### Steam Trap Replacement or Repair

**Description**

The measure is for the repair or replacement of faulty steam traps that are allowing excess steam to escape and thereby increasing steam generation. The measure is applicable to commercial applications, commercial HVAC (low pressure steam) including multifamily buildings, low pressure industrial applications, medium pressure industrial applications, applications and high pressure industrial applications.

This measure was developed to be applicable to the following program types: TOS, RF. If applied to other program types, the measure savings should be verified.

**Definition of Efficient Equipment**

Customers must have leaking traps to qualify for rebates. However, if a commercial customer opts to replace all traps without inspection, rebates and the savings are discounted to take into consideration the fact that some traps are being replaced that have not yet failed.

**Definition of Baseline Equipment**

The baseline criterion is a faulty steam trap in need of replacing. No minimum leak rate is required. Any leaking or blow through trap can be repaired or replaced. If a commercial customer chooses to repair or replace all the steam traps at the facility without verification, the savings are adjusted. Savings for commercial full replacement projects are reduced by the percentage of traps found to be leaking on average from the studies listed. If an audit is performed on a commercial site, then the leaking and blowdown can be adjusted.

**Deemed Lifetime of Efficient Equipment**

The life of this measure is 6 years[[1]](#footnote-2)

**Deemed Measure Cost**

| **Steam System** | **Cost per trap**[[2]](#footnote-3) **($)** |
| --- | --- |
| Commercial Dry Cleaners | 77 |
| Commercial Heating (including Multifamily), low pressure steam | 77 |
| Industrial Medium Pressure >15 psig psig < 30 psig | 180 |
| Steam Trap, Industrial Medium Pressure ≥30 <75 psig | 223 |
| Steam Trap, Industrial High Pressure ≥75 <125 psig | 276 |
| Steam Trap, Industrial High Pressure ≥125 <175 psig | 322 |
| Steam Trap, Industrial High Pressure ≥175 <250 psig | 370 |
| Steam Trap, Industrial High Pressure ≥250 psig | 418 |
| Steam Trap, Industrial Medium Pressure ≥30 <75 psig | 223 |
| Steam Trap, Industrial High Pressure ≥75 <125 psig | 276 |
| Steam Trap, Industrial High Pressure ≥125 <175 psig | 322 |
| Steam Trap, Industrial High Pressure ≥175 <250 psig | 370 |
| Steam Trap, Industrial High Pressure ≥250 psig | 418 |

**Loadshape**

N/A

**Coincidence Factor**

N/A

**Algorithm**

**Calculation of Savings**

**Energy Savings**

**Electric Energy Savings**

N/A

**Summer Coincident Peak Demand Savings**

N/A

###### **Natural Gas Savings**

ΔTherm = Sa \* (Hv/B) \* Hours \* L / 100,000

Where:

Sa = Average actual steam loss per leaking trap

= 24.24 x Pia x D² x A x FF

Where:

Pia = Pig + Patm

= Average steam trap inlet pressure, absolute, psia

Pig = Average steam trap inlet pressure, gauge, psig

Patm = Atmospheric pressure, 14.7 psia

D = Diameter of Orifice, in.

A = Adjustment factor

= 50%,[[3]](#footnote-4) all steam systems. This factor is to account for reducing the maximum theoretical steam flow to the average steam flow (the Enbridge factor).

FF = Flow Factor. In addition to the Enbridge factor (A), an additional 50 percent flow factor adjustment is recommended for medium and high pressure steam systems to address industrial float and thermostatic style traps where additional blockage is possible.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Steam System** | **Average Steam Trap Inlet Pressure psig**[[4]](#footnote-5) | **Diameter of Orifice in** | **Enbridge Factor** | **Flow Factor** | **Average Actual Steam Loss per Leaking Trap (lb/hr/trap)** |
| Commercial Dry Cleaners | - | - | 50% | 100% | 19.1 |
| Commercial Heating (including Multifamily) LPS | - | - | 50% | 100% | 6.9 |
| Industrial or Process Low Pressure, <15 psig | - | - | 50% | 100% | 6.9 |
| Medium Pressure >15 psig < 30 psig | 16 | 0.1875 | 50% | 50% | 6.5 |
| Medium Pressure ≥30 <75 psig | 47 | 0.2500 | 50% | 50% | 23.4 |
| High Pressure ≥75 <125 psig | 101 | 0.2500 | 50% | 50% | 43.8 |
| High Pressure ≥125 <175 psig | 146 | 0.2500 | 50% | 50% | 60.9 |
| High Pressure ≥175 <250 psig | 202 | 0.2500 | 50% | 50% | 82.1 |
| High Pressure ≥250 ≤300 psig | 263 | 0.2500 | 50% | 50% | 105.2 |
| High Pressure > 300 psig | Custom | Custom | 50% | 50% | Calculated |

Hv = Heat of vaporization of steam

|  |  |  |
| --- | --- | --- |
| **Steam System** | **Average Inlet Pressure psig** | **Heat of Vaporization**[[5]](#footnote-7) **(Btu/lb)** |
| Commercial Dry Cleaners | -- | 890 |
| Commercial Heating (including Multifamily) LPS | -- | 951 |
| Industrial and Process Low Pressure ≤15 psig | -- | 951 |
| Medium Pressure >15 psig < 30 psig | 16 | 944 |
| Medium Pressure ≥30 <75 psig | 47 | 915 |
| High Pressure ≥75 <125 psig | 101 | 880 |
| High Pressure ≥125 <175 psig | 146 | 859 |
| High Pressure ≥175 <250 psig | 202 | 837 |
| High Pressure ≥250 ≤300 psig | 263 | 816 |
| High Pressure > 300 psig | -- | Custom |

B = Boiler efficiency

= custom, if unknown:

= 80.7% for steam boilers, except multifamily low-pressure [[6]](#footnote-8)

= 64.8% for multifamily low-pressure steam boilers [[7]](#footnote-9)

Hours = Annual operating hours of steam plant

= custom, if unknown:

| **Steam System** | **Zone (where applicable)** | **Hours/Yr**[[8]](#footnote-10) |
| --- | --- | --- |
| Commercial Dry Cleaners | n/a | 2,425 |
| Industrial and Process Low Pressure ≤15 psig | 8,282 |
| Medium Pressure >15 psig < 30 psig | 8,282 |
| Medium Pressure ≥30 <75 psig | 8,282 |
| High Pressure ≥75 <125 psig | 8,282 |
| High Pressure ≥125 <175 psig | 8,282 |
| High Pressure ≥175 <250 psig | 8,282 |
| High Pressure ≥250 psig | 8,282 |
| Commercial Heating (including Multifamily)LPS[[9]](#footnote-11) | 1 (Rockford) | 4,272 |
| 2 (Chicago O'Hare) | 4,029 |
| 3 (Springfield) | 3,406 |
| 4 (Belleville) | 2,515 |
| 5 (Marion) | 2,546 |

L = Leaking & blow-thru

L is 1.0 when applied to the replacment of an individual leaking trap. If a number of steam traps are replaced and the system has not been audited, the leaking and blow-thru is applied to reflect the assumed percentage of steam traps that were actually leaking and need to be replaced. A custom value can be utilized if a supported by an evaluation.

|  |  |
| --- | --- |
| **Steam System** | **L (%)**[[10]](#footnote-13) |
| Custom | Custom |
| Commercial Dry Cleaners | 27% |
| Industrial Low Pressure ≤15 psig | 16% |
| Industrial Medium and High Pressure >15 psig | 16% |
| Commercial Heating (including Multifamily) LPS | 27% |

EXAMPLE

For example, a commercial dry cleaning facility with the default hours of operation and boiler efficiency;

ΔTherms = Sa \* (Hv/B) \* Hours \* L

= 19.1 lbs/hr/trap \* (890 Btu/lb / 80%)/100,000 \* 2,425 \* 27%

= 138.8 therms per trap

**Water Impact Descriptions and Calculation**

N/A

**Deemed O&M Cost Adjustment Calculation**

N/A

**Measure Code: CI-HVC-STRE-V04-160601**

1. Source paper is the CLEAResult "Steam Traps Revision #1" dated August 2011. Primary studies used to prepare the source paper include Enbridge Steam Trap Survey, KW Engineering Steam Trap Survey, Enbridge Steam Saver Program 2005, Armstrong Steam Trap Survey, DOE Federal Energy Management Program Steam Trap Performance Assessment, Oak Ridge National Laboratory Steam System Survey Guide, KEMA Evaluation of PG&E's Steam Trap Program, Sept. 2007. Communication with vendors suggested a inverted bucket steam trap life typically in the range of 5 - 7 years, float and thermostatic traps 4- 6 years, float and thermodynamic disc traps of 1 - 3 years. Cost does not include installation. [↑](#footnote-ref-2)
2. Ibid. [↑](#footnote-ref-3)
3. Enbridge adjustment factor used as referenced in CLEAResult “Work Paper Steam Traps Revision #2" Revision 3 dated March 2, 2012 and DOE Federal Energy Management Program Steam Trap Performance Assessment. [↑](#footnote-ref-4)
4. Medium and high pressure steam trap inlet pressure based on Navigant analysis of source collected during program implementation by Nicor Gas for GPY1 through GPY4. For each steam trap project, the data provided measure savings description, operating pressure, installation Zip code, business building type, program year, and annual operating hours. [↑](#footnote-ref-5)
5. Heat of vaporization of steam at the inlet pressure to the steam trap. Implicit assumption that the average boiler nominal pressure where the vaporization occurs, is essentially that same pressure. Referenced in CLEAResult “Work Paper Steam Traps Revision #2" Revision 3 dated March 2, 2012. [↑](#footnote-ref-7)
6. Ibid. [↑](#footnote-ref-8)
7. Katrakis, J. and T.S. Zawacki. “Field-Measured Seasonal Efficiency of Intermediate-sized Low-Pressure Steam Boilers”. ASHRAE V99, pt. 2, 1993. [↑](#footnote-ref-9)
8. Medium and high pressure steam trap annual operating hours based on Navigant analysis of source collected during program implementation by Nicor Gas for GPY1 through GPY4. For each steam trap project, the data provided measure savings description, operating pressure, installation Zip code, business building type, program year, and annual operating hours. [↑](#footnote-ref-10)
9. Since commercial LPS reflect heating systems, Hours/yr are equivalent to HDD55 zone table [↑](#footnote-ref-11)
10. Dry cleaners survey data as referenced in CLEAResult “Work Paper Steam Traps Revision #2" Revision 3 dated March 2, 2012. [↑](#footnote-ref-13)