Two-Tier Steam Trap Savings Study

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To: Tony Larson (National Grid), Erik Mellen (Eversource)

From: Cameron Kinney, Jon Maxwell

OBJECTIVES

The goals of this study are as follows:

- Generate two prescriptive steam trap repair and replacement deemed savings estimates by leveraging the existing data collected from the Phase 2 Steam Trap Evaluation.
- Establish qualification criteria to be used when assigning the proper savings tier for prescriptive steam trap replacements.

METHODOLOGY

A prototype model-basis approach was used to calculate the deemed savings values, which involves tabulating the various parameters from the custom savings equation and taking median and weighted average values. A breakdown of the approach used is below:

1. Determine the best variable to use for bifurcating the results (pressure).
2. Review the data and past interviews to determine the most appropriate breakpoint between the two categories (15 psig).
3. Analyze the other variables in the savings equation for variability as a function of the defining variable (enthalpy, orifice size, annual hours, and efficiency vary with pressure, the other variables do not).
4. Run the prototype calculations twice, using the low- and high-pressure configurations for all variables.

FINDINGS

Key Variable and Threshold

ERS chose pressure as the sole key variable and 15 psig as the threshold value for the deemed savings tiers for the reasons listed below:

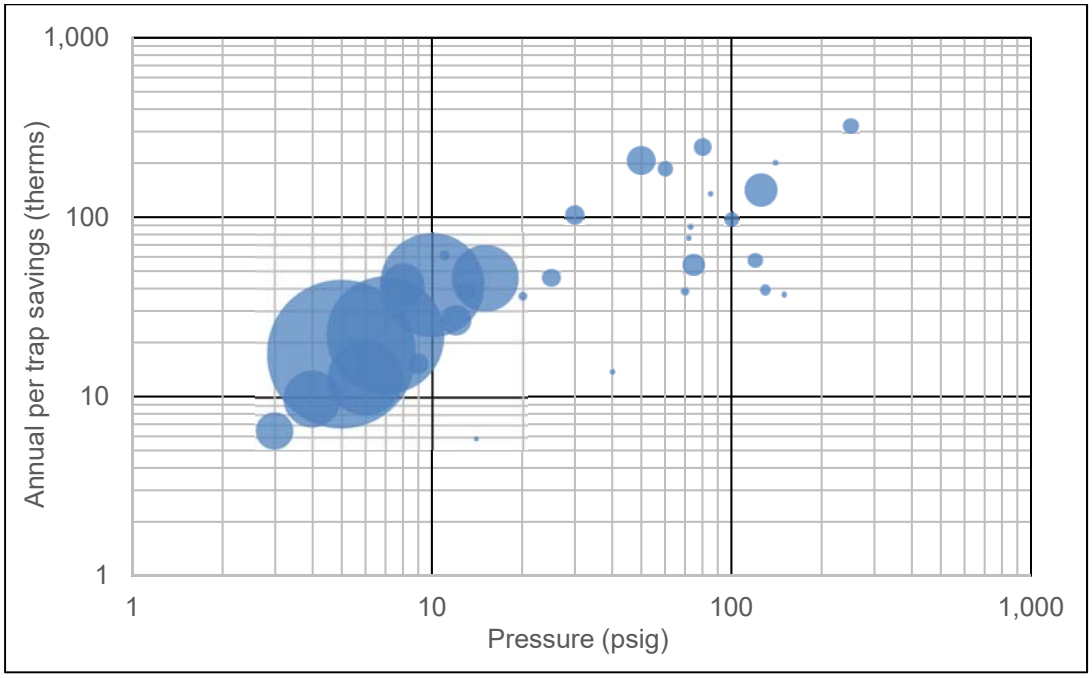
- Pressure is an easily identifiable parameter in the field.
- The industry widely accepts 15 psig as the maximum for low-pressure applications.
- Pressure is routinely used as the qualification criteria for deemed steam trap savings in other jurisdictions' technical resource manuals (TRMs).
- Most steam systems will operate exclusively in one range or the other. While low-pressure boilers can't create high-pressure steam, it is likely that high-pressure systems include a small number of low-pressure traps. Review of historic trap data and discussions with

PAs confirmed that there are a limited number of distinct high-pressure customers throughout the state (less than 8%) and that they are unlikely to use the prescriptive savings stream when applying for incentives.

- The previous Phase 2 study identified pressure as the most divisive parameter among the custom savings equation inputs.[1]

The plot in Figure 1 compares trap operating pressure with annual custom savings (on a logarithmic scale to highlight the clustering of traps at lower pressures).

Figure 1. Steam Trap Pressure vs. Annual Savings



Equation Variables' Sensitivity to Pressure

ERS concluded that pressure will be the driving variable separating the two tiers of deemed savings; the next step is to determine the other parameters that have a direct relationship with operating pressure. ERS reviewed the various inputs to the custom savings equation and established that the trap orifice size, hours of operation, leak factor, and efficiency were subject to having a potential relationship with trap pressure. Graphical comparisons (similar to Figure 1) were used to identify potential relationships between pressure and input parameters. Figures 2, 3, and 4 illustrate the relationship between pressure and orifice size, hours and leak factors, respectively. Pressure on the x-axis is on a logarithmic scale to illustrate low-end clustering while the parameters of interest on the y-axis are on a linear scale.

[1] The deemed savings value from the Phase 2 steam trap evaluation was calculated by determining the average low (≤15 psig) and high (>15 psig) pressure values and then blending them on an industry standard low-pressure incidence rate of 90%.

Figure 2 shows a clear trend among low-pressure traps where the majority of values do not stray far from the ¼" diameter mark while high-pressure traps see smaller orifice sizes as the pressure increases.

Figure 2. Steam Trap Pressure vs. Orifice Size

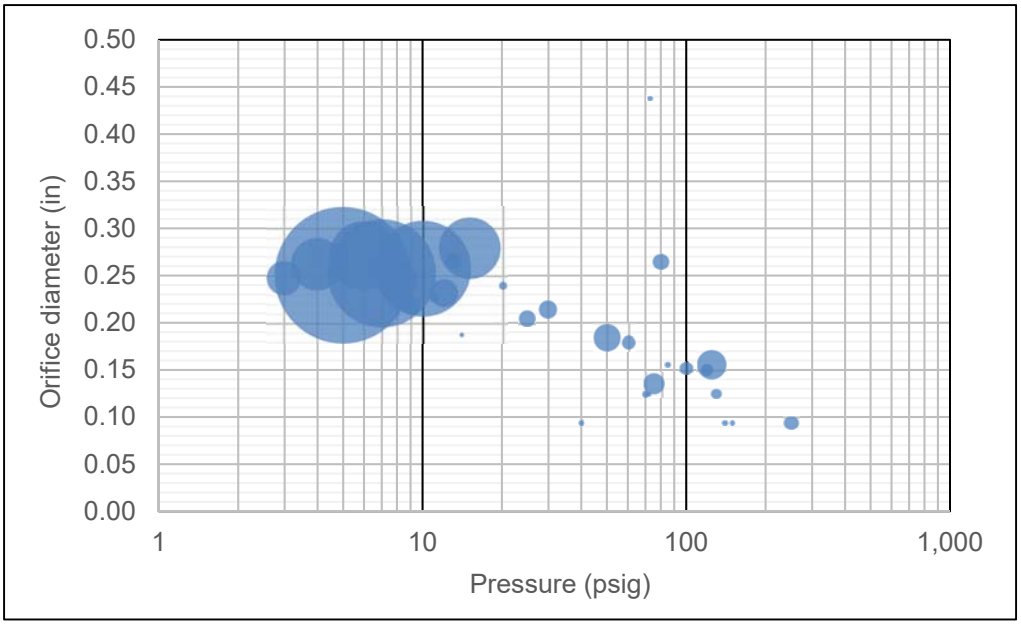
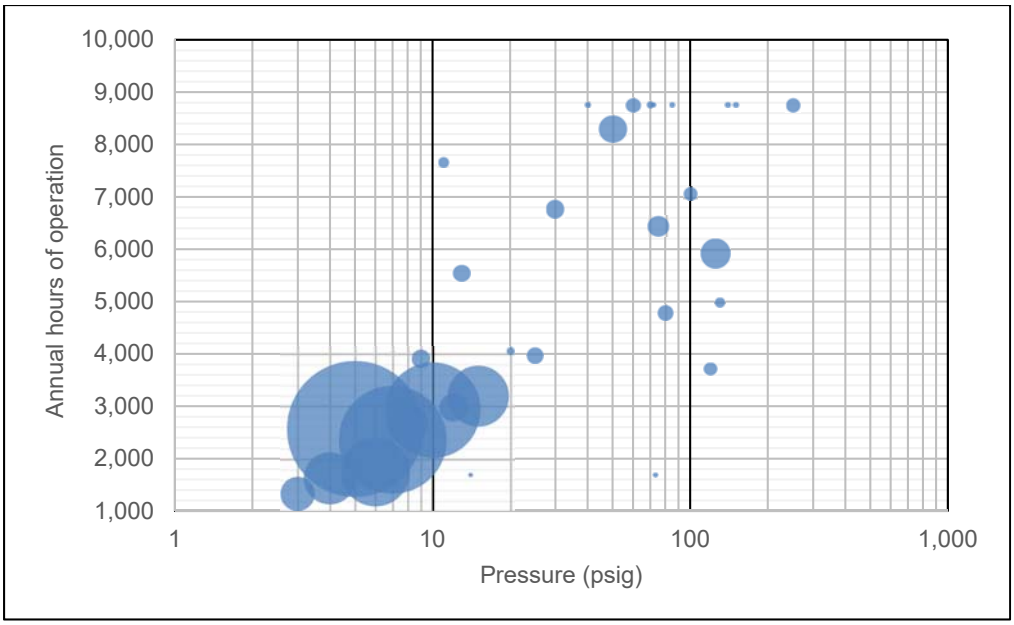


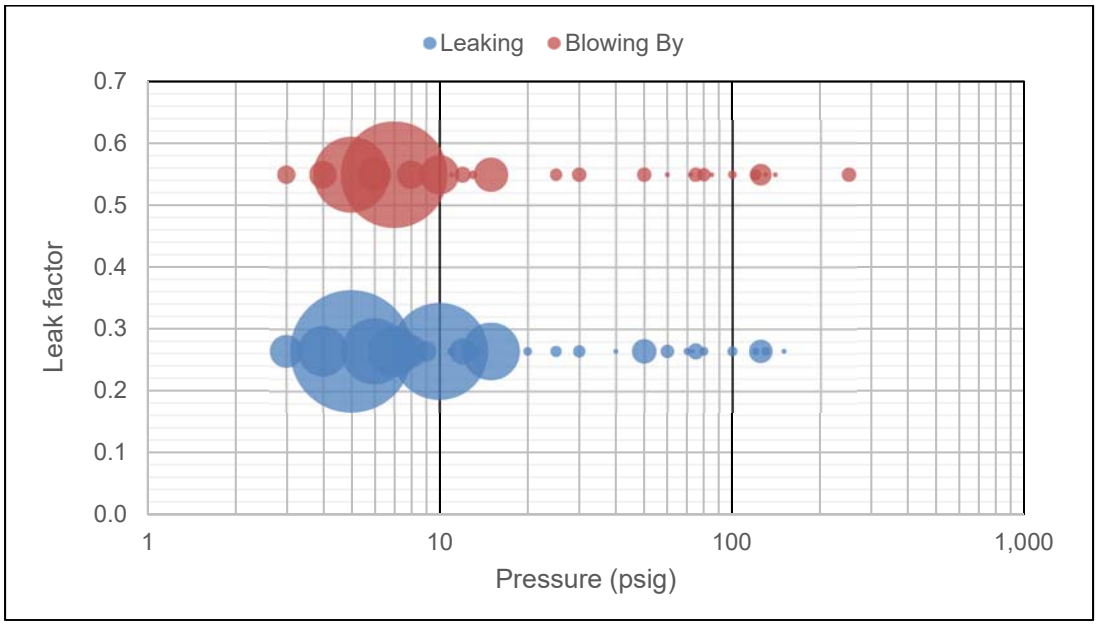
Figure 3 also shows a consistent trend between pressure and hours of operation. The majority of low-pressure traps do not exceed 4,000 hours of operation while a very small number of high-pressure traps stray below this mark.

Figure 3. Steam Trap Pressure vs. Hours of Operation



The means of comparison is slightly different in Figure 4 since two values (instead of one) are being compared. If there was an apparent relationship between pressure and leak factor, one would expect the two series to bunch up on opposite ends of the x-axis rather than what is currently observed.

Figure 4. Steam Trap Pressure vs. Hours of Operation



Regarding efficiency, ERS relied on recent conclusions made by the MA79/80 Baseline Advisory Group (BAG) that identified a modestly lower thermal efficiency in identical systems operating at higher pressures. The general assumption is that an identical piece of equipment operating at a higher pressure will see slight efficiency losses (in the range of 1%–3%) due to the increase in the boiler stack temperature.

The Phase 2 data did not show any other parameters – leak factor, discharge coefficient, condensate return factor, and rate of failure in bulk installations – vary as a function of pressure.

RESULTS SUMMARY

Based on the parameter assessment, ERS concluded that the orifice size, hours of operation, and thermal efficiency have a direct relationship with operating pressure while leak factor (among the other parameters not chosen for assessment) has no relationship with pressure. Table 1, below, provides a breakdown of the original and revised high- and low-pressure savings input parameters.

Table 1. Savings Equation Input Parameter Breakdown

Parameter	Units	Original	Low Pressure	High Pressure
Pressure	psig	7.2 / 86.7	7.2	86.7
Enthalpy, sat. liquid	Btu/lb_m	196 / 295	196	295
Enthalpy, sat. steam	Btu/lb_m	1,156 / 1,186	1,156	1,186
Orifice size (diameter)	in	0.25	0.25	0.156
Hours of operation	hours/yr	2,802	2,525	6,558
Thermal efficiency	%	80	80	78
Leak factor	%	36.9	36.9	36.9
Discharge coefficient	%	70	70	70
Condensate return factor	%	36.3	36.3	36.3
Low pressure incidence rate	%	90	N/A	N/A
Rate of failure in bulk installations	%	50	50	50
Per trap annual savings	MMBtu	12.2	8.4	35.6

CONCLUSION

ERS recommends that the PAs adopt a two-tier approach for prescriptive steam trap savings in 2019 and beyond using the following criteria for applying deemed savings appropriately:

- If the system operating pressure is **≤15 psig**, PAs should claim **8.4 MMBtu/yr** for every steam trap repaired or replaced at the facility through the program.
- If the system operating pressure is **>15 psig**, PAs should claim **35.6 MMBtu/yr** for every steam trap repaired or replaced at the facility through the program.