### Boiler Pipe Insulation

###### Description

This measure describes adding insulation to un-insulated boiler pipes in un-conditioned basements or crawlspaces.

This measure was developed to be applicable to the following program types:  TOS, RNC, RF, DI.

If applied to other program types, the measure savings should be verified.

###### Definition of Efficient Equipment

The efficient case is installing pipe wrap insulation to a length of boiler pipe.

###### Definition of Baseline Equipment

The baseline is an un-insulated boiler pipe.

###### Deemed Lifetime of Efficient Equipment

The measure life is assumed to be 15 years[[1]](#footnote-1).

###### Deemed Measure Cost

The measure cost including material and installation is assumed to be $3 per linear foot[[2]](#footnote-2).

###### Loadshape

N/A

###### Coincidence Factor

N/A

Algorithm

###### Calculation of Savings

###### Electric Energy Savings

N/A

###### Summer Coincident Peak Demand Savings

N/A

###### Natural Gas Savings

ΔTherm = (((1/Rexist \* Cexist) – (1/Rnew \* Cnew)) \* FLH\_heat \* L \* ΔT) / ηBoiler /100,000

Where:

Rexist = Pipe heat loss coefficient of uninsulated pipe (existing) [(hr-°F-ft2)/Btu]

= 0.5[[3]](#footnote-3)

Rnew = Pipe heat loss coefficient of insulated pipe (new) [(hr-°F-ft2)/Btu]

= Actual (0.5 + R value of insulation)

FLH\_heat = Full load hours of heating

= Dependent on location[[4]](#footnote-4):

|  |  |
| --- | --- |
| **Climate Zone**  **(City based upon)** | **FLH\_heat** |
| 1 (Rockford) | 1,969 |
| 2 (Chicago) | 1,840 |
| 3 (Springfield) | 1,754 |
| 4 (Belleville) | 1,266 |
| 5 (Marion) | 1,288 |
| Weighted Average[[5]](#footnote-5) | 1,821 |

L = Length of boiler pipe in unconditioned space covered by pipe wrap (ft)

= Actual

Cexist = Circumference of bare pipe (ft) (Diameter (in) \* π/12)

= Actual (0.5” pipe = 0.131ft, 0.75” pipe = 0.196ft)

Cnew = Circumference of pipe with insulation (ft) ([Diameter of pipe (in)] + ([Thickness of Insulation (in)]\*2)) \* π/12)

= Actual

ΔT = Average temperature difference between circulated heated water and unconditioned space air temperature (°F) [[6]](#footnote-6)

Pipes in unconditioned basement:

|  |  |
| --- | --- |
| **Outdoor reset controls** | **ΔT (°F)** |
| Boiler without reset control | 110 |
| Boiler with reset control | 70 |

Pipes in crawl space:

|  |  |  |
| --- | --- | --- |
| **Climate Zone**  **(City based upon)** | **ΔT (°F)** | |
| **Boiler without reset control** | **Boiler with reset control** |
| 1 (Rockford) | 127 | 87 |
| 2 (Chicago) | 126 | 86 |
| 3 (Springfield) | 122 | 82 |
| 4 (Belleville) | 120 | 80 |
| 5 (Marion) | 120 | 80 |
| Weighted Average[[7]](#footnote-7) | 125 | 85 |

ηBoiler = Efficiency of boiler

= 0.819 [[8]](#footnote-8)

For example, insulating 10 feet of 0.75” pipe with R-3 wrap (0.75” thickness) in a crawl space of a Marion home with a boiler without reset control:

ΔTherm = (((1/0.5 \* 0.196) – (1/3.5 \* 0.589)) \* 10 \* 120 \* 1288) / 0.819 / 100,000

= 4.2 therms

###### Water Impact Descriptions and Calculation

N/A

###### Deemed O&M Cost Adjustment Calculation

N/A

###### Measure Code: RS-HVC-PINS-V01-130601

1. Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007.

   [http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf](http://mn.gov/commerce/energy/images/ElectricFoodService_v03.2.xls) [↑](#footnote-ref-1)
2. Consistent with DEER 2008 Database Technology and Measure Cost Data ([www.deeresources.com](http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf)). [↑](#footnote-ref-2)
3. Assumption based on data obtained from the 3E Plus heat loss calculation software provided by the NAIMA (North American Insulation Manufacturer Association) and derived from Table 15 and Table 16 of 2009 ASHRAE Fundamentals Handbook, Chapter 23 Insulation for Mechanical Systems, page 23.17. [↑](#footnote-ref-3)
4. Full load heating hours for heat pumps are provided for Rockford, Chicago and Springfield in the Energy Star Calculator. Estimates for the other locations were calculated based on the FLH to Heating Degree Day (from NCDC) ratio. VEIC consider Energy Star estimates to be high due to oversizing not being adequately addressed. Using average Illinois billing data (from <http://www.icc.illinois.gov/ags/consumereducation.aspx>) VEIC estimated the average gas heating load and used this to estimate the average home heating output (using 83% average gas heat efficiency). Dividing this by a typical 36,000 Btu/hr ASHP gives an estimate of average ASHP FLH\_heat of 1821 hours. We used the ratio of this value to the average of the locations using the Energy Star data (1994 hours) to scale down the Energy Star estimates. There is a county mapping table in the Appendix providing the appropriate city to use for each county of Illinois. [↑](#footnote-ref-4)
5. Weighted based on number of occupied residential housing units in each zone. [↑](#footnote-ref-5)
6. Assumes 160°F water temp for a boiler without reset control, 120°F for a boiler with reset control, and 50°F air temperature for pipes in unconditioned basements and the following average heating season outdoor temperatures as the air temperature in crawl spaces: Zone 1 – 33.1, Zone 2 – 34.4, Zone 3 – 37.7, Zone 4 – 40.0, Zone 5 – 39.8, Weighted Average – 35.3 (NCDC 1881-2010 Normals, average of monthly averages Nov – Apr for zones 1-3 and Nov-March for zones 4 and 5). [↑](#footnote-ref-6)
7. Weighted based on number of occupied residential housing units in each zone. [↑](#footnote-ref-7)
8. Average efficiency of boiler units found in Ameren PY3-PY4 data. [↑](#footnote-ref-8)