Emerging Technology Program

#1033: Real Time Steam Trap Monitoring

Public Project Report – Executive Summary

August 26, 2016 FINAL

Technical Contact

Douglas Kosar
Senior Institute Engineer
Douglas.Kosar@gastechnology.org
847.768.0725

Gas Technology Institute
1700 South Mount Prospect Road
Des Plaines, IL 60018

Nicor Gas Contact

Gary Cushman
Program Manager, Research and Emerging Technology
GCushma@aglresources.com
630.388.2392

Nicor Gas Company
1844 Ferry Road
Naperville, IL 60563

Legal Notice

This report was prepared by Gas Technology Institute (GTI) for Nicor Gas Company (Nicor Gas). Any use of or reliance on this report and/or any information contained in this report by any party is at that party's sole risk. Neither GTI nor Nicor Gas, or any person acting on behalf of either of them:

a) *Makes any warranty or representation, express or implied with respect to the ownership, accuracy, completeness, or usefulness of the information contained in this report. Inasmuch as this work is experimental in nature, the technical information, results, or conclusions cannot be predicted. Conclusions and analysis of the results by GTI represent GTI's opinion based on inferences from measurements and empirical relationships, which inferences and assumptions are not infallible, and with respect to which competent specialists may differ.*
b) *Assumes any liability with respect to the use of, reliance on, or for any and all damages resulting from the use of or reliance on this work and/or any information, apparatus, method, or processes disclosed in this report.*

The results within this report relate only to the items tested.

Full Report

The following executive summary is made publicly available by Nicor Gas as part of their Emerging Technology Program (ETP). The detailed Nicor Gas ETP report is available to qualified state and utility run energy efficiency programs upon request. Please contact the Nicor Gas ETP administrator at NicorGasETP@gastechnology.org to find out how to access the full report.

Executive Summary

Introduction

The Nicor Gas Emerging Technology Program (ETP), a part of the utility's ongoing energySMART Energy Efficiency Program (EEP), assesses new or underutilized technologies that have the potential to provide natural gas savings for the 2.2 million Nicor Gas customers in Northern Illinois. The Gas Technology Institute (GTI) implements the ETP for Nicor Gas. This report summarizes the findings from an evaluation of a real time steam trap monitoring system and its potential to provide a new energy efficiency measure to Nicor Gas commercial and industrial (C&I) customers.

Background

This pilot evaluated a real time steam trap monitoring system in C&I settings as a means to decrease steam trap losses and reduce boiler gas consumption. A steam trap is a valve that holds steam at the load device until it gives up its heat energy and condenses to water (condensate). Leakage at a trap allows steam to pass through the trap without useful heat extraction from condensation. The useful energy of that steam is wasted as it condenses in the return piping back to the boiler.

All steam traps, regardless of type, are prone to failure. The Illinois Technical Reference Manual (TRM) cites a failed open (leaking or blowing) rate of 16% annually on traps for all C&I steam pressure ranges [Illinois TRM 2015]. Many C&I facilities conduct manual surveys of steam trap conditions once a year or every few years to identify those failures. However, over the course of time, steam losses for a failed open trap will accumulate prior to discovery in the manual survey. A real time monitoring system can identify steam traps as they fail over time. This would allow for timely steam trap repair or replacement and immediate realization of boiler gas savings. The TRM establishes deemed steam losses per trap, for various steam pressure ranges, on which to base the calculation of gas savings.

Results

In this Nicor Gas ETP pilot, two hospitals with boilers generating steam pressure from 100 to 105 psig (categorized as Industrial High Pressure ≥75 and <125 psig in the TRM) were selected as host sites. At each site, 100 steam traps covering a range of high, medium (Industrial Medium Pressure ≥15 psig and <75 psig), and low pressure ranges (Industrial Low Pressure <15 psig) were equipped with the real time steam trap monitoring system.

Of the 200 total steam traps monitored during the pilot, there were four traps (three at Hospital A and one at Hospital B) identified as failed open by the monitoring system at the start of the pilot. However, after the January/February 2014 installation and over the course of the pilot through to its June 2015 conclusion, no additional steam traps were identified as failed open at either site by the monitoring systems.

The annual gas savings from identification and replacement of the failed open traps at the outset of the pilot is presented in Table 1. The savings are based on 12 months of steam loss savings and resulting therm savings using the calculation methodology in the TRM. Cost savings are based on a gas price of $0.706 per therm [DOE EIA 2016]. The simple payback shown in Table 1, and the proceeding tables, are based on the installed system costs shown in those tables.

Table 1: Monitored Savings from Steam Trap Monitoring System

	Site #1	**Site #2**
Designation	Hospital A	Hospital B
Number of Monitored Steam Traps	100	100
Number of Failed Steam Traps	3	1
Pressure of Failed Steam Traps (psig)	6, 30, 30	100
Annual Gas Savings (therms/yr)	2,344	2,941
Annual Cost Savings ($/yr)	$1,654	$2,075
System Cost ($)	$77,140	$77,140
Simple Payback (years)	46.6	37.2

As noted previously, there was an absence of detected, failed open traps by the real time monitoring systems over the course of the pilot period from February 2014 through June 2015 at both sites. So this report also provides an additional hypothetical evaluation of the savings potential for both sites based on the TRM deemed 16% annual rate of failed open traps. The results of this analysis are shown in Table 2, which assumes an annual manual survey baseline typical of the two pilot site hospitals. The annual gas savings are based on a linear distribution of steam trap failures over a year, with those savings accumulating for a single year.

Table 2: Analytical Savings from Steam Trap Monitoring System

	Site #1	**Site #2**
Designation	Hospital A	Hospital B
Number of Monitored Steam Traps	100	100
Number of Failed Steam Traps	16	16
Annual Gas Savings (therms/yr)	8,511	8,197
Annual Cost Savings ($/yr)	$6,005	$5,783
System Cost ($)	$77,140	$77,140
Simple Payback (years)	12.8	13.3

As a frame of reference for these monitoring system economics, the annual manual surveys conducted by an outside auditor, at these two hospitals, in conjunction with this pilot, cost $2,000 each, or $20 per trap. Based on the monitored annual cost savings from Table 1, Hospital A has a simple payback of 1.21 years, and Hospital B has a simple payback of 0.96 years, for the annual manual survey. Based on the analytical annual cost savings from Table 2, Hospital A has a simple payback of 0.33 years, and Hospital B has a simple payback of 0.35 years, for the annual manual survey.

Given the poor resulting paybacks for utilizing the real time monitoring system, one more economic scenario was addressed for its application to high pressure steam traps only (defined as Industrial High Pressure ≥75 and <125 psig), where the steam losses and gas savings would be highest for the two sites. Those economics, again based on the TRM deemed rates of failed open traps, are found in Table 3, which assumes an annual manual survey baseline typical of the two pilot site hospitals. The annual gas savings are based on a linear distribution of steam trap failures over a year, with those savings accumulating for a single year. Since each hospital site had a significantly smaller subset of high pressure steam traps monitored, the number of monitoring units installed was lower, which correspondingly reduced the system cost.

Table 3: Analytical Savings from Steam Trap Monitoring System (High Pressure ONLY)

	Site #1	**Site #2**
Designation	Hospital A	Hospital B
Number of Monitored Steam Traps	18	13
Number of Failed Steam Traps	2.9	2.1
Annual Gas Savings (therms/yr)	4,235	3,059
Annual Cost Savings ($/yr)	$2,988	$2,158
System Cost ($)	$17,036	$13,198
Simple Payback (years)	5.7	6.1

This last analysis points out the improved cost effectiveness of such trap monitoring systems when applied only to the higher pressure sections of a steam system. Later analysis in the report also quantifies the shorter simple paybacks when the baseline assumption for manual surveys is extended from yearly to every two, three, four, and five years. At the five year manual survey interval, simple paybacks can be reduced to on the order of 2.5 years for the monitoring system application to all pressure ranges, and to on the order of one year for the monitoring system application to high pressure only.

Nonetheless, the much faster paybacks calculated for manual surveys brings into question the economic viability of a real time monitoring system under those comparative circumstances. Furthermore, the participating manufacturer does not presently see their monitoring system completely displacing manual audits of steam trap conditions. Per this manufacturer, they state their monitoring system provides an “indication” as to the status of the steam trap. They further state, that when their monitoring system indicates a steam trap is now failing (closed or open), they then expect facility personnel, or an outside contractor, to perform a targeted manual evaluation of the suspect steam trap to make a final determination regarding its failure status. So this manufacturer indicates that a manual steam trap evaluation is still the most reliable method to make a final determination on steam trap status and recommends a manual evaluation provide the final verdict on the monitored condition of any steam trap status in question.

Finally, coincident manual surveys were conducted on all 100 steam traps at each site at the conclusion of the pilot during early July 2015. Those manual surveys did identify seven failed open traps (four at Hospital A and three at Hospital B) that went undetected by the monitoring system. This finding from the pilot raises concerns about the current state of the piloted “temperature only” monitoring technology to reliably identify failed open steam traps over time.

Overall, given the faster manual survey payback economics and the questionable accuracy of the current monitoring technology, manual surveys are still the most reliable and cost-effective option for identifying failed steam traps. Given TRM deemed steam trap failure rates, annual surveys will pay for themselves in less than one year based on steam losses avoided (and gas therms saved). Although, well commissioned and properly adjusted real time monitoring systems may still have a role in alerting facilities to potential failures of steam traps in locations which are difficult for the surveyors to access and where the resulting survey timeframes become extended, especially in high pressure segments of a steam system where per trap losses are greatest.