ENERGY SOLUTIONS CENTER

Energy Industry Fundamentals

Customer Piping Fundamentals

Eric Burgis, Energy Solutions Center

This unit is part of Energy Solutions Center's: Energy Industry Fundamentals Training Program

Presentation Outline

- Overview & Gas Pressure
- Black Iron Piping Systems
- System Sizing
- Copper Piping Systems
- Corrugated Stainless Steel Tubing (CSST) Systems
- Associations & Resources

Overview

- Traditionally black iron piping has been used for the gas delivery systems in most residential and commercial construction
- In certain locations, new piping systems like copper tubing and corrugated stainless steel tubing are approved for use and making it easy to bring the advantages of natural gas to new and retrofit customers

Natural Gas Pressure Basics

- Typically measured in inches water column (w.c.)
- Very precise “low pressure” measurement
- 1 inch water column equals 0.036 PSI
- Typically residential interior piping is at low pressure 7-10” w.c.
- Higher pressures (pounds) are used in commercial applications

Black Iron Piping Systems

Black Iron Piping Systems

- Normally smaller systems with piping below 4"
- Will typically incorporate threaded joints
- Any system above 4“ will have welded joints
- Black Iron Pipe and fittings are readily available
- Most fittings and nipples are black iron with longer straight pipes being black coated and threaded steel pipe

Fittings

- Systems will incorporate numerous fittings including:
  - Reducers
  - Elbows
  - Tees
  - Valves
  - Unions
- Allows for connection of pipes, creating joints and uncoupling the system

Larger Internal Piping Systems

- Piping systems larger than 4” must be welded
- Adds significant cost and complexity to the piping system
- Welded piping systems are suitable for elevated pressures

Pipe Design / System Sizing

- When sizing gas piping systems certain factors must be considered including:
  1. System shall provide sufficient gas to meet the maximum demand of the gas equipment – piping must be sized to supply enough fuel for all appliances to operate at the same time
  2. Maximum gas demand shall be determined by adding all of the equipment Btu ratings from appliances connected on the system
  3. Gas piping should be sized in accordance with the tables in the National Fuel Gas Code or by other engineering methods approved by local Authority having jurisdiction

Pipe Sizing Table

Table 6.2.1(a) **Schedule 40 Metallic Pipe**

Gas	Natural
Inlet pressure	Less than 2 psi
Pressure Drop	0.3 in. w.c.
Specific Gravity	0.60

	Pipe Size (in.)													
Nominal:	½	¾	1	1 ¼	1½	2	2½	3	4	5	6	8	10	12
Actual ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	**Capacity in Cubic Feet of Gas per Hour**													
10	131	273	514	1,060	1,580	3,050	4,860	8,580	17,500	31,700	51,300	105,000	191,000	303,000
20	90	188	353	73326	1,090	2,090	3,340	5,900	12,000	21,800	35,300	72,400	132,000	208,000
30	72	151	284	583	873	1,680	2,680	4,740	9,660	17,500	28,300	58,200	106,000	167,000
40	62	129	243	499	747	1,440	2,290	4,050	8,270	15,000	24,200	49,800	90,400	143,000
50	55	114	215	442	662	1,280	2,030	3,590	7,330	13,300	21,500	44,100	80,100	127,000
60	50	104	195	400	600	1,160	1,840	3,260	6,640	12,000	19,500	40,000	72,600	115,000
70	46	95	179	368	552	1,060	1,690	3,000	6,110	11,100	17,900	36,800	66,800	106,000
80	42	89	167	343	514	989	1,580	2,790	5,680	10,300	16,700	34,200	62,100	98,400
90	40	83	157	322	482	928	1,480	2,610	5,330	9,650	15,600	32,100	58,300	92,300

NFPA 54

Then National Fuel gas Code contains multiple tables for varying pressure drops and various types of pipe

What You Need To Know

- When sizing piping you must first determine the gas pressure at point of delivery
- You must know this information to use the correct sizing table in the Gas Code
- Typical gas pressure delivered after the gas meter to residential buildings systems is 1/2 pound per square inch (psi) or less
- Many gas appliances operate on 1/4 pound (psi) pressure or less
- In most cases high pressure (2 psi and up) is generally reserved for commercial and industrial applications

ESC

Use the Correct Table

- Each table in the gas code has a header that describes the system to which it applies
- Always make sure that the information in this header matches the system you are sizing
- All of the information listed in the header of the table must be used to size pipe

Table 6.2.1(a) **Schedule 40 Metallic Pipe**

Gas	Natural
Inlet pressure	Less than 2 psi
Pressure Drop	0.3 in. w.c.
Specific Gravity	0.60

Use the Correct Table

- The sizing tables are based on a number of factors; the main factor being gas pressure of the system
- The tables cover pressures up to 50 pounds (psi) for schedule 40 pipe materials and up to 5 pound for semi-rigid tubing and Corrugated Stainless Steel Tubing (CSST)
- Gas pressure of 0.5 pounds (1/2 psi) is a common pressure for residential systems

Pressure Drop

- You will notice on the table also that the words Water Column (inches w.c.) is used in the headers above the tables
- The tables in the Gas Code indicate pressure drop of the gas pressure in water column or in pounds per square foot (psi) or a certain percentage of pressure
- Pressure drop is the loss of pressure of the gas as it travels through the system caused by friction on the interior surface of the pipe, fittings etc.

Compensating for Fittings

Table B.3.2 Equivalent Lengths of Pipe Fittings and Valves

		Screwed Fittings[2]				90° Welding Elbows And Smooth Bends[2]					
		45°/Ell	90°/Ell	180° close return bends	Tee	$R/d = 1$	$R/d = 1^1/_3$	$R/d = 2$	$R/d = 4$	$R/d = 6$	$R/d = 8$
k factor =		0.42	0.90	2.00	1.80	0.48	0.36	0.27	0.21	0.27	0.36
L/d' ratio[4] n =		14	30	67	60	16	12	9	7	9	12
Nominal pipe size, in.	Inside diam. d, in., Sched. 40[6]										
L = Equivalent Length In Feet of Schedule 40 (Standard Weight) Straight Pipe[6]											
½	0.622	0.73	1.55	3.47	3.10	0.83	0.62	0.47	0.36	0.47	0.62
¾	0.824	0.96	2.06	4.60	4.12	1.10	0.82	0.62	0.48	0.62	0.82
1	1.049	1.22	2.62	5.82	5.24	1.40	1.05	0.79	0.61	0.79	1.05
1¼	1.380	1.61	3.45	7.66	6.90	1.84	1.38	1.03	0.81	1.03	1.38
1½	1.610	1.88	4.02	8.95	8.04	2.14	1.61	1.21	0.94	1.21	1.61
2	2.067	2.41	5.17	11.5	10.3	2.76	2.07	1.55	1.21	1.55	2.07
2½	2.469	2.88	6.16	13.7	12.3	3.29	2.47	1.85	1.44	1.85	2.47
3	3.068	3.58	7.67	17.1	15.3	4.09	3.07	2.30	1.79	2.30	3.07
4	4.026	4.70	10.1	22.4	20.2	5.37	4.03	3.02	2.35	3.02	4.03
5	5.047	5.88	12.6	28.0	25.2	6.72	5.05	3.78	2.94	3.78	5.05
6	6.065	7.07	15.2	33.8	30.4	8.09	6.07	4.55	3.54	4.55	6.07
8	7.981	9.31	20.0	44.6	40.0	10.6	7.98	5.98	4.65	5.98	7.98
10	10.02	11.7	25.0	55.7	50.0	13.3	10.0	7.51	5.85	7.51	10.0
12	11.94	13.9	29.8	66.3	59.6	15.9	11.9	8.95	6.96	8.95	11.9

¾” Piping System:

The elbow adds 2.06’ equivalent to the piping system

The T adds 4.12’ equivalent to the piping system

Collecting Data

- When determining the total load of the systems you need to know the type and input of the appliances being connected to the system
- Review the appliance data plates to determine Btu input rate (maximum gas demand)
- While the appliances are rated in Btu, the gas code tables list the size of piping in cubic feet per hour (cfh)
- Convert each Btu input rating to cubic feet of gas before sizing the distribution piping

ESC

BTU to CFH Conversion

- Assume you're sizing pipe for a gas range with a maximum demand of 68,000 Btu per hour
- Divide the value in Btu by 1,000 to find the demand in cubic feet per hour:
- Example: 68,000 Btu ÷ 1,000 = 68 cfh

Appliance Loads

Table A.5.3.2.1 Approximate Gas Input for Typical Appliances

Appliance	Input Btu/hr. (Approx.)
Space Heating Units	
Warm air furnace	
Single family	100,000
Multifamily, per unit	60,000
Hydronic boiler	
Single family	100,000
Multifamily, per unit	60,000
Space and Water Heating Units	
Hydronic boiler	
Single family	120,000
Multifamily, per unit	75,000
Water Heating Appliances	
Water heater, automatic storage 30 to 40 gal tank	35,000
Water heater, automatic storage 50 gal tank	50,000
Water heater, automatic instantaneous	
Capacity at 2 gal/min	142,800
Capacity at 4 gal/min	285,000
Capacity at 6 gal/min	428,400
Water heater, domestic, circulating or side-arm	35,000
Cooking Appliances	
Range, free standing, domestic	65,000
Built-in oven or broiler unit, domestic	25,000
Built-in top unit, domestic	40,000
Other Appliances	
Refrigerator	3,000
Clothes dryer, type 1 (domestic)	35,000
Gas fireplace direct vent	40,000
Gas log	80,000
Barbecue	40,000
Gas light	2,500

For SI units, 1 Btu/hr = 0.293 W.

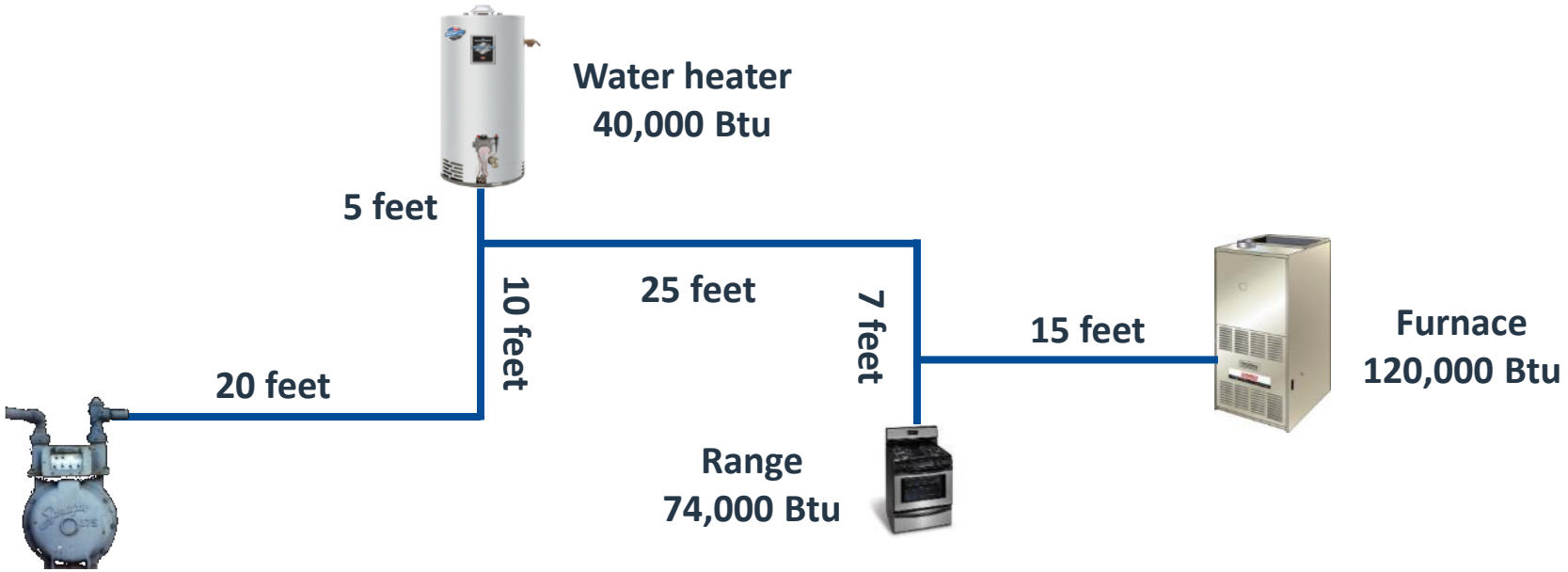
Home with gas heat, water heating, range, dryer, and fireplace the load might be equivalent to 275,000 BTU/hour =~ 275 CFH

Pipe size decreases as it gets closer to the appliance it will serve

Working a Problem

- Total of the Btuh for all the appliances connected to the system and the distance gas will travel through the pipe to the farthest appliance connected
- This is called sizing by the “Longest Length Method”
- When the footage is determined, it will be the only distance used to size piping in the system

System Layout



- Maximum Load = 40 + 74 + 120 = 234 cfh (234,000 Btus)
- Pipe Length: 20’ + 5’ + 10’ + 25’ + 7’ + 15’ = 82’ + elbows and tees

Pipe Sizing Table

Capacity of Pipe (MBH ≈ CFH)							
Pipe Size *(in)*		Pipe Length *(ft)*					
Nominal	Inside diameter	10	20	40	80	150	300
1/2	0.622	120	85	60	42	31	22
3/4	0.824	272	192	136	96	70	50
1	1.049	547	387	273	193	141	100
1 1/4	1.380	1200	849	600	424	310	219
1 1/2	1.610	1860	1316	930	658	480	340
2	2.067	3759	2658	1880	1330	971	686
2 1/2	2.469	6169	4362	3084	2189	1593	1126
3	3.068	11225	7938	5613	3969	2898	2049
4	4.026	23479	16602	11740	8301	6062	4287
5	5.047	42945	30367	21473	15183	11088	7841
6	6.065	69671	49265	34836	24632	17989	12720
8	7.981	141832	100290	70916	50145	36621	25895

- Maximum Load = 40 + 74 + 120 = 234 cfh (234,000 Btus)
- Pipe Length: 20’ + 5’ + 10’ + 25’ + 7’ + 15’ = 82’ + elbows and tees

ESC

Pipe Sizing Table

Capacity of Pipe (MBH ≈ CFH)							
Pipe Size *(in)*		Pipe Length *(ft)*					
Nominal	Inside diameter	10	20	40	80	150	300
1/2	0.622	120	85	60	42	31	22
3/4	0.824	272	192	136	96	70	50
1	1.049	547	387	273	193	141	100
1 1/4	1.380	1200	849	600	424	310	219
1 1/2	1.610	1860	1316	930	658	480	340
2	2.067	3759	2658	1880	1330	971	686
2 1/2	2.469	6169	4362	3084	2189	1593	1126
3	3.068	11225	7938	5613	3969	2898	2049
4	4.026	23479	16602	11740	8301	6062	4287
5	5.047	42945	30367	21473	15183	11088	7841
6	6.065	69671	49265	34836	24632	17989	12720
8	7.981	141832	100290	70916	50145	36621	25895

- Maximum Load = 40 + 74 + 120 = 234 cfh (234,000 Btus)
- Pipe Length: 20’ + 5’ + 10’ + 25’ + 7’ + 15’ = 82’ + elbows and tees

ESC

System Sizing

- Charts indicate the longest run of pipe to carry the full load on the system requires 1¼” houseline
- This is the most conservative method of sizing a houseline system
- To reduce costs you can calculate a branch length method where you consider each load and individual pipe size required to carry that specific load.

Copper Tubing Systems

Copper Piping Systems

- Installation codes and regulations now permit the use of flexible copper tubing using brass fittings for interior distribution systems
- Copper tubing distribution systems allow options for neat, low-cost installations
- With the availability of long length runs, all connection joints are eliminated
- Due to copper's flexibility, the piping can be pulled through wall studding similar to electrical wiring
- Copper tubing is an excellent choice for and can be easily installed in retrofit applications

ESC

Types and Standards

- National, local and ASTM standards dictate the type of copper tubing that can be used for above and below ground systems
- Copper tubing is rated as Type G/GAS, Type L or Type K, depending upon its application.
- Some manufacturers jacket the tubing with a colored plastic for easy identification purposes

Installations

- Copper systems are installed over a wide range of operating pressures from low-pressure, 7-inch water column to a maximum of 5 psig
- Copper piping can be added to existing steel piping systems where, in certain applications, it is more cost effective to pipe to remote locations inside the residence – including furnaces, fireplaces and water heaters

Specifications for Customer Piping

- Flared brass fittings rated over 125 psig with a single 45º flare with forged or machined nuts are used for all connections
- It is important that the tubing is cleanly cut and deburred for a proper flaring to be applied to the pipe
- Connections to a steel distribution system use a NPS thread adapter
- Compression fittings are not allowed in gas systems unless locally approved

Specifications

- All joints within walls or other concealed places must be inspected and tested prior to concealment
- Piping installed in enclosed locations must not contain any inaccessible mechanical joints

Copper Tubing Advantages

- Flexibility and ease of bending
- Ease of joining
- Resistance to corrosion
- Available in long lengths
- Requires smaller tools for installation
- Less joints / less leaks

Corrugated Stainless Steel Tubing

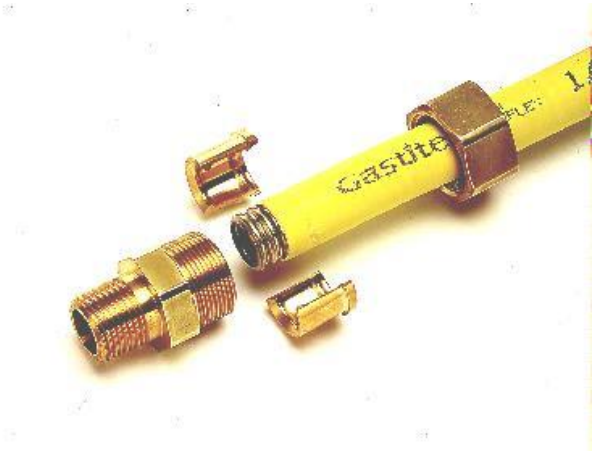
History of CSST

- Initially developed in Japan
- In the U.S. – Developed by GRI (now GTI) and funded largely by gas utilities
- Commercialized by two manufacturers in 1988 – six manufacturers today
- Greatest area of success to date
  - Residential
- Greatest avenue for growth
  - Commercial

ESC

CSST Benefits

- Resistance to leaks due to fewer connections
- Flexibility – can be snaked through walls and around obstacles with fittings only at the ends of the run
- Estimates show CSST can be installed in a third of the time it takes to install black iron pipe



CSST System Components

- Tubing
- Fittings
- Accessories
- Regulators

Key CSST Product Advantages

- Ability to bend tubing when making directional changes
- Can be installed in one continuous run
  - Does not require intermediate joints in most installations
  - Fewer joints
- Reduces the potential for leaks
- No Special tools required
  - None (for most mfrs.)
- Ability to withstand seismic pressures
- Speed – able to run lines quickly
- Great for retrofit installations

ESC

Key CSST Labor Advantages

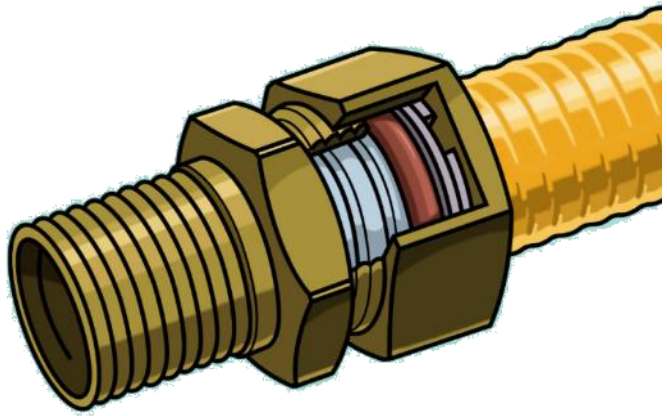
- Can save up to 75% or more on gas piping labor over black iron
- Less strenuous work than threading
- Flexible design affords greater installation options:
  - Installer can avoid existing obstacles
  - No need for repetitive measuring, cutting, threading and joint assembly

Other CSST Advantages

- Weight of product is much lighter – lighter trucks
- No threading equipment
- Insurance Claims – i.e. Workers Comp claims
- 3/8” through 2” in size

Specifications

- Tubing annealed to enhance flexibility
- Annularly corrugated 304 stainless steel tubing
- Approved to 25 lb operating pressure
- Helium tested
- Approved by the CSA to be installed in concealed locations



Approved Standards

- IAPMO Classified Marking (File No 3353)
- CABO One & Two Family Dwelling Code
- Uniform Mechanical Code (ICBO)
- International Fuel Gas Code
- International Plumbing Code
- International Mechanical Code
- ICC ESR-1879
- FM 3011939
- City of Los Angeles Approval
- ANSI/ISO 14001:2004 (Environmental Certification)
- ISO 9001:2000 Certified
- ANSI LC 1-2005 (CSA Design Certified)
- CSA 626-M05 (Canadian Gas Association)
- National Fuel Gas Code (NFPA 54)
- Standard Gas Code (SBCCI)
- BOCA Mechanical Code

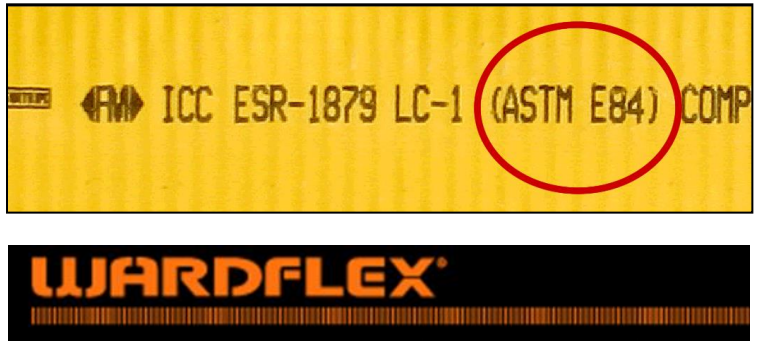
ESC

Signature Coating

E84 Compliance:

Flame Spread/Smoke Density

- Allows tubing to be routed through air plenums and ducts without removing the coating



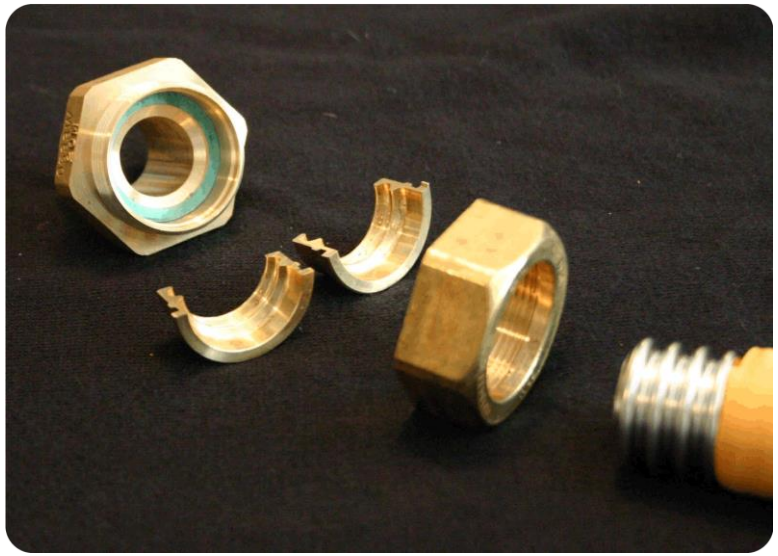
Installation Locations

The same locations as black pipe:

- Indoors or Out
- Crawl Space
- Attic
- Rooftop

Fittings

- Compression fitting
- Three components
  - Body
  - Split ring
  - Nut

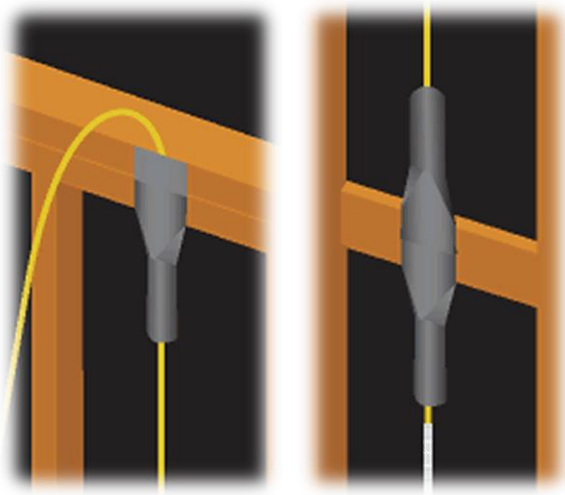


WARDFLEX StepSaver Dual Seal Fitting

Installation Practices

Striker Plates: Always Protect CSST

- When installed in concealed areas and within 3" of any nailing surface

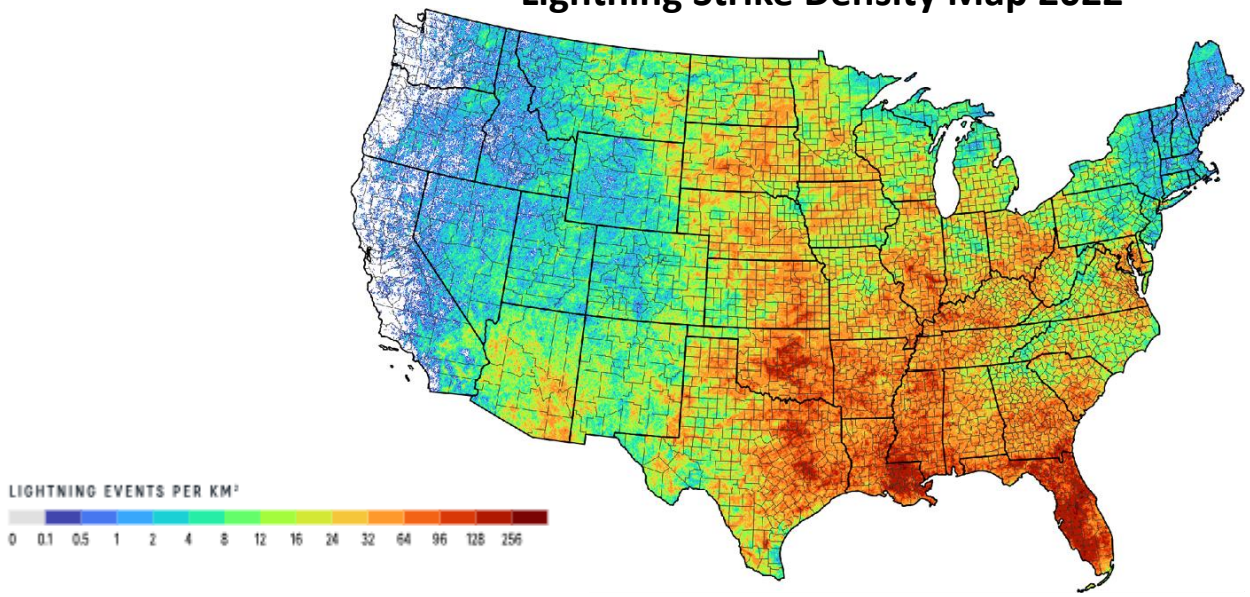


Electrical Protection of CSST of Gas Piping Systems

Electrical Protection of CSST Piping Systems

- Total lightning strikes in the U.S. per year: >198,000,000
- No house, equipment or material safe from direct lightning strikes
- Most damage from indirect strikes

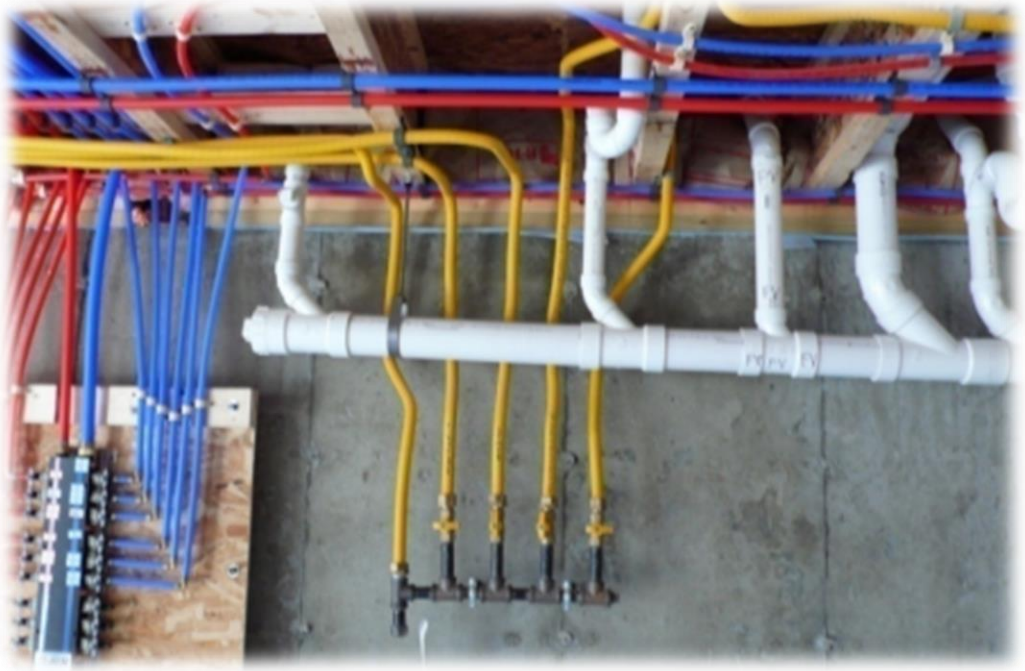
Lightning Strike Density Map 2022



Total Lightning Events in the U.S in 2022, https://www.xweather.com/annual-lightning-report

What Is Causing the Problem

- Root causes:
  - Changes in house construction/size/location
  - Loss of metal piping
  - Loss of copper wire for communications
  - Loss of metal conduit for electric wiring



Pathways to Ground

Adding to the Problem

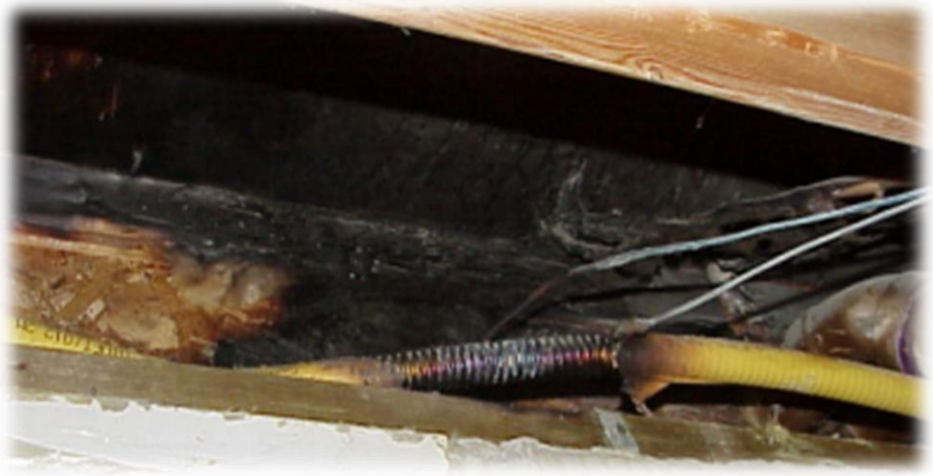
- Metallic appliance flue (in stead of brick/clay chimneys) that rises above the roofline
- Metal vent acts like lightning rod not directly connected to the electrical grounding system
- Sprayed Polyurethane Foam (SPF) insulation creates an ultra-tight attic space where gas appliances are located and operated requiring ignition barriers and flame retardants
  - SPF can cover wires and gas piping
  - SPF can impact combustion air

Lightning Doesn’t Discriminate

- It seeks any and all pathways to ground
- It will damage all electrical/mechanical systems
  - Arcing damage impacts all metallic systems including wiring and all gas piping materials
  - Damage not due to lightning induced voltage levels, but due to large differential in voltage potential

Arcing Fire Requirements

- Lightning energy enters house and all metallic systems/components
- Close proximity of metallic systems
- Sufficient energy to “jump” air gap, overcome dielectric strength of CSST jacket and burn through CSST wall
- Gas flame near combustible materials



Electrical Protection of CSST Piping Systems

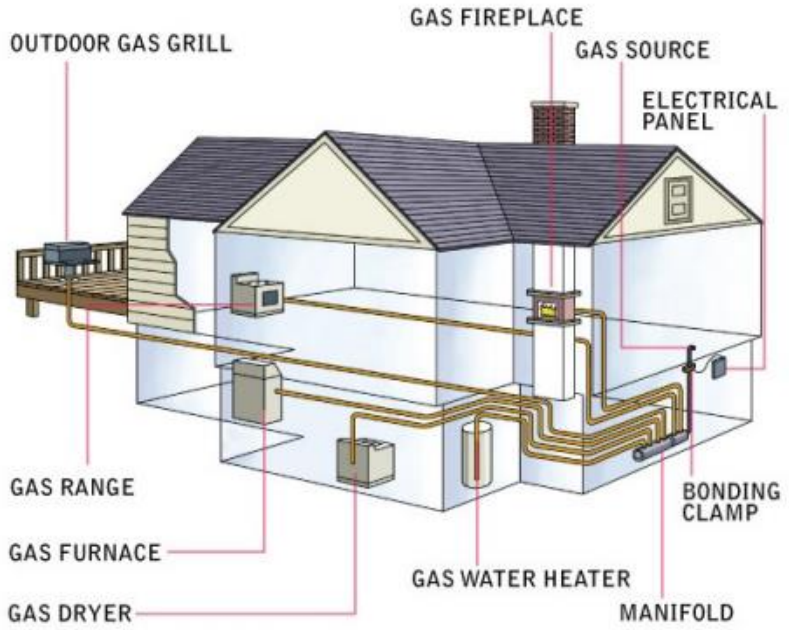
- NFPA 54 – Electrical Bonding*
  - CSST gas piping systems shall be bonded to the electrical service grounding electrode system
  - The bonding jumper shall connect to a metallic pipe or fitting between the point of delivery and the first down- stream CSST fitting
  - The bonding jumper shall not be smaller than 6 AWG copper wire or equivalent
  - Gas piping systems that contain one or more segments of CSST shall be bonded in accordance with this section

ESC

* Look for more changes in future editions

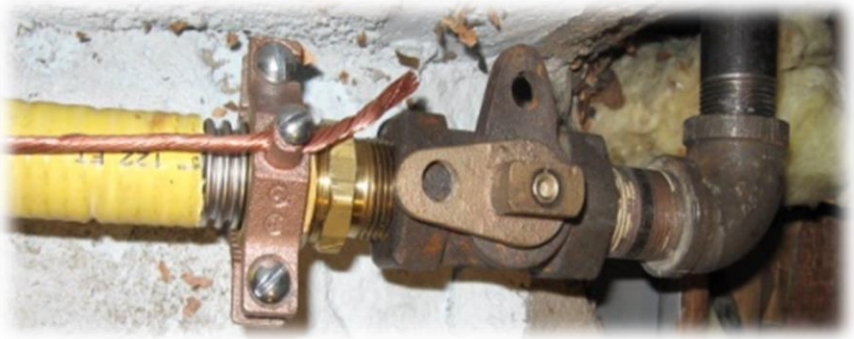
Bonding Location

- Bond at the most convenient location within the house with the shortest practical conductor length



Bonding Gas Systems After “Point of Delivery”

Bonding Clamp* Attachments



* Bonding Clamps listed to UL 467

Piping Systems

- Gas piping systems that contain one or more segments of CSST shall be bonded
- Gas piping shall not be used as a grounding electrode
- Bond connection to home grounding system

Bonding Conductor Sizing

- Conductor at least 6 AWG copper or 4 AWG aluminum
- Conductor single or multi-strand
- Conductor length and gauge are inter-related, but length is not specified in the NEC

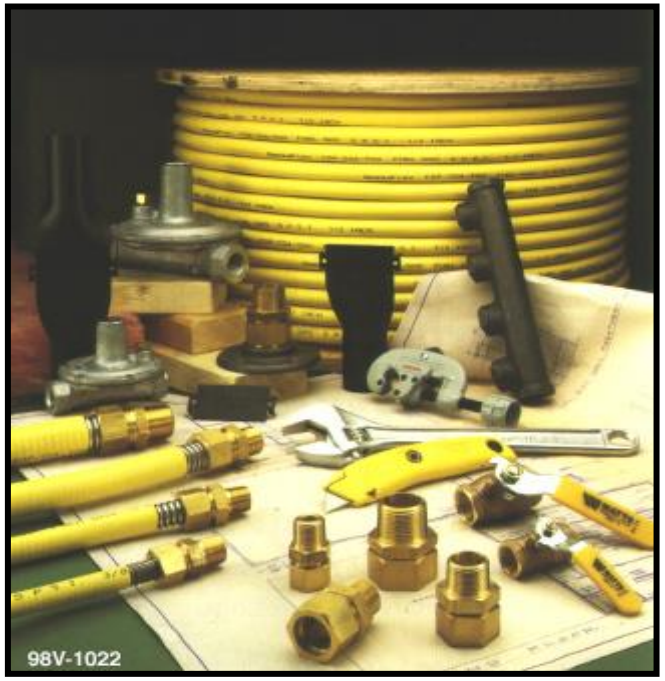
Bonding Effectiveness Factors

- Lightning entry point
- Bonding location
- Length of conductor
- Proximity of other pathways
- Grounding electrode system
- Code requirements

Who Performs the Work

- On new installations, bonding should be performed (and permitted) by on-site electrical contractor
- On retrofit job, plumbing contractor should pull both plumbing and electrical permit, but get electrical contractor for bonding
- Some jurisdictions do not restrict who does bonding

Types of CSST Pipe



Standard Yellow

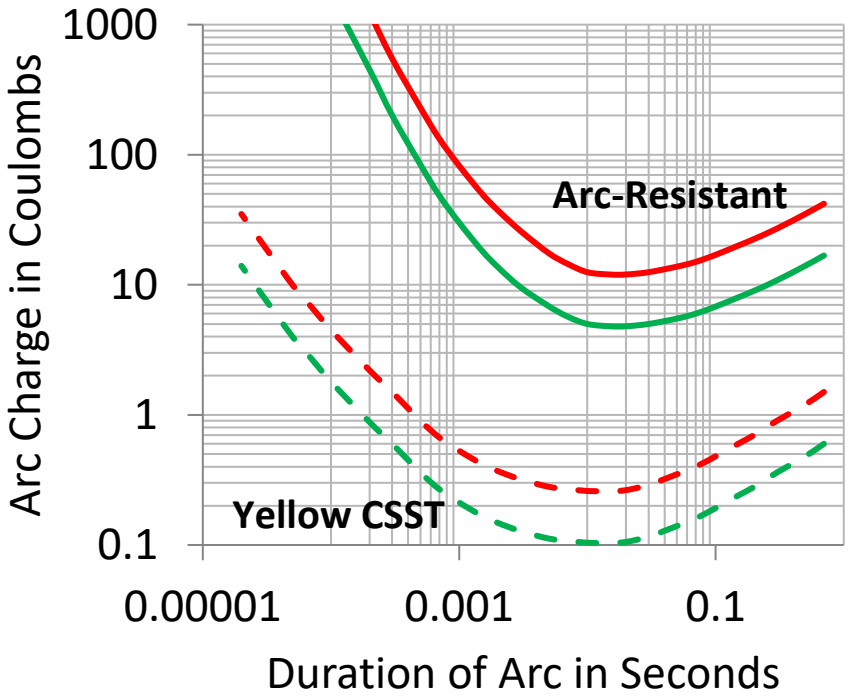
Arc-Resistant Protective Jacket (Black)*

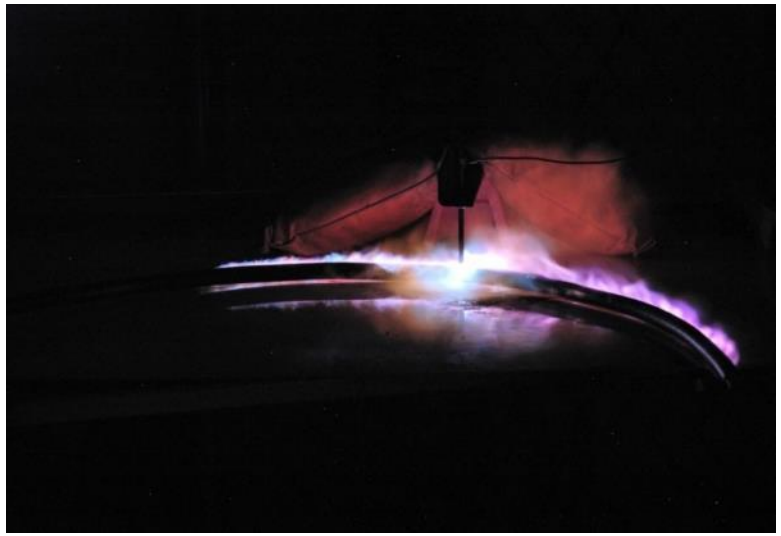
ESC

* No product is immune from lightning damage

Electrical Protection of CSST Gas Piping Systems

Arc-resistant Protective Jacket*





Why You Should Care

- CSST reduces installation cost
- CSST encourages more appliances
- CSST permits retrofits/remodeling
- CSST connects you to the customer

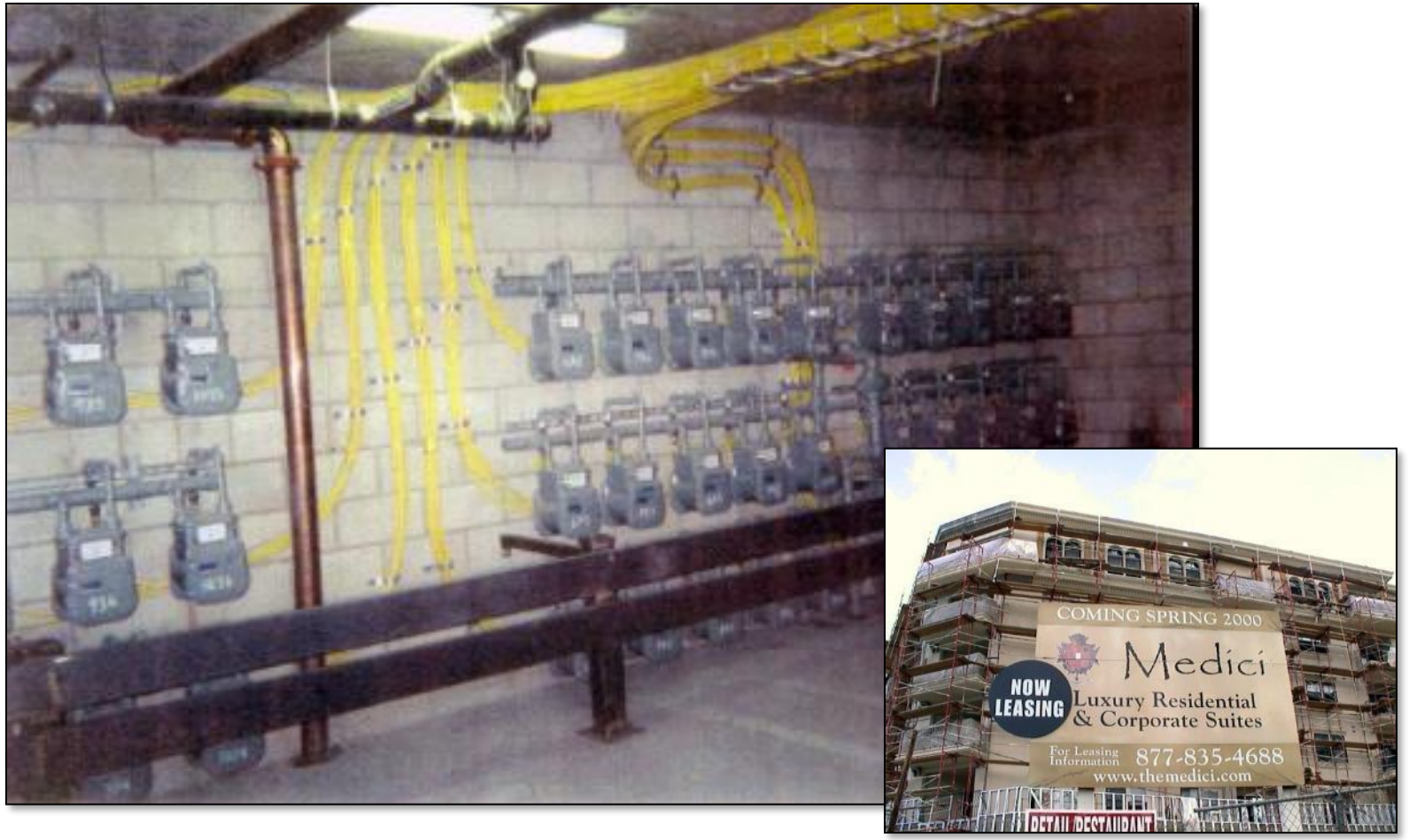
Case Study – Residential

Single Family Homes
Charlotte, NC

John Wieland Homes Andy Lewis Heating & Air Conditioning enjoy a 75% labor savings using CSST vs. black iron.

Additional savings of $20.00 per home using TracPipe vs. other leading brand due to TracPipe's 3/8" sizing advantage.

Case Study – High Rise



Case Study – Master Meter/Electrical/Oil Conversions

Old Industrial Building turned into Apartments Lebanon, PA

Due to restricted space, meter lines had to be run outside into the building.

Piping needed to go downstream of the meter through a foundation wall.

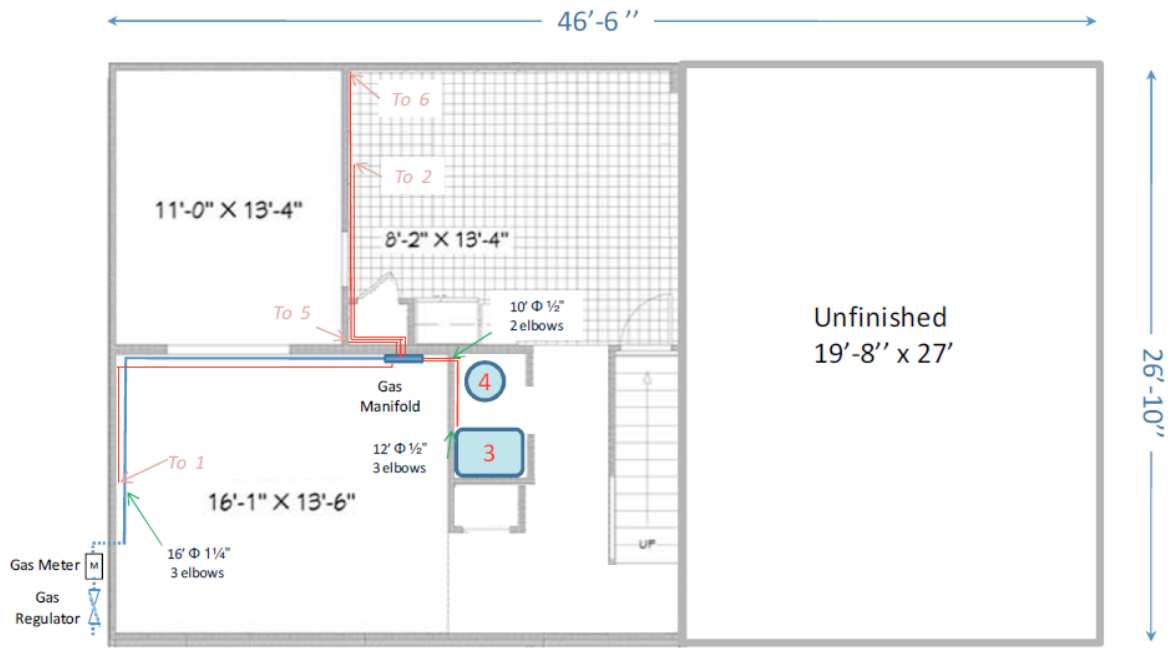
With black iron, the Contractor claims that this would have been a 3-4 day project.

Total installation time: 2 hours!

Study/Calculator

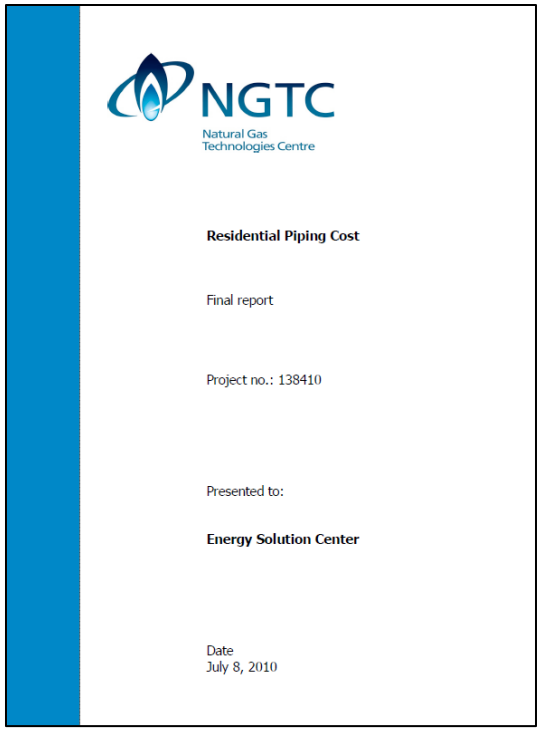
Piping Cost Study

- Comparison of various piping options
- Performed for ESC's Residential Consortium



1. Fireplace, 2. Range, 3. Furnace, 4. Water Heater, 5. Dryer, 6. BBQ

Figure 4-1a. Schedule 40: Pipe dimensions and number of bends, Basement


NGTC
Natural Gas
Technologies Centre

Residential Piping Cost

Final report

Project no.: 138410

Presented to:

Energy Solution Center

Date
July 8, 2010

Piping Cost Study

Table 5-1. Details of purchase and installation costs for different pipe materials

		inch	1/4	3/8	1/2	5/8	3/4	1	1¼	1½	2
Schedule 40	pipe	Material ($/ft)	-	-	2.23	-	2.64	3.87	8.49	5.75	7.70
		Installation (h/ft)	-	-	0.13	-	0.13	0.15	0.18	0.2	0.25
	Elbow	Material ($/unit)	-	-	11.9	-	13.5	17.15	25.00	29.8	42.5
		Installation (h/unit)	-	-	0.53	-	0.57	0.62	0.73	0.80	0.89
Copper	pipe	Material ($/ft)	3.43	4.29	5.00	6.40	9.15	12.10	15.10	19.7	30.4
		Installation (h/ft)	0.095	0.098	0.103	0.104	0.108	0.121	0.143	0.16	0.2
	Elbow	Material ($/unit)	3.89	3.69	1.23	4.34	2.76	6.80	10.25	16.1	29
		Installation (h/unit)	0.36	0.36	0.40	0.42	0.42	0.50	0.53	0.62	0.73
CSST		***EHD***	**-**	**15**	**19**	**-**	**25**	**30**	**37**	**48**	**62**
	Pipe	Material ($/ft)	-	3.87	4.33	-	5.65	8.05	10.07	17.68	25.44
	Straight Fitting	Material ($/unit)	-	16.86	18.18	-	24.78	41.15	85.00	174.85	297.98
	End Fitting	Material ($/unit)	-	16.99	19.36	-	22.09	36.64	77.76	166.91	278.92

Excel Cost Calculator

Residential Piping Cost

ESC Energy Solutions Center

NGTC Natural Gas Technologies Centre

		Pipe Length (ft)	No. Of Elbows
A	From gas meter to manifold	16	3

Default Settings

	Appliances	Capacity (BTU/h)	Pipe Length (ft)	No. Of Elbows	Vertical Length (ft)
1	Fireplace	25,000	22	4	0
2	Range	70,000	13	4	0
3	Furnace	70,000	12	3	0
4	Water Heater	45,000	10	2	0
5	Dryer	22,000	20	5	10
6	BBQ	50,000	20	6	0
7	Other	-	0	0	0

Rates			
	Plumber	48.75	$/h
	Apprentice	39.00	$/h

Calculate

	Material Cost ($)	Labor Cost ($)	Total Cost ($)
Schedule 40	713	2,648	3,360
Copper	842	2,051	2,892
CSST	1,045	1,162	2,207
Hybrid	978	1,538	2,517

A bonding cost of $50 is added to the CSST and Hybrid cases installation costs.

ESC

Piping Cost Study

6. PROS AND CONS OF PIPING MATERIALS

The pros and cons of different piping materials (schedule 40 rigid pipe, copper tubing, and CSST) are presented in Table 6-1.

Table 6-1. Advantages and disadvantages of different piping materials

Advantages	Disadvantages
Schedule 40 Rigid Pipe	
• Less expensive material cost • Resistant against damages	• Intensive installation job • Special tools necessary for installation • Hard to modify • Corrosion a possibility • Large number of supports needed
Copper Tubing	
• Rather flexible (compared to Schedule 40) • Faster installation (compared to Schedule 40) • Few connections needed • Easy to modify • Good resistance to corrosion • Cleaner installation	• Higher material cost (compared to Schedule 40) • May be confused with water piping • Lesser number of supports needed (compared to Schedule 40) • Tinning of the tube interior necessary
Corrugated Stainless Steel Tubing (CSST)	
• Flexible • Light • Fast and easy installation • Possibility of installation by one plumber	• Great number of supports needed • High material costs • Special tools necessary for installation • Training needed for installers

ESC

Available Resources

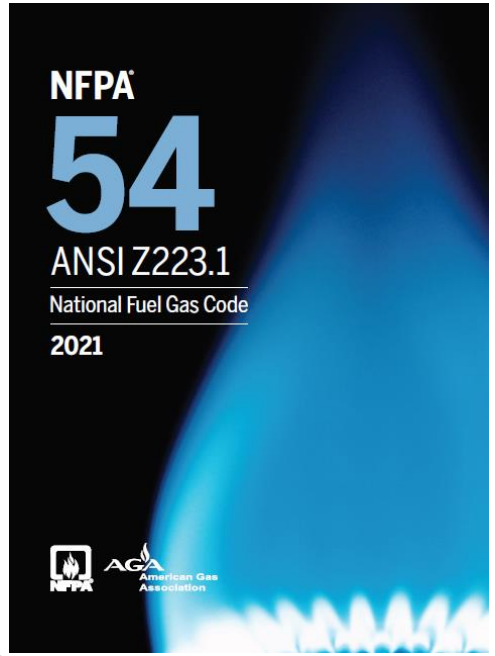
Associations & Resources

- ESC – Energy Solutions Center
  - Located in Washington, DC
  - Group of utility companies
  - www.escenter.org

ESC

Associations & Resources

- National Fire Protection Association
- NFPA develops, publishes, and disseminates more than 300 consensus codes and standards
- More than 65,000 individual members
- Authors NFPA 54: National Fuel Gas Code
- www.nfpa.org



National Fire Protection Association
The authority on fire, electrical, and building safety

ESC

Associations & Resources

- International Code Council
- A member-focused association dedicated to developing model codes and standards used in the design, build and compliance process to construct safe, sustainable, affordable and resilient structures
- Located in Washington, DC
- www.iccsafe.org

Thank You

ENERGY SOLUTIONS CENTER

400 North Capitol Street, 4th Floor
Washington, DC 20001
escenter.org