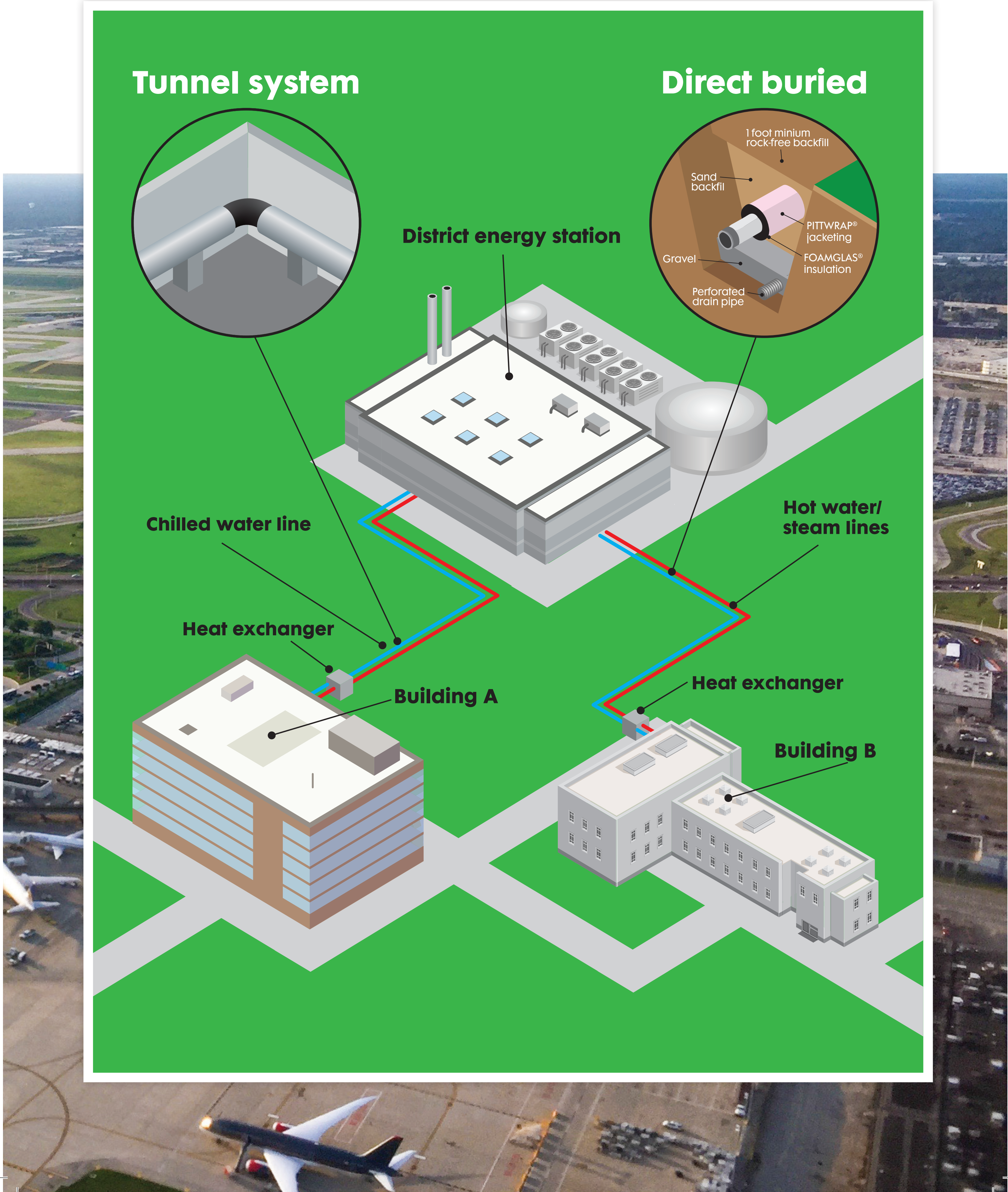
FOAMGLAS®

District Energy Insulation Systems

Underground | Direct Buried | Tunnels | Vaults

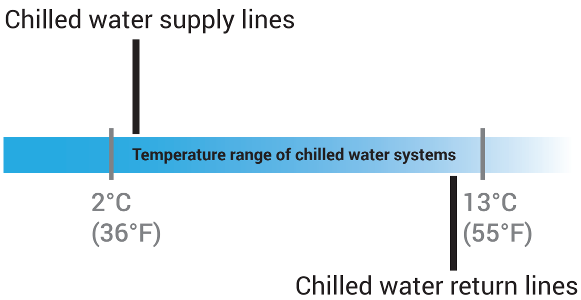
DISTRICT ENERGY SYSTEMS

Energy efficiency and sustainability are high priorities for the district energy systems for multi-facility sites such as universities, airports, hospitals and cities/municipalities. These integrated systems use a dedicated location to provide heating and cooling to multiple buildings in the network and typically employ chilled water, hot water or steam lines to provide temperature control to different buildings. Most commonly, pipes used to provide climate control are either direct buried or located in vaults or tunnels. Both arrangements bring specific challenges in terms of insulating the pipe system. A well-designed and correctly installed insulation system is necessary to protect the system's lifespan, ensure efficient thermal performance, lower energy expenditures and protect piping.


Tunnel system
Direct buried
1 foot minium
rock-free backfill
Sand
backfil
PITTWRAP®
jacketing
FOAMGLAS®
insulation
Gravel
Perforated
drain pipe
District energy station
Chilled water line
Hot water/
steam lines
Heat exchanger
Building A
Heat exchanger
Building B

CHILLED WATER SYSTEM CONSIDERATIONS: VAULTS AND TUNNELS

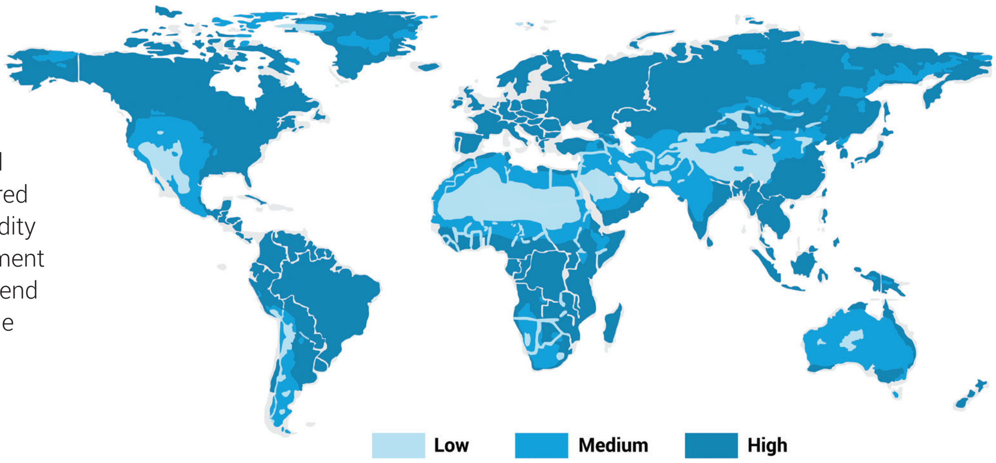
Due to their below-ambient nature, chilled water lines bring about some specific challenges when designing vaulted or tunneled district energy insulation systems. Tunnels and vaulted spaces face the possibility of elevated temperatures occurring within, along with the potential for increased humidity and low airflow. Porous walls, floors or ceilings used to contain chilled lines can contribute to these issues. The temperature of chilled water systems can typically range from 2°C (36°F) for supply lines to 13°C (55°F) for return lines.



1 HUMIDITY

The concentration of water vapor present in the air.

Relative humidity indicates the actual amount of moisture in the air compared to how much could be present. Humidity levels vary across the world. One element to remember is that humidity tables tend to track regional averages not extreme weather events, and both have to be considered.



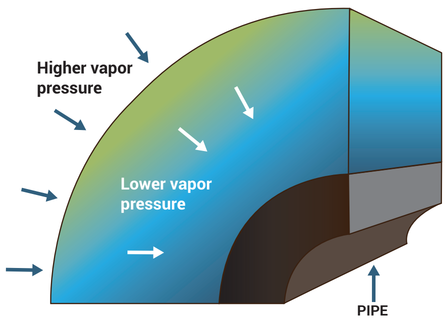
Condensation becomes a critical concern in high-humidity environments where there exists a much higher vapor drive from ambient air towards a cold pipe surface.

Note: Map represents averages. For general use only. Extremes may differ depending on seasonal or atypical weather patterns.

2 VAPOR PRESSURE

The balance point where water can exist as both a liquid and a gas.

When a colder object – like a cold-water pipe – enters the system, it disrupts the equilibrium and prompts water to collect as condensation on that colder surface until the balance is restored.

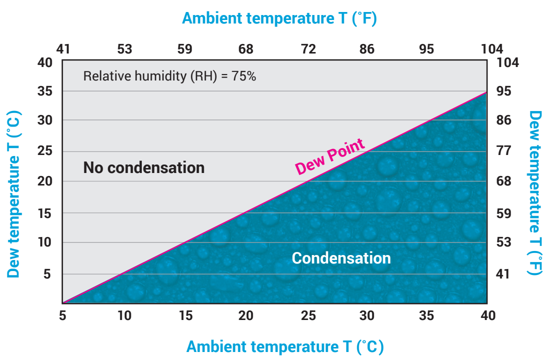


A compromised insulation system can allow moisture to move towards the pipe, where it can condense into liquid moisture on the pipe surface. This can occur from poor installation or physical damage to the insulation system.

3 DEW POINT

The temperature where condensation begins.

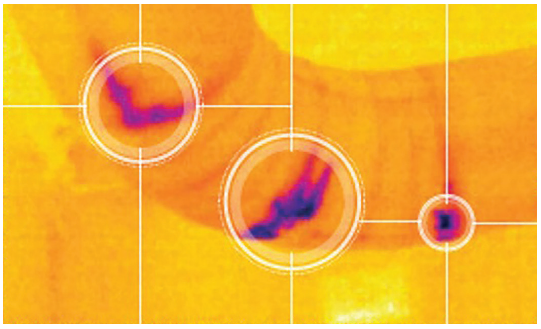
When air cools to its dew point through contact with a surface that is colder than the air, water will condense on the surface.



When considering chilled water pipes in warm environments, low emissivity jacketings (aluminum, steel) absorb less heat, resulting in a lower surface temperature. Conversely, high emissivity jacketings (PVC, ASJ) absorb more heat, resulting in a higher surface temperature. Condensation on the jacketing can become a concern when the surface temperature is less than the dew point of the surrounding air.

PROBLEMS ASSOCIATED WITH SATURATED INSULATION

Excessive condensation buildup within the insulation can lead to loss of the insulation's efficiency and the possibility of corrosion under insulation (CUI). It is widely known within the industry that insulation becomes much less effective when it's saturated with water, and long-term exposure to moisture can lead to complete system failure due to CUI.



Saturated insulation can lead to loss of insulation efficiency, creating hot spots that require more energy to cool pipe contents to the desired operating temperature.

Loss of insulation efficiency

- Thermal bridging
  - Allows more heat gain into chilled water supply lines
- Energy losses
  - More energy required to cool pipes back to 4°C (40°F) operating temperature
- Loss of process control
  - Warmer supply lines lead to diminished cooling effect
- Equipment strain
  - Added stress on chillers to reduce water to target temperature, potentially lessening equipment life

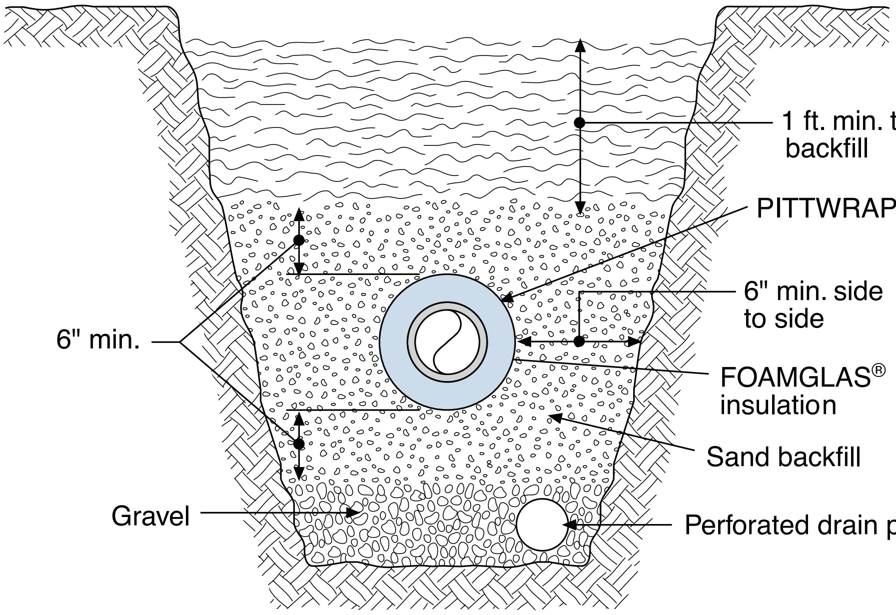
Consequences associated with CUI include: unanticipated failure of the process, damage to equipment, costly repairs, downtime and increased potential for leaks.

Corrosion under insulation (CUI)

- Key ingredients for carbon steel corrosion include:
  - Oxygen
  - Liquid moisture
- Potential damage:
  - Exterior pipe damage
  - Complete system failure
- Damage can remain hidden in district energy systems

DIRECT BURIED APPLICATIONS

The direct burial of insulated pipelines is often the most practical method of installing underground piping systems. This method eliminates the need for costly tunnels and speeds up the installation of the piping system. The ideal insulation system must be capable of meeting the mechanical and corrosion resistance requirements of direct burial while providing long-term insulation efficiency. Ignoring these basic considerations may result in problems.



A compromised insulation system can allow moisture to move towards the pipe, where it can condense into liquid moisture on the pipe surface. This can occur from poor installation or physical damage to the insulation system.

FOAMGLAS® INSULATION BENEFITS

High compressive strength

- Designed to withstand loads which crush most other insulating materials

Nonabsorbent

- 100% closed-cell material
- Will not absorb water
- No warping or swelling

Dimensionally stable

- Better matches substrate expansion and contraction than other insulations
- Will not compress or deform leading to tears or punctures

CONSIDERATIONS CHECKLIST: DIRECT BURIED

Load-bearing requirements of the piping and insulation system

- What to consider:
  - Direct load comes from the soil on top of the pipe and increases based on burial depth and with higher soil compression.
  - Live load is weight added to the pipe from the surface by factors like vehicle traffic or buildings.
- What to look for:
  - High compressive strength

Water tables, hydrostatic loading potential, vapor drive and potential for flooding

- What to consider:
  - Changes in hydrostatic pressure – or pressure exerted by moisture in the ground – can force water towards or into contact with the insulation protecting buried pipes.
  - If there is a break in the moisture barrier and permeable insulation was used, this movement may force moisture into the insulation.
  - The force exerted by hydrostatic pressure can be of particular concern at sealed areas like joints or protrusions in insulation.
- What to look for:
  - Closed-cell, impermeable insulation

Potential for system movement due to temperature changes

- What to consider:
  - On high-temperature steam or hot water lines, insulation design must account for pipe movement.
  - As metal pipes warm, they expand, and space needs to be provided for the alteration, otherwise insulation and joints can be damaged.
- What to look for:
  - Thermal expansion/contraction properties similar to pipe material

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Heat transfer fundamentals

- What to consider:
  - Soil is a poor insulating material and, in addition to allowing water into the system, gaps in insulation allow heat to bleed away from high-temperature pipes.
  - Heat transfer can negatively affect the function of nearby chilled water lines, adding strain to the cooling process and increasing energy use.
  - Heat bleed can also damage other in-ground utilities, potentially melting PVC piping or damaging the casing used on electrical wiring.
- What to look for:
  - Thermal consistency and performance

VAULT AND TUNNEL APPLICATIONS

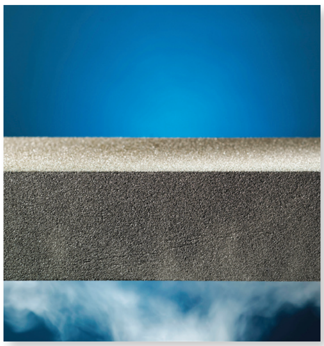
The use of vaults or tunnels for district energy systems is common in very cold climates, where direct burial below the frost line is not feasible, or where the water table is too high. These tunnel systems may also be built to avoid disruptions during recurring construct, repair or upgrading of large-scale services infrastructure (telecommunications, gas, water, power, etc.). The ideal insulation system must be robust enough to prevent accidental damage from the traffic of maintenance personnel and to withstand vermin. It must also be impermeable to moisture to defend against possible flood events and to protect other utility systems sharing the vault or tunnel system.

Insulation systems in vaulted or tunneled applications must be able to withstand potential flooding, limit risk to other assets and protect pipes from maintenance traffic or burrowing vermin that could cause damage.

FOAMGLAS® INSULATION BENEFITS

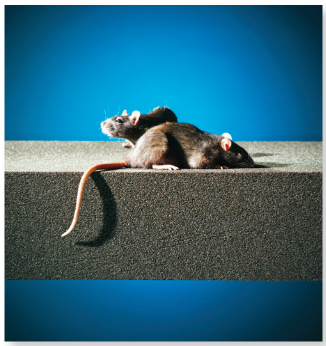
Nonabsorbent

- 100% closed-cell material
- Will not absorb water
- No warping or swelling



Vapor Impermeable

- Prevents the passage of water vapor and other gases
- Insulation will not accumulate moisture over time



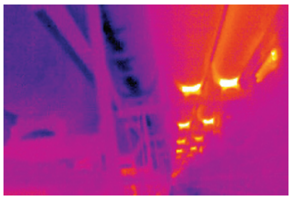
Resistant to Vermin

- Inorganic
- Not a source of food for rodents, insects or micro-organisms over time

Worst-case planning questions for vaults and tunnels:

- What risks are posed by flooding?
- What risks could be generated by tunnel traffic?
- What extreme weather events are likely to occur, and can the insulation handle them?
- Is the system able to manage abrupt disruptions in operations?
- What lifespan should this system have, and is the insulation designed to provide that?

CONSIDERATIONS CHECKLIST: VAULTS AND TUNNELS



Heat transfer fundamentals

- What to consider:
  - As water, vapor or compressive pressures cause insulation to deteriorate, radiant heat can place pressure on conduit assets such as fiber optic cables.
  - In urban environments, other utilities, including power and computer networks, are often housed in the tunnels used for chilled water and steam pipes.
  - Any damage to heating or cooling pipes could affect multiple additional systems as climate conditions within the tunnels alter.
- What to look for:
  - High compressive strength
  - Impermeable insulation

Potential for tunnel flooding

- What to consider:
  - Vault-entrenched pipes can be subject to dripping water from overhead pipes/equipment or experience tunnel flooding.
  - Moisture ingress into insulated pipes can reduce the effectiveness of insulation's protection, increase thermal conductivity and raise the potential for other types of damage, including corrosion.
  - Corrosion under insulation (CUI) can occur when steel pipes come into contact with moisture, especially while operating at -4°C – 175°C (25°F – 350°F).
- What to look for:
  - Closed-cell, impermeable insulation to defend against moisture infiltration
  - Appropriate insulation accessories

Risk to other assets

- What to consider:
  - On high-temperature steam or hot water lines, insulation design must account for pipe movement.
  - As metal pipes warm, they expand and space needs to be provided for the alteration, otherwise insulation and joints can be damaged.
- What to look for:
  - Thermal expansion/contraction properties similar to pipe material

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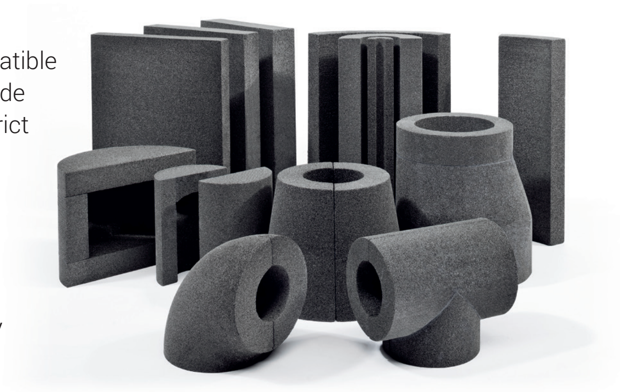
Insulation exposure to foot traffic and burrowing vermin

- What to consider:
  - It's not uncommon for maintenance activities involving workers to take place within district energy tunnels or vaults, regardless of size.
  - Insulation systems can experience damage from foot traffic or impacts associated with maintenance activities.
  - Depending on the tunnel's location and various access points, it may be possible that vermin could find their way in.
- What to look for:
  - Compressive strength
  - Inorganic insulation resistant to burrowing vermin

DISTRICT ENERGY INSULATION SYSTEM SOLUTIONS



FOAMGLAS® insulation systems consist of cellular glass insulation and compatible accessories such as jacketings, sealants and adhesives. These systems provide superior performance for direct burial underground, vaulted and tunneled district energy systems.

FOAMGLAS® ONE™ insulation is a lightweight, rigid material composed of millions of completely sealed glass cells.

Features

- Constant insulating efficiency
- Noncombustible
- Nonabsorbent
- Impermeable to water and water vapor
- Corrosion/chemical resistant
- Long-term dimensional stability
- Vermin resistance
- High compressive strength

FLEXIBLE PITTWRAP® INSULATION JACKETING

PITTWRAP® HS jacketing

PITTWRAP® HS (Heat Seal) jacketing is a heat-sealable, multi-ply laminate for protecting underground FOAMGLAS® insulation systems for outer surface temperatures at or below 88°C (190°F).

PITTWRAP® HS jacketing consists of three layers of a polymer-modified, bituminous compound separated by glass fabric reinforcement and aluminum foil. An outer layer of polyester film is laminated to the bituminous compound. The product is supplied with a release paper to aid efficient application.

PITTWRAP® SS jacketing

PITTWRAP® SS (Self Seal) jacketing is a 1.78 mm (70 mil) thick self-sealing, modified bituminous membrane for protecting underground FOAMGLAS® insulation systems with outer surface temperatures at or below 77°C (170°F). It is recommended for underground/direct buried pipelines including shallow buried water service pipelines, above ambient service pipelines, commercial chilled water and cold service applications. Manual pressure seals the jacketing without the use of a torch or heater in most circumstances.

PITTWRAP® SS jacketing may be factory or field applied to the insulation. PITTWRAP® SS jacketing consists of a polymer-modified bituminous compound reinforced with a glass fabric and a 0.03 mm (1 mil) aluminum top film and release paper backing.

PITTWRAP® CW PLUS jacketing

PITTWRAP® CW PLUS jacketing is a 1.27 mm (50 mil) thick self-sealing, modified bituminous membrane for protecting underground FOAMGLAS® insulation systems on chilled water and hot water service pipelines. Manual pressure seals the jacketing without the use of a torch or heater. PITTWRAP® CW PLUS jacketing may be field applied or factory applied on the prefabricated insulation components.

PITTWRAP® CW PLUS jacketing consists of a polymer-modified bituminous compound reinforced with a glass fabric and a 0.0254 mm (1 mil) aluminum top film and release paper backing.

FOAMGLAS® ONE™ INSULATION

Figure 1: Thermal contraction of insulations versus steel (70°F to -300°F)

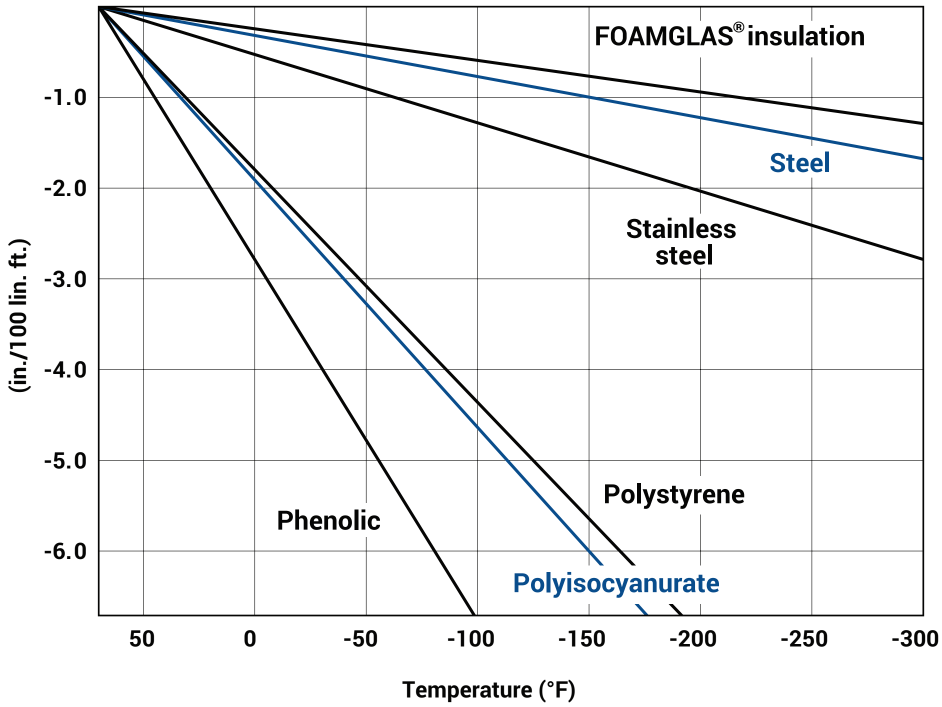
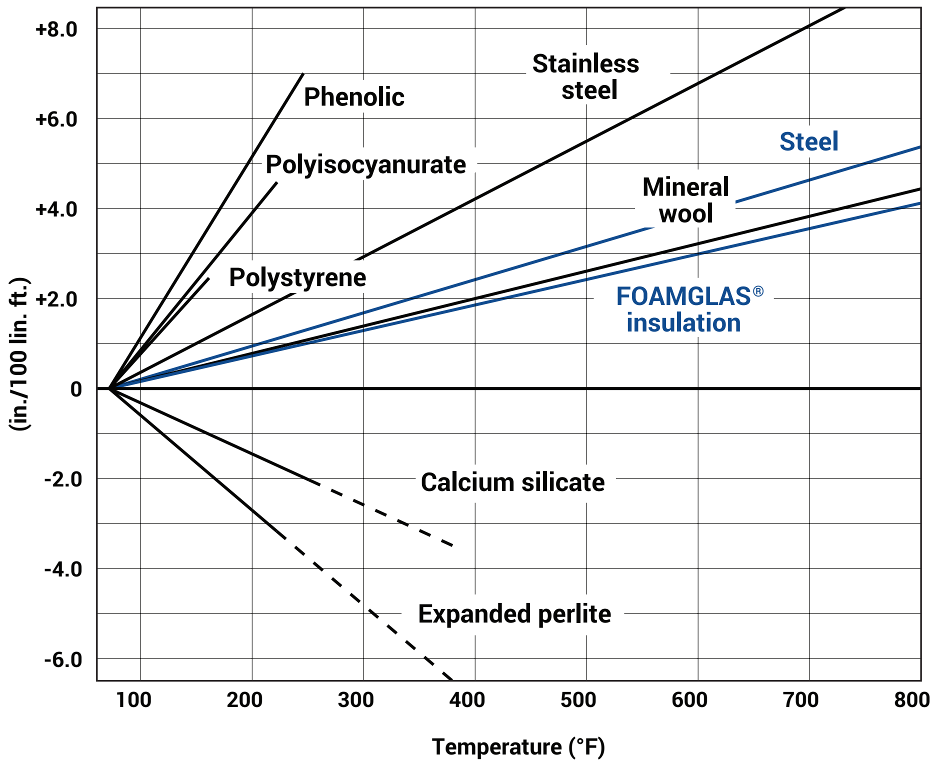
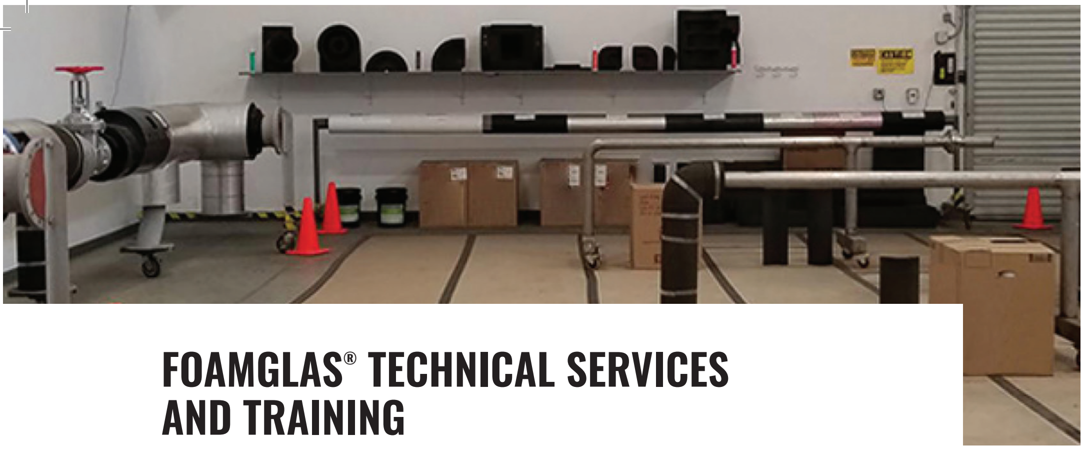


Figure 2: Thermal expansion/contraction of insulations versus steel (70°F to 800°F)





FOAMGLAS® TECHNICAL SERVICES AND TRAINING

Our Global Technical Services & Training team can help optimize your district energy system's performance by supporting you during design, installation, maintenance and follow-up with a periodic assessment of the performance of your insulation systems. Our objective is to give you accurate and effective technical advice, application guidance and personalized support.

Technical services include:

- Training and education
- Product specification review
- Insulation thickness calculations
- Energy and thermal imaging surveys
- Jobsite training and startup support
- Installation guide specifications
- Special testing services

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