Test Procedures, Getting Them Right

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ABSTRACT

The Department of Energy specifies test procedures for appliances it regulates. Most of these tests are adopted from those developed by industry organizations whose primary goals are simplicity, procedural stability, repeatability, minimal burden and least cost. The consequence is that often these tests do not capture all aspects of energy use, including climatic, system, standby, interactive, or parasitic effects, making them less than ideal predictors of real-world performance. Where performance is misunderstood or misrepresented, energy efficiency improvement efforts cannot be optimal. This paper surveys and identifies some of these gaps for common appliances, with sometimes surprising findings. In this paper, improvements already achieved are recognized and further actions are recommended.

Introduction:

Energy efficiency policy makers and program administrators rely on standards and related test procedures to estimate the savings potential from utilizing more efficient appliances. These standards and test procedures are most often codified by the U.S. Department of Energy (DOE) based on industry-developed standards and recommendations for DOE-covered equipment and appliance categories. The resulting test outcomes are required to be reported to DOE, such that those relying on them can have a degree of confidence that they are accurate and correct. Additional users of DOE test procedure results are the Federal Trade Commission which publishes "Energy Guide" labels, Energy Star which recognized highly energy efficient products relative to the market in general, and the Consortium for Energy Efficiency which develops standardized programs and qualifying product lists for energy efficiency program providers nationwide. Use of these standardized criteria brings about some commonality and consistency among efficiency incentive programs. Similarly, the California Energy Commission specifies test and list requirements for products that it uniquely regulates. Where DOE has established test procedures for these CEC regulated products, CEC is obligated to specify DOE's test procedure, but for some CEC only regulated products, such as portable electric spas, the CEC's test procedure and Appliance Efficiency Database (MAEDBS) are often used as a reference for efficiency program design.

While appearing straightforward, reported energy efficiency performance values are often in need of a multitude of interpretational and application specific adjustments. It is not sufficient to just presume the test result is a good predictor of real world performance, or that differences in performance measurements will be a good predictor of energy savings.

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This phenomenon is qualitatively addressed in this paper for a number of different appliance measures considering:

- Climactic conditions
- Operational modes
- Application or system effects
- Interactive or parasitic effects, such as thermal and those relating to power factor
- Differences from "Real World" utilization
- Test conditions
- Accuracy or precision of measurement instrumentation specified relative to uncertainty on results
- Alternative fuels

A question to be asked is, "What do we expect of our test procedures and equipment efficiency performance ratings?" Ideally, reports would give us a highly accurate, repeatable, and realistic indication of comparable real world energy efficiency, considering the way products are actually used. Alternatively, perhaps only a single-condition-operating point would be reported, with the user left to establish the transferability from the reported condition to his or her individual application. Increasingly DOE is moving to single performance metrics that reflect an average performance, such as Integrated Energy Efficiency Ratio (IEER) for air conditioning. With only one average performance number to work with, it is difficult to extrapolate performance to individual climate zones with different temperatures', humidity's, types of HVAC systems, and customer usage patterns'. These challenges become further exacerbated when performance figures are presented on the small subset of regulated appliances that have Federal Trade Commission Energy Guide Labels. Current efficiency comparisons are "within-fuel-type"; i.e., electric to electric and gas to gas, where in some cases gas appliances can consume significantly less source energy and be less expensive to operate than electric ones, while efficiency metrics would show electric only appliances to generally be more efficient from the currently used "site-fuel" perspective.

The Environmental Protection Agency (EPA) seems to provide clear and useful efficiency performance with its Fuel Economy Estimates Sticker on new cars. The city and highway miles-per-gallon estimates give buyers a good idea what to expect for the two most common driving conditions. With this information and average gas prices, buyers can usually predict what their operating cost will be. While there are a lot of factors that are considered when buying a car, the EPA makes efficiency, or fuel economy very clear such that it should be well understood by the average consumer. On the other hand, it may not be so clear when buying an air conditioner, as the real efficiency of some types of products (such as a central unit) may not be so correctly represented by the performance reported. While consumers may have a good idea what their utility bill is, they most probably are not aware of their marginal electricity rate.

Below are some equipment-specific examples of perhaps unrecognized caveats in test procedures, for consideration by policy makers, energy efficiency program designers, and program implementers. If readers find any of this troubling, consideration might be given to a concerted, collaborative effort by efficiency advocates to review, address, and be actively involved in test procedure development and improvement by DOE as contrast to relying on the work of industry organizations which are often slow and narrowly focused on simplicity.

Refrigerators

Refrigerators are a very common and pervasive appliance where the California Energy Commission's Residential Appliance Saturation Survey reports 24% of households have a second or third one, usually located in the garage.

Of all appliances, DOE test procedure for refrigerator performance[5] is probably among the best and most representative of real world performance, with a few exceptions:

> **Application**: Performance is reported for refrigerators operating in conditioned space. Where second refrigerators are in garages, or other unconditioned space, performance would be expected to differ by the extent to which the average installed location ambient temperature is different than the average conditioned temperature. Do second refrigerator energy efficiency programs take this into account, or simply rely on the average age-weighted reported efficiencies? Operation in garages or basements, where the average annual ambient may be different than inside homes, would make the average annual energy use substantially different than predicted by DOE / FTC estimates.
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> **Ice Makers**: DOE estimates that nearly all residential refrigerators manufactured today have automatic ice makers, or are built with the internal componentry to accommodate them. DOE and industry stakeholders have been working towards a test procedure to measure ice making performance, but it still isn't in place. The current practice in DOE's regulatory framework continues to add 84 kWh per year for automatic icemakers. This may or may not be correct and does not offer a direct measurement, such that differences in current performance, or improvements in design can be evaluated. The bottom line is that icemakers in nearly all refrigerators continue to not be measured by any test procedure.
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> **Refrigerator Volume**: Interestingly, DOE has agreed with Industry that any space taken up by water tanks in refrigerators to serve icemakers and/or chilled water through the door should be part of the refrigerator's calculated volume. For consumers, this means that of the listed volume of refrigerators is overstated by a non-identifiable or quantifiable, non-usable space taken up by water tanks.
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> **Line Voltage**: The voltage at which refrigerators must be operated does not seem to be specified in the test procedure.[6] Work done many years ago by PG&E's Department of Engineering Research showed refrigerators operate more efficiently at lower line voltages

[5] http://energy.gov/sites/prod/files/2014/04/f14/rf_tp_final_rule.pdf
[6] http://energy.gov/sites/prod/files/2014/04/f14/rf_tp_final_rule.pdf

than at higher ones. Since the nominal residential service voltage is 120 VAC, it would seem reasonable that the test conditions would reflect this required service voltage in the event there is any difference in performance as a function of service voltage.

Water Heaters at or Below 55 Gallons

According to the Appliance Standards Awareness Project[7], "Water heating represents 20% percent of total annual household energy consumption in the U.S. About 53% of U.S. households use natural gas water heaters, while 38% use electric and less than 4% use oil.

DOE regulates residential water heaters. The test procedure[8] for storage products at or below 55 gallons essentially measures thermal energy output using a specified water draw schedule, divided by energy input, over a period of time to capture tank losses. This ratio is stated as Energy Factor. This approach can lead to different conclusions about energy efficiency performance, depending on what one's environmental and fuel choice related preferences are. Additionally, electricity use for controls and fan power vents used in gas water heaters can lead to unexpected and unintended source energy and operating cost consequences:

Fuel Choice: Using DOE's test methodology, the resulting federal minimum energy efficiency standards for gas-fired storage products is: EF = 0.675 - (.0015 x rated storage volume in gallons). The electric storage standard is EF = 0.960 - (.0003 x rated storage volume in gallons). For the common 40-gallon tank size, this results in a gas minimum EF of 0.615, and an electric minimum EF of 0.948, leading one to believe that electric resistance water heaters are more efficient than gas ones, while gas ones have the larger market share since they are less costly to operate.

ASAP explains it this way, "According to DOE, a baseline 0.90 EF electric water heater consumes around 2,700 kWh annually. Though electric water heaters are rated with higher energy factors than gas or oil, these ratings do not account for the fact that about 3 Btu's of fuel need to be burned to generate 1 Btu of electricity. All water heaters generally waste a portion of fuel they use to keep storage water heated: for example, in a conventional gas water heater, only 43% of the fuel energy actually reaches the point of use. The remaining 57% dissipates through standby losses, distribution losses, or combustion losses. Thicker tank insulation can increase the efficiency of all types of water heaters, but this has decreasing gains at higher efficiency levels, which already have relatively thick insulation." In contrast and according to ASAP, for electric resistance storage water heaters, only about 30% of the source energy actually reaches the point of use.

Heat pump water heaters can decrease energy use by about 50% compared to electric resistance storage water heaters. Instant or tankless electric and gas water heaters offer a

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[7] http://www.appliance-standards.org/product/water-heaters

[8] https://www.federalregister.gov/articles/2013/01/11/2013-00483/energy-conservation-program-test-procedures-for-residential-water-heaters-and-commercial-water

different utility and in some low or infrequent draw applications can be significantly better than tanked models. There is about 30% potential for additional efficiency gains for conventional gas storage water heaters by using condensing technology; however, this comes at the cost of some additional electricity use for the controls and powered venting.

High Efficiency Gas Storage Water Heater Electric Parasitic Loss: According to the California Energy Commission's Study[9], in part performed by PG&E's Applied Technology Services department in San Ramon, "From an annual energy cost perspective, the condensing storage water heater is the most cost effective as it is the most efficient SWH (Storage Water Heater). At the other end of the efficiency spectrum are the 15 year old and 0.62 EF atmospheric SWHs which at times are as cost-effective, if not slightly more so, than 0.67 EF SWHs for the non-standard draw patterns. Certainly these two have the lowest installed cost, thus they are overall more cost-effective. *Considering operating cost only, the difference in the cost of electricity eliminates savings from reduced fuel usage for some of the 0.67 EF SWHs*." While not all the background assumptions included in the referenced report are included here, the following Table 37 from the Study, shows that on account of the added electricity usage, with California electricity and gas costs, the .67 EF Power Vent model on the Gas Technology Institute Mid Draw schedule costs more to operate than the old water heater. The energy efficiency performance, Energy Factor, depends on the draw schedule (the volume, rate, and frequency of how water deliveries). There isn't much difference in the operating costs between the old water heater and any of the 0.67 EF models at what is perhaps the most realistic draw schedule, leading one to question if these models should be candidates for incentive programs. More can be found on this subject at http://energy.gov/sites/prod/files/2014/06/f17/rwh_tp_final_rule.pdf.

Table 37: Estimated Annual Energy Operating Cost at 2010 Natural Gas & Electricity Prices

	15 year old water heater	0.62 EF Atmos	0.67 EF Atmos/Vent Damper	0.67 EF Power Vent	0.67 EF Direct Vent	0.70 EF Atmos/Fan Boost	Hybrid	Conde-nsing Storage
DOE Standard EF	$239.74	$231.25	$229.17	$219.74	$236.53	$194.31	$208.69	$194.01
GTI Mid Draw	$246.81	$246.10	$255.53	$244.03	$245.71	$242.43	$226.91	$206.41
GTI Low Draw	$141.08	$136.13	$144.06	$129.85	$134.35	$136.18	$132.16	$103.31

[9] http://www.energy.ca.gov/2013publications/CEC-500-2013-060/CEC-500-2013-060.pdf, pp. 179

Commercial Rooftop Air Conditioning Units

During the DOE Appliance Standard Regulation Advisory Committee (ASRAC) Working Group on Commercial – Industrial Fans, it became apparent that the ventilation mode of rooftop unitary air conditioning is not tested or rated. This mode of operation accounts for half the energy consumption of these units. The Working Group on Unitary AC Equipment agreed to work towards including ventilation mode in future test procedures and metrics.

Dedicated Purpose Pool Pumps

Swimming pool pump motors are currently in a CEC Rulemaking with regulations expected to be adopted the end of this year. Concurrently, DOE is conducting a rulemaking on dedicated purpose pool pumps. DOE's Appliance Standard Regulatory Advisory Committee has commissioned a Working Group to negotiate a consensus proposal in the form of a Term Sheet to be submitted to ASRAC, and if approved to be used to guide DOE's final rule. Generally the process is going well with one exception:

> **Operating Modes**: The Working Group process was half completed before efficiency advocates on the working group realized that the freeze protection mode of operation offered on variable speed pumps and motors was not included in the test procedure or metric. This mode of operation can add as much as 20% to the annual energy use depending on how it operates.[10] DOE's consultants are now looking at ways to account for this in their analysis such that it can be accommodated in the final term sheet. The issue here is that most variable speed products sense the ambient temperature and turn on when it drops below 42^0 F to help prevent damage from potential freezing. Much of the equipment on the market allows the trigger temperature and pump speed to be user selectable, but one product's default settings cause it to run for 10 hours at half speed. If included in the metric and tested, the least efficient products could easily approach the most efficient in this currently un recognized operating mode. It is expected that this issue will be addressed when the working group issues its final term sheet, but it could have been easily overlooked.

Swimming Pool Heaters

Swimming pool heaters are federally regulated, where their thermal efficiency performance is tested and reported. The majority of pools have gas or heat–pump heaters, although residential, single family heaters may not be used much, likely due to the high cost of pool heating. According to the California Energy Commission's Residential Appliance Saturation Survey[11], the annual unit energy consumption of gas pool heaters in California is 208 Therms. At 4 MBtu input, that amounts to 52 hours of full load operation. Natural gas heaters

[10] Based on California Investor Owned Utilities, Calculations as included in the proceedings of this working goup
http://www.energy.ca.gov/2010publications/CEC-200-2010-004/CEC-200-2010-004-ES.PDF[11]

predominate in California, while heat pump heaters are popular in Florida. Fully condensing gas heaters are available, offering about a 10% improvement in thermal efficiency, but with such low residential use, the additional cost is not justified by the potential savings. Where heaters are heavily used on a year-round basis, the additional cost of fully condensing or solar thermal heaters is fully justified.

Application: The federal minimum energy efficiency performance standard for natural gas pool heaters is 84% thermal efficiency. According to Ray Pak's document, "The Facts About Venting And Efficiencies"[12], if a boiler has a combustion efficiency of 83.6% or less, the flue gases will have enough energy to properly vent without condensing. Since thermal efficiency can never be greater than combustion efficiency, and jacket losses are in the range of 1.0 to 3.0% depending on the design and materials used, a pool heater operating at 84% thermal efficiency has a good chance of condensing, and therefore should use a corrosion resistant vent material. RayPak notes though, "Due to differences in "Category" (Stack Performance) and "Efficiency" test procedures, plus rounding, it is possible to have a Category I (Non Condensing Vent) Appliance that is rated at 84% efficiency". This calls into question whether pool heaters with non-corrosion resistant vent materials really achieve the minimum 84% thermal efficiency in practice.

Heat Pump Pool Heater Test Conditions: The federal test procedure for heat pump pool heaters sets the test conditions at 80^0 ambient dry bulb, 63% relative humidity, and 80^0 pool water. Using these idealized test conditions, high coefficients of performance are achieved, but these conditions may be unrealistic for most of the time pool heating is needed. If more realistic ambient conditions were used, the energy efficiency performance would be worse.

Hydraulic System Parasitic Losses: Pool heaters are normally connected into pools' filtration water circulation system between the filter output and the returns to the pool. While a hydraulic bypass could be installed, it normally is not, leaving heaters permanently plumed into pool's hydraulic systems. As with any other component in the hydraulic system, pool heaters' manifolds present some resistance to the flow of water, or Total Dynamic Head, that must be overcome by filtration pumps. This results from the water needing to pass through a heat exchanger manifold, as well as past a pressure switch designed to verify sufficient flow for the heater to fire. Use of the pressure switch design for sensing proper flow necessitates a continuous flow restriction, which in-turn requires additional pumping power and energy to maintain desired flow rate and pool turnover. This non-measured or valued parasitic effect varies by more than a factor of 4 times among pool heater products and therefore offers a pool pumping energy savings opportunity if it were recognized in the test procedure and metric.

[12] http://www.raypak.com/userfiles/file/100012.pdf

Portable Electric Spas

Portable electric spas sold or offered for sale in California are regulated by the California Energy Commission. The CEC specifies a test procedure and requires testing, reporting, and listing of these appliances in its Appliance Efficiency Database. The specified test procedure measures the standby energy use over a 72 hour period after the spa stabilizes under specified water and ambient air conditions. These are a water temperature of be 102°F, ± 2°F, and an ambient air temperature of 60°F, ± 3°F for the duration of the test. Since the metric is standby power in Watts, the measured energy use is then divided by the hours to provide standby power.

Compatibility with Real World Conditions: While a good "first step" into testing, there are several aspects of this test that might be revisited:

- If average outdoor ambient temperatures were weighted by the distribution of spas in different climate zones, a different and perhaps more realistic ambient temperature might be specified. It is likely that the outdoor ambient resulting from this approach would be lower, yielding higher standby power draw.
- The current test conditions do not account for humidity. Outdoor air likely has lower humidity than realized in the test chamber, so evaporative cooling might be greater in application than in the test
- Spas are tested with their manufacturer supplied cover installed, but cover performance is suspected to vary widely as a function of aging and becoming water logged. This effect should be evaluated in laboratory tests and a spa cover efficiency regulation developed.

Linear Fluorescent Lamps

Linear fluorescent lamps of all types are pervasive in commercial and industrial buildings applications. Test Procedures for these lamps are specified by DOE and are often developed by the Illuminating Engineering Society of North America. Lighting test procedures and results are probably the most complicated and difficult to comprehend of any appliance measure. Even the best qualified and intended efficiency program designers can sometimes misinterpret specifications and come to incorrect conclusions. A few examples are given below to illustrate the situation.

Operating Conditions: The Lighting Research Center of Rensselaer Polytechnic Institute through its National Lighting Products Information Program has published a paper on the efficacy of T8 fluorescent lamps. It notes at the bottom of the second page that, "NLPIP testing was conducted using a low-frequency reference ballast as described in American National Standards for Lamp Ballasts-Reference Ballasts for Fluorescent Lamps (ANSI C82.3-2002). T8 lamp efficacy increases by approximately 10% under high-frequency operation (Hitchcock 1983). For more details on testing protocols, see Appendix A: Test methods."

T5 lamps in contrast are tested on ballasts operating at high frequency, giving them an approximately 10% better performance score relative to T8's. Both these products are almost universally operated on electronic, high frequency ballasts, so what would appear based on catalogue specifications only to show T5's to be more efficacious would be erroneous.

T8 lamps are both tested at 25^0C, while T5 lamps are tested at 24^0C. Neither of these normally operates at exactly these temperatures in real world applications. As temperature rises, light output falls, but power demand remains relatively constant.

Both the ballast and optical performance parameters relative to test result specifications are nicely discussed in a paper by Peter Ngai of Peerless Lighting, "Does Size Really Matter".[13] Without the insight reflected in this paper, users could easily be influenced by manufacturers' specifications to think that T5s are intrinsically more efficacious than T8s. Since they are of smaller diameter, T5s are capable of better optical performance than T8s, but this depends on the fixture in which they may be installed.

Small Diameter Directional Lamps

While small diameter directional lamps have been around for a long time, they are presently not federally regulated. DOE is moving to reclassify these as general service lamps. When this happens, they will be federally regulated. In the meantime, the CEC regulates them. Among the performance parameters regulated is lamp efficacy. These lamps originally served projectors and were primarily developed for that application. Architects and lighting designers quickly found use for these, particularly the MR16, as accent lights for merchandise or art work. Today, they are used primarily for the latter application, as projectors using them have largely been replaced with newer technologies.

Test Conditions: Little information other than the Wattage has historically been published or specified about these lamps, making it difficult to compare performance. Center Beam Candlepower is sometimes available, but this metric is most useful in projector applications. Total beam lumens and distribution uniformity might be most useful in characterizing performance for accent lighting. The CEC has chosen total lumens per Watt as their metric for energy efficiency performance. For LED lamps, most of the light output appears within the beam, so the 2 measures may be relatively close. This is not so much the case for halogen lamps as "spill" occurs outside the beam. Again, for LED lamps, color is an issue, while for halogen lamps; Correlated Color Temperature and Color Rendering Index are well known and predictable.

Metrics and test procedures might best follow the criteria of application, technology, and resulting key performance metrics. It is likely that further refinement of the tests for small diameter directional lamps will be worth consideration as DOE includes them in its

[13] http://www.peerlesslighting.com/libraries/downloads/doessizematter.sflb.ashx

regulations, which may preempt the CEC ones. Preemption is complicated, so it is unclear at this time exactly what the outcome will be.

Clothes Washers and Dryers

Clothes washers and dryers are federally regulated and pervasive in residences and laundromats. After many years of work in California, DOE has adopted a metric for clothes washers which includes water factor. In many parts of the country water is a precious commodity. Hot water has embedded heat energy. Both water and wastewater are usually pumped within water transmission and distribution systems, so it makes sense to include all forms of energy utilized in evaluating their performance.

Higher spin speeds in washers may use more electricity, lessening their individual efficiency, but the resulting dryer clothes may make dryers significantly more efficient. DOE has adopted a metric and test procedure approach which addresses this system effect, however experience in the Northwest has shown that washers do not always realize their high speed spin potential on account of load imbalance.

Differences from Real World Utilization: The current test procedure calls for a test load of polyester clothes, which are presumed to be more easily replicated than the cotton or mixed loads commonly washed and dried in residential laundry applications. Testing by the Northwest Energy Efficiency Alliance has found that the DOE test load is not very representative or predictive of real world performance. In its energy efficiency program, the Northwest has specified a unique test load consisting of mixed fabrics and apparel, which more correctly represents real world conditions. DOE might reconsider its test procedure based on this finding, opting for a more representative load if a consistent, easily repeatable load can be established.

Alternative Fuels: As is the case with water heaters, DOE shows electric dryers to be more efficient than gas ones. From a source energy perspective, gas dryers are more efficient and are usually less costly to operate. Heat pump clothes dryers are popular in Europe. With a high coefficient of performance, they may outperform gas dryers on a source energy basis, however dryer capacity (load size) and drying time need to be considered.

System Effects: When operated inside conditioned spaces, the thermal interactive effect of dryers needs to be considered with respect to their influence on heating and cooling loads.

Portable or Spot Air Conditioners

Portable or spot air conditioners are not presently regulated at the federal or state level. DOE is in the process of conducting a rulemaking on them. Unlike window, wall, or package terminal air conditioners, portable air conditioners are freestanding. They usually take condenser make-up air from the conditioned space and exhaust it through a flexible duct to a nearby window or other through the wall opening. This offers an attractive unique utility or convenience in that they do not need to be mounted in a window or wall opening.

<u>System Effects</u>: Since condenser make-up air comes from the conditioned space and is exhausted outside, it is replaced by air that infiltrates from outside into the conditioned space. The result is that while they may cool the immediate area in which they are located, overall hot air is brought in from outside in a manner that negates the overall cooling effect. Other areas get warmer. The energy savings from this type of product is negative, and their efficiency is a matter of how little relative overall heat is added by their use.

The way the test procedure and metric is currently drafted, it will ignore the system effect of hot air infiltration and contrast these products to window, wall, and package terminal air conditioners which do not increase hot air infiltration from outside.

Boilers

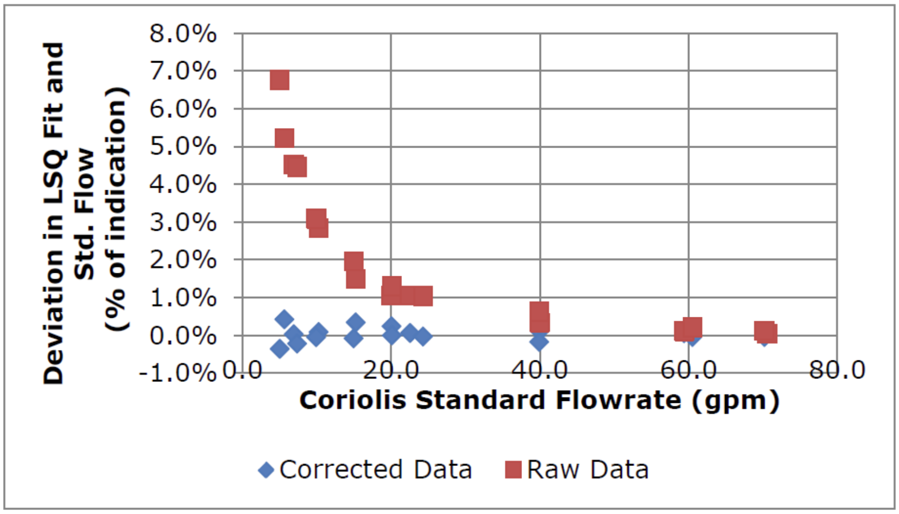
Boilers are federally regulated products. They are mentioned here to draw attention to the accuracy, precision, availability, and cost of measurement equipment required in test procedures relative to their impact on the uncertainty of results. For boiler tests a high accuracy, expensive, and difficult to obtain Coriolis flow meters are required to measure flow. Analysis shows that relaxing the measurement requirements adds little uncertainty to the results. In this case, less expensive test equipment might be acceptable. There are other situations where the reverse is probably true. Test equipment requirements should be reviewed relative to uncertainty added, cost, and availability, such that good compromises are reached.

<u>Accuracy or Precision of Measurement Instrumentation</u>

In the measurement of boiler efficiency, meeting the natural gas volumetric flow accuracy requirement of ASHRAE Std. 155P is not possible with a standard rotary volume meter. As indicated in Figure 37[14], meter accuracy degrades significantly below 10 percent of the meters rated capacity. Under the current requirements of 155P, overall uncertainty in thermal efficiency is over 1%. Relaxing the accuracy of the natural gas volume meter from 0.25% of hourly rate to 0.5% of hourly rate, which was achieved using a calibrated rotary volume meter, only increases the uncertainty in the standard by hundredths of a percent overall uncertainty. Further relaxing the requirement to 1% would allow even more meters to be used for testing, and increases the overall uncertainty in thermal efficiency by about .25%.

[14] PG&E Applied Technology Services internal study of boiler efficiency

Figure 37. Comparison Between Raw and Corrected Deviation (% of Indication) Between Coriolis Standard and Magnetic Flow meter



Conclusion

There are many caveats in current test procedures which need to be considered in transferring energy efficiency performance ratings to real world applications. In designing energy efficiency programs, it is easy to misunderstand ratings relative to source energy, fuel choice, system effects, inclusion of all operating modes, and many other attributes. Test procedures should be designed and revisited such as to make them as clear and predictive of real world performance as possible.