Thermal Insulation Association of Canada
55th Annual Conference – August 2017
Toronto, Ontario

The “A” in TIAC is for…

ASSERTIVE!

Le ‘A’ en ACIT est pour…

ASSURÉ!

We'll be looking at…

- ASHRAE 90.1-2010
- NECB-2015
- NBC-2010
- NPC-2015
- What's wrong with this picture?
- Water/Energy Nexus
- Legionella Disease
- TIAC O&M Inspection Protocol

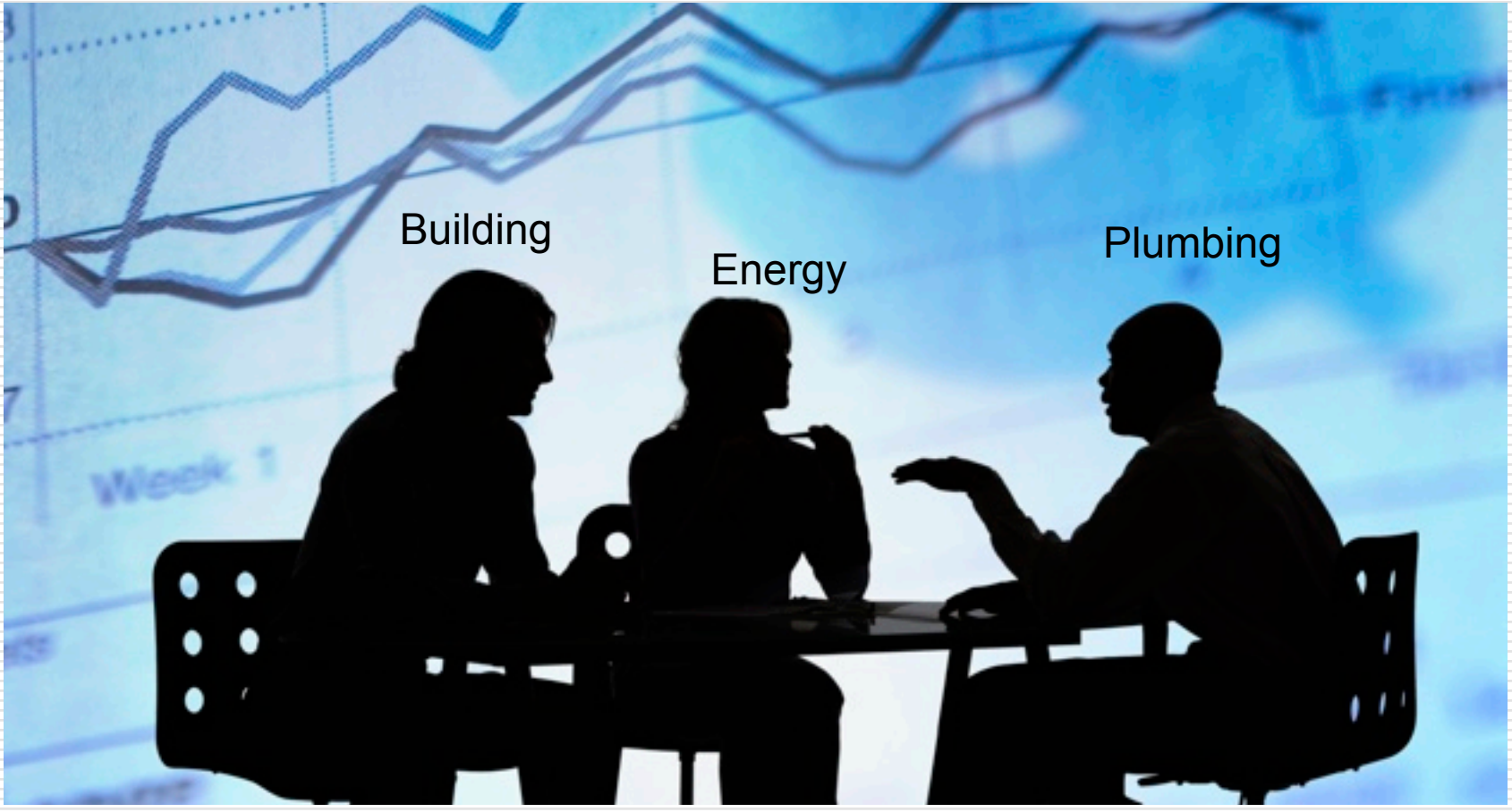
Changing the conversation…

- What is important in the smooth operation of your facility?
- What are your benchmarking goals?
- What keeps you up at night?
- Specifications.

Newly joined

- ASHRAE Cold Climate Building Committee
- Canadian Pipeline Energy Association

Let’s have a meeting…



ASHRAE 90.1-2010
Minimum Pipe Insulation Thickness
Large Buildings

TABLE 6.8.3A Minimum Pipe Insulation Thickness
Heating and Hot Water Systems[a,b,c,d]
(Steam, Steam Condensate, Hot Water Heating and Domestic Water Systems)

Fluid Operating Temperature Range (°C) and Usage	Insulation Conductivity		Nominal Pipe or Tube Size (mm)				
	Conductivity W/(m°C)	Mean Rating Temperature, °C	<25	25 to <40	40 to <100	100 to <200	≥200
			Insulation Thickness (mm)				
>177 °C	0.046–0.049	121	115	125	125	125	125
122°C–177°C	0.042–0.046	93	80	100	115	115	115
94°C–121°C	0.039–0.043	66	65	65	80	80	80
61°C–93°C	0.036–0.042	52	40	40	50	50	50
41°C–60°C	0.032–0.040	38	25	25	40	40	40

a For insulation outside the stated conductivity range, the minimum thickness (*T*) shall be determined as follows: $T = r\{(1 + t/r)^{K/k} - 1\}$ where T = minimum insulation thickness (mm), r = actual outside radius of pipe (mm), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (W/(m°C)); and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
b These thicknesses are based on energy efficiency considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.
c For piping smaller than 40mm and located in partitions within *conditioned spaces*, reduction of these thicknesses by 25mm shall be permitted (before thickness adjustment required in footnote a) but not to thicknesses below 25 mm.
d For direct-buried heating and hot water system piping, reduction of these thicknesses by 40mm shall be permitted (before thickness adjustment required in footnote a) but not to thickness below 25 mm.
e The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown in the table.

TABLE 6.8.3B Minimum Pipe Insulation Thickness
Cooling Systems (Chilled Water, Brine, and Refrigerant)[a,b,c]

Fluid Operating Temperature Range (°C) and Usage	Insulation Conductivity		Nominal Pipe or Tube Size (mm)				
	Conductivity W/(m°C)	Mean Rating Temperature, °C	<25	25 to <40	40 to <100	100 to <200	≥200
			Insulation Thickness (mm)				
4°C–16°C	0.030–0.039	24	15	15	25	25	25
<4°C	0.029–0.037	10	15	25	25	25	40

a. For insulation outside the stated conductivity range, the minimum thickness (*T*) shall be determined as follows: $T = r\{(1 + t/r)^{K/k} - 1\}$ where T = minimum insulation thickness (mm), r = actual outside radius of pipe (mm.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (W/(m°C)); and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
b. These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.
c. For direct-buried cooling system piping, insulation is not required.
d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown in the table.

National Energy Code for Buildings-2015

- Clarification on pipe and duct insulation *installed* and *full* thickness.
- Adopted modified ASHRAE 90.1-2010 minimum pipe insulation thicknesses.
- No credit for claimed insulation value of plastic pipe.

NECB-2015 Pipe Insulation

8) The insulation thickness used to determine compliance with Table 5.2.5.3. shall be the thickness of the insulation after installation. (See Note A-5.2.2.5.(2), 5.2.5.3.(8) and 6.2.3.1.(6).)

Table 5.2.5.3.
Minimum Thickness of Piping Insulation
Forming Part of Sentences 5.2.5.3.(1), (3) to (5), and (8)

Type of System	Design Operating Temperature Range, °C	Thermal Conductivity of Insulation		Nominal Pipe Diameter, mm (inches)				
		Conductivity Range, W/m·°C	Mean Rating Temperature, °C	Runouts[1] ≤ 51 (2)	≤ 25.4 (1)	32 to 51 (1¼ to 2)	64 to 102 (2½ to 4)	≥ 127 (5)
				Minimum Thickness of Piping Insulation, mm				
Heating Systems (Steam, Steam Condensate and Hot Water)	> 177	0.046–0.049	121	38.1	114	127	127	127
	122–177	0.042–0.045	93	38.1	76.2	101.6	114	114
	94–121	0.039–0.043	65	38.1	63.5	63.5	76.2	76.2
	61–93	0.036–0.042	52	25.4	38.1	50.8	50.8	50.8
	41–60	0.035–0.040	38	25.4	25.4	38.1	38.1	38.1
Cooling Systems (Chilled Water, Brine and Refrigerant)	4–16	0.030–0.039	24	25.4	25.4	25.4	25.4	25.4
	< 4	0.030–0.039	24	25.4	25.4	38.1	38.1	38.1

Notes to Table 5.2.5.3.:

(1) Refers to runouts to individual terminal units not exceeding 3.7 m in length.

NECB-2015 Duct Insulation

5.2.2.5. Duct and Plenum Insulation

1) Except as provided in Sentences (3) to (6), all air-handling ducts, *plenums* and run-outs forming part of a heating, ventilating, or air-conditioning system shall be thermally insulated in accordance with Table 5.2.2.5.

2) The insulation thickness used to determine compliance with Table 5.2.2.5. shall be the thickness of the insulation after installation. (See Note A-5.2.2.5.(2), 5.2.5.3.(8) and 6.2.3.1.(6).)

Table 5.2.2.5.
Insulation of Ducts
Forming Part of Sentences 5.2.2.5.(1) and (2)

Temperature Difference,(1) °C	Minimum Thermal Resistance of Ducts and *Plenums*, m²·°C/W	Minimum Thermal Resistance of Run-outs,(2) m²·°C/W
< 5	0	0
5 to 22	0.58	0.58
> 22	0.88	0.58

Notes to Table 5.2.2.5.:

(1) Refers to the temperature difference at design conditions between the space within which the duct is located and the design temperature of the air carried by the duct. Where a duct is used for both heating and cooling purposes, the larger temperature difference shall be used.

(2) Refers to ducts not exceeding 3 m in length that connect to terminal grilles or diffusers.

The not-so-fine print

Installed R-values

Type	Labeled Thickness in	Labeled Thickness mm	Installed "R"** (hr•ft²•°F)/Btu	Installed "R"** m²•°C/W	Out-of-Package "R" (hr•ft²•°F)/Btu	Out-of-Package "R" m²•°C/W
Type 75 - 0.75 pcf (12kg/m³)						
75	1½	38	4.2	0.74	5.2	0.92
	2	51	5.6	0.99	6.9	1.22
	2 ⅛	56	6.0	1.08	7.5	1.33
	3	76	8.3	1.46	10.3	1.81
Type 100 - 1.00 pcf (16kg/m³)						
100	1½	38	4.5	0.79	5.6	0.99
	2	51	6.0	1.06	7.4	1.30
Type 150 - 1.5 pcf (24kg/m³)						
150	1½	38	4.7	0.83	6.0	1.06
	2	51	6.3	1.11	8.0	1.41

***Installed R-value calculated with a material thickness compressed to a maximum of 25% following recommended duct wrap stretch-outs.*

NECB-2015

- **5.2.2.5. Duct and Plenum Insulation**
  - 8) Manufactured insulation thickness shall not be altered.

- **5.2.5.3. Piping Insulation**
  - 8) The insulation thickness used to determine compliance with Table 5.2.5.3. shall be the thickness of the insulation after installation.

NECB-2015

- **Division B – Notes to Part 5**

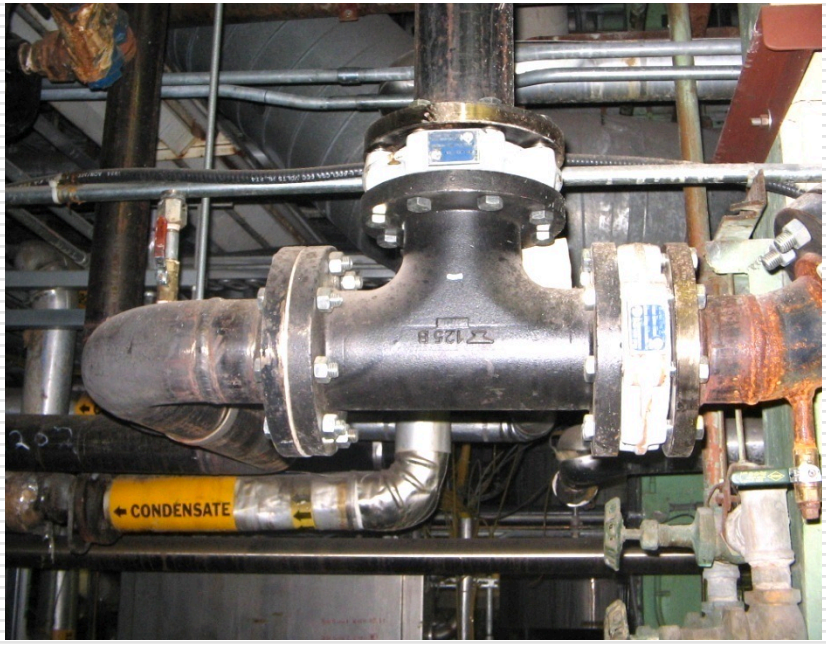
  Heating, Ventilating and Air-conditioning Systems

  - A-5.2.2.5.(7) and 5.2.5.3.(7) Installation. For the purposes of Sentences 5.2.2.5.(7) and 5.2.5.3.(7), “good practices” includes the TIAC “Mechanical Insulation Best Practices Guide.”

National Building Code of Canada-2010

- National Building Code of Canada-2010 requires surface temperature not to exceed 70C (158F).
- ASTM C1055-03: “Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries.”
  - At 70C (158F) and with skin exposure of 1 second, “Complete Transepidermal Necrosis (Cell Death)”.
  - TIAC proposes a more reasonable and safer maximum temperature is 40C (104F).

Frying Eggs?



National Plumbing Code of Canada-2015

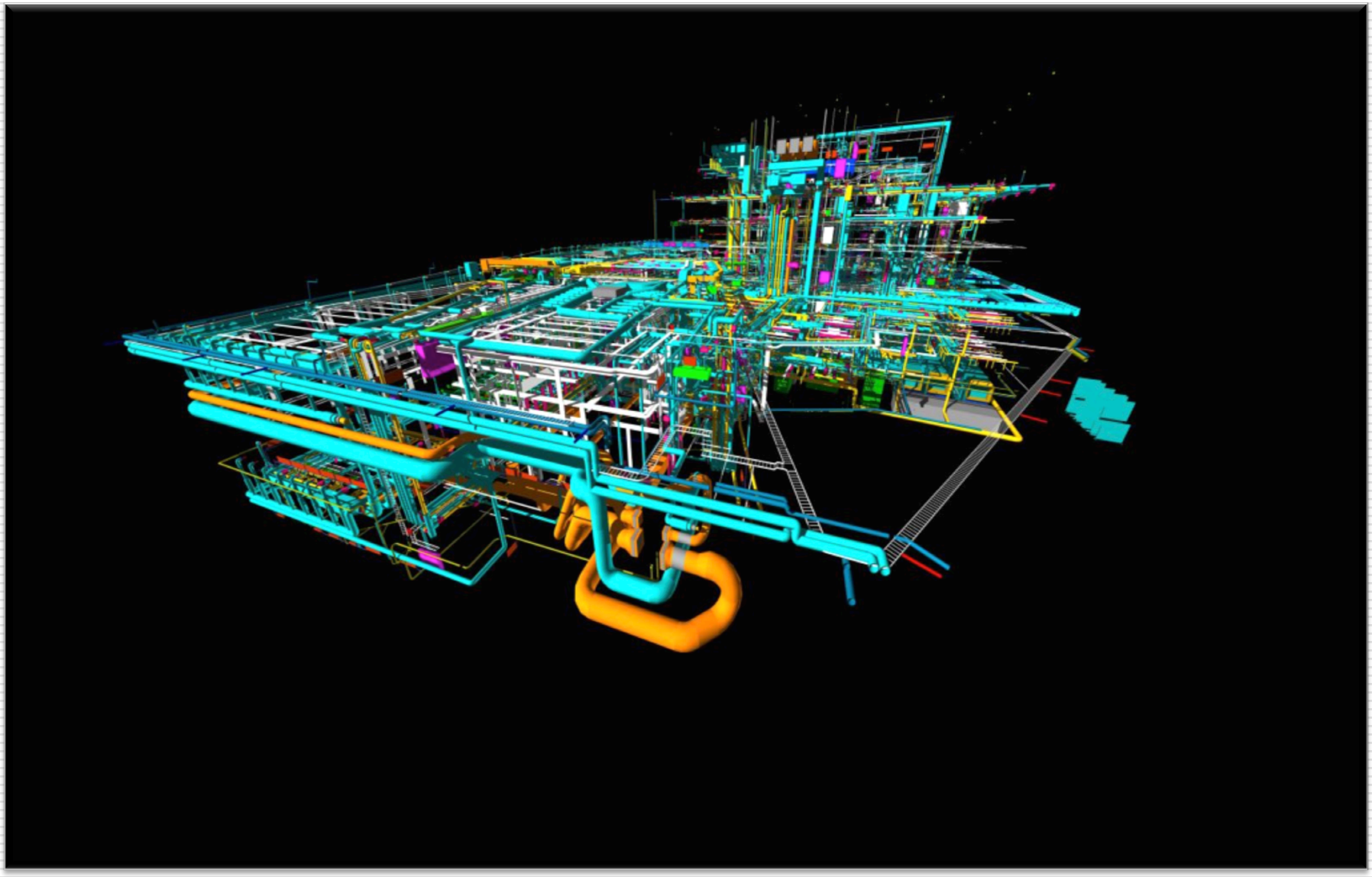
- "The NPC establishes requirements to address the following four objectives, which are fully described in Division A of the Code:"
  - safety
  - health
  - protection of buildings and facilities from water and sewage damage
  - environment

National Plumbing Code of Canada-2015

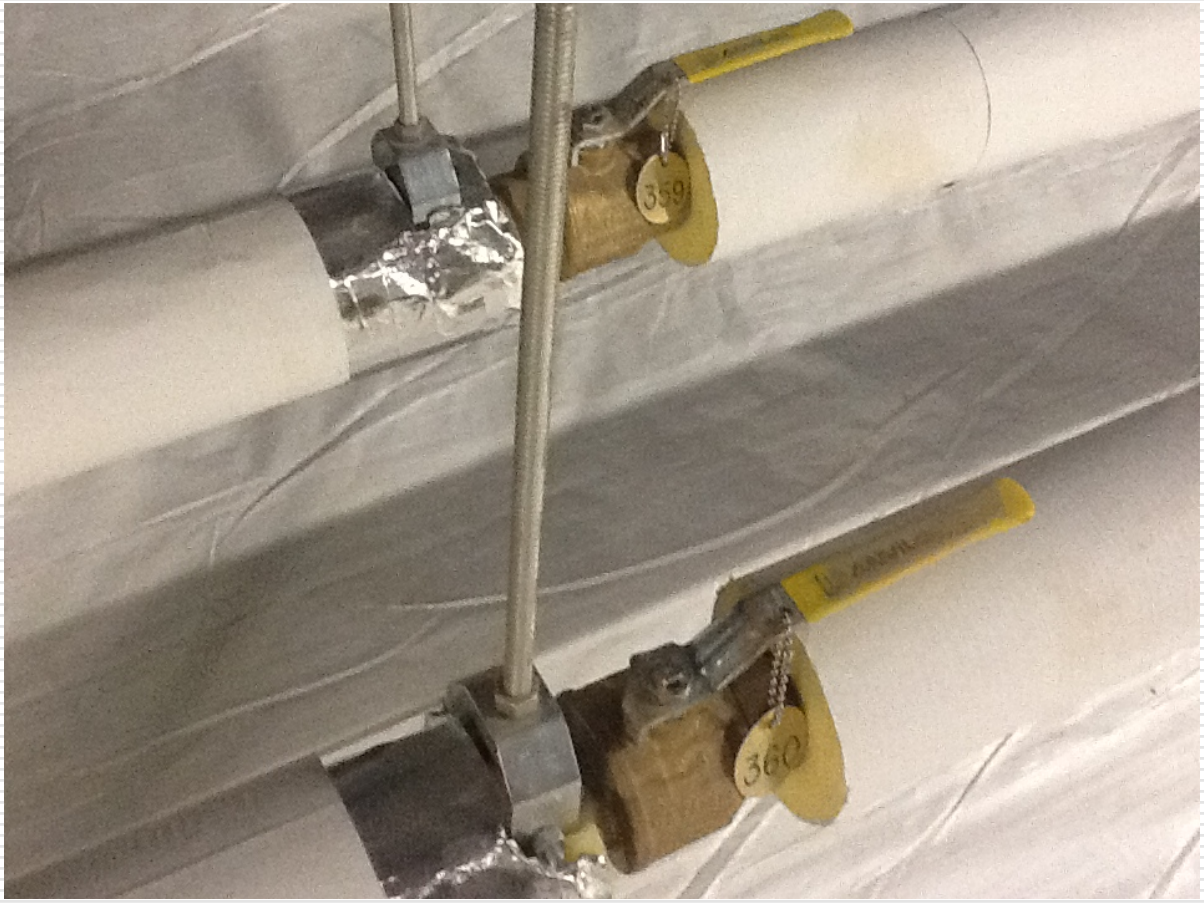
- TIAC submission:

"The design, configuration and installation of piping systems and related fittings and supports shall comply with the intent of NECB-2015, Sections 5.2.2.5.8), 5.2.5.3., 5.2.5.3.8) and 5.2.5.4.1)."

Clearance! Clearance! Clearance!



What's wrong with this picture?



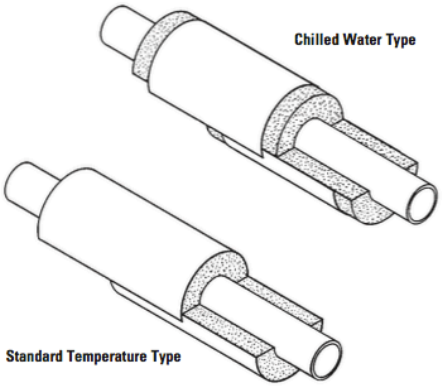
What’s wrong with this picture?

What’s wrong with this picture?

Pipe support with high density insulation

Pipe Supports, Guides, Shields & Saddles

B3380 thru B3387
360° Calcium Silicate Shield
Pre-Insulated Support



Size Range: Up to 24" (600mm)

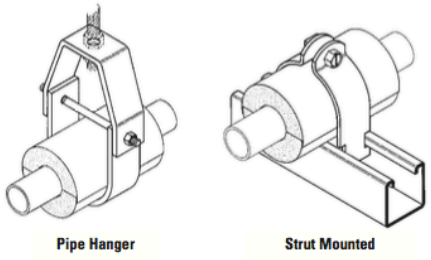
Material: Asbestos-free, Hydrous Calcium Silicate Insulation with Pre-Galvanized steel jacket

Function: Designed to provide a crush resistant insulation insert at pipe support points. Can be used with hangers or straps.
Standard type has functionality for both chilled water and hot water.

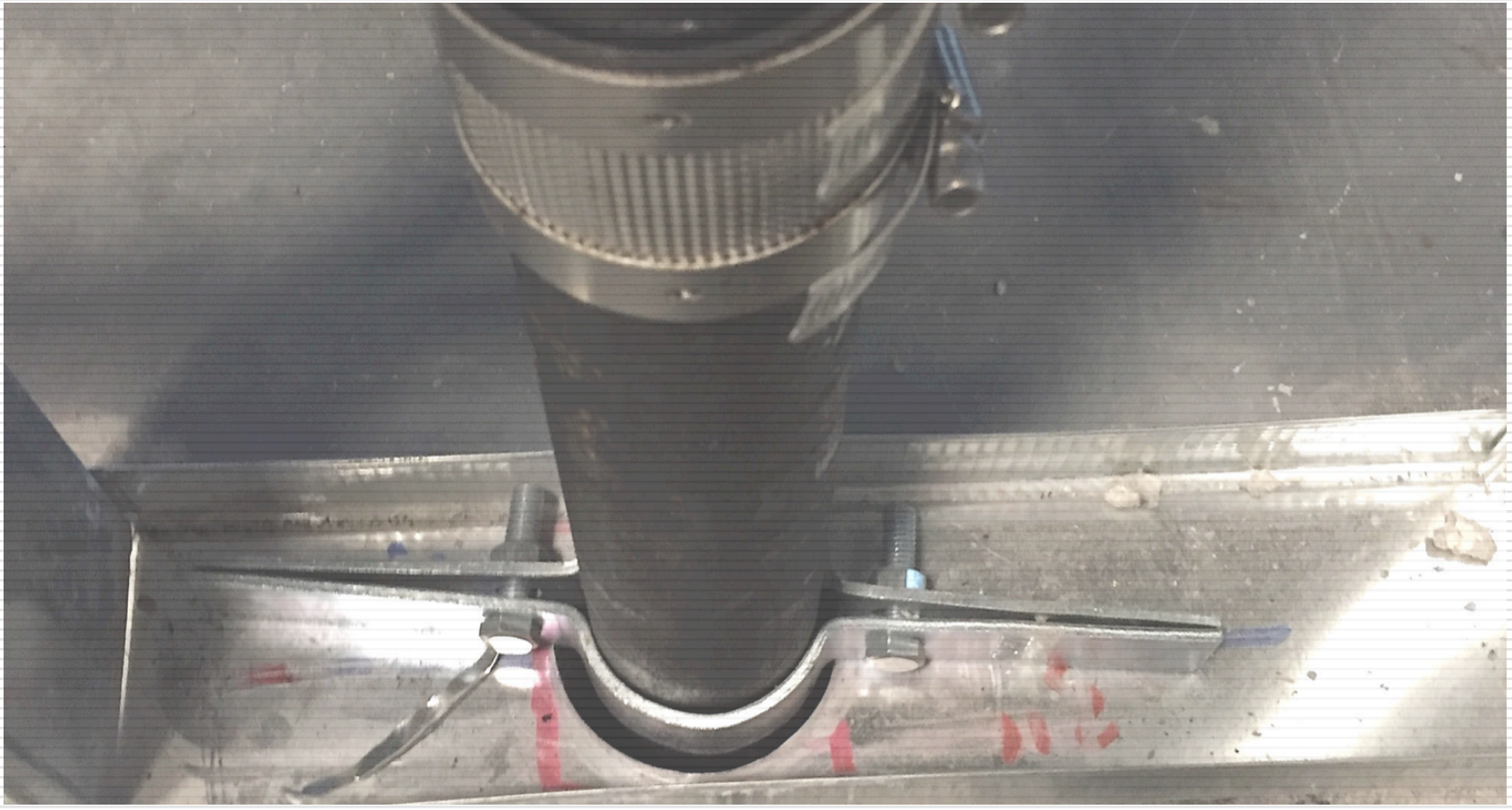
Miscellaneous Information: Flame retardant, water and rot resistant, temperature range from -20°F (-29°C) to 1200°F (649°C). Easily installed in a pipe hanger or mounted to strut.

Order By: Part number.
(See part number legend below.)
For additional information, contact factory.

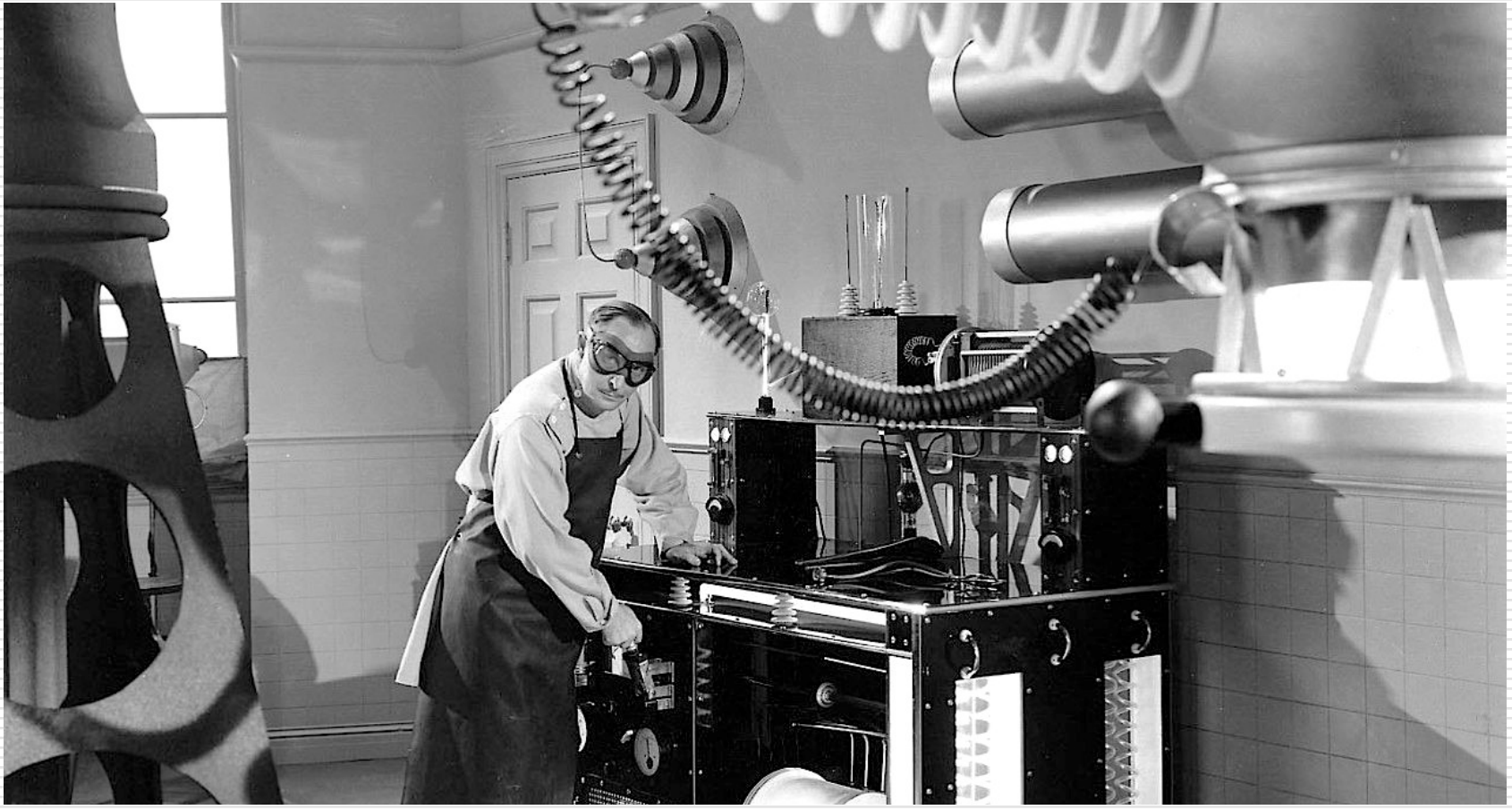
Applications



Design/Application Considerations



We've been experimenting…



PHIGENICS

Things don’t always work out

- Wolseley Canada
- M. A. Stewart & Sons Ltd.
- Canadian Institute of Plumbing and Heating (CIPH)
- The Heating, Refrigeration & Air-conditioning Institute of Canada (HRAI)
- BOMA Canada & BOMA U.S.
- Milwaukee Valve Company Ltd.
- Mechanical Contractors Association of Canada (MCAC)

Benchmarking

Establishing a baseline of energy and water consumption with the intention of certifying measurable improvements.

Government of Ontario

ONTARIO REGULATION 20/17 made under the

GREEN ENERGY ACT, 2009

Made: February 2, 2017
Filed: February 6, 2017
Published on e-Laws: February 6, 2017
Printed in *The Ontario Gazette*: February 25, 2017

REPORTING OF *ENERGY* CONSUMPTION AND *WATER* USE

The Water-Energy Nexus

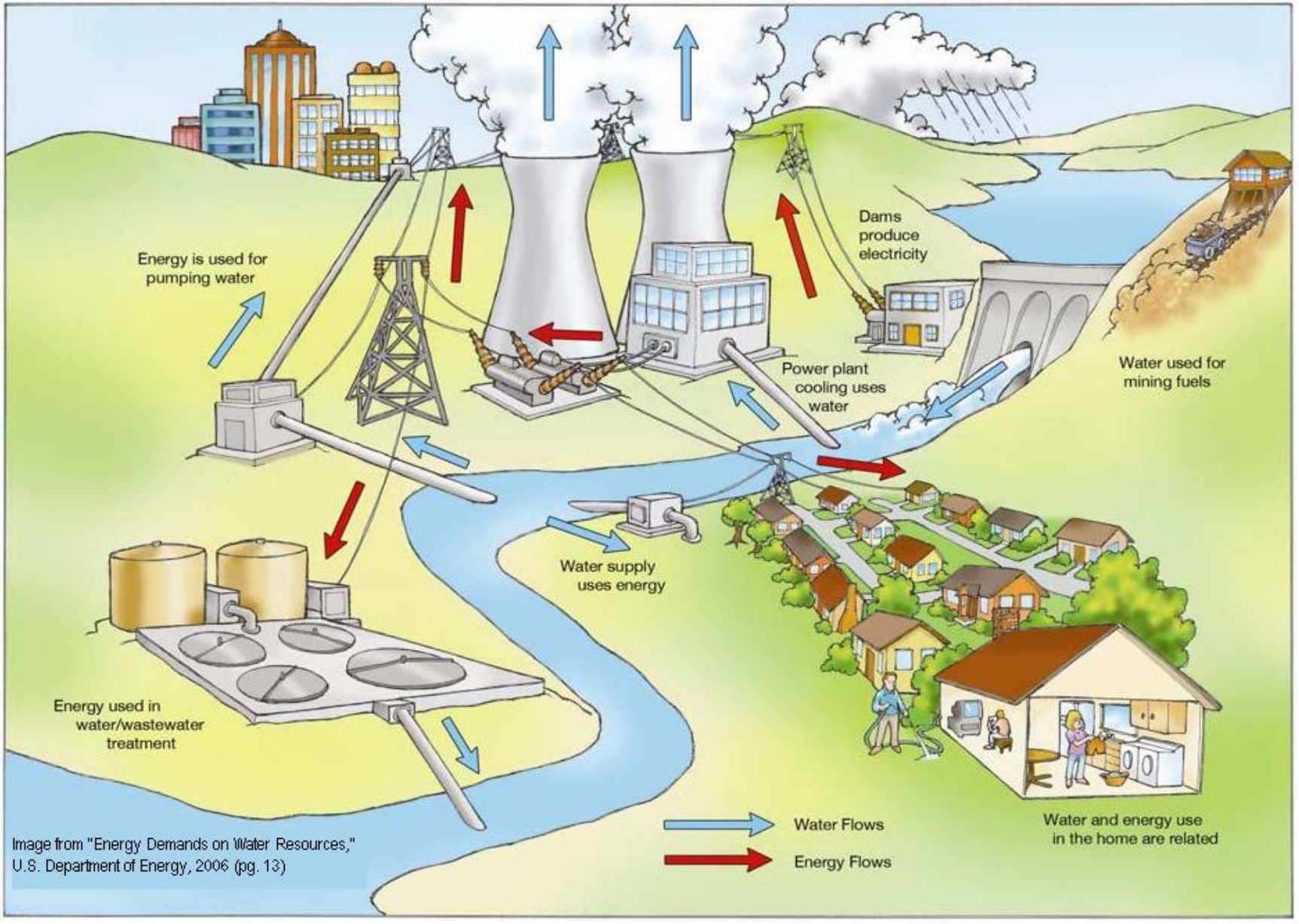


Image from "Energy Demands on Water Resources," U.S. Department of Energy, 2006 (pg. 13)

The Water/Energy Nexus

The American Society of Plumbing Engineers

10 seconds or less – Acceptable

11 to 30 seconds – Marginal

31 seconds or more – Unacceptable

**Domestic Hot Water Heating Design Manual* - ASPE, 2003

The Water/Energy Nexus

The Water/Energy Nexus

"Improving DHW System Performance"

ASHRAE Journal-March 2012

Texas A & M University is located about 90 miles NW of Houston.

"DHW system is over 12 miles long. It serves 71 buildings and is part of a 45MW co-gen system."

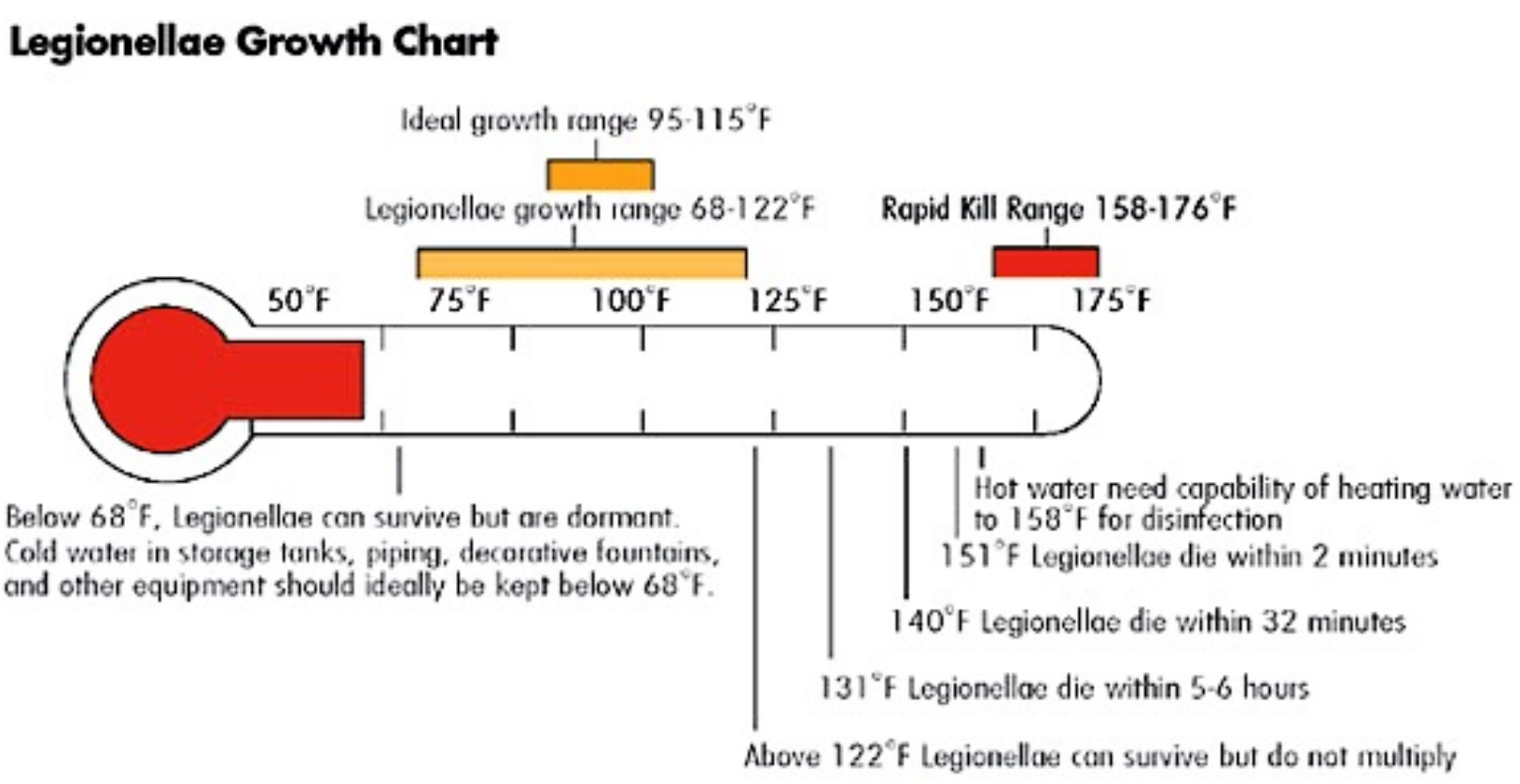
"Savings of about $572,300.00 annually"

The Water/Energy Nexus

"The best improvement for a DHW system would be a combination of improved insulation and reduced circulation flow rate."*

* International Journal of Energy Research 14:73-81

Legionella


Legionellae Growth Chart
Ideal growth range 95-115°F
Legionellae growth range 68-122°F
Rapid Kill Range 158-176°F
50°F
75°F
100°F
125°F
150°F
175°F
Below 68°F, Legionellae can survive but are dormant.
Cold water in storage tanks, piping, decorative fountains,
and other equipment should ideally be kept below 68°F.
Hot water need capability of heating water
to 158°F for disinfection
151°F Legionellae die within 2 minutes
140°F Legionellae die within 32 minutes
131°F Legionellae die within 5-6 hours
Above 122°F Legionellae can survive but do not multiply

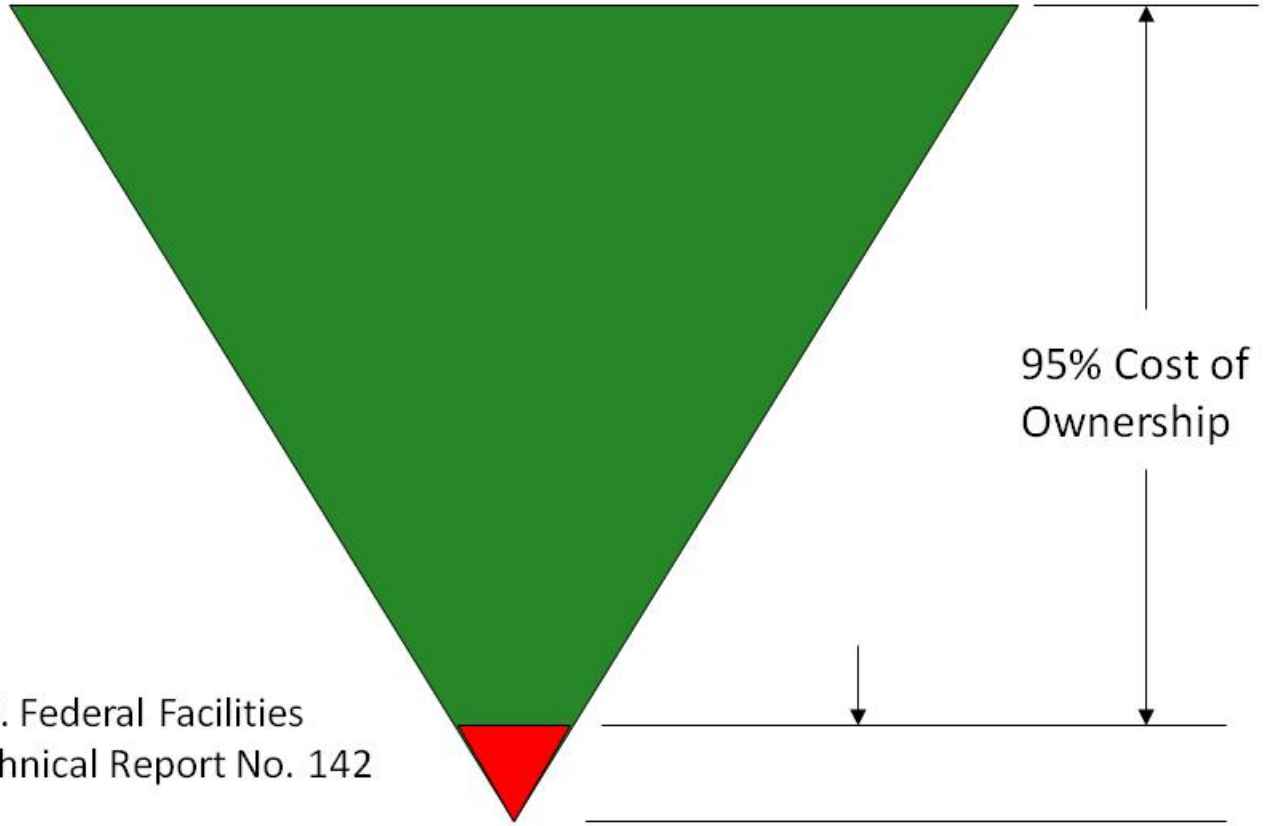
Legionella and pipe insulation

- ASHRAE 188-2015
  - 8.2.1.g. "…material specifications for all water systems insulation."
- OSHA
  - Section II C-1: "Proper insulation of hot water and heat tracing of lines can help maintain distribution and delivery temperatures at 50°C (122°F).
- Health and Safety Executive (UK)
  - "…adequately insulating pipes and tanks;"

Mechanical Insulation Design Guide

- MIDG – Calculator Tools
  - Temperature drop for air in an insulated duct or fluid in an insulated pipe.

Cost of Owning a Building



Source: U.S. Federal Facilities Council Technical Report No. 142

Unqualified contractor!

Unqualified contractor!

What to do?

- Specifications
  - Prequalify contractors.
  - Recognized trade school certification.
  - Apprenticeship programme.
  - Experienced supervision
  - Red Seal
  - BCICA/“QAP”.

When Specifications Don’t Work

- Calgary Hockey Arena
- Roof Duct:
  - 36” x 36”
  - 2.25 pcf rigid-2 layers 2”, pinned.
  - .020 stucco embossed aluminum.
  - Mastic sealant.
  - Penetrations-structural supports.

TIAC O&M Mechanical Insulation Inspection Protocol

- Understand how to self-assess deficiencies.
- Observations during normal inspection procedures.
- Quantify observations and measurements.
- Decide how to proceed.
- Initially little or no cost involved.

3E Plus
www.pipeinsulation.org
Free Calculator Tool

- Energy
  - Optimize insulation thickness.
  - What if's.
- Economics
  - Payback.
- Environmental
  - GHG emission reductions: CO_2, No_x & Carbon Equivalent (CE).

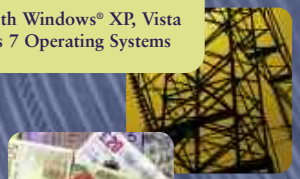
NAIMA
North American Insulation Manufacturers Association

3E plus®

User Guide

Version 4.1

Compatible with Windows® XP, Vista and Windows 7 Operating Systems



Insulation Thickness Computer Program

FEATURES:

- Able to retain user installed data when updating the program
- Contains updated thermal data for insulation materials
- Exports data to spreadsheets for further analysis
- Automatically calculates thickness tables
- Simple payback calculations
- New user interface
- Improved report formats
- Calculates in both metric and inch-pound units
- Ability to add custom fuels
- Calculates multiple insulation layers

Calculates The Savings For A Range of Insulation Thicknesses

Energy Savings • Economic Savings • Environmental Savings

www.PipeInsulation.org

Mechanical Insulation Design Guide (MIDG) Free Calculator Tool

- www.wbdg.org/design/midg_calculators.php
  - CONDENSATION CONTROL CALCULATOR – HORIZONTAL PIPE.
  - ENERGY LOSS, EMISSION REDUCTION, SURFACE TEMPERATURE, AND ANNUAL RETURN.
  - FINANCIAL RETURNS.
  - ESTIMATE TIME TO FREEZING FOR WATER IN AN INSULATED PIPE.
  - PERSONNEL PROTECTION CALCULATOR FOR HORIZONTAL PIPING.
  - TEMPERATURE DROP FOR AIR IN AN INSULATED DUCT OR FLUID IN AN INSULATED PIPE.

Changing the conversation…

We, as a national trade association have to become more assertive.

TIAC's members are at the vanguard on moving the needle forward.

No one else will do for us what we have to do for ourselves.

Thank you

- Steve Clayman
  - steve.clayman@tiac.ca
  - 416-606-1512

- Thermal Insulation Association of Canada
  - www.tiac.ca
  - Tel: 613-724-4834
  - Fax: 613-729-6206