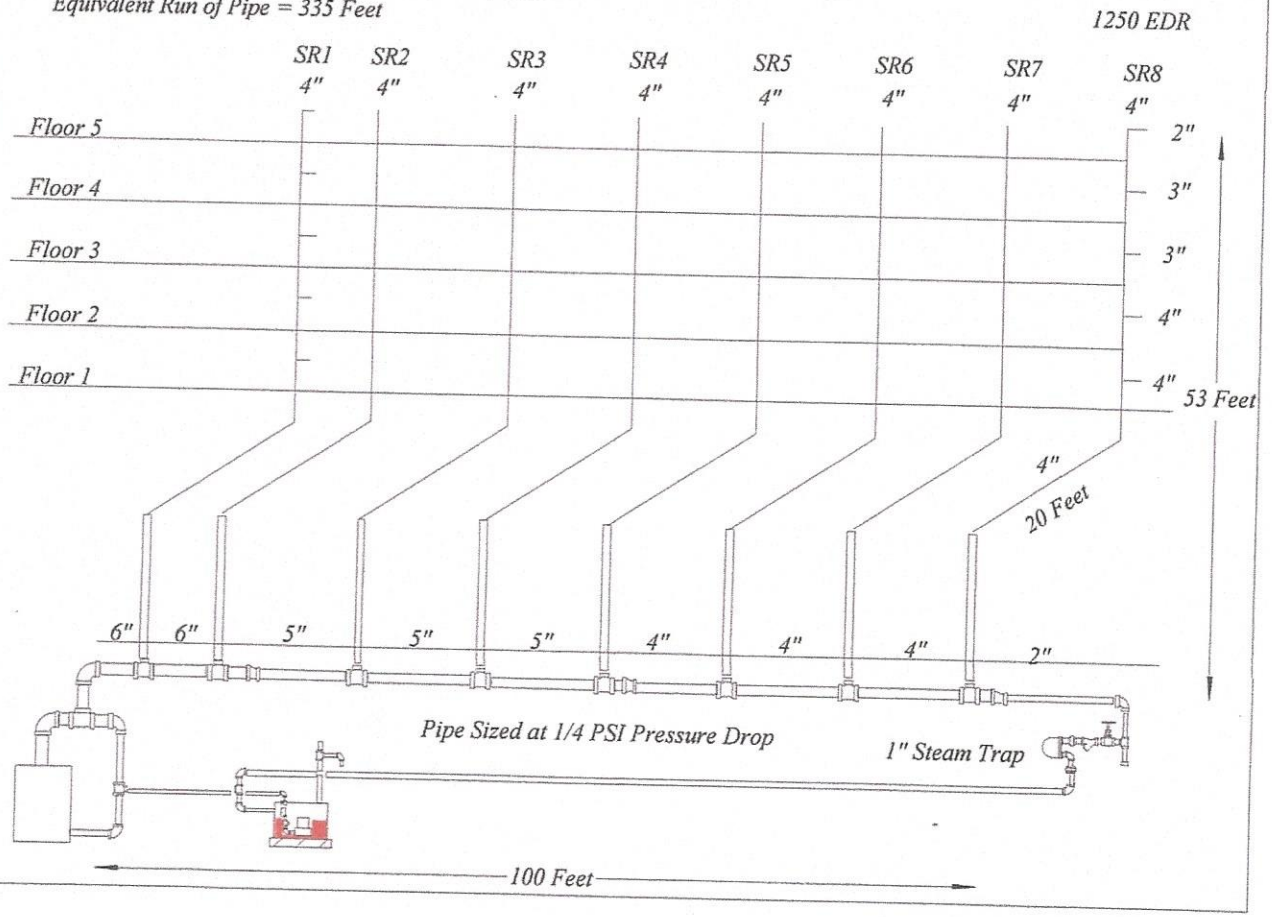
Two Pipe Steam System No Return Riser Shown

Each Riser Supplies 1250 EDR
Take off from each riser, each floor 250 EDR
Connected Heating Load 10, 000 EDR
Story Height = 10 feet
Riser Branch = 15 feet
Take Off From Steam Main = 3 feet
Total Length of Steam Main & Riser # 8 = 173 Feet
Equivalent Run of Pipe = 335 Feet



Heat Loss Calculations For Black Steel Pipe & Fittings

Ambient Air-70 Deg. F, 2 PSIG Steam, Pipe surface Temp. 212 Deg. F

Steam Main

Number	Description	Length	Btu Loss Pipe	Total BTU Loss
1	Pipe & Fittings	of Pipe	Per Linear Foot	
2				
3	2" Cooling Leg	10	210	2100
4	SR8-SR7 4" Pipe	12.5	380	4750
5	SR7-SR6 4" Pipe	12.5	380	4750
6	SR6-SR5 4" Pipe	12.5	380	4750
7	SR5-SR4 4" Pipe	12.5	380	4750
8	SR4-SR3 4" Pipe	12.5	380	4750
9	SR3-SR2 4" Pipe	12.5	380	4750
10	SR2-SR1 5" Pipe	12.5	470	5875
11	SR1- Boiler 5" Pipe	12.5	470	5875
12				
13	***Total Feet of Pipe***	110	***Total BTUH Loss***	***42350***

Heat Loss Calculations For Black Steel Pipe & Fittings

Ambient Air - 70 degrees F, 2 PSIG steam, surface pipe temp. 212 degrees F

Number	Description	Length	Btu Loss Pipe	Total BTU Loss	Risers
1	Pipe & Fittings	of Pipe	Per Linear Foot		
2					8
3	Risers SR8-SR1				
4	SR8 Flr 5-4, 2" Pipe	10	210	2100	16800
5	SR8 Flr 4-3, 3" Pipe	10	300	3000	24000
6	SR8 Flr 3-2, 3" Pipe	10	300	3000	24000
7	SR8 Flr 2-1, 4" Pipe	10	300	3000	24000
8	SR8 Flr 1- bsmt 4" Pipe	3	300	900	7200
9	SR8 Riser to main 4" Pipe	20	300	6000	48000
10	SR8 Vertical drop to main	3	300	900	7200
11					0
12					0
	Total Feet	66	***Total BTU Loss***	***All Risers***	***151200***

A steam trap's discharge capacity is variable. Steam systems can begin to heat a building at 0 psi steam pressure. As steam pressure rises, the discharge capacity of the steam trap increases. The steam trap's capacity is determined by the differential pressure; the higher the steam pressure, the greater the differential. In actuality, no matter what the steam pressure is, the condensate load of a building cannot be greater than the connected load plus the piping pickup factors. Steam traps are sized to the greatest condensate load generated by the steam piping, radiator, or other devices that use steam.

Building heat loss, pressure drop, and pipe sizing calculations were developed to assure that the steam heating system will supply sufficient steam to heat a building at the design temperatures. Lastly, we need to learn the true value of insulating steam piping. The tables and calculations on pages 180 and 181 show the energy savings attributed to properly-insulated steam piping.

Heat Loss Calculations for Insulated Black Steel Pipe and Fittings
1-Inch Thick 85% Magnesia-Type Insulation
Ambient Air: 75 Degrees; Surface Temperature of the Pipe: 212 Degrees F

Number	Description	Length of Pipe	BTU Loss Pipe per Linear Foot	Total BTU Loss
1	Pipe and fittings			
2				
3	Riser SR8			
4	SR8 5th-4th fl. 2" pipe	10	0.2	2
5	SR8 4th-3rd fl. 3" pipe	10	0.385	3.85
6	SR8 3rd -2nd fl. 3" pipe	10	0.385	3.85
7	SR8 2nd-1st fl. 3" pipe	10	0.385	3.85
8	SR8 1st fl.-Bsmt. 3" pipe	3	0.385	1.155
9	SR8 Riser to main 4" pipe	20	0.385	7.7
10	SR8 vertical drop to main	3	0.385	1.155
10	Heat loss 8 risers			
12	SR8 multiplied by 8			523
13	Cooling leg bsmnt. 2" pipe	10	0.2	2
14	SR8-SR7 4" pipe	10	0.385	3.85
15	SR7-SR6 4" pipe	10	0.385	3.85
16	SR6-SR5 4" pipe	10	0.385	3.85
17	SR5-SR4 4" pipe	10	0.385	3.85
18	SR4-SR3 4" pipe	10	0.385	3.85
19	SR3-SR2 4" pipe	10	0.385	3.85
20	SR2-SR1 5" pipe	10	0.572	5.72
21	SR1-boiler hdr.	30	0.572	17.16
	Total feet of pipe	770	*Total BTU loss*	595.54

The heat loss chart and calculations show that the uninsulated pipe will radiate 193,550 BTUH. That number was converted to pounds of steam per hour and used to size the end of main steam trap. In this example, 193,550 BTUH is important, as it has an additional operating cost when heating a building. Insulation plays a very important role in life cycle costing. Pipe insulation is not noticed, makes no noise, needs little or no maintenance, and passively occupies a space on the piping. Think of

insulation as a government bond that cannot be redeemed, and this bond pays a fixed dividend every hour that steam flows through the piping. To understand the potential savings, subtract 595.54 BTUH (the heat loss of the insulated piping) from 193,550 BTUH (the heat loss of the uninsulated piping) and the potential energy savings is 192,954.46 BTU per hour of steam heating system operation.

To learn the actual monetary savings, we need to use a term called a therm. A therm is valued at 100,000 BTUs. In heating and cooling, we use different fuels to provide the energy needed to add or remove heat from a building. Electricity is used for heating, in areas where the cost to produce electricity is not prohibitive. Electricity, natural gas, and different grades of fuel oil are used to heat buildings. Fossil fuels and atomic energy are used to produce electricity, and in the future, fuel cells will be used in every building to generate electricity, heat, and cool buildings.

A therm (100,000 BTUs) is the smallest unit used in billing for energy consumption. The therm is a unit of energy and allows all fuels to be converted to a simple comparative unit. For instance, 1 gallon of number 2 oil can supply about 140,000 BTUs. A cubic foot of natural gas will deliver about 1,000 BTUH, and 1 watt of electricity will yield about 3.5 BTUs.

Natural gas is billed by the therm; fuel oil is billed by the gallon and electricity by the kilowatt hour. In 2002, in New York City, a kilowatt of electricity cost about 15 cents. A gallon of number 2 oil was about $1.43, and a therm of natural gas was about $1.16. To learn the potential cost savings that insulated steam piping will yield when using number 2 oil and the cost is $1.43 per gallon, we need to find the cost value of a therm. The following calculations do not take into consideration combustion or heating system efficiency. Number 2 fuel oil yields about 140,000 BTUs per gallon of oil; 140,000 BTUs equals 1.40 therms. At a $1.43 per gallon, a therm of number 2 oil costs about $1.00.

I selected fuel oil as the fuel because it costs less than natural gas or electricity. A therm of electricity equals 28.5 kilowatts and costs about $4.28. A therm of natural gas is priced about $1.16, and the number 2 oil costs about $1.00. The energy savings due to insulation is about 192, 000 BTUH. To find the cost savings, multiply 192 therms by $1.00 and the savings for each hour of operation equals $1.92. The $1.92 does not sound like much, so let us figure out about how much this savings can be.

In the New York City area, heat is generally provided from October to May, about 130 heating days a year and about 1,400 hours of operation. The potential monetary savings due to insulating the steam piping is $2,688.00 per year. An approximate cost to insulate about 770 feet of steam piping and fittings with 1-inch thick fiberglass insulation would be about $14,500. If fuel costs do not increase, the payback will occur in less than seven years.

The insulation calculations were based on an average ambient temperature of 75 degrees F. Basements in most buildings range in temperature from 55 degrees to 70 degrees. In many buildings, the steam risers are in pipe chases at the outside wall of a building. For the most part, we can see that a greater savings can occur because the actual ambient temperatures are less than 75 degrees F.

Properly-insulated steam piping lowers the amount of condensate generated during the start of a heating cycle. Couple that with properly-sized and installed quality air vents or steam traps, and the result is improved system circulation and an extended life for vent valves and steam traps. Finally, the cost of maintenance and repair becomes less and expenditures for fuel are lower than a similar system without insulation.