of building including connections unless pipe exits into gas/oil separator or grease waste interceptor, then Contractor shall connect to discharge side of separator/interceptor and pipe to discharge location. The work associated with this item is to include but not limited to:
  - a) All pipe, borings and sleeves, fittings, valves, and associated accessories for storm lines.
  - b) Provide all storm water utility and sub-drainage discharge work including all connections from +/- 5'-0" outside buildings (reference plumbing documents) or from discharge (exit) locations of gas/oil separators including connections, to storm system. Actual foundation drains and building exit piping to 5'-0" outside building line is by others.
  - c) Make all connections to existing utility structures and existing lines including coordination with utility Service Companies.
  - d) All taps and connections not provided by utility agencies or as part of permits and fees.
  - e) All structures and pipe
  - f) Rip rap & filter fabric at outlets
  - g) Connection to roof drains. Connection to be made at 5' from building.
  - h) Cast Iron Trench Drains (1 and 2 / C9.25b) (C5.02b, Item 1.05f)

3. Provide all Site Sanitary Sewer systems complete including all connections in accordance with contract documents. Work is to include all systems to within 5'-0" of building unless pipe exits into gas/oil separator or grease waste interceptor, then Contractor shall connect to discharge side of separator/interceptor and pipe to discharge location. The work associated with this item is to include, but is not necessarily limited to, the following:
  - a. All pipe, borings and sleeves, fittings, valves, and associated accessories for sanitary sewer lines. Seal piping penetrations to sleeves at both ends as required.
  - b. All force mains (upstream of lift station), lift stations, wet wells, pumping equipment and controls (turnkey) including force main discharge to existing structure. (Electrical Power by others).
  - c. Provide all connections as indicated on documents to Utility services including connection to services) to existing lines, and connections to structures.
  - d. Provide required taps & sleeves, valves and appurtenances, clean-outs, valve boxes, etc. not provided by utility agencies or part of permits and associated fees.
  - e. Provide all structures, manholes, inlets, drains, frames, gratings, collars, clean-outs, concrete aprons, marking tape/trace wires, bollards, pads and any and all other requirements necessary for a complete, operable and approved system as indicated in documents
4. Provide all Water Lines, Complete to within 5' of the Building, including but not limited to below items:
  - a. Water lines A, B, C, D
  - b. Prop 6" PVC Fire Supply Line
  - c. Prop 4" PVC FDC Line
  - d. All vaults, manholes, and associated concrete structures.
  - e. All fire hydrants, fire department connections, post indicator valves, etc.
  - f. All valves
  - g. All water meters
  - h. All backflow preventers or reduced pressure zone devices
  - i. Air release valves and associated vaults, manholes, or access holes
  - j. All associated tapping
5. Provide all required concrete structures, vaults, etc. for utilities included in this package. Including but not limited to water meter and backflow preventer vaults.
6. Provide all precast and cast-in-place concrete manholes.
7. Provide all cleaning, flushing, testing and certification as required by Contract Documents and prevailing jurisdictions.
8. Provide temporary bracing, shoring for all utility work as required.
9. Provide all saw cutting of the work as required.
10. Provide all trenching, excavation and acceptable backfill, including pipe beddings and cover, Flowable fills. Etc. for all Storm Sewer system lines as indicated or required.
11. Note: ref. all general information notes and legends for additional requirements.
12. Note: this contractor is considered a secondary permittee and all requirements of a secondary permittee are the responsibility of this contractor.
13. All required utility site clearing and earthwork as required for installation of required utilities. All waste, debris, and demolished items to be removed from site and legally disposed.
14. Provide all related cutting, patching, and repair as required for work in accordance with documents, Owner, CM, and jurisdictional entities. Provide patching of all pavements and components whether new, existing, or temporary, including curb/gutter and sidewalk in accordance with documents.
15. Remove, relocate, and reinstall all temporary fencing and gates (installed by others) as required to perform work of this contract. Note: Contractor shall make every effort to remove, relocate and reinstall temporary fencing and gates without damage. All damage resulting from relocation of fencing will be to the account of this contractor.
16. Provide sod and necessary amendments for all areas disturbed by work of this contract. Permanent sodding for all areas to be sodded indicated on Landscape drawings, is by others.
17. Provide all Utility system(s) earthwork in accordance with documents including Geotechnical Engineering Report, all as required per tolerances per documents but no more than +/- 1/10 foot of new finished grade elevations or existing grades as scheduled.
18. Provide all temporary trench protection measures including sheeting, shoring, and sloping as required for the work of this package and as required by OSHA, including any temporary fencing. Provide all engineering and calculations as required for trenching, shoring, sheeting, sloping, and plating.
19. Open excavations shall be barricaded and protected at all times as required by OSHA, the Owner, or any authorities having jurisdiction. Provide temporary bracing and hangers for new, existing or temporary utilities as necessary to perform the work including for backfill operations.
20. Backfill all utilities, bore pits, etc. with approved materials. Remove and legally dispose all boring mud from site. Contractor shall be responsible to re-establish all existing grades disturbed by work including replacement and maintenance of new sod, plantings, and irrigation systems as required at disturbed areas not to be reworked.
21. Provide temporary plating where necessary to allow vehicular/pedestrian traffic crossing over open trenches.
22. Provide all dewatering system(s) and pump / bale equipment and accessories required for proper water discharge to perform the Work. Additionally, remove muck/spoil from all areas immediately. Additionally, restore grade with new materials if rutted or damaged by dewatering/pump/bale operations. Dewatering and Adequate pump/bale equipment and accessories shall be on the project at all times during performance of the Work.
  - a) Dewatering equipment shall be on the project at all times during performance of the work including (e.g. portable generators, piping, etc.) Additionally, remove muck and spoil from all areas immediately. Additionally, restore grade with new materials if rutted or damaged.

23. All waste concrete and concrete truck washouts is to be confined to an area as approved in writing by the Construction Manager. Remove and dispose on weekly bases all washout and waste material from site and legally dispose. Washout shall be confined to plywood box with filter media. Boxes shall be cleaned weekly of all debris, waste and removed from site. Restore all areas to original condition upon removal.
24. Provide all traffic control measures (vehicular and pedestrian), safety and security protection as needed to complete the work. This is to include all barricades, fencing, flagging, signage, flagmen, temporary striping, removal of striping, cones, or other necessary measures required to complete the work. Coordinate with CM and get approvals for placement locations of all items.
25. Provide traffic control plans, job hazard analysis, and all relevant safety notices prior to start of work.
26. Provide all field surveying, engineering, layout and staking as required from established benchmarks.
27. Bidders shall include general cleanup of debris created by work scope, as directed. Trash shall be deposited in project dumpsters provided by others.
28. All waste generated other than from general clean-up debris shall be removed and legally disposed from site by this Contractor. (Not to be deposited into project dumpsters described above).
29. Clean streets as required such that roadways required to remain operational during performance of the work remain clean at all times. Provide street sweeper equipment during performance of this work at all times and ready for use. Note: equipment must not create dust during street cleaning operations.
30. Provide dust and noise control as required by the contract documents, governing authorities and as required by the Construction Manager during the performance of this subcontractors work.
31. Provide all necessary means for the complete and proper protection of adjacent surfaces. Damage caused by work of this contract to adjacent surfaces/structures shall be repaired at this Subcontractors expense.
32. Provide shut-down, safe-off, capping, temporary caps or plugs as required for demolition work.
33. Provide a complete installation that complies with all applicable codes, ordinances and satisfying all Authorities Having Jurisdiction.
34. Contractor shall be cognizant and recognize that various utilities, mechanical, plumbing, high and low voltage electrical and communication services will be required to be maintained operational during construction of the project in this same area, and contractor shall include all protection, barriers, partitions, etc.; provide all hand, loading and removal of waste debris and import of new materials as required so as to maintain operation of all existing components to remain, during and until new construction is complete.
35. Disposal of all hazardous waste and demolition debris shall be in licensed sanitary landfills. Contractor shall keep and submit to the Construction Manager the following work day, a copy of the previous days manifest and all dump receipts corresponding to each manifest.
36. Provide all required permits and pay required fees for all Municipal and jurisdictions having authority including for demolition, hazardous waste removal, and waste and debris disposal.
37. All utility systems are to be installed per governing authorities and shall include all utility company service and installation charges, permits and costs thereof, cleaning and sterilization, testing, inspections and required earthwork for burial, piping and fittings, connection, devices, etc. as required for complete services.
38. Contractor shall be responsible to re-establish all existing grades disturbed by Work including replacement and maintenance of new sod, plantings, and irrigation systems as required at disturbed areas outside the limits of construction.
39. Adjust all existing utility structures (vaults, valve boxes, manholes, junction boxes, clean-outs, inlets (both area and curb) to match new finish grade contours, as required..
40. All utility work shall comply with all Utility Companies and/or other authorities having jurisdictional complete including all required appurtenances, structures and apparatus.
41. Provide all warning tapes as indicated per applicable specifications.
42. Provide, relocate and remove upon completion, all temporary power (generators) and all required temporary lighting for work performance, safety and convenience for the work of this subcontractor, and as required to maintain required schedule.
43. Provide all field engineering and layout from benchmarks and base building control (benchmarks and baseline control is furnished by others). This Subcontractor is responsible for replacement of any damaged benchmarks, base line control or layout work of other trades/packages damaged or destroyed by the work of this work package.
44. Provide all patching of existing concrete /asphalt damaged during construction.
45. Provide all Utility system Earthwork including excavation, backfill, backfill materials, hand work, and compaction in accordance with the contract documents and Geotechnical Engineering Report including all Addenda. Provide all backfill, compaction, fine grade, etc. Note: all back-fill under any paved surface to be aggregate as indicated and specified.
46. Coordinate all work with utility companies/agencies and CM as required. Where utility cutting, capping, or plugging is required, perform such work in accordance with requirements of the utility company or governmental agency having jurisdiction.
47. Provide required provisions per EPA guidelines for Storm Water Pollution control as applicable to utility systems, and/or as required.
48. Provide all related pumping, bailing, discharge and maintenance thereof including temporary drainage requirements for control of run-off and the prevention of ponding and repair to resulting damaged sub-grades.
49. Authorized Subcontractor supervision must be onsite while work is being performed.
50. Provide coordination, assistance, and necessary access for the Owner's furnished Testing Laboratory, including notification, obtaining samples and data gathering as required for scope of work. Costs for retesting due to failed tests and/or for Subcontractor's unpreparedness, will be paid by this Subcontractor.
51. Subcontractor will assist CM with providing material quantities and cost breakdowns as required for the Owner's and CM's budget requirements. All breakouts will be used for accounting purposes and tracking only.

**GENERAL ITEMS**

1. Include separate mobilizations / demobilizations as required by the Project Schedule and Phasing Plans.



2. Provide all shop drawings, product data, sample and other pertinent submittals for the work of this Subcontract. Provide engineering and printing costs for all shop drawings, coordination drawings, and product submittals for architect approval as required to properly coordinate the work included in this Subcontract with other trades. Include costs for revising and resubmitting shop/ coordination drawings as needed.
3. Subcontractor will assist Foreman Manhattan with providing material quantities and cost breakdowns as required for the Owner's and Foreman Manhattan's budget requirements. All breakouts specified in this subcontract will be used for accounting purposes and tracking only.
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  - Exhibit G – Tax Exempt – O.D.P.I.
  - Exhibit H – (Foreman Manhattan Additional Safety Requirements)

**SCOPE OF WORK EXCLUSIONS:**

The following items are excluded from this Subcontract:

1. Masonry rebar or grouting.
2. Joint sealants.
3. Furnishing of embeds; anchor bolts and/or anchor bolt assemblies.
4. Mass Excavation for Building Pad and Site work
5. Site Concrete
6. Sidewalks
7. Maintenance Building
8. Grease Interceptors
9. Storm Sewer in Bid Package 01 Drawings and Specs (By Others)
10. Primary Electric Service
11. Secondary Electric Extension
12. Bid Package 1 Storm Sewer (Line 2.50a – By Others)
13. Natural Gas Service Line
14. Communications Service Line

1. The Subcontract Agreement (including all attached and referenced Exhibits).
2. Manhattan General Provisions.
3. The Agreement between Manhattan and the Owner ("Agreement").
4. General Conditions of the Contract.
5. Supplementary and other Conditions.
6. Exhibits and Riders enumerated and attached to the Agreement.
7. All Addenda issued prior to and all modifications issued after execution of the Agreement.
8. Alternates as selected and incorporated herein.
9. Unit Prices.
10. Plans and Specifications as follows:

**BIDDING & CONTRACTING REQUIREMENTS:** Bid and Contracting Manual, as prepared by Manhattan Construction, dated March 29, 2018

**GEOTECH REPORT:** CNE Tahlequah Casino as prepared by Building & Earth (*Project No. OK170293*) dated January 17<sup>th</sup>, 2018

**SPECIFICATIONS:**

CNE Tahlequah Casino Bid Package 01: As prepared by James R. Childers dated March 6<sup>th</sup>, 2018

CNE Tahlequah Casino Bid Package 02: As prepared by James R. Childers dated March 27<sup>th</sup>, 2018

**DRAWINGS:**

CNE Tahlequah Casino Bid Package 01: As prepared by James R. Childers dated March 6<sup>th</sup>, 2018

CNE Tahlequah Casino Bid Package 02: As prepared by James R. Childers dated March 27<sup>th</sup>, 2018

**SWPPP:** CNE Tahlequah Casino as prepared by ADG dated March 6<sup>th</sup>, 2018

**ADDENDA/AMENDMENTS:**

James R. Childers Architect, Inc. Addendum #001 dated 04/09/2018

James R. Childers Architect, Inc. Addendum #002 dated 04/09/2018

James R. Childers Architect, Inc. Addendum #003 dated 04/16/2018

**MCC CLARIFICATIONS:**

MCC Clarification #001: 3/27/18

MCC Clarification #002: 3/28/18

MCC Clarification #003: 4/6/18

MCC Clarification #004: 4/9/18

MCC Clarification #005: 4/16/18



**BID PACKAGE 01 (March 6, 2018)**

**SPECIFICATIONS**

**DIVISION 00 – Procurement Requirements and Contracting Requirements**

00 0102 – Project Information

00 0105 – Geotechnical Data

**DIVISION 01 – General Requirements**

**DIVISION 03 – Concrete**

03 3000 – Cast in Place Concrete

**DIVISION 31 – EARTHWORK**

31 2000 – Earthwork

31 2319 – Dewatering

31 2500 – Erosion and Sedimentation Control

31 5000 – Excavation Support and Protection

31 6329 – Drilled Concrete Piers and Shafts

**DIVISION 32 – SITE IMPROVEMENTS**

Section 32 9200 – Turf and Grasses

32 9200 – Turf and Grasses

**DIVISION 33 – UTILITIES**

Section 33 4100 – Private Storm Sewer

Geotechnical Engineering Report by Building & Earth Sciences, Inc. dated January 17, 2018

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07 1300 – Sheet Waterproofing  
07 2100 – Thermal Insulation

**DIVISION 22 – PLUMBING**

22 1113 – Water Distribution  
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FS108 FOODSERVICE EQUIPMENT SPECIAL COND. PLAN  
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ITS102 LOW VOLTAGE CONDUIT PLAN

# FOREMAN | MANHATTAN Construction Team

RFI #001

Foreman | Manhattan, A Joint Venture  
5601 South 122nd East Avenue  
Tulsa, Oklahoma 74146  
Phone: (918) 583-6900  
Fax: (918) 592-4334

Project: 3882 - Tahlequah Cherokee Casino  
Tahlequah, Oklahoma

## Underslab Waste and Grease Waste Piping

<b>TO:</b>	Gary Moore (Childers)	<b>FROM:</b>	Dalton Fanning (Manhattan - Tulsa) 5601 South 122nd East Avenue Tulsa, Oklahoma 74146
<b>DATE INITIATED:</b>	04/12/ 2018	<b>STATUS:</b>	Closed
<b>LOCATION:</b>		<b>DUE DATE:</b>	04/16/2018
<b>COST CODE:</b>		<b>REFERENCE:</b>	
<b>COST IMPACT:</b>	Yes (Unknown)	<b>SCHEDULE IMPACT:</b>	Yes (Unknown)
<b>DRAWING NUMBER:</b>	PU0.0	<b>SPEC SECTION:</b>	22 1316 - SANITARY WASTE AND VENT PIPING

### LINKED DRAWINGS:

### RECEIVED FROM:

### COPIES TO:

James Carter (CNE/CNB), Dalton Fanning (Manhattan - Tulsa), Patrick Fogarty (Manhattan - Tulsa), Chris Griffin (Manhattan - Tulsa), Chad Stabers (Manhattan - Tulsa), Luke Wilson (Manhattan - Tulsa)

### Question from Dalton Fanning (Manhattan - Tulsa) at 02:47 PM on 04/12/2018

Per sheet PU0.0 underslab Domestic Waste & Vent Piping materials shall be No-Hub Cast Iron or PVC/ABS based on soil conditions. Please verify if soil conditions are acceptable to use PVC/ABS in lieu of cast iron.

Regarding Grease Waste piping, please verify if grease waste piping to be heat traced and insulated?

**Official Response:** Gary Moore (Childers) responded on Monday, April 16th, 2018 at 11:28AM CDT

All underground piping can be PVC/ABS, Except grease waste shall be stainless steel and shall be heat traced.

See attached heat traced spec

Robbie Jones

MSA Engineering

4-15-2018

### Attachments:

[Heat Traced Spec.pdf](#)

Coordinate and/or incorporate the enclosed clarifications to the Contract Documents as described in this RFI. Proceed with the clarifications described herein unless there is a cost or time impact to your work. If this RFI constitutes a change in cost or contract time to your scope, provide written notification of change to Manhattan within 48 hours of receipt of this RFI.



## XL-Trace System

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*This step-by-step design guide provides the tools necessary to design a Raychem XL-Trace pipe freeze protection or flow maintenance system. For other applications or for design assistance, contact your Tyco Thermal Controls representative or phone Tyco Thermal Controls at (800) 545-6258. Also, visit our web site at [www.tycothermal.com](http://www.tycothermal.com).*

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## Introduction

Raychem XL-Trace is designed for pipe freeze protection and flow maintenance in the following applications:

- Freeze protection of general water piping (aboveground and buried)
- Freeze protection of fire sprinkler systems (aboveground and buried supply pipes)
- Flow waste lines (aboveground and buried)
- Flow maintenance of fuel lines (aboveground)

This guide does **not** cover applications in which any of the following conditions exist:

- Hazardous locations, as defined in the national electrical codes
- Pipe temperature other than specified in Table 1 on page 3
- Pipe maintenance temperatures above 150°F (65°C)
- Supply voltage other than 120 V or 208–277 V

If your application conditions are different, or if you have any questions, contact your Tyco Thermal Controls representative or contact Tyco Thermal Controls directly at (800) 545-6258.

### How to Use this Guide

This design guide presents Tyco Thermal Controls' recommendations for designing an XL-Trace pipe freeze protection or flow maintenance system. It provides design and performance data, electrical sizing information, and application configuration suggestions. Following these recommendations will result in a reliable, energy-efficient system.

#### OTHER REQUIRED DOCUMENTS

This guide is not intended to provide comprehensive installation instructions. For complete XL-Trace pipe freeze protection and flow maintenance system installation instructions, please refer to the following additional required documents:


- *XL-Trace System Installation and Operation Manual* (H58033)
- Additional installation instructions are included with the connection kits, thermostats, controllers, and accessories


If you do not have these documents, you can obtain them from the Tyco Thermal Controls web site at [www.tycothermal.com](http://www.tycothermal.com).


For products and applications not covered by this design guide, please contact your Tyco Thermal Controls representative or call Tyco Thermal Controls directly at (800) 545-6258.

### Safety Guidelines

As with any electrical equipment, the safety and reliability of any system depends on the quality of the products selected and the manner in which they are installed and maintained. Incorrect design, handling, installation, or maintenance of any of the system connection kits could damage the system and may result in inadequate performance, overheating, electric shock, or fire. To minimize these risks and to ensure that the system performs reliably, read and carefully follow the information, warnings, and instructions in this guide.

 This symbol identifies important instructions or information.

 This symbol identifies particularly important safety warnings that must be followed.

 **WARNING:** To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of Tyco Thermal Controls, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection.

## Warranty

Tyco Thermal Controls' standard limited warranty applies to all products.



An extension of the limited warranty period to ten (10) years from the date of installation is available if a properly completed online warranty form is submitted within thirty (30) days from the date of installation. You can access the complete warranty on our web site at [www.tycothermal.com](http://www.tycothermal.com).

## System Overview

The XL-Trace system provides freeze protection and flow maintenance for aboveground and buried pipe applications. The XL-Trace system is based on self-regulating heating cable technology. Tyco Thermal Controls offers the option of three self-regulating heating cables with the XL-Trace system: 5XL, 8XL, and 12XL (208–277 V only) for applications using 120 and 208–277 V power supplies. The cable's output is reduced automatically as the pipe warms, so there is no possibility of failure due to overheating.

An XL-Trace system includes the heating cable, power connection, splice, tee connections, controls, contactors, power distribution panels, accessories, and the tools necessary for a complete installation.

## XL-Trace Applications

Identify which of the standard XL-Trace applications below pertain to your installation. Proceed to the appropriate design sections that follow.

**Table 1 XL-Trace Applications**

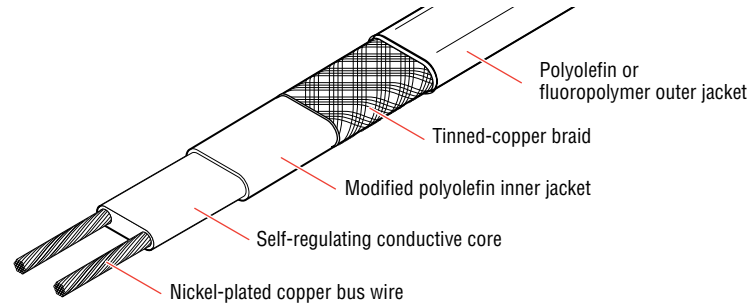
Application	Description	Specific application requirements
<b>Pipe freeze protection</b>		
General water piping	Freeze protection (40°F [4°C] minimum) of insulated, metal or plastic water piping	"Aboveground piping," page 6 "Buried piping," page 7
Sprinkler piping	Freeze protection (40°F [4°C] minimum) of standpipes up to 20", supply pipes and branch lines with sprinklers	"Standpipes, supply pipes, and branch lines with sprinklers" on page 8. Also see " <i>XL-Trace System for Fire Sprinkler Freeze Protection Design Guide</i> " (H58489).
<b>Flow maintenance</b>		
Greasy waste lines	Flow maintenance (110°F [43°C] minimum) for insulated greasy waste lines	"Aboveground piping" on page 10 "Buried piping" on page 11
Fuel lines	Flow maintenance (40°F [4°C] minimum) for insulated metal piping containing #2 fuel oil	"For aboveground piping only," page 12

**Note:** If your application does not fit these guidelines, contact your local Tyco Thermal Controls representative or call (800) 545-6258.



**Self-Regulating Heating Cable Construction**

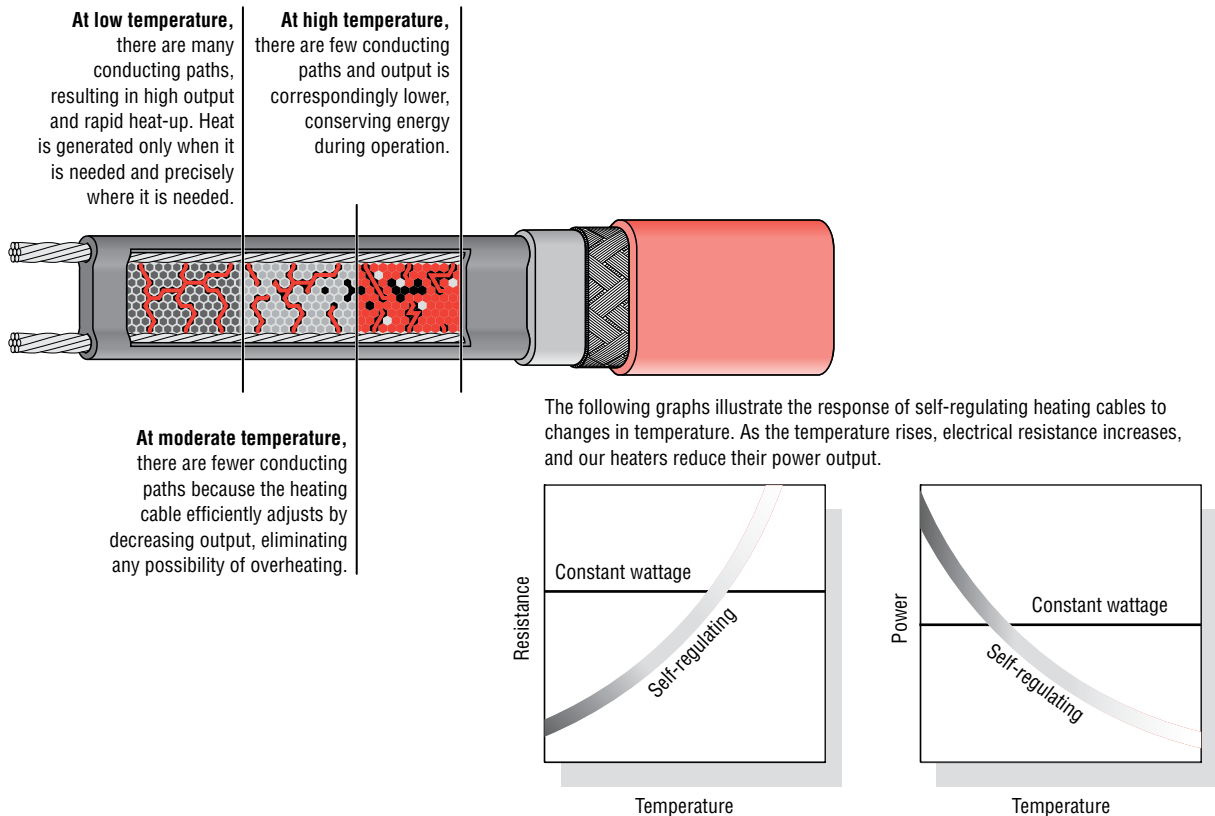
Raychem XL-Trace self-regulating heating cables are comprised of two parallel nickel-coated bus wires in a cross-linked polymer core, a tinned copper braid, and a fluoropolymer or polyolefin outer jacket. These cables are cut to length, simplifying the application design and installation.



**Fig. 1 XL-Trace heating cable construction**

With self-regulating technology, the number of electrical paths between bus wires changes in response to temperature fluctuations. As the temperature surrounding the heater decreases, the conductive core contracts microscopically. This contraction decreases electrical resistance and creates numerous electrical paths between the bus wires. Current flows across these paths to warm the core.

As the temperature rises, the core expands microscopically. This expansion increases electrical resistance and the number of electrical paths decreases. The heating cable automatically reduces its output.



**Fig. 2 Self-regulating heating cable technology**

## Pipe Freeze Protection Applications

A pipe freeze protection system is designed to maintain water temperature at a minimum of 40°F (4°C) to prevent freezing.

### Typical Pipe Freeze Protection System

A typical pipe freeze protection system includes the XL-Trace self-regulating heating cables, connection kits, ambient temperature control, and power distribution.

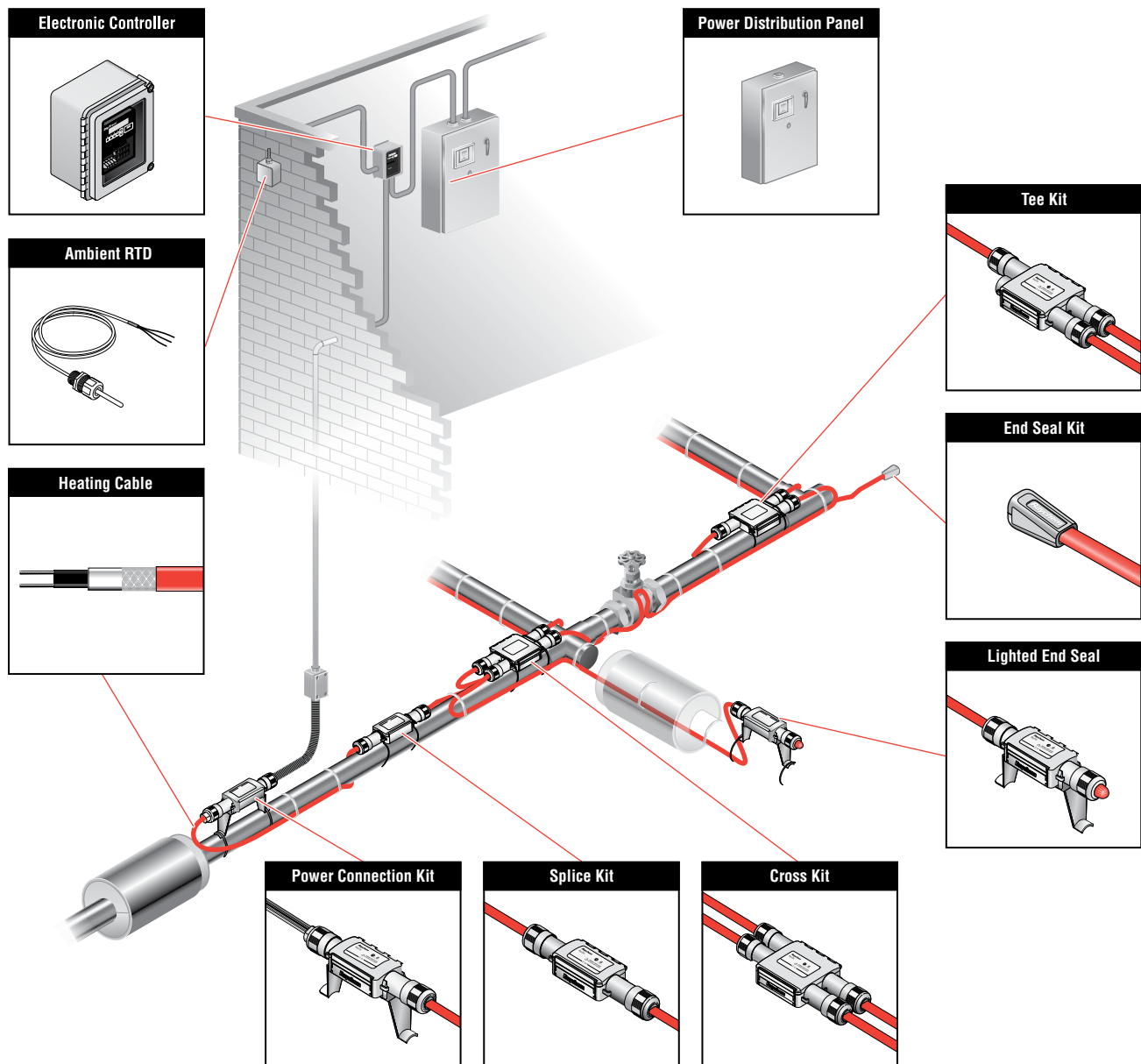
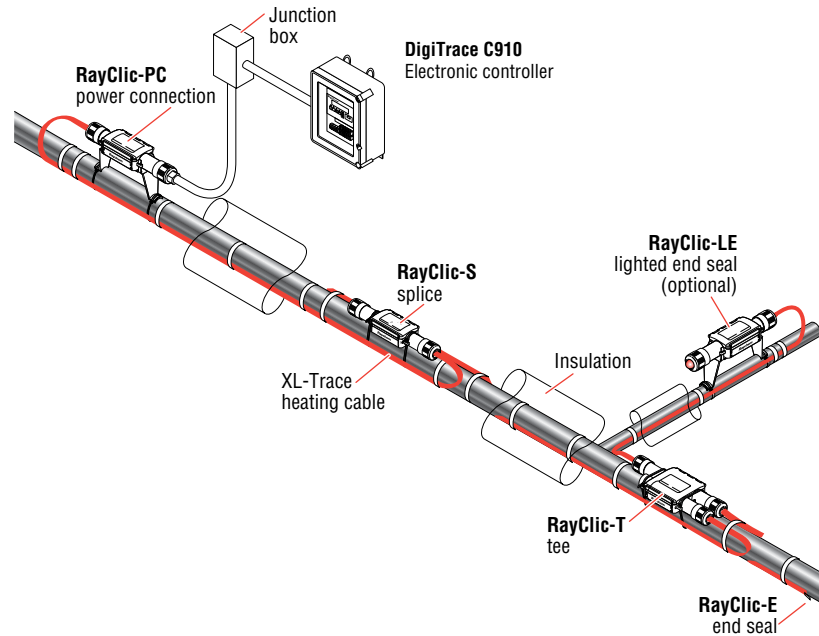


Fig. 3 Typical XL-Trace pipe freeze protection system

**General Water Piping**

General water piping is defined as metal or plastic water piping located in nonhazardous locations.

**ABOVEGROUND PIPING**



**Fig. 4 Typical aboveground piping system**

**Application Requirements**

The system complies with Tyco Thermal Controls requirements for aboveground general water piping when:

- The heating cable is permanently secured to insulated metal pipes with GT-66 glass tape, or to plastic pipes using AT-180 aluminum tape.
- A 30-mA ground-fault protection device (GFPD) is used.
- The heating cable is installed per manufacturer’s instructions with approved Raychem connection kits. See Table 13 on page 27 and the *XL-Trace System Installation and Operation Manual* (H58033).

**Cable Selection**

See “Other Required Documents” page 14.

**Approvals**

UL Listed, FM Approved, and c-CSA-us Certified for nonhazardous locations.



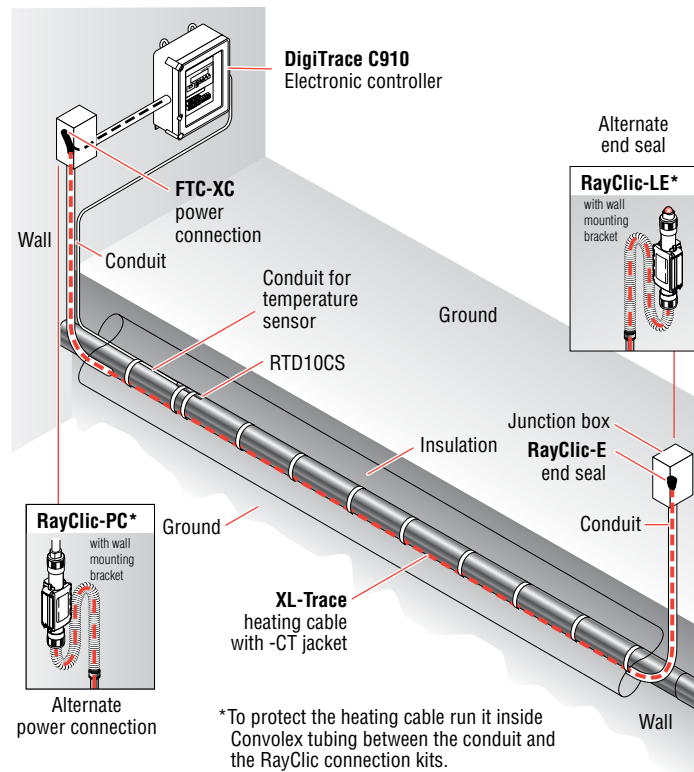
5XL1-CR, -CT  
5XL2-CR, -CT

8XL1-CR, -CT  
8XL2-CR, -CT

5XL1-CR, -CT  
5XL2-CR, -CT

8XL1-CR, -CT  
8XL2-CR, -CT

12XL2-CR, -CT

**BURIED PIPING****Fig. 5 Typical buried piping system****Application Requirements**

The system complies with Tyco Thermal Controls requirements for use on buried insulated metal or plastic pipe when:

- The pipeline is buried at least 2 feet deep.
- All heating cable connections (power, splice, tee, and end termination) are made above-ground. No buried or in-conduit splices or tees are allowed.
- The heating cable has a fluoropolymer outer jacket (-CT).
- The power connection and end seal are made in UL Listed and CSA Certified junction boxes above grade.
- The heating cable is protected from the pipe to the power connection box in UL Listed and CSA Certified water-sealed conduit (minimum 3/4-inch diameter) suitable for the location.
- A 30-mA ground-fault protection device (GFPD) is used.
- Closed-cell, waterproof thermal insulation with fire-retardant, waterproof covering is used.
- The heating cable is installed per manufacturer's instructions with approved Tyco Thermal Controls connection kits. See Table 15 on page 29 and the *XL-Trace System Installation and Operation Manual* (H58033).

**Cable Selection**

See "Pipe Heat Loss Calculations," page 14.

**Approvals**

UL Listed, FM Approved, and c-CSA-us Certified for nonhazardous locations.



5XL1-CT  
5XL2-CT



8XL1-CT  
8XL2-CT



5XL1-CT  
5XL2-CT

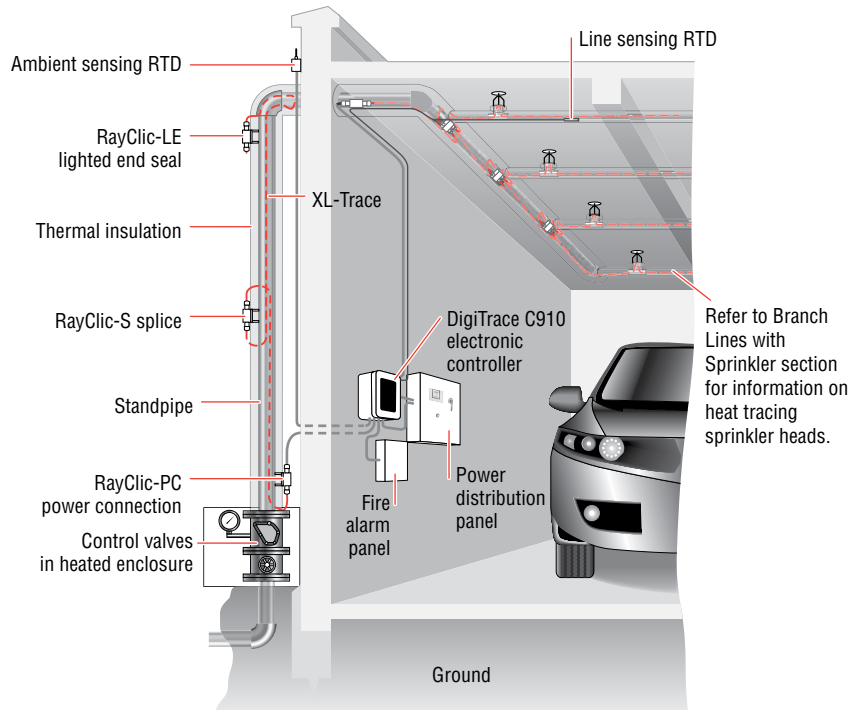
8XL1-CT  
8XL2-CT

12XL2-CT

**Fire Sprinkler Systems**

XL-Trace is designed to maintain fire suppression system standpipes, supply piping, mains, feeders, branch lines and sprinklers at 40°F (4°C) in areas subject to freezing.

**STANDPIPES, SUPPLY PIPES, AND BRANCH LINES WITH SPRINKLERS**



**Fig. 6 Standard sprinkler standpipe heating system layout**

Refer to the *Fire Sprinkler System Freeze Protection Design Guide* (H58489) for detailed instructions to design XL-Trace heating cable circuits to freeze protect aboveground or buried supply pipe, feeders, mains standpipes, branch lines and sprinklers.

**Approvals**

The 2007 edition of NFPA 13 (Standard for the Installation of Sprinkler Systems) allows Listed electrical heat tracing to freeze protect fire suppression systems including supply lines, standpipes and branch lines containing sprinklers. XL-Trace is c-CSA-us Certified for use on fire suppression systems under CSA C22.2 No. 130-03 for Canada and IEEE 515.1-2005 for the US. The system covered in this manual includes supply lines, standpipes, branch lines and sprinkler heads.

XL-Trace systems are also UL and ULC Listed for freeze-protecting sprinkler supply lines, standpipes up to 20 inches in diameter and branch lines not containing sprinklers.



5XL1-CR, -CT  
5XL2-CR, -CT



8XL1-CR, -CT  
8XL2-CR, -CT



5XL1-CR, -CT  
5XL2-CR, -CT

12XL2-CR, -CT (not for branch lines with sprinklers and sprinkler heads)

## Flow Maintenance Applications

A flow maintenance system is designed to maintain cooking greasy waste lines and #2 fuel oil lines above the temperature at which the viscosity inhibits fluid flow.

### Typical Flow Maintenance System

A typical flow maintenance system includes the XL-Trace self-regulating heating cables with a fluoropolymer outer jacket, connection kits, line-sensing temperature control and power distribution.

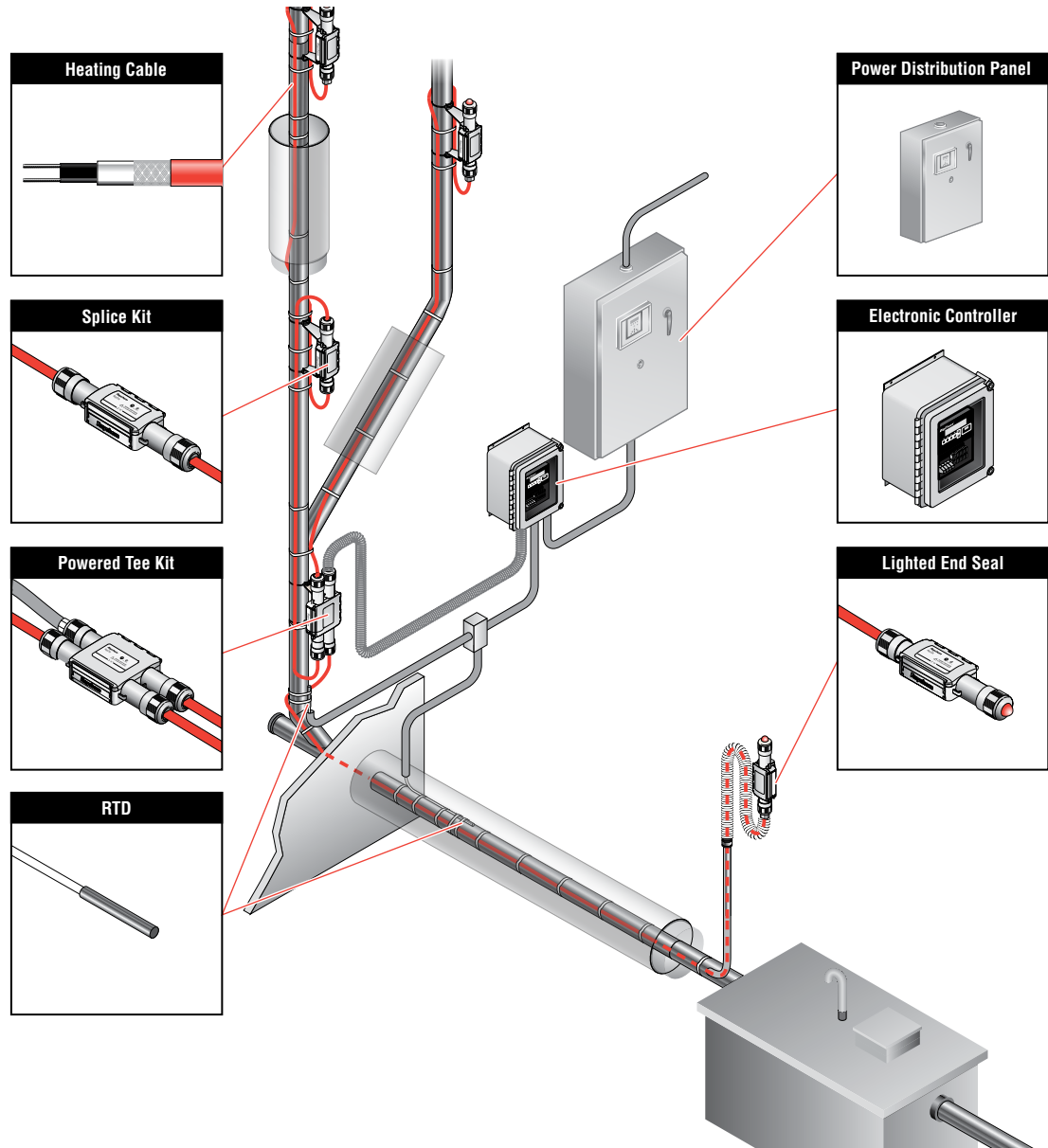
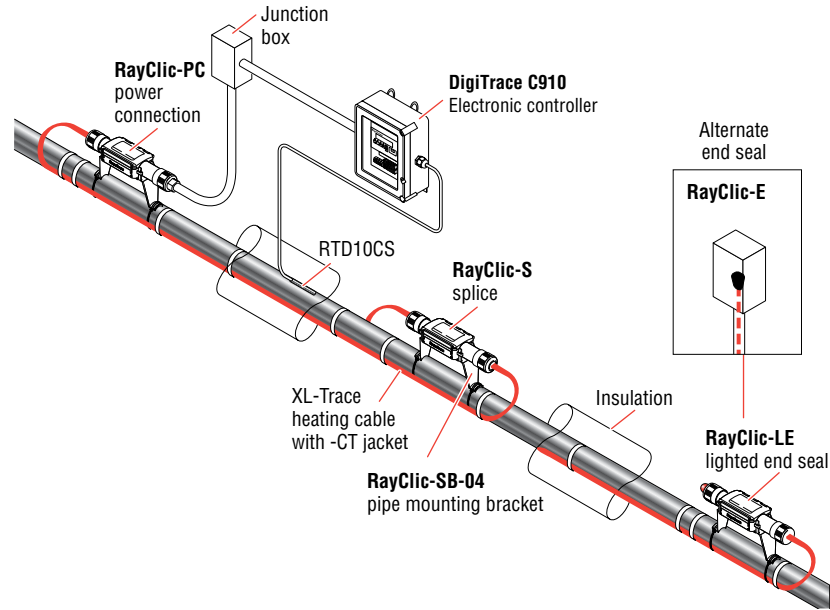


Fig. 7 Typical XL-Trace flow maintenance system

**Greasy Waste Lines**

Greasy waste lines are defined as piping used for the disposal of waste oils and fats created in the cooking process. Typical applications include greasy waste lines from commercial restaurants. A grease-line flow maintenance system is designed to maintain a 110°F (43°C) minimum fluid temperature.

**ABOVEGROUND PIPING**



**Fig. 8 Typical aboveground piping system**

**Application Requirements**

The system complies with Tyco Thermal Controls requirements for aboveground greasy waste lines when:

- The heating cable is permanently secured to metal pipes with GT-66 glass tape, or to plastic pipes using AT-180 aluminum tape.
- The heating cable must have a fluoropolymer outer jacket (-CT).
- A 30-mA ground-fault protection device (GFPD) is used.
- Tees and splices are installed using pipe mounting brackets, not in direct contact with piping.
- The heating cable is installed per manufacturer’s instructions with approved Tyco Thermal Controls connection kits. See Table 13 on page 27 and the *XL-Trace System Installation and Operation Manual* (H58033).

**Cable Selection**

See “Pipe Heat Loss Calculations,” page 14.

**Approvals**

XL-Trace systems (-CT only) are UL Listed, FM Approved, and c-CSA-us Certified for nonhazardous locations.



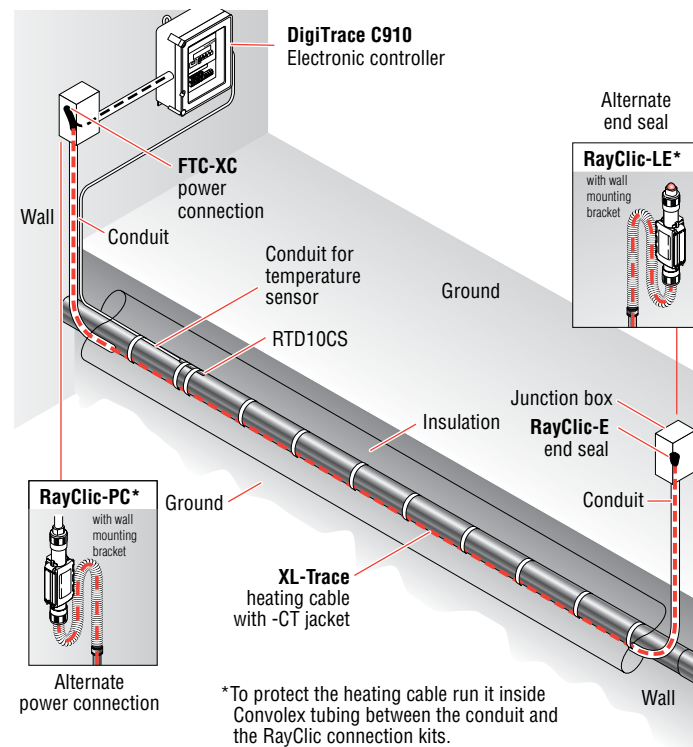
5XL1-CT  
5XL2-CT



8XL1-CT  
8XL2-CT



5XL1-CT 8XL1-CT 12XL2-CT  
5XL2-CT 8XL2-CT

**BURIED PIPING****Fig. 9 Typical buried greasy waste line****Application Requirements**

The system complies with Tyco Thermal Controls requirements for buried greasy waste lines when:

- The heating cable is permanently secured to metal pipes with GT-66 glass tape, or to plastic pipes using AT-180 aluminum tape.
- The heating cable must have a fluoropolymer outer jacket (-CT).
- The pipeline is buried at least 2 feet deep.
- All heating cable splices or tees are made aboveground. No buried or in-conduit splices or tees are allowed.
- The power connection and end seal are made in UL Listed and CSA Certified junction boxes above grade.
- The heating cable is protected from the pipe to the power connection box in UL Listed and CSA Certified conduit (minimum 3/4-inch diameter) suitable for the location.
- A 30-mA ground-fault protection device (GFPD) is used.
- Closed-cell, waterproof thermal insulation with fire-retardant, waterproof covering is used.
- The heating cable is installed per manufacturer's instructions with approved Tyco Thermal Controls connection kits. See Table 15 on page 29 and the *XL-Trace System Installation and Operation Manual* (H58033).

**Cable Selection**

See "Heating Cable Catalog Number" on page 18.

**Approvals**

XL-Trace systems (-CT only) are UL Listed, FM Approved, and c-CSA-us Certified for nonhazardous locations.



5XL1-CT  
5XL2-CT



8XL1-CT  
8XL2-CT



5XL1-CT  
5XL2-CT

8XL1-CT  
8XL2-CT

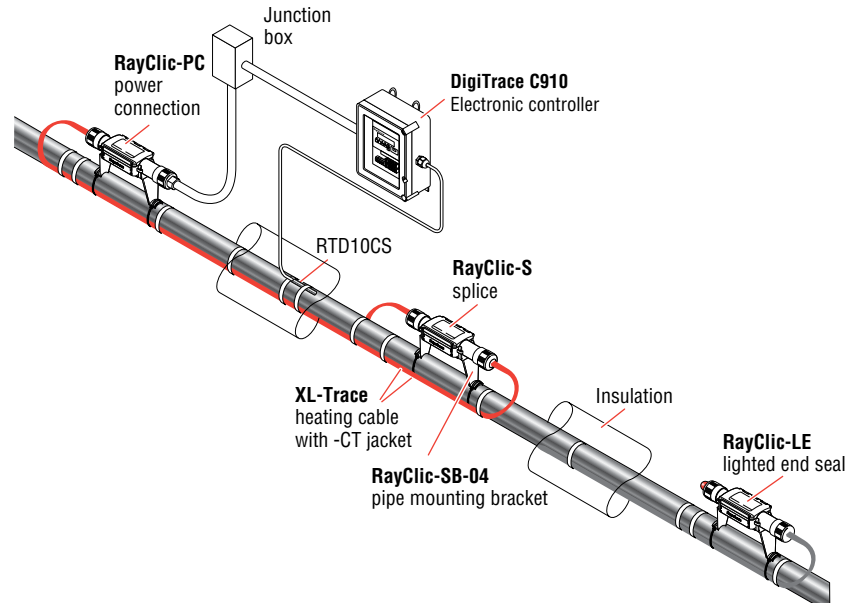
12XL2-CT



**Fuel Lines**

Fuel lines are defined as those carrying #2 fuel oil. A fuel line flow maintenance system is designed to maintain a 40°F (4°C) minimum fluid temperature to maintain flow.

**FOR ABOVEGROUND PIPING ONLY**



**Fig. 10 Typical aboveground piping system**

**Application Requirements**

The system complies with Tyco Thermal Controls requirements for aboveground #2 fuel oil piping when:

- The heating cable is permanently secured to metal pipes with GT-66 glass tape, or to plastic pipes using AT-180 aluminum tape.
- The heating cable must have a fluoropolymer outer jacket (-CT).
- Tees and splices are installed using pipe mounting brackets, not in direct contact with piping.
- A 30-mA ground-fault protection device (GFPD) is used.
- The heating cable is installed per manufacturer’s instructions with approved Tyco Thermal Controls connection kits. See Table 13 on page 27 and the *XL-Trace System Installation and Operation Manual* (H58033).

**Cable Selection**

See “Pipe Heat Loss Calculations,” page 14.

**Approvals**

XL-Trace systems (-CT only) are UL Listed, FM Approved, and c-CSA-us Certified for nonhazardous locations.



5XL1-CT  
5XL2-CT



8XL1-CT  
8XL2-CT



5XL1-CT 8XL1-CT 12XL2-CT  
5XL2-CT 8XL2-CT

## Pipe Freeze Protection and Flow Maintenance Design

This section details the design steps necessary to design your application. The examples provided in each step are intended to incrementally illustrate the project parameter output for two sample designs from start to finish. As you go through each step, use the “XL-Trace System Pipe Freeze Protection and Flow Maintenance Design Worksheet,” page 37, to document your project parameters, so that by the end of this section you will have the information you need for your Bill of Materials.



XL-Erate, the commercial pipe freeze protection and flow maintenance design software is available at <http://www.tycothermal.com> to assist with your design.

### Design Step by Step

Your system design requires the following essential steps.

- 1 Determine design conditions and pipe heat loss
- 2 Select the heating cable
- 3 Determine the heating cable length
- 4 Determine the electrical parameters
- 5 Select the connection kits and accessories
- 6 Select the control system
- 7 Select the power distribution
- 8 Complete the Bill of Materials

Pipe Freeze Protection and Flow Maintenance
1. Determine design conditions and heat loss
2. Select the heating cable
3. Determine the heating cable length
4. Determine the electrical parameters
5. Select the connection kits and accessories
6. Select the control system
7. Select the power distribution
8. Complete the Bill of Materials

#### Step 1 Determine design conditions and pipe heat loss

Collect the following information to determine your design conditions:

- XL-Trace application (*from Table 1* Location)
  - Indoors
  - Outdoors
  - Aboveground
  - Buried
- Maintain temperature ( $T_M$ )
- Maximum system temperature ( $T_{MAX}$ )
- Minimum ambient temperature ( $T_A$ )
- Pipe diameter and material
- Pipe length
- Thermal insulation type and thickness
- Supply voltage

#### Example: Pipe Freeze Protection – Water Piping

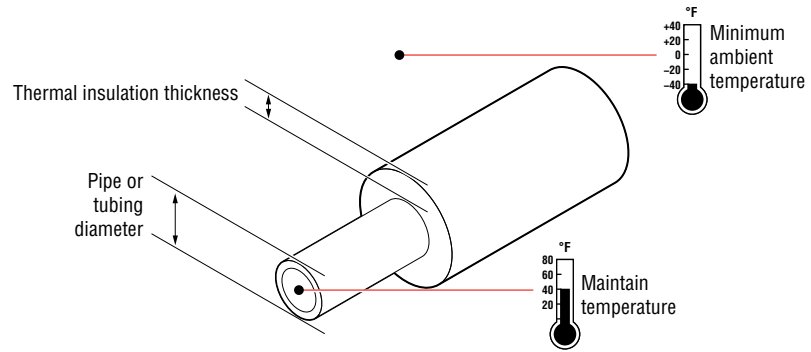
Location	Aboveground, outdoor
Maintain temperature ( $T_M$ )	40°F (4°C)
Maximum system temperature ( $T_{MAX}$ )	80°F (27°C)
Minimum ambient temperature ( $T_A$ )	-20°F (-29°C)
Pipe diameter and material	2-inch plastic
Pipe length	300 ft (91 m)
Thermal insulation type and thickness	1-inch fiberglass
Supply voltage	120 V

**Example: Pipe Freeze Protection – Greasy Waste Line**

Location	Buried
Maintain temperature (T <sub>M</sub> )	110°F (43°C)
Maximum system temperature (T <sub>MAX</sub> )	125°F (52°C)
Minimum ambient temperature (T <sub>A</sub> )	50°F (10°C) (soil temperature)
Pipe diameter and material	4-inch metal
Pipe length	200 ft (61 m)
Thermal insulation type and thickness	1-inch rigid cellular urethane
Supply voltage	208 V

**PIPE HEAT LOSS CALCULATIONS**

To select the proper heating cable you must first determine the pipe heat loss. To do this you must first calculate the temperature differential (ΔT) between the pipe maintain temperature and the minimum ambient temperature.



**Fig. 11 Pipe heat loss**

**Calculate temperature differential ΔT**

To calculate the temperature differential (ΔT), use the formula below:

$$\Delta T = T_M - T_A$$

**Example: Pipe Freeze Protection – Water Piping**

T <sub>M</sub>	40°F (4°C)
T <sub>A</sub>	-20°F (-29°C)
	<b>ΔT = 40°F - (-20°F) = 60°F</b>
	<b>ΔT = 4°C - (-29°C) = 33°C</b>

**Example: Flow Maintenance – Greasy Waste Line**

T <sub>M</sub>	110°F (43°C)
T <sub>A</sub>	50°F (10°C)
	<b>ΔT = 110°F - (50°F) = 60°F</b>
	<b>ΔT = 43°C - (10°C) = 33°C</b>

**Determine the pipe heat loss**

Match the pipe size, insulation thickness, and temperature differential (ΔT) from Table 2 to determine the base heat loss of the pipe (Q<sub>B</sub>).

**Example: Pipe Freeze Protection – Water Piping**

Pipe diameter	2 inch
---------------	--------

Insulation thickness 1 inch  
 $\Delta T$  60°F (33°C)

Heat loss ( $Q_B$ ) for 60°F must be calculated through interpolation between  $\Delta T$  at 50°F and  $\Delta T$  at 100°F from Table 2. For difference between the  $\Delta T$  of 50°F and the  $\Delta T$  of 100°F:

$Q_{B-50}$  3.2 W/ft (from Table 2)  
 $Q_{B-100}$  6.8 W/ft (from Table 2)  
 $\Delta T$  interpolation  $\Delta T$  60°F is 20% of the distance between  $\Delta T$  50°F and  $\Delta T$  100°F  
 $Q_{B-60}$   $Q_{B-50} + [0.20 \times (Q_{B-100} - Q_{B-50})] = 3.2 + [0.20 \times (6.8 - 3.2)] = 3.9$  W/ft  
 Pipe heat loss ( $Q_B$ ) **3.9 W/ft @  $T_M$  40°F (12.9 W/m @  $T_M$  4°C)**

**Example: Flow Maintenance – Greasy Waste Line**

Pipe diameter 4 inch  
 Insulation thickness 1 inch  
 $\Delta T$  60°F (33°C)

$Q_B$  for 60°F must be calculated through interpolation between  $\Delta T$  at 50°F and  $\Delta T$  at 100°F from Table 2. For difference between the  $\Delta T$  of 50°F and the  $\Delta T$  of 100°F:

$Q_{B-50}$  5.4 W/ft (from Table 2)  
 $Q_{B-100}$  11.2 W/ft (from Table 2)  
 $\Delta T$  interpolation  $\Delta T$  60°F is 20% of the distance between  $\Delta T$  50°F and  $\Delta T$  100°F  
 $Q_{B-60}$   $Q_{B-50} + [0.20 \times (Q_{B-100} - Q_{B-50})] = 5.4 + [0.20 \times (11.2 - 5.4)] = 6.6$  W/ft  
 Pipe heat loss  $Q_B$  **6.6 W/ft @  $T_M$  110°F (21.5 W/m @  $T_M$  43°C)**

**Compensate for insulation type and pipe location**

The base heat loss is calculated for a pipe insulated with thermal insulation with a k-factor ranging from 0.2 to 0.3 BTU/hr-°F-ft<sup>2</sup>/in (fiberglass or foamed elastomer) in an outdoor, or buried application. To get the heat loss for pipes insulated with alternate types of thermal insulation and for pipes installed indoors, multiply the base heat loss of the pipe ( $Q_B$ ) from Step 3 by the insulation multiple from Table 4 and the indoor multiple from Table 3 to get the corrected heat loss:

$$Q_{CORRECTED} = Q_B \times \text{Insulation multiple} \times \text{Indoor multiple}$$

**Example: Pipe Freeze Protection – Water Piping**

Location Aboveground, outdoor  
 Thermal insulation thickness and type 1-inch fiberglass  
 Pipe heat loss  $Q_B$  3.9 W/ft @  $T_M$  40°F (12.9 W/m @  $T_M$  4°C)  
 $Q_{CORRECTED}$   $3.9 \text{ W/ft} \times 1.00 \times 1.00 = 3.9 \text{ W/ft @ } T_M 40^\circ\text{F}$   
**(12.9 W/m @  $T_M$  4°C)**

**Example: Flow Maintenance – Greasy Waste Line**

Location Buried  
 Thermal insulation type and thickness 1-inch rigid cellular urethane  
 Pipe heat loss  $Q_B =$  6.6 W/ft @  $T_M$  110°F (21.5 W/m @  $T_M$  43°C)  
 $Q_{CORRECTED} =$   $6.6 \text{ W/ft} \times 0.6 \times 1.00 = 4.0 \text{ W/ft @ } T_M 110^\circ\text{F}$   
**(13.1 W/m @  $T_M$  43°C)**

**Table 2 Pipe Heat Loss (Q<sub>p</sub>) for Outdoor or Buried Pipe (W/ft) for 1/2 to 3-1/2 inches**

Insulation thickness (in)	(ΔT)		Pipe diameter (IPS) in inches								
	°F	°C	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2
0.5	20	11	1.0	1.2	1.4	1.6	1.8	2.2	2.5	3.0	3.4
	50	28	2.5	2.9	3.5	4.1	4.6	5.5	6.5	7.7	8.6
	100	56	5.2	6.1	7.2	8.6	9.6	11.5	13.5	16.0	18.0
	150	83	8.1	9.5	11.2	13.4	14.9	17.9	21.1	25.0	28.1
1.0	20	11	0.6	0.7	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	50	28	1.6	1.9	2.2	2.5	2.8	3.2	3.8	4.4	4.9
	100	56	3.4	3.9	4.5	5.2	5.8	6.8	7.8	9.1	10.2
	150	83	5.3	6.1	7.0	8.2	9.0	10.6	12.2	14.2	15.9
1.5	20	11	0.5	0.6	0.7	0.8	0.8	1.0	1.1	1.3	1.4
	50	28	1.3	1.5	1.7	1.9	2.1	2.4	2.8	3.2	3.6
	100	56	2.8	3.1	3.5	4.0	4.4	5.1	5.8	6.7	7.4
	150	83	4.3	4.8	5.5	6.3	6.9	8.0	9.1	10.5	11.6
2.0	20	11	0.5	0.5	0.6	0.6	0.7	0.8	0.9	1.0	1.1
	50	28	1.1	1.3	1.4	1.6	1.8	2.0	2.3	2.6	2.9
	100	56	2.4	2.7	3.0	3.4	3.7	4.2	4.8	5.5	6.0
	150	83	3.7	4.2	4.7	5.3	5.8	6.6	7.5	8.5	9.4
2.5	20	11	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.9	1.0
	50	28	1.0	1.2	1.3	1.4	1.6	1.8	2.0	2.3	2.5
	100	56	2.2	2.4	2.7	3.0	3.3	3.7	4.2	4.7	5.2
	150	83	3.4	3.7	4.2	4.7	5.1	5.8	6.5	7.4	8.1
3.0	20	11	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.9
	50	28	1.0	1.1	1.2	1.3	1.4	1.6	1.8	2.0	2.2
	100	56	2.0	2.2	2.4	2.7	2.9	3.3	3.7	4.2	4.6
	150	83	3.1	3.4	3.8	4.3	4.6	5.2	5.8	6.6	7.1
4.0	20	11	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.7	0.7
	50	28	0.9	0.9	1.0	1.1	1.2	1.4	1.5	1.7	1.8
	100	56	1.8	2.0	2.1	2.4	2.5	2.9	3.2	3.5	3.8
	150	83	2.8	3.0	3.4	3.7	4.0	4.4	4.9	5.5	6.0

**Note:** Multiply the W/ft heat loss values by 3.28 for W/m.

**Table 1.2 continued Pipe Heat Loss ( $Q_B$ ) for Outdoor or Buried Pipe (W/ft) for 4 to 20 inches**

Insulation thickness (in)	$(\Delta T)$		Pipe diameter (IPS) in inches									
	°F	°C	4	6	8	10	12	14	16	18	20	
0.5	20	11	3.8	5.3	6.8	8.4	9.9	10.8	12.2	13.7	15.2	
	50	28	9.6	13.6	17.4	21.4	25.2	27.5	31.3	35.0	38.8	
	100	56	20.0	28.4	36.3	44.6	52.5	57.4	65.2	73.0	80.8	
	150	83	31.2	44.3	56.6	69.6	81.9	89.5	101.7	113.8	126.0	
1.0	20	11	2.1	2.9	3.7	4.5	5.3	5.8	6.5	7.3	8.0	
	50	28	5.4	7.5	9.4	11.5	13.5	14.7	16.6	18.6	20.5	
	100	56	11.2	15.6	19.7	24.0	28.1	30.6	34.7	38.7	42.8	
	150	83	17.5	24.3	30.7	37.4	43.8	47.8	54.1	60.4	66.7	
1.5	20	11	1.5	2.1	2.6	3.2	3.7	4.0	4.5	5.0	5.5	
	50	28	3.9	5.3	6.7	8.1	9.4	10.2	11.5	12.9	14.2	
	100	56	8.1	11.1	13.9	16.8	19.6	21.3	24.0	26.8	29.5	
	150	83	12.7	17.3	21.6	26.2	30.5	33.2	37.5	41.8	46.1	
2.0	20	11	1.2	1.7	2.1	2.5	2.9	3.1	3.5	3.9	4.3	
	50	28	3.1	4.2	5.2	6.3	7.3	7.9	8.9	9.9	10.9	
	100	56	6.6	8.8	10.9	13.1	15.2	16.5	18.6	20.7	22.8	
	150	83	10.2	13.8	17.0	20.5	23.8	25.8	29.0	32.3	35.5	
2.5	20	11	1.1	1.4	1.7	2.1	2.4	2.6	2.9	3.2	3.5	
	50	28	2.7	3.6	4.4	5.2	6.1	6.6	7.4	8.2	9.0	
	100	56	5.6	7.4	9.1	10.9	12.6	13.7	15.3	17.0	18.7	
	150	83	8.7	11.6	14.2	17.0	19.7	21.3	23.9	26.5	29.1	
3.0	20	11	0.9	1.2	1.5	1.8	2.0	2.2	2.5	2.7	3.0	
	50	28	2.4	3.1	3.8	4.5	5.2	5.6	6.3	7.0	7.6	
	100	56	4.9	6.5	7.9	9.4	10.8	11.7	13.1	14.5	15.9	
	150	83	7.7	10.1	12.4	14.7	16.9	18.3	20.5	22.6	24.8	
4.0	20	11	0.8	1.0	1.2	1.4	1.6	1.7	1.9	2.1	2.3	
	50	28	2.0	2.5	3.1	3.6	4.1	4.4	5.0	5.5	6.0	
	100	56	4.1	5.3	6.4	7.5	8.6	9.3	10.3	11.4	12.4	
	150	83	6.4	8.3	10.0	11.8	13.4	14.5	16.1	17.8	19.4	

**Note:** Multiply the W/ft heat loss values by 3.28 for W/m.

**Table 3 Indoor Pipe Heat Loss Multiples**

Fiberglass thickness (in)	Indoor multiple
0.5	0.79
1	0.88
1.5	0.91
2	0.93
2.5	0.94
3	0.95
4	0.97

**Table 4 Insulation Heat Loss Multiples**

k factor at 50°F (10°C) (BTU/hr-°F-ft <sup>2</sup> /in)	Insulation multiple	Examples of preformed pipe insulation
0.1-0.2	0.6	Rigid cellular urethane (ASTM C591)
0.2-0.3	1.0	Glass fiber (ASTM C547) Foamed elastomer (ASTM C534)
0.3-0.4	1.4	Cellular glass (ASTM C552) Mineral fiber blanket (ASTM C553)

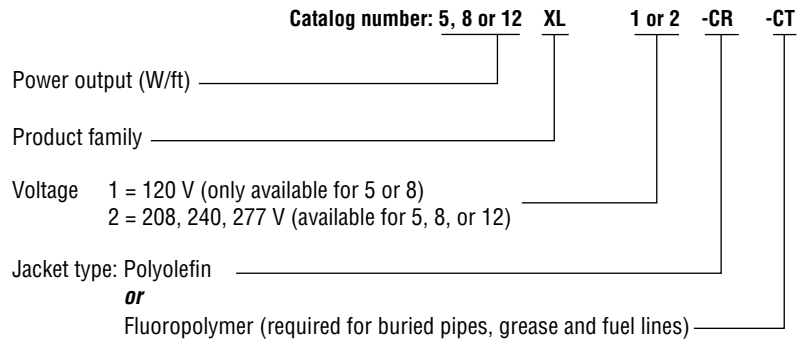
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4. Determine the electrical parameters
5. Select the connection kits and accessories
6. Select the control system
7. Select the power distribution
8. Complete the Bill of Materials

**Step 2 Select the heating cable**

To select the appropriate XL-Trace heating cable for your application, you must determine your cable supply voltage, power output, and outer jacket. Once you select these, you will be able to determine the catalog number for your cable.

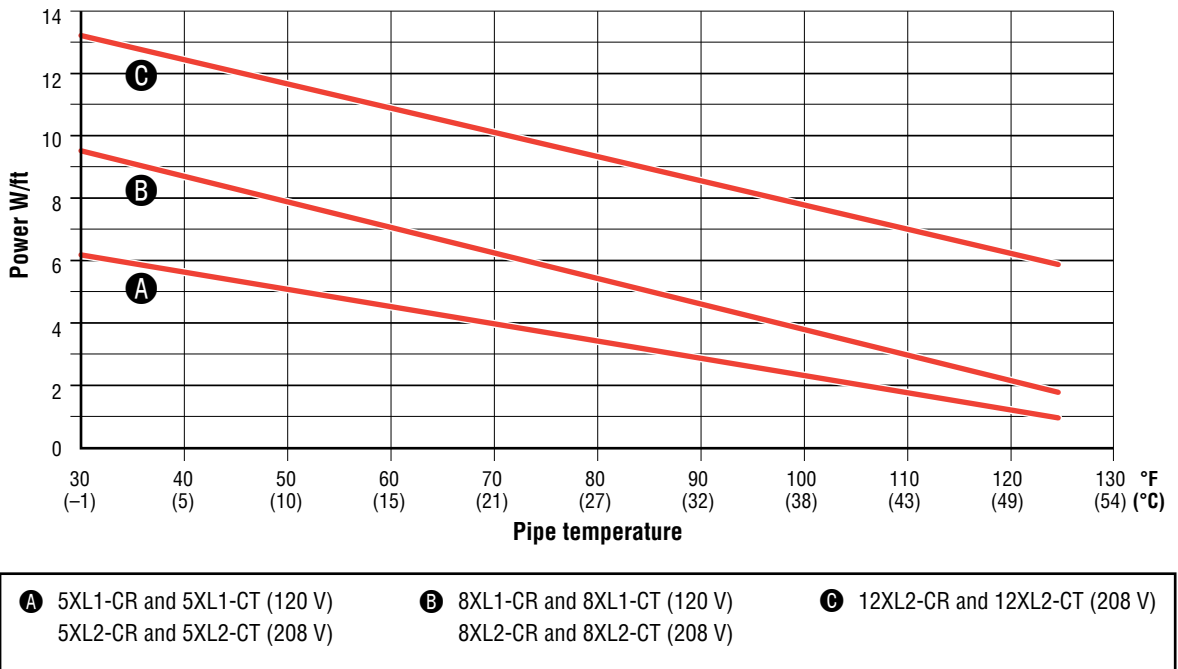
**HEATING CABLE CATALOG NUMBER**

Before beginning, take a moment to understand the structure underlying heating cable catalog numbers. You will refer to this numbering convention throughout the product selection process. Your goal is to determine the catalog number for the product that best suits your needs.



**Fig. 12 Heating cable catalog number**

Select the heating cable from Fig. 13 that provides the required power output to match the corrected heat loss for your application. Fig. 13 shows the power output for the heating cables on metal pipe at 120/208 volts. To correct the power output for other applied voltage or plastic pipes multiply the power output at the desired maintain temperature by the factors listed in Table 5. If the pipe heat loss,  $Q_{CORRECTED}$ , is between the two heating cable power output curves, select the higher-rated heating cable.



**Fig. 13 Heating cable power output on metal pipe**

**Table 5 Power Output Correction Factors**

Voltage correction factors	5XL1	8XL1	5XL2	8XL2	12XL2
120 V	1.00	1.00	–	–	–
208 V	–	–	1.00	1.00	1.00
240 V	–	–	1.12	1.12	1.14
277 V	–	–	1.29	1.27	1.30
<b>Plastic pipe correction factor</b> (With AT-180 Aluminum tape)	0.75	0.75	0.75	0.75	0.75

Confirm that the corrected power output of the heating cable selected is greater than the corrected pipe heat loss ( $Q_{CORRECTED}$ ). If  $Q_{CORRECTED}$  is greater than the power output of the highest-rated heating cable, you can:

- Use two or more heating cables run in parallel
- Use thicker insulation to reduce heat loss
- Use insulation material with a lower k factor to reduce heat loss

**Example: Pipe Freeze Protection – Water Piping**

Pipe maintain temperature ( $T_M$ )	40°F (4°C) (from Step 1)
$Q_{CORRECTED}$	$Q_{CORRECTED} = 3.9 \text{ W/ft @ } T_M 40^\circ\text{F}$ (13.1 W/m @ $T_M 4^\circ\text{C}$ )
Supply voltage	120 V (from Step 1)
Pipe material	Plastic (from Step 1)
Select heating cable:	$Q_b = 3.9 \text{ W/ft @ } T_M 40^\circ\text{F}$ (from Step 1) <b>5XL1 = 5.6 W/ft @ 40°F</b> (from Fig. 13)
Supply voltage correction factor	<b>1.00</b> (from Table 5)
Pipe material correction factor	<b>Plastic = 0.75</b> (from Table 5)
Corrected heating cable power	<b>5.6 W/ft x 1.00 x 0.75 = 4.2 W/ft</b>
Selected heating cable	<b>5XL1</b>

**Example: Flow Maintenance – Greasy Waste Line**

Pipe maintain temperature ( $T_M$ )	110°F (43°C) (from Step 1)
$Q_{CORRECTED}$	3.9 W/ft @ $T_M 110^\circ\text{F}$ (13.1 W/m @ $T_M 43^\circ\text{C}$ )
Supply voltage	208 V (from Step 1)
Pipe material	Metal (from Step 1)
Select heating cable:	$Q_b = 3.9 \text{ W/ft @ } T_M 110^\circ\text{F}$ (from Step 1) <b>12XL2 = 7.0 W/ft @ 110°F</b> (from Fig. 13)
Supply voltage correction factor	<b>1.00</b> (from Table 5)
Pipe material correction factor	<b>Metal = 1.00</b>
Corrected heating cable power	<b>7.0 x 1.00 x 1.00 = 7.0 W/ft</b>
Selected heating cable	<b>12XL2</b>



**CONFIRM EXPOSURE TEMPERATURE RATING FOR THE HEATING CABLE**

Refer to Table 6 to verify that the maximum system temperature does not exceed the exposure temperature of the selected heating cable.

**Table 6 Heating Cable Temperature Ratings**

	5XL1	5XL2	8XL1	8XL2	12XL2
Maximum maintain temperature (T <sub>M</sub> )	150°F (65°C)	150°F (65°C)	150°F (65°C)	150°F (65°C)	150°F (65°C)
Maximum exposure temperature (T <sub>EXP</sub> )	150°F (65°C)	150°F (65°C)	150°F (65°C)	150°F (65°C)	185°F (85°C)

**Example: Pipe Freeze Protection – Water Piping**

Maximum system temperature (T<sub>MAX</sub>) 80°F (27°C) (from Step 1)  
 Selected heating cable 5XL1 (from previous step)  
 Maximum heating cable exposure temperature (T<sub>EXP</sub>) 150°F (65°C) (from Table 6)  
 T<sub>MAX</sub> < T<sub>EXP</sub> **Yes**

**Example: Flow Maintenance - Greasy Waste Line**

Maximum system temperature (T<sub>MAX</sub>) 125°F (52°C) (from Step 1)  
 Selected heating cable 12XL2 (from previous step)  
 Maximum heating cable exposure temperature (T<sub>EXP</sub>) 185°F (85°C) (from Table 6)  
 T<sub>MAX</sub> < T<sub>EXP</sub> **Yes**

**SELECT OUTER JACKET**

Select the appropriate heating cable outer jacket for the application. Jacket options are:

- CR Compatible with most XL-Trace applications
- CT Required for grease and fuel line flow maintenance; may be used in other XL-Trace applications for improved mechanical strength and chemical resistance.

**Example: Pipe Freeze Protection – Water Piping**

Selection: 5XL1-CR

**Example: Flow Maintenance - Greasy Waste Line**

Selection: 12XL2-CT

Pipe Freeze Protection and Flow Maintenance
1. Determine design conditions and heat loss
2. Select the heating cable
3. Determine the heating cable length
4. Determine the electrical parameters
5. Select the connection kits and accessories
6. Select the control system
7. Select the power distribution
8. Complete the Bill of Materials

**Step 3 Determine the heating cable length**

In Step 2 you selected the appropriate heating cable and the number of runs of heating cable required for the pipe. Multiply the length of the pipe by the number of heating cable runs for the heating cable length.

Heating cable length = Pipe length x No. heating cable runs

Additional heating cable will be required for heat sinks and connection kits. Use Table 7 and Table 8 to determine the additional footage required for heat sinks (valves, flanges, and pipe supports). You will determine the additional heating cable for connection kits in Step 5. Round up fractional lengths to ensure heating cable lengths are sufficient.

Total heating cable length required = (Pipe length x No. heating cable runs) + Additional heating cable for heat sinks (valves, pipe supports, and flanges)

**Table 7 Additional Heating Cable for Valves**

Pipe diameter (IPS) (inches)	Heating cable (feet (meters))	
1/2	0.8	(0.24)
3/4	1.3	(0.4)
1	2.0	(0.6)
1-1/4	3.3	(1.1)
1-1/2	4.3	(1.3)
2	4.3	(1.3)
3	4.3	(1.3)
4	4.3	(1.3)
6	5.0	(1.5)
8	5.0	(1.5)
10	5.6	(1.7)
12	5.9	(1.9)
14	7.3	(2.2)
18	9.4	(2.9)
20	10.5	(3.2)

**Table 8 Additional Heating Cable for Pipe Supports and Flanges**

Support	Additional cable
Pipe hangers (insulated)	No additional heating cable
Pipe hangers noninsulated and U-bolt supports	Add 2x pipe diameter
Welded support shoes	Add 3x the length of the shoe
<b>Flanges</b>	Add 2x pipe diameter

**Note:** For applications where more than one heating cable is required per foot of pipe, this correction factor applies for each cable run.

**Example: Pipe Freeze Protection – Water Piping**

Pipe length	300 ft (91 m) (from Step 1)
Pipe diameter	2-inch plastic (from Step 1)
Number of heating cable runs	1 (from Step 2)
Valves	3 gate valves 4.3 ft x 3 gate valves = 12.9 ft (3.9 m)
Pipe supports	5 pipe hangers with U-bolts 2-inch pipe diameter = 2 / 12 = 0.17 ft [0.17 ft pipe diameter x 2] x 5 pipe supports = 1.7 ft (0.5 m)
Flanges	0
Total heating cable for heat sinks	12.9 ft (3.9 m) + 1.7 ft (0.5 m) = 14.6 ft (4.4 m) Rounded up to 15 ft (5 m)
Total heating cable length required	300 ft (91 m) x 1 run + 15 ft = <b>315 ft (96 m) of 5XL1-CR</b> <b>(Note: AT-180 Aluminum tape is required for installing heating cable on plastic pipe.)</b>

**Example: Flow Maintenance – Greasy Waste Line**

Pipe length	200 ft (61 m) (from Step 1)
Pipe diameter	4-inch metal (from Step 1)
Number of heating cable runs	1 (from Step 2)
Valves	2 gate valves [4.3 ft x 2 gate valves] x 1 run = 8.6 ft (2.6 m)
Pipe supports	2 non-insulated hangers 4-inch pipe diameter = 4 /12 = 0.33 ft [(0.33 ft pipe diameter x 2) x 2 pipe supports] x 1 run = 1.3 ft (0.4 m)
Flanges	2 4-inch pipe diameter = 4 /12 = 0.33 ft [(2 x 0.33 ft (pipe diameter)) x 2 flanges] x 1 run = 1.3 ft (0.4 m)
Total heating cable for heat sinks	8.6 ft (2.6 m) + 1.3 ft (0.4 m) + 1.3 ft (0.4 m) = 11.2 ft (2.2 m) Rounded up to 12 ft (3 m)
Total heating cable length required	200 ft x 1 run + 12 ft = <b>212 ft (65 m) of 12XL2-CT</b>

Pipe Freeze Protection and Flow Maintenance
1. Determine design conditions and heat loss
2. Select the heating cable
3. Determine the heating cable length
4. Determine the electrical parameters
5. Select the connection kits and accessories
6. Select the control system
7. Select the power distribution
8. Complete the Bill of Materials

**Step 4 Determine the electrical parameters**

To determine the electrical requirements for your application, you must determine the number of circuits and calculate the transformer load.

**DETERMINE NUMBER OF CIRCUITS**


To determine the number of circuits, you need to know:

- Total heating cable length
- Supply voltage
- Minimum start-up temperature

Use Table 9 to determine the maximum circuit length allowed. If the total heating cable length exceeds the maximum circuit length for the expected start-up temperature, more than one circuit will be required.

$$\text{Number of circuits} = \frac{\text{Heating cable length required}}{\text{Maximum heating cable circuit length}}$$

 **Important:** Select the smallest appropriate ground-fault circuit breaker size.

 **WARNING:** To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of Tyco Thermal Controls, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection.

**Table 9 Maximum Circuit Length in Feet**

		40°F / 110°F Maintain*											
Start-up temperature (°F)	CB size (A)	5XL1			5XL2			8XL2			12XL2		
		120 V	120 V	208 V	240 V	277 V	208 V	240 V	277 V	208 V	240 V	277 V	
-20°F	15	101	76	174	178	183	131	138	146	111	114	117	
	20	134	101	232	237	245	175	184	194	148	151	156	
	30	201	151	349	356	367	262	276	291	223	227	234	
	40	270	201	465	474	478	349	368	388	297	303	312	
0°F	15	115	86	199	203	209	149	157	166	120	122	126	
	20	153	115	265	271	279	199	209	221	160	163	168	
	30	230	172	398	406	419	298	314	331	239	244	252	
	40	270	210	470	490	530	370/399	390/420	420/443	319	326	336	
20°F	15	134	100	232	237	244	173	182	192	126	129	133	
	20	178	133	309	315	325	231	243	257	169	172	177	
	30	270	200	464	473	488	346	365	385	253	258	266	
	40	270	210	470	490	530	370/462	390/486	420/513	340/349	344	355	
40°F	15	160	119	278	283	292	206	217	229	142	145	150	
	20	214	159	370	378	390	275	290	306	190	194	200	
	30	270	210	470	490	530	370/416	390/438	420/462	285	291	300	
	40	270	210	470	490	530	370/554	390/584	420/616	340/398	360/406	380/419	
50°F (buried)	15	–	–	–	–	–	228	240	254	152	155	160	
	20	–	–	–	–	–	304	320	338	203	207	213	
	30	–	–	–	–	–	457	481	507	304	310	320	
	40	–	–	–	–	–	609	641	676	405	414	427	
65°F (indoors grease)	15	–	–	–	–	–	272	286	302	169	172	178	
	20	–	–	–	–	–	362	381	402	225	230	237	
	30	–	–	–	–	–	543	572	603	338	345	356	
	40	–	–	–	–	–	610	660	720	430	460	490	

\* When maximum circuit length is listed in:

- black type, the value is for applications with a 40°F maintain
- red italic type, the value is for applications with a 110°F maintain

**Table 10 Maximum Circuit Length in Meters**

		4°C / 43°C Maintain*										
Start-up temperature (°C)	CB size (A)	5XL1	8XL1	5XL2			8XL2			12XL2		
		120 V	120 V	208 V	240 V	277 V	208 V	240 V	277 V	208 V	240 V	277 V
-29°C	15	31	23	53	54	56	40	42	44	34	35	36
	20	41	31	71	72	75	53	56	59	45	46	48
	30	61	46	106	108	112	80	84	89	68	69	71
	40	82	61	142	145	149	106	112	118	90	92	95
-18°C	15	35	26	61	62	64	45	48	51	36	37	38
	20	47	35	81	83	85	61	64	67	49	50	51
	30	70	52	121	124	128	91	96	101	73	74	77
	40	82	64	143	149	162	113/122	119/128	128/135	97	99	102
-7°C	15	41	31	71	72	74	53	56	59	39	39	41
	20	54	41	94	96	99	70	74	78	51	52	54
	30	82	61	141	144	149	106	111	117	77	79	81
	40	82	64	143	149	162	113/141	119/148	128/156	104/106	105	108
4°C	15	49	36	85	86	89	63	66	70	43	44	46
	20	65	48	113	115	119	84	88	93	58	59	61
	30	82	64	143	149	162	113/127	119/134	128/141	87	89	91
	40	82	64	143	149	162	113/169	119/178	128/188	104/121	110/124	116/128
10°C (buried grease)	15	-	-	-	-	-	70	73	77	46	47	49
	20	-	-	-	-	-	93	98	103	62	63	65
	30	-	-	-	-	-	139	147	155	93	95	98
	40	-	-	-	-	-	186	195	206	124	126	130
18°C (indoors grease)	15	-	-	-	-	-	83	87	92	52	53	54
	20	-	-	-	-	-	110	116	123	69	70	72
	30	-	-	-	-	-	166	174	184	103	105	108
	40	-	-	-	-	-	186	201	220	131	140	149

- \* When maximum circuit length is listed in:
- black type, the value is for applications with a 4°C maintain
  - *red italic* type, the value is for applications with a 43°C maintain

**Example: Pipe Freeze Protection – Water Piping**

Total heating cable length            315 ft of 5XL1-CR (from Step 3)  
 Supply voltage                            120 V (from Step 1)  
 Minimum start-up temperature        -20°F (-29°C) (from Step 1)  
 Number of circuits                        315 ft / (210 ft max CL) = 1.8 circuits  
**Round up to 2 circuits**

**Example: Flow Maintenance – Greasy Waste Line**

Total heating cable length            223 ft of 12XL2-CT (from Step 3)  
 Supply voltage                            208 V (from Step 1)  
 Minimum start-up temperature        50°F (10°C) (from Step 1)  
 Number of circuits                        223 ft / 428 ft = 0.8 circuits  
**Round up to 1 circuit**

**DETERMINE TRANSFORMER LOAD**

Transformers must be sized to handle the load of the heating cable. Use the following tables to calculate the total transformer load.

**Table 11 Transformer Sizing (Amperes/foot)**

Minimum start-up temperature (°F)	5XL1	8XL1	5XL2			8XL2			12XL2		
	120	120	208	240	277	208	240	277	208	240	277
-20	0.119	0.159	0.069	0.067	0.065	0.092	0.087	0.082	0.108	0.106	0.102
0	0.105	0.139	0.060	0.059	0.057	0.080	0.076	0.072	0.100	0.098	0.095
20	0.090	0.120	0.052	0.051	0.049	0.069	0.066	0.062	0.095	0.093	0.090
40	0.075	0.101	0.043	0.042	0.041	0.058	0.055	0.052	0.084	0.083	0.080
50	-	-	-	-	-	0.053	0.050	0.047	0.079	0.077	0.075
65	-	-	-	-	-	0.044	0.042	0.040	0.072	0.070	0.067

**Table 12 Transformer Sizing (Amperes/meter)**

Minimum start-up temperature (°C)	5XL1	8XL1	5XL2			8XL2			12XL2		
	120	120	208	240	277	208	240	277	208	240	277
-20	0.391	0.521	0.226	0.221	0.215	0.301	0.286	0.270	0.354	0.347	0.336
-18	0.343	0.457	0.198	0.194	0.188	0.264	0.251	0.238	0.329	0.322	0.312
-7	0.294	0.394	0.170	0.166	0.161	0.227	0.216	0.205	0.311	0.305	0.296
4	0.246	0.331	0.142	0.139	0.135	0.191	0.181	0.172	0.276	0.271	0.263
10	-	-	-	-	-	0.172	0.164	0.155	0.259	0.254	0.246
18	-	-	-	-	-	0.145	0.138	0.130	0.233	0.228	0.221

Use Table 11 or Table 12 to determine the applied voltage and the maximum A/ft (A/m) at the minimum start up temperature to calculate the transformer load as follows:

$$\frac{\text{Max A/ft at minimum start-up temperature} \times \text{Heating cable length (ft)}}{1000} = \text{Transformer load (kW)}$$

**Example: Pipe Freeze Protection – Water Piping**

Total heating cable length	315 ft of 5XL1-CR (from Step 3)
Minimum start-up temperature	-20°F (-29°C) (from Step 1)
Circuit breaker sizing	30 A

$$\frac{\text{Max A/ft at } -20^{\circ}\text{F} \times \text{Total feet}}{1000} = (0.119 \text{ A/ft} \times 315 \text{ ft} \times 120 \text{ V}) / 1000$$

$$\text{Transformer load (kW)} = 4.5 \text{ kW}$$

**Example: Flow Maintenance – Greasy Waste Line**

Total heating cable length	212 ft of 12XL2-CT (from Step 3)
Supply voltage	208 V
Minimum start-up temperature	50°F (10°C) (from Step 1)
Maximum circuit length	$T_M = 110^\circ\text{F}, 304 \text{ ft}$

$$\frac{\text{Max A/ft at } 50^\circ\text{F} \times \text{Total feet} \times \text{Supply voltage}}{1000} = (0.079 \text{ A/ft} \times 212 \text{ ft} \times 208 \text{ V}) / 1000$$

**Transformer load (kW) = 3.5 kW**

Pipe Freeze Protection and Flow Maintenance
1. Determine design conditions and heat loss
2. Select the heating cable
3. Determine the heating cable length
4. Determine the electrical parameters
5. Select the connection kits and accessories
6. Select the control system
7. Select the power distribution
8. Complete the Bill of Materials

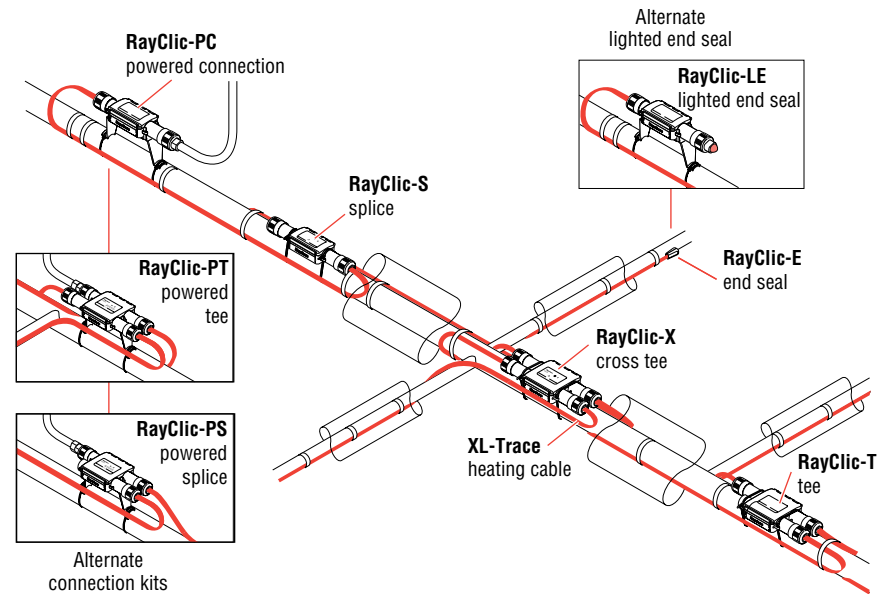
**Step 5 Select the connection kits and accessories**

All XL-Trace systems require a power connection and end seal kit. Splice and tee kits are used as required. Use Table 13 on page 27 (for aboveground applications) and Table 15 on page 29 (for buried applications) to select the appropriate connection kits.

**Note** Add extra cable on your Bill of Materials for power connections, tees, and end seals. See Table 13 on page 27, Table 15 on page 29, and Table 16 on page 30 for more information.

**WARNING:** Approvals and performance are based on the use of Tyco Thermal Controls-specified parts only. Do not substitute parts or use vinyl electrical tape.

**ABOVEGROUND PIPING**

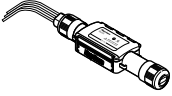
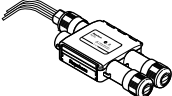
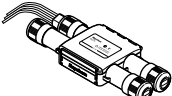
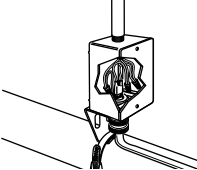
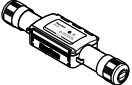
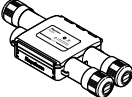
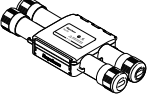
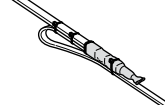
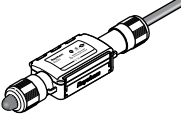



**Fig. 14 RayClic connection system**

Use the following table for general piping, standpipe sprinkler piping, and greasy waste and fuel lines. Develop a bill of materials from the connection kits listed in this table.

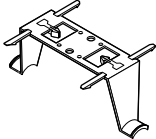
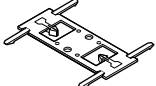

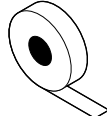

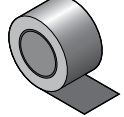
**Note** Connection kits must be off the pipe when installed on greasy waste, fuel oil, or pipes exceeding 150°F (65°C).

**Table 13 Connection Kits and Accessories for Aboveground Piping**

	Catalog number	Description	Standard packaging	Usage	Heating cable allowance <sup>1</sup>
<b>Connection kits</b>					
	RayClic-PC	Power connection and end seal (RayClic-SB-04 pipe mounting bracket included)	1	1 per circuit	2 ft (0.6 m)
	RayClic-PS	Powered splice and end seal (RayClic-SB-04 pipe mounting bracket included)	1	1 per circuit	4 ft (1.2 m)
	RayClic-PT	Powered tee and end seal (RayClic-SB-04 pipe mounting bracket included)	1	1 per circuit	6 ft (1.8 m)
	FTC-P <sup>2</sup>	Power connection and end seal <b>Note:</b> FTC-P is required for circuits requiring 40 A circuit breakers.	1	1 per circuit	3 ft (0.9 m)
	RayClic-S	Splice	1	As required	2 ft (0.6 m)
	RayClic-T	Tee kit with end seal	1	As required	3 ft (0.9 m)
	RayClic-X	Cross connection to connect four heating cables	1	As required	8 ft (2.4 m)
	FTC-HST <sup>3</sup>	Low-profile splice/tee	2	As required	3 ft (0.9 m)
	RayClic-LE	Lighted end seal (RayClic-SB-04 pipe mounting bracket included)	1	Alternate end seal	2 ft (0.6 m)
	RayClic-E	Extra end seal	1	Additional end seal	0.3 ft (0.1 m)



**Table 13 Connection Kits and Accessories for Aboveground Piping (Continued)**

	Catalog number	Description	Standard packaging	Usage	Heating cable allowance <sup>1</sup>
<b>Accessories</b>					
	RayClic-SB-04	Pipe mounting bracket	1	As required	-
	RayClic-SB-02	Wall mounting bracket	1	As required	-
	ETL	"Electric-Traced" label	1	1 label per 10 feet (3 m) of pipe	-
	GT-66	Glass cloth adhesive tape	66 ft (20 m)	See Table 14	-
	GS-54	Glass cloth adhesive tape	54 ft (20 m)	See Table 14	-
	AT-180	Aluminum tape - required for installing heating cable on plastic pipe	180 ft (55 m)	1 ft/ft [0.3 m/m] of heating cable	-

<sup>1</sup> Allow extra heating cable for ease of component installation.

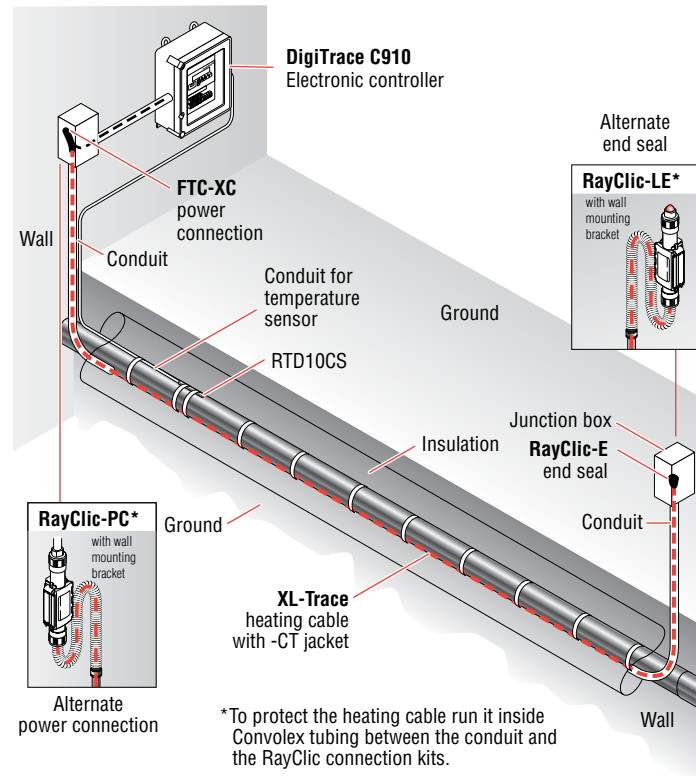
<sup>2</sup> Junction box not included.

<sup>3</sup> One RayClic-E end seal is required for each FTC-HST used as a tee kit.

**Table 14 Quantity of Glass Cloth Adhesive Tape Required (attach at 1-foot intervals)**

Pipe size (in)	<2	3	4	6	8	10
Feet of pipe per GT-66 roll	60 (18 m)	50 (15 m)	40 (12 m)	25 (8 m)	20 (6 m)	15 (5 m)
Feet of pipe per GS-54 roll	49 (15 m)	41 (13 m)	33 (10 m)	20 (6 m)	16 (5 m)	12 (4 m)

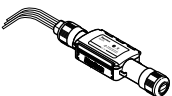
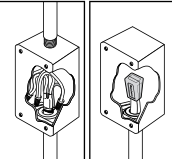
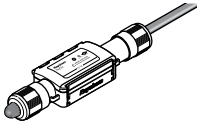

**BURIED PIPING**



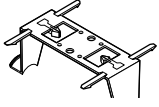
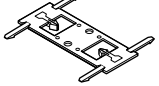



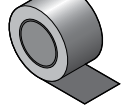
**Fig. 15 Typical buried piping system**

Use the following for buried water piping and greasy waste lines. Note that all connections must be aboveground and that no splices/tees are allowed. Develop a bill of materials from the connection kits in this table.

**Table 15 Connection Kits and Accessories for Buried Piping**

	<b>Catalog number</b>	<b>Description</b>	<b>Standard packaging</b>	<b>Usage</b>	<b>Heating cable allowance<sup>1</sup></b>
	RayClic-PC	Power connection and end seal (RayClic-SB-04 pipe mounting bracket included)	1	1 per circuit	2 ft (0.6 m)
	FTC-XC	The FTC-XC power connection and end seal kit is for use with XL-Trace heating cable that is run through conduit to a junction box. Materials for one power connection and end seal is included in the kit.  <b>Note:</b> FTC-XC is required for circuits requiring 40 A circuit breakers.	1	1 per circuit	2 ft (0.6 m)
	RayClic-LE	Lighted end seal (RayClic-SB-04 pipe mounting bracket included)	1	Alternate end seal	2 ft (0.6 m)
	RayClic-E	Extra end seal	1	Additional end seal	0.3 ft (0.1 m)

**Table 15 Connection Kits and Accessories for Buried Piping (Continued)**

	Catalog number	Description	Standard packaging	Usage	Heating cable allowance <sup>1</sup>
<b>Accessories</b>					
	RayClic-SB-04	Pipe mounting bracket	1	As required	–
	RayClic-SB-02	Wall mounting bracket	1	As required	–
	ETL	“Electric-Traced” label	1	1 label per 10 feet (3 m) of pipe	–
	GT-66	Glass cloth adhesive tape	66 ft (20 m)	See Table 16	–
	GS-54	Glass cloth adhesive tape	54 ft (20 m)	See Table 16	–
	AT-180	Aluminum tape - required for installing heating cable on plastic pipe	180 ft (55 m)	1 ft/ft [0.3 m/m] of heating cable	–

<sup>1</sup> Allow extra heating cable for ease of component installation.

**Table 16 Quantity of Glass Cloth Adhesive Tape Required (attach at 1-foot intervals)**


Pipe size (in)	<2	3	4	6	8	10
Feet of pipe per GT-66 roll	60 (18 m)	50 (15 m)	40 (12 m)	25 (8 m)	20 (6 m)	15 (5 m)
Feet of pipe per GS-54 roll	49 (15 m)	41 (13 m)	33 (10 m)	20 (6 m)	16 (5 m)	12 (4 m)


Pipe Freeze Protection and Flow Maintenance
1. Determine design conditions and heat loss
2. Select the heating cable
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5. Select the connection kits and accessories
6. Select the control system
7. Select the power distribution
8. Complete the Bill of Materials

## Step 6 Select the control system

Temperature controls save energy by ensuring that the system is energized only when necessary. Tyco Thermal Controls offers a wide variety of monitoring and control options, including:

- Mechanical thermostats provide a cost effective control solution.
- Electronic thermostats provide higher accuracy of the heating cable circuit with thermistor sensors.
- Electronic controllers provide superior accuracy with RTD temperature sensors, built-in ground-fault protection, monitoring and alarm output.
- Modbus® protocol communication over RS-485 system is supported using DigiTrace ProtoNode multi-protocol gateways.

 **Note:** Fire sprinkler standpipe freeze protection requires DigiTrace C910, DigiTrace C910-485 or ACCS-30 controllers with alarm relays connected to the fire control panel.

 **Note:** Greasy waste flow maintenance requires line sensing controllers such as the DigiTrace EC-TS or DigiTrace C910, or the DigiTrace ACCS-30.

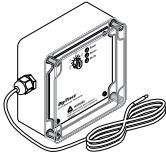
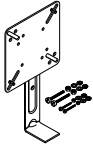


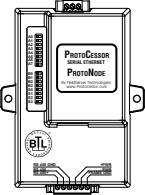
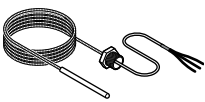
Use the following table to identify the control system suitable for your application. Contact your Tyco Thermal Controls representative or contact Tyco Thermal Controls directly at (800) 545-6258 for more information.

**Table 17 Temperature Control Options**

Application	Electronic thermostat	Electronic controllers	
		Single-point	Multipoint
	EC-TS	DigiTrace C910*	ACCS-30
Ambient sensing	X	X	X
Line sensing	X	X	X
Buried pipe	X	X	X
Fire sprinklers	–	X	X
Sensor	Thermistor	See data sheet	See data sheet
Sensor length	–	10 ft	"
Set point range	30°F to 110°F (–1°C to 43°C)	–76°F to 1058°F (–60°C to 570°C)	"
Enclosure	NEMA 4X	NEMA 4X	"
Differential	3°F (1.6°C)	3°F (1.6°C)	"
Set point repeatability	3°F (1.6°C)	3°F (1.6°C)	"
Enclosure limits	–40°F to 140°F (–40°C to 60°C)	–40°F to 140°F (–40°C to 60°C)	"
Switch rating	30 A	30 A	"
Switch type	SPST	DPST	"
Electrical rating	100–277 V	100–277 V	"
Approvals	c-UL-us	c-CSA-us	"
Ground-fault protection	–	20 mA to 250 mA	"
Alarm outputs			"
AC relay	–	100–277 V, 0.75 A max.	"
Dry contact relay	–	48 Vac/dc, 500 mA max.	"

\* The C910-485 is available to provide RS-485 communication capability. Connect to the BMS using DigiTrace ProtoNode multi-protocol gateways

**Table 18 Control Systems**

	Catalog number	Description
<b>Electronic Thermostats and Accessories</b>		
	EC-TS	Electronic thermostat housed in a NEMA 4X enclosure with 2 x 1/2-in conduit entries for power and one gland entry for the sensor. The temperature set point and LED indicators for alarm, power, and heating cable status can be visually checked through the clear lid. Electrical rating is 30 A at 100–277 V, 50–60 Hz, SPST switch. EC-TS includes a 25 ft (7.6 m) sensor.
	SB-110	Pipe mounting bracket for EC-TS
<b>Electronic Controllers and Sensors</b>		
	C910 C910-485	The C910 is a compact, full-featured microprocessor-based single-point heat-trace controller. The C910 provides control and monitoring of electrical heat-tracing circuits for both freeze protection and temperature maintenance, and can be set to monitor and alarm for high and low temperature, high and low current, ground-fault level, and voltage. The DigiTrace C910 controller is available with an electromechanical relay (EMR) for use in ordinary areas. The C910-485 comes with an RS-485 communication module.
	ACCS-UIT2 ACCS-PCM2-5	The DigiTrace ACCS-30 Advanced Commercial Control System is a multipoint electronic control and monitoring system for heat-tracing used in commercial freeze protection and flow maintenance applications. The DigiTrace ACCS-30 system can control up to 260 circuits with multiple networked ACCS-PCM2-5 panels, with a single ACCS-UIT2 user interface terminal. The ACCS-PCM2-5 panel can directly control up to 5 individual heat-tracing circuits using electromechanical relays rated at 30 A up to 277 V.
	ProtoNode-LER ProtoNode-RER	The DigiTrace ProtoNode is an external, high performance multi-protocol gateway for customers needing protocol translation between Building Management Systems (BMS) and the DigiTrace ACCS-30 or C910-485 controllers.  The ProtoNode-LER is for LonWorks® systems; and the ProtoNode-RER is for BACnet® or Metasys® N2 systems.
	RTD-200 RTD3CS RTD10CS	Three-wire RTD (Resistance Temperature Device) used with DigiTrace C910 and ACCS-30 controllers.  RTD-200: 6-ft (1.8 m) fluoropolymer with 1/2-in NPT bushing RTD3CS: 3-ft (0.9 m) flexible armor with 1/2-in NPT bushing RTD10CS: 10-ft (3 m) flexible armor with 1/2-in NPT bushing

Pipe Freeze Protection and Flow Maintenance	
1.	Determine design conditions and heat loss
2.	Select the heating cable
3.	Determine the heating cable length
4.	Determine the electrical parameters
5.	Select the connection kits and accessories
6.	Select the control system
7.	Select the power distribution
8.	Complete the Bill of Materials

**Step 7 Select the power distribution**

Once the heating cable circuits have been defined, you must select how to provide power to them. Power to the XL-Trace heating cables can be provided in several ways: directly through the temperature control, through external contactors, or through HTPG power distribution panels.

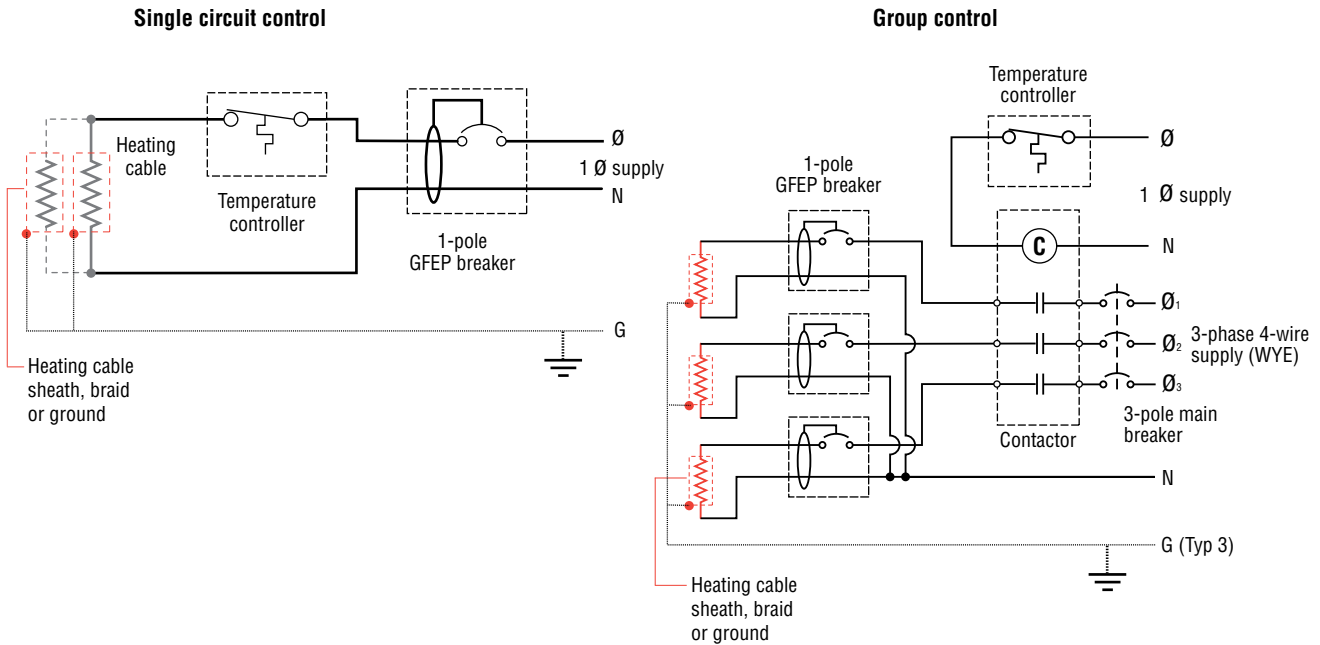
**SINGLE CIRCUIT CONTROL**

Heating cable circuits that do not exceed the current rating of the selected temperature control device shown in Table 18 can be switched directly (see Fig. 16).

**GROUP CONTROL**

If the current draw exceeds the switch rating, or if the controller will activate more than one circuit (group control, an external contactor must be used (see Fig. 16 on page 33).

Large systems with many circuits should use an HTPG power distribution panel. The HTPG is a dedicated power-distribution, control, ground-fault protection, monitoring, and alarm panel for freeze protection and broad temperature maintenance heat-tracing applications. This enclosure contains an assembled circuit-breaker panelboard. Panels are equipped with ground-fault circuit breakers with or without alarm contacts. The group control package allows the system to operate automatically in conjunction with an ambient-sensing thermostat, individual electronic, or duty cycle controller.



**Fig. 16 Single circuit and group control**

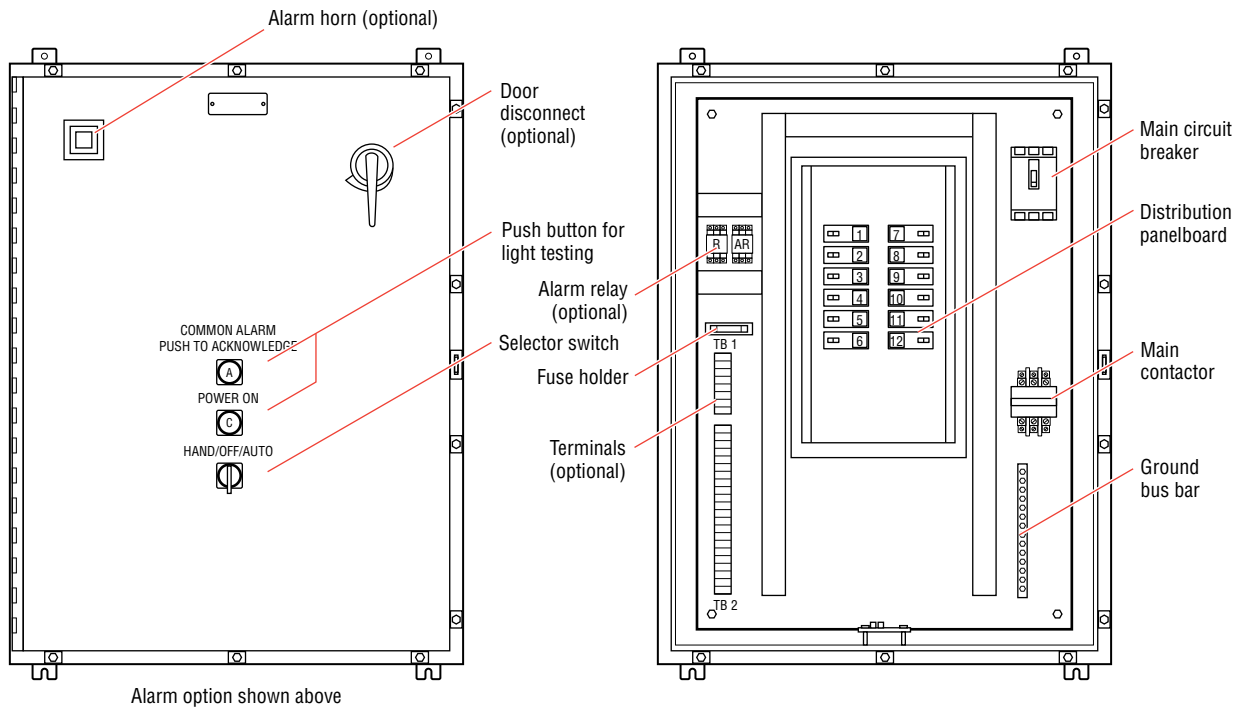


Fig. 17 HTPG power distribution panel

Three-phase, 4 wire supply (Wye)

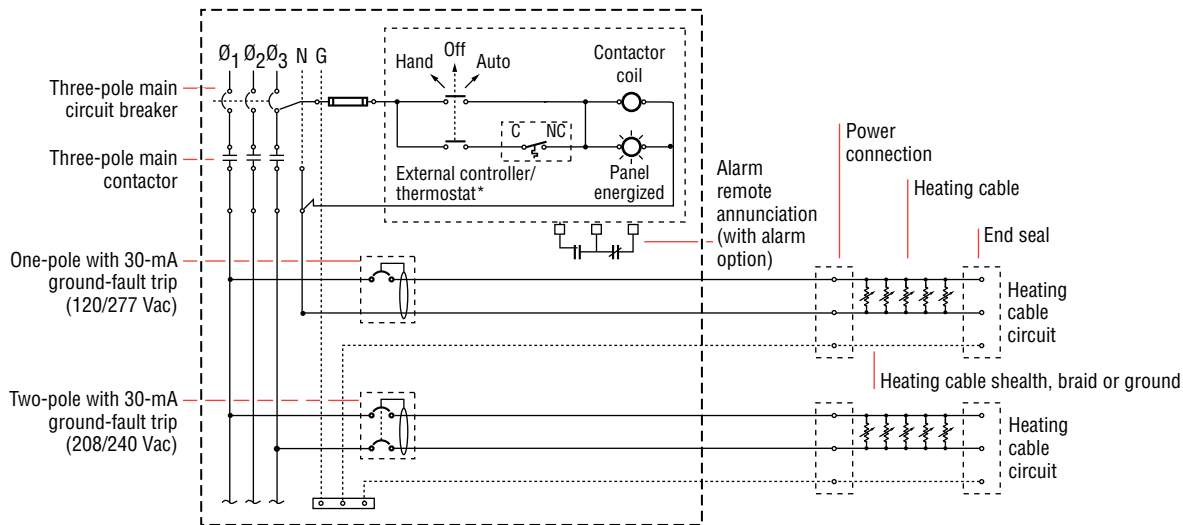

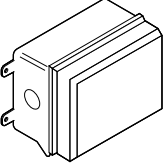
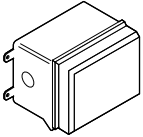


Fig. 18 HTPG power schematic

**Table 19 Power Distribution**

	Catalog number	Description
<b>Power Distribution</b>		
	HTPG	Heat-tracing power distribution panel with ground-fault and monitoring for group control.
<b>Contactors</b>		
	E104	Three-pole, 100 Amp per pole, 600 V maximum contactor housed in UL Listed, CSA Certified, NEMA 4X enclosure with two 1-inch conduit entries. When ordering, select coil voltage (110–120, 208–240, 277 V).  Enclosure dimensions: 13-1/2 in x 9-1/5 in x 6-11/16 in (343 mm x 234 mm x 170 mm).
	E304	Three-pole, 40 Amp per pole, 600 V maximum contactor housed in UL Listed, CSA Certified NEMA 4X enclosure with two 1-inch conduit entries. When ordering, select coil voltage (110–120, 208–240, 277 V).  Enclosure dimensions: 9-1/2 in x 7-1/5 in x 6-11/16 in (241 mm x 183 mm x 170 mm).



Pipe Freeze Protection and Flow Maintenance
1. Determine design conditions and heat loss
2. Select the heating cable
3. Determine the heating cable length
4. Determine the electrical parameters
5. Select the connection kits and accessories
6. Select the control system
7. Select the power distribution
8. Complete the Bill of Materials

**Step 8 Complete the Bill of Materials**

If you used the Design Worksheet to document all your design parameters, you should have all the details necessary complete your Bill of Materials.

## XL-Trace System Pipe Freeze Protection and Flow Maintenance Design Worksheet

### Step 1 Determine design conditions and pipe heat loss

#### Design conditions

XL-Trace application	Location		Maintain temp. (T <sub>M</sub> )	Max. system temp. (T <sub>MAX</sub> )	Min. ambient temp. (T <sub>A</sub> )	Pipe diameter and material	Pipe length	Thermal insulation type and thickness
<b>Pipe freeze protection</b>								
<input type="checkbox"/> Water piping	<input type="checkbox"/> Indoors <input type="checkbox"/> Outdoors	<input type="checkbox"/> Aboveground <input type="checkbox"/> Buried	_____	_____	_____	____ in <input type="checkbox"/> Metal <input type="checkbox"/> Plastic	_____ ft (m)	<input type="checkbox"/> Fiberglass <input type="checkbox"/> _____ in
<input type="checkbox"/> Sprinkler piping	<input type="checkbox"/> Indoors <input type="checkbox"/> Outdoors	<input type="checkbox"/> Aboveground <input type="checkbox"/> Buried	_____	_____	_____	____ in <input type="checkbox"/> Metal <input type="checkbox"/> Plastic	_____ ft (m)	<input type="checkbox"/> Fiberglass <input type="checkbox"/> _____ in
<b>Flow maintenance</b>								
<input type="checkbox"/> Greasy waste lines	<input type="checkbox"/> Indoors <input type="checkbox"/> Outdoors	<input type="checkbox"/> Aboveground <input type="checkbox"/> Buried	_____	_____	_____	____ in <input type="checkbox"/> Metal <input type="checkbox"/> Plastic	_____ ft (m)	<input type="checkbox"/> Fiberglass <input type="checkbox"/> _____ in
<input type="checkbox"/> Fuel lines	<input type="checkbox"/> Indoors <input type="checkbox"/> Outdoors	<input type="checkbox"/> Aboveground <input type="checkbox"/> Buried	_____	_____	_____	____ in <input type="checkbox"/> Metal <input type="checkbox"/> Plastic	_____ ft (m)	<input type="checkbox"/> Fiberglass <input type="checkbox"/> _____ in
<b>Example:</b> ✓ Water piping	✓ Aboveground ✓ Outdoor		40°F	80°F	-20°F	2 in ✓ Plastic	300 ft	✓ Fiberglass 1 in

#### Pipe heat loss

#### Calculate temperature differential ΔT

Pipe maintain temperature (T<sub>M</sub>) \_\_\_\_\_ °F (°C)

Ambient temperature (T<sub>A</sub>) \_\_\_\_\_ °F (°C)

$$\underline{T_M} - \underline{T_A} \longrightarrow = \underline{\Delta T}$$

#### Example: Pipe Freeze Protection – Water Piping

Pipe maintain temperature (T<sub>M</sub>) 40 °F (from Step 1)  
°F

Ambient temperature (T<sub>A</sub>) -20 °F (from Step 1)  
°F

$$\underline{40\text{ °F}} - \underline{-20\text{ °F}} \longrightarrow = \underline{60\text{ °F}} \\ T_M \qquad T_A \qquad \qquad \qquad \Delta T$$

**Determine the pipe heat loss:** See Table 2 for the base heat loss of the pipe ( $Q_B$ ). If the  $\Delta T$  for your system is not listed, interpolate between the two closest values.

$Q_{B-50} \Delta T1$	_____
	W/ft (W/m)
$Q_{B-100} \Delta T2$	_____
	W/ft (W/m)
$Q_B$	_____
	W/ft (W/m)
Pipe diameter	_____
	in
Insulation thickness	_____
	in
$\Delta T$	_____
	°F (°C)
$Q_{B-50}$	_____
	W/ft (W/m)
$Q_{B-100}$	_____
	W/ft (W/m)

**Example: Pipe Freeze Protection – Water Piping**

Pipe diameter	_____	2 in
Insulation thickness	_____	1 in
$\Delta T$	_____	60°F
$Q_{B-50}$	_____	3.2 W/ft
$Q_{B-100}$	_____	6.8 W/ft
$\Delta T$ interpolation	$\Delta T$ 60°F is 20% of the distance between $\Delta T$ 50°F and $\Delta T$ 100°F	
	$Q_{B-50} + [0.20 \times (Q_{B-100} - Q_{B-50})]$	
$Q_{B-60}$	$3.2 + [0.20 \times (6.8 - 3.2)] = 3.9$ W/ft	
Pipe heat loss ( $Q_{B-60}$ )	<b>3.9 W/ft @ <math>T_M</math> 40°F</b>	

**Compensate for insulation type and pipe location**

See Table 2 for the pipe heat loss ( $Q_B$ ). If the  $\Delta T$  for your system is not listed, interpolate between the two closest values.

See Table 3 for indoor multiple

See Table 4 for insulation multiple

Location \_\_\_\_\_

Insulation thickness and type \_\_\_\_\_

$Q_B$  \_\_\_\_\_  
W/ft (W/m)

Insulation multiple \_\_\_\_\_

Indoor multiple (if applicable) \_\_\_\_\_

$$\frac{Q_B}{Q_B} \times \frac{\text{Insulation multiple}}{\text{Insulation multiple}} \times \frac{\text{Indoor multiple (if applicable)}}{\text{Indoor multiple (if applicable)}} = Q_{\text{CORRECTED}}$$

**Example: Pipe Freeze Protection – Water Piping**

Location **Aboveground, indoor**

Thermal insulation thickness and type **1-in fiberglass**

$Q_B$  **3.9 W/ft @  $T_M$  40°F**

Insulation multiple **1.00**

Indoor multiple **N/A**

$$Q_{\text{CORRECTED}} = \frac{3.9 \text{ W/ft}}{Q_B} \times \frac{1.00}{\text{Insulation multiple}} = \mathbf{3.9 \text{ W/ft @ } T_M \text{ 40°F}}$$

**Step 2 Select the heating cable**

**Power output data:** See Fig. 13

**Power output correction factors:** See Table 5

**Heating cable temperature ratings:** See Table 6

Pipe maintain temperature ( $T_M$ ) \_\_\_\_\_ (from Step 1)

Corrected heat loss ( $Q_{CORRECTED}$ ) \_\_\_\_\_ (from Step 1)

Supply voltage \_\_\_\_\_ (from Step 1)

Pipe material (metal or plastic) \_\_\_\_\_ (from Step 1)

XL-Trace application (water, fuel oil, or greasy waste) \_\_\_\_\_ (from Step 1)

    Pipe freeze protection: general water piping, sprinkler piping \_\_\_\_\_

    Flow maintenance: greasy waste lines, fuel lines \_\_\_\_\_

Maximum system use temperature ( $T_{MAX}$ ) \_\_\_\_\_ (from Step 1)

Heating cable selected \_\_\_\_\_ (from Step 1)

Power at  $T_M$  (120/208 V) \_\_\_\_\_

Power output correction factor \_\_\_\_\_ (from Step 1)

Plastic pipe correction factor \_\_\_\_\_

\_\_\_\_\_ x \_\_\_\_\_ = \_\_\_\_\_

Power at rated V factor      Plastic pipe correction factor      Corrected power

Is the heating cable power output ( $P_{CORRECTED}$ )  $\geq$  the corrected heat loss?  Yes  No

If No, then design with additional runs of heating cable or thicker thermal insulation.

**Example: Pipe Freeze Protection – Water Piping**

Maintain temperature ( $T_M$ ) \_\_\_\_\_ 40°F

Corrected heat loss ( $Q_{CORRECTED}$ ) \_\_\_\_\_ 3.9 W/ft @  $T_M$  40°F

Supply voltage \_\_\_\_\_ 120 V

Pipe material (metal or plastic\*) \_\_\_\_\_ plastic

(\*AT-180 aluminum tape required for installing heating cable on plastic pipes)

$Q_B = 3.9 \text{ W/ft @ } T_M \text{ 40°F}$   
 Select curve C: 5XL1 = **5.6 W/ft @ 40°F**  
 Power output correction factor: 120 V = 1.00  
 Pipe material correction factor: Plastic = 0.75  
 Corrected heating cable power: 5.6 @/ft x 1.00 x 0.75 = **4.2 W/ft**  
 Select: **5XL1**  
 Maximum system temperature ( $T_{MAX}$ ): 80°F  
 Maximum heating cable exposure temperature ( $T_{EXP}$ ): 150°F  
 $T_{MAX} < T_{EXP}$ : Yes

**Select outer jacket**

- CR
- CT

**Example: Pipe Freeze Protection – Water Piping**  
**5XL1-CR**

**Step 3 Determine the heating cable length**

For additional heating cable allowance for valves: See Table 7.

For additional heating cable allowance for pipe supports and flanges: See Table 8.

**Heat sinks**

$$\frac{\text{Type of valves}}{\text{How many}} \times \frac{\text{Additional heating cable}}{\text{Additional heating cable}} = \frac{\text{Total heating cable for valves}}{\text{Total heating cable for valves}}$$

$$\frac{\text{Type of pipe supports}}{\text{How many}} \times \frac{\text{Additional heating cable}}{\text{Additional heating cable *2-in pipe diameter = 0.17 ft}} = \frac{\text{Total heating cable for pipe supports}}{\text{Total heating cable for pipe supports}}$$

$$\frac{\text{Type of flanges}}{\text{How many}} \times \frac{\text{Additional heating cable}}{\text{Additional heating cable}} = \frac{\text{Total heating cable for flanges}}{\text{Total heating cable for flanges}}$$

**Total heating cable for heat sinks:** \_\_\_\_\_

**Total heating cable length**

$$\left( \frac{\text{Pipe length}}{\text{Pipe length}} \times \frac{\text{Number of heating cable runs}}{\text{Number of heating cable runs}} \right) + \frac{\text{Additional cable for valves, pipe supports, and flanges}}{\text{Additional cable for valves, pipe supports, and flanges}} = \frac{\text{Total heating cable length required}}{\text{Total heating cable length required}}$$

**Example:**

**Heat sinks**

$$\frac{\text{Gate valves}}{\text{How many}} \times \frac{\text{Additional heating cable}}{\text{Additional heating cable}} = \frac{\text{Total}}{\text{Total}}$$

$$\frac{\text{Pipe hangers noninsulated and U-bolt supports}}{\text{How many}} \times \frac{\text{Additional heating cable}}{\text{Additional heating cable *2-in pipe diameter = 0.17 ft}} = \frac{\text{Total}}{\text{Total}}$$

$$\frac{\text{n/a}}{\text{How many}} \times \frac{\text{Additional heating cable}}{\text{Additional heating cable}} = \frac{\text{Total}}{\text{Total}}$$

**Total: 14.6 ft rounded up to 15 ft**

**Total heating cable length**

$$\left( \frac{300 \text{ ft}}{\text{Pipe length}} \times \frac{1}{\text{Number of heating cable runs}} \right) + \frac{15 \text{ ft}}{\text{Additional cable for valves, pipe supports, and flanges}} = \frac{315 \text{ ft}}{\text{Total heating cable length required}}$$

**Step 4 Determine the electrical parameters**

**Determine maximum circuit length and number of circuits**

See Table 9 and Table 10.

Total heating cable length required \_\_\_\_\_

Supply voltage:     120 V     208 V  
                            240 V     277 V

Circuit breaker size:     15 A     20 A  
                                    30 A     40 A

Minimum start-up temperature \_\_\_\_\_

Maximum circuit length \_\_\_\_\_

$$\frac{\text{Total heating cable length required}}{\text{Maximum heating cable circuit length}} = \text{Number of circuits}$$

**Example:**

Total heating cable length required 315 ft of 5XL1-CR

Supply voltage:     120 V     208 V  
                            240 V     277 V

Circuit breaker size:     15 A     20 A  
                                    30 A     40 A

Minimum start-up temperature -20°F

Maximum circuit length 201 ft

$$\frac{315 \text{ ft}}{201 \text{ ft}} = 1.6 \text{ circuits, round up to 2}$$

Number of circuits

**Determine transformer load**

See Table 11 and Table 12.

$$\frac{\text{Max A/ft at minimum start-up temperature}}{\text{Heating cable length}} \times \frac{\text{Supply voltage}}{1000} = \text{Transformer load (kW)}$$

**Example:**

$$\frac{0.119 \text{ A/ft}}{315 \text{ ft}} \times \frac{120 \text{ V}}{1000} = 4.5 \text{ kW}$$

Transformer load (kW)

**Step 5 Select the connection kits and accessories**

See Table 13.

Connection kits – Aboveground	Description	Quantity	Heating cable allowance
<input type="checkbox"/> RayClic-PC	Power connection and end seal	_____	_____
<input type="checkbox"/> RayClic-PS	Power splice and end seal	_____	_____
<input type="checkbox"/> RayClic-PT	Powered tee and end seal	_____	_____
<input type="checkbox"/> FTC-P	Power connection and end seal	_____	_____
<input type="checkbox"/> RayClic-S	Splice	_____	_____
<input type="checkbox"/> RayClic-T	Tee kit with end seal	_____	_____
<input type="checkbox"/> RayClic-X	Cross connection	_____	_____
<input type="checkbox"/> FTC-HST	Low-profile splice/tee	_____	_____
<input type="checkbox"/> RayClic-LE	Lighted end seal	_____	_____
<input type="checkbox"/> RayClic-E	Extra end seal	_____	_____
Connection kits – Buried	Description	Quantity	Heating cable allowance
<input type="checkbox"/> RayClic-PC	Power connection and end seal	_____	_____
<input type="checkbox"/> FTC-XC	Power splice and end seal	_____	_____
<input type="checkbox"/> RayClic-LE	Lighted end seal	_____	_____
<input type="checkbox"/> RayClic-E	Extra end seal	_____	_____
Accessories – Aboveground and buried	Description	Quantity	
<input type="checkbox"/> RayClic-SB-04	Pipe mounting bracket	_____	
<input type="checkbox"/> RayClic-SB-02	Wall mounting bracket	_____	
<input type="checkbox"/> ETL	“Electric-Traced” label	_____	
<input type="checkbox"/> GT-66	Glass cloth adhesive tape	_____	
<input type="checkbox"/> GS-54	Glass cloth adhesive tape	_____	
<input type="checkbox"/> AT-180	Aluminum tape (for plastic pipes)	_____	

**Total heating cable allowance for connection kits**

$$\text{_____} + \text{_____} = \text{_____}$$

Total heating cable length      Total heating cable allowance for connection kits      **Total heating cable length required**



**Step 6 Select the control system**

See Table 18.

Thermostats, controllers and accessories	Description	Quantity
<input type="checkbox"/> EC-TS	Electronic thermostat with 25-ft sensor	_____
<input type="checkbox"/> SB-110	Pipe mounting bracket for EC-TS	_____
<input type="checkbox"/> DigiTrace C910	Microprocessor-based single-point heat-tracing controller	_____
<input type="checkbox"/> ACCS-UIT2	ACCS-30 user interface terminal	_____
<input type="checkbox"/> ACCS-PCM2-5	ACCS-30 power control panel	_____
<input type="checkbox"/> ProtoNode-LER	Multi-protocol gateway	_____
<input type="checkbox"/> ProtoNode-RER	Multi-protocol gateway	_____
<input type="checkbox"/> RTD3CS	Resistance temperature device	_____
<input type="checkbox"/> RTD10CS	Resistance temperature device	_____
<input type="checkbox"/> RTD-200	Resistance temperature device	_____

**Step 7 Select the power distribution**

See Table 19.

Power distribution	Description	Quantity
<input type="checkbox"/> HTPG	Heat-tracing power distribution panel for group control	_____

Contactors	Description	Quantity
<input type="checkbox"/> E104	Three-pole, 100 Amp per pole contactor	_____
<input type="checkbox"/> E304	Three-pole, 40 Amp per pole contactor	_____

**Step 8 Complete the Bill of Materials**

Use the information recorded in this worksheet to complete the Bill of Materials.

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