September 16, 2011

Ms. Brenda Edwards
U.S. Department of Energy
Building Technologies Program
Mailstop EE-2J
RFI for Commercial & Industrial Pumps
EERE-2011-BT-STD-0031 and/or RIN 1904-AC54
1000 Independence Avenue, SW
Washington, DC 20585-0121

Dear Ms. Edwards:

Subject: DOE 10 CFR, Part 431; Docket EERE-2011-BT-STD-0031; RIN 1904-AC54

---- Hydraulic Institute (HI) Response to DOE Request for Information ----

This letter is our third response to the U.S. DOE's referenced Request for Information, as published in the Federal Register on June 13, 2011. We are doing so, at this date, in response to the deadline extension to September 16, 2011 as granted by DOE. Our previous two letters to DOE, dated July 11, 2011 and September 16, 2011, we incorporate by reference herein. We hereby provide further evidence of points previously made:

This letter presents specific cases from various industries in the U.S. that demonstrate a pump systems approach to efficiency improvements **It is the contention of the Hydraulic Institute that a systems approach represents the greatest gains for efficiency improvements that are economically feasible.** In order to support this claim, we have structured this letter as follows:

Part One: assembled a specific list of systems improvements suggestions (published by the DOE);
Part Two: assembled examples from various industries where systems approach suggestions were implemented, showing the concrete savings in energy use and cost.

Consequently, HI's suggestion is that the U.S. DOE address the rule-making by approaching this issue on the basis of pumping systems – where the greatest energy savings for the United States can be realized, and where it is most economically feasible to achieve improved efficiencies.

The U.S. Department of Energy has been a leader not just in advocating for a pump systems approach, but in implementing and documenting case studies to demonstrate the economic feasibility and technical viability of a systems approach for pump efficiency. In a 2002 *Electric Motor Systems Opportunities Assessment*, the U.S. Department of Energy writes that, **"DOE's primary strategy is to support plant managers in applying a systems approach to specifying, purchasing, and managing electric motors and related machines so as to minimize the electricity needed to achieve production goals"** (DOE 2002:1).

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Part One: The Pump Systems Approach

Pumping systems are one example of the motor systems for which the DOE urges a systems approach. The DOE Industrial Technologies Program (ITP) [soon to be re-named Advanced Manufacturing Office] explains the rationale behind a pump systems approach: **"The systems approach is a way to increase the efficiency of an electric motor system by shifting the focus away from the individual elements and functions to total system performance"** (ITP Case Study: City of Milford, CT).

In an effort to improve the efficiency and operation of pumping systems, the DOE's Industrial Technologies Program has published a series of "Tip Sheets" that give advice for how to improve pumping systems to engineers, technicians, equipment operators, and other practitioners. Each of the dozen DOE ITP "Energy Tips – Pumping Systems" guides offers a practical guide for how to apply a systems approach to improving a pump system (ITP Best Practices Pumping Tip Sheets #1-#12). The suggestions include:

- Prescreen pumps in the facility and survey the systems identified as priorities
- Use Adjustable Speed Drives (ASD) in pumping applications that range from 1 to 1000 horsepower (hp)
- Use the DOE's Pumping System Assessment Tool (PSAT) to estimate energy use, identify potential savings, and evaluate performance of control valves
- Establish a pumping system maintenance program that includes: preventative actions, predictive actions, periodic efficiency testing
- Achieve flow control via Adjustable Speed Drives, trimming impellers, installing multiple pumps, adding a multi-speed motor
- Match pumps to systems requirements by identifying misapplied, oversized, and throttled pumps
- Compare multiple pump scenarios with single-pump systems
- Use Life Cycle Costing (LCC) techniques to justify acquiring high efficiency pumps and designing efficient systems
- Use Optimum Pipe Sizing to reduce the friction factor
- Select a correctly sized pump and drive motor
- Determine the cost effectiveness of each improvement
- Consider trimming or replacing the impeller

This letter will present specific cases from various industrial sectors, from agriculture and irrigation to water and waste-water treatment, which demonstrate that a pump systems approach to efficiency improvements is both economically feasible and technically viable. Many of the cases cited here have been tested and documented by the DOE. Many of the cases use more than one of the recommendations in the DOE ITP "Energy Tips – Pumping Systems" listed above in order to achieve efficiency improvements.

A pump systems approach has been shown to offer energy efficiency improvements that are economically feasible and contribute substantial energy savings. For example, the U.S. Department of Energy 2002 "*Electric Motor Systems Opportunities Assessment*" (cited in the DOE's RFI on June 13, 2011 on page 34193) reports: "Improving the performance of this coal slurry pumping system has saved Peabody Holding Company 87,184 kWh per year. In U.S. industry, improvements to fluid systems represent over 60% of the overall industrial motor system energy savings potential" (DOE 2002:7). The Peabody Holding Company case study is just one of several which are detailed below. The document goes on to report that an ASD (e.g. Adjustable Speed Drive) retrofit has resulted in savings of more than $68,000 annually for General Dynamics Armament Systems—a 1.5 year payback (DOE 2002:10).

In a 2011 interview with the Alliance to Save Energy, John Masters of Danfoss Corporation explained that pump systems efficiency improvements offer strong energy efficiency potential to industrial and industrial-scale facilities. He said that, "Implementation of variable speed drives in the Water/Wastewater segment has proven to provide a 30-60% reduction in energy usage for most pumping applications" (Alliance to Save Energy 2011). In addition to the solution Masters' offers, a number of other systems approach changes have been shown to reduce energy consumption while having low implementation costs.

These findings are consistent with the work of the Hydraulic Institute and Pump Systems Matter, which insists that a pump systems efficiency approach:

1) Offers the most gains in energy efficiency improvements;
2) Offers economically feasible gains in energy efficiency improvement;
3) Shows that a targeted approach focusing on a few industries will result in the greatest gains.

Below are summaries of lengthier case studies where a systems approach was taken in order to determine how to improve efficiency, lower electricity demand, and lower operating costs. These cases range in size and industry. The U.S. Department of Energy has been a leader in advocating for a pump systems approach to energy efficiency improvements. Several of the case studies below were conducted and documented by the U.S. DOE.

Part Two: Examples from Industry

In this next section, we describe a series of site-specific studies and case studies that demonstrate how a pump systems approach leads to efficiency improvements. Each of these cases and studies shows that a systems approach is both economically feasible and technically viable.

Example from Energy Industry

1) Case Study: Peabody Holding Company
U.S. Department of Energy – Energy Efficiency and Renewable Energy
Industrial Technologies Program – Motor Challenge Technical Case Study

At a glance:

- Coal Slurry Pumping System
- Systems Analysis Conclusion: Improvements to three main elements of pumping system: pump casing and impeller, motor, and the V-belt drive
- Results: 87,184 kWh/year reduction in station energy consumption (a 15% reduction); $5,231 in annual savings

- Implementation cost: $15,693
- Payback period: 3.3 years
- Original efficiency: 58.7% New efficiency: 73.6%

Peabody Holding Company provides policy management and strategic planning to the Peabody Group, which comprises 50 coal mining, marketing, and related corporations in the U.S. and Austrailia. The Randolph Coal plant (Illinois) processes and cleans coal supplied by Peabody's Marissa Underground Mine by adding water to raw coal producing a 12% coal slurry that is then transported to two classifying cyclones that then separate the slurry into two types. The larger type is dewatered and discharged as clean coal.

Engineers used a pump systems approach to determine how to improve the performance of the entire system, rather than just component parts and tested their recommendations on one of the six similar pumps that operate the system, to determine the effectiveness of the recommendations without incurring great cost. The solution suggested by engineers and then implemented had several components. First, a smaller pump with properly sized casing that matched system requirements was used. The original motor was replaced with a more efficient model and the motor slide belt was also replaced. Finally, the V-belt drive was serviced (to prevent corrosion and set the proper tension).

The systems approach was successful and it was determined that, when all six pump systems at the Randolph Coal plant are improved, annual savings will be 523,000 kWh/$31,000.

<u>Examples from Agriculture and Irrigation</u>

U.S. agriculture relies heavily on pump systems for irrigation. Experts and practitioners within the industry have found that the specific context of each pumping system—not merely its components—affects the efficiency of the system. The examples below demonstrate a pump systems approach to achieving efficiency improvments in pumping system. It is important to note that, although the expression "pump systems efficiency" is not a term that is used in these cases, experts in agriculture have arrived at the same principle on their own, based on their hands-on experience. This fact is an even stronger argument for the necessity of implementing a systems approach for efficiency improvements.

1) Dakota Aquifer in Kansas

The Kansas Geological Survey's first annual report (1990) on the Dakota Aquifer Program found that multiple factors affected the amount of energy used in pumping the aquifer for agriculture irrigation. They found that "Depth to water, pumping depth, pressure developed in the transmission lines, and efficiency of the pumping plant all affect energy use in the production of water" (MacFarlane et al 1990:8). And the high rates of energy use were affected by: "deeper pump settings, higher system pressures, and lower pumping-plant efficiencies" (MacFarlane et al 1990:8).

2) Center for Irrigation Technology, California State University at Fresno

CSU's Center for Irrigation Technology, which is targeted towards agriculture in California, gives an extended summary regarding pump efficiency. They administer an "Agricultural Pumping Efficiency Program" for the agriculture industry of California and explain:

The first part of the program's educational message is to know how to specify an efficient pump. There is no single "most efficient pump" for all conditions. Specifying an efficient pump depends largely on correctly identifying the required operating conditions (the required combination of flow rate and pressure). Also important is recognizing when the required operating conditions are likely to change. However, recognize that **the overall pumping plant efficiency depends on three factors:**

1. Power plant efficiency - how efficient the electric motor or engine is in using input energy (either electricity or liquid fuel).
2. Transmission efficiency - losses in drive shafts or v-belts, bearings, etc.
3. Bowl efficiency - the efficiency of the pump itself in converting brake horsepower to water horsepower.

There are also many other aspects to consider since the prime goal is lowest (lifetime) cost, such as: • First cost vs. operating costs • Reliability • Serviceability (fast response from supplier) • Other factors (required payback, borrowing capacity, experience, etc.) (Center for Irrigation Technology: Summary).

<u>Examples from Water and WasteWater Treatment</u>

Water and wastewater treatment in the U.S. uses an average 50,000 GWh of electricity per year—a staggering 1.4% of all the electricity consumed in the U.S.[1] Pumps systems represent 80% of the electricity used in water and wastewater treatment. As mentioned in HI's letter to the DOE (dated September 16, 2011), the potential for energy efficiency improvments in pump systems is concentrated in specific industrial areas and water/waste-water is one sector where the potential for improvements are higher than the general average. Based on the studies represented here, the potential for energy efficienct improvements via a pump systems approach ranges from 15 – 42% for this sector alone, with a payback period ranging from 4 – 5.4 years.

1) Case Study: Trumball, CT
U.S. Department of Energy – Energy Efficiency and Renewable Energy
Industrial Technologies Program – Best Practices

At a glance:
- Sewage Station Pumping System

[1] See the American Council for an Energy Efficient Economy for more information.
http://www.aceee.org/topics/water-and-wastewater

- Systems Analysis Conclusion: Add small pump and modify system control scheme

- Results: 31,900 kWh/year reduction in station energy consumption from 72,500 kWh/year (a 44% reduction); $2,400 in savings
- Implementation cost: $12,000
- Payback period: 4 years

The Town of Trumball, CT, with a population of 32,000, operates 10 sewage stations that transport sewage to a main lifting station, which then pumps the sewage to a treatment plant in Bridgeport. The Reservoir Avenue Pump Station in Trumball, built in 1971, handles approximately 0.34 million gallons of raw sewage per day, consuming approximately 72,500 kWh of electricity annually at a cost of $5,495.

Engineers took a systems approach to determine how to improve the efficiency of the entire system rather than focusing on individual elements. The solution that was suggested and implemented was the installation of a smaller pump that could handle the same volume as the original pumps during non-peak periods. The smaller pump had a lower outflow rate than the larger pumps, thus reducing friction in the piping and reducing the amount of energy consumed. Additionally, the existing pump speed control was eliminated, allowing the motors that power the older pumps to run at a higher RPM, with trimmed impellers. The older pumps are still used at peak inflows, those greater than the handling capacity of the smaller pump.

The total energy saved by the new pump and process was 31,875 kWh per year (a reduction of 44%). Moreover, the modifications reduced cleaning and maintenance requirements of the system as well as the control subsystem's maintenance requirements, reducing the labor needs of the station. Lastly, the expected life of the operating equipment and electrical switch gear also increased.

2) Case Study: Milford, CT
U.S. Department of Energy – Energy Efficiency and Renewable Energy
Industrial Technologies Program – Best Practices

At a glance:

- Sewage Station Pumping System
- Systems Analysis Conclusion: Add small booster pump
- Results: 36,096 kWh/year reduction in station energy consumption from 240,000 kWh/year (a 15% reduction); $2,960 in savings
- Implementation cost: $16,000
- Payback period: 5.4 years

The City of Milford, CT, with a population of 48,000, operates 37 sewage stations that transport more than 7 [sic] million gallons of raw sewage each year to the city’s two sewage treatment plants. The Welches Point pump station in Milford, built in 1963, is a medium-sized plant which handles approximately 750 million gallons of raw sewage annually, consuming an estimated 240,000 kWh of electricity annually.

In order to determine the efficiency of the pumping system at Welches Point, engineers evaluated volume flow, operating times, and energy use. The overall system efficiency was rated at 73 percent. They determined that reducing pump capacity would significantly reduce energy consumption. The solution that was suggested and implemented was the installation of a small booster pump. A small booster pump was found to save energy because larger pumps use more energy as they operate at higher outflow rates. The higher outflow rate increases friction in the piping, which requires more energy to be consumed to pump each gallon. Adding a small booster pump allowed the system to operate a reduced outflow rate, reducing the electricity consumed.

3) Case Study: California
(See Thompson et al 2011)

At a glance:

- Municipal Wasterwater Treatment, 2006
- Systems Analysis Conclusion: Shift treated effluent pumping to non-peak periods, divert wastewater to storage ponds
- Results: Pump systems peak energy demand reduced by more than 30% (204-300 kW)

In 2006, as part of a research study into Open Automated Demand Response (OpenADR) applications in California industry—with the goal of improving the reliability of the electric grid and lowering electricity use during periods of peak demand—the Public Interest Energy Research Group (PIER) Demand Response Research Center (DRRC) at Lawrence Berkeley National Laboratory chose to focus on municipal wasterwater treatment facilities because they are energy-intensive and have significant energy demand during utility peak periods. Estimates of energy use in water and wastewater treatment range from 75,000 to 100,000 GWh annually for the United States and loads at treatment facilities are expected to increase by 20 percent over the next decade.

The study further narrowed its scope by focusing on a municipal wasterwater treatment facility in Southern California, where the DRRC conducted a submetering study, which revealed that the pumping systems in the treatment facility offered the greatest potential for energy use reduction.

By pumping treated effluent to the ocean during off-peak hours and diverting wastewater to effluent storage ponds, electricity demand tests revealed an average reduction of 204 kW (36 percent of pump load) during peak periods and an overall 300 kW reduction. That is to say, by coordinating the pumping system with utility peak periods, energy demand was diminished.

This is an example of effectively coordinating pump usage with a local utility. Application of end-user based pumping solutions and improvements with utility based demand supply management programs can accelerate access to latent energy savings potential in this and other sectors. Further, more widespread engagement of electric power utilities, and their representative associations and public utility commissions in an oversight capacity, could stimulate energy savings associated with rebates/incentives associated with systems benefits charges.

Example from Food and Beverage Industry

Case study of G. Heileman Brewing Company
U.S. Department of Energy – Energy Efficiency and Renewable Energy
Industrial Technologies Program – Best Practices

At a glance:

- Glycol Cooling System, 1996-8
- Systems Analysis Conclusion: Reduce diameter of pump impeller, fully open discharge gate valve
- Results: kWh/year reduction in energy consumption from kWh/year (a 50% reduction); $19,000 in savings
- Implementation cost: $1,500
- Payback period: 1 month

Stroh Brewing Company purchased G. Heileman Brewing Company in 1996 and as part of the agreement, took over Heileman's five breweries, including the La Crosse brewery in Wisconsin. Engineers evaluated the performance of the plant's glycol cooling pump system and offered three options for increasing the efficiency of the cooling system: (1) trimming the pump impeller, (2) installing a new pump that matched the existing system, and (3) installing a new pump with a variable speed drive. The first option was deemed most cost-effective and took only 15 hours to complete. The smaller motor reduced electricity demand by more than 50 percent for an annual consumption rate of 473,000 kWh (where it was originally 981,000 kWh).

DOE's and U.S. Experts' Pump Systems Approach Applied in China

The pump systems approach to efficiency improvements advocated by energy experts in the U.S. has had traction in China.

Case Study: Shanghai New Asiatic Pharmaceuticals Company, China
(See Tutterow et al 2004)

At a glance:

- Shanghai New Asiatic Pharmaceuticals Company (SNAPC), 2004
- Systems Analysis Conclusion: installing two new pumps, applying variable speed control, cleaning the piping system.
- Results: 1.09 million kWh/year reduction in energy consumption, $80,000 savings.
- Implementation cost: $145,000
- Payback period: 1.8 years

SNAPC is a large facility that produces over 120 different pharmaceutical products. About 13% of the plant's electricity consumption (more than 2 million kWh/year out of about 17 million kWh/year) is consumed by the plant's cooling water system. Based on a systems approach, engineers determined that the overall efficiency of the pump system was 37%. American and Chinese experts suggested the following plan, which was implemented: installing two new pumps, applying variable speed control, cleaning the piping system.

Enforceability:

As HI noted in its letter of July 13, 2011 it is HI's opinion that should DOE proceed with a pump efficiency rule-making, over our objections, the United States will also have to establish – at considerable additional cost to U.S. taxpayers and the U.S. government – the means of enforcing compliance of a new pump efficiency rule-making with foreign imports of pumps and pumps integrated into pumping systems. Failure to do so will place U.S. pump manufacturers on an un-level playing field. Non-U.S. competitors will have an un-fair advantage.

We would ask the U.S. DOE and the U.S. Congress how such an enforcement mechanism will be created and sustained to protect the pump industry and its employees in the United States?

The pump industry represents an estimated 35,000 employees associated with these firms in the U.S. (See U.S. Census Bureau 2007). Subjecting the industry to an un-level playing field for failure to adequately enforce a DOE pump efficiency rule-making should not be an unintended consequence of this effort.

The Hydraulic Institute Board of Directors, on behalf of its 65 pump manufacturing companies and division members, believes that a DOE rule-making on pump efficiency will also have an adverse consequence on the viability of these companies, should enforcement be ignored.

We do, however, favor a pump systems approach and are willing to work with the DOE and the energy efficiency community to develop sensible alternatives, with substantially greater pumping systems energy efficiency improvements with economic benefits to all parties.

In Summary:

HI offers case studies as examples of the points made in our previous two letters. The greatest opportunities for pump efficiency improvement and energy savings is in optimizing the pumping system…including designing pumping systems correctly from the beginning.

HI has, since 1917, written pump standards that are widely recognized authoritative sources of information on pump definitions, installation, operation and maintenance and test procedures. There are many other unique characteristics that affect pump performance including such matters as preferred and allowable operating region, pump vibration and pump intake design that we also address in standards. HI pump standards, when followed, offer pump end-users and engineering consulting firms that design pump systems professional guidance based on the collective experience of the pump industry. We are currently working collaboratively on an AWWA/WRF project on improving the efficiency of water station design. HI is open to suggestions for improving its standards and guidelines. We welcome further participation of interested parties.

We are also working on new areas, such as the creation of a pump systems standard – and invite the participation of appropriate experts from outside the pump industry to consider joining us in this important endeavor. HI has sought out experts already from engineering consulting firms

who now affiliate with us as "Standards Partners," adding their unique perspectives and knowledge into our standards-writing process. We remain open to more participation and input.

While we won't elaborate further on the many references we've made to DOE's own studies, reports and publications on this subject in this and our previous two letters, the evidence is overwhelming that the nation's energy usage associated with motor-driven pumping systems could most significantly benefit from a number of parties working together to optimize those systems. This has been DOE's approach for the past two decades, and according to DOE's own studies the evidence is overwhelming that this is the right path to follow.

We wrote a comprehensive book on "Optimizing Pumping Systems: A Guide for Improved Energy Efficiency, Reliability and Profitability" and built a day-long training course on "Pumping Systems Optimization: Energy Efficiency and Bottom-Line Savings." We look forward to leveraging our education/training resources cooperatively with DOE.

We've explained that HI has established the Pump Systems Matter 501(c) 3 organization to address education/training of pump end-users, engaging electric power utilities, serves engineering consulting firms, pump and supplier OEMs and interested associations, state energy offices, and others in enhancing pumping systems efficiency and energy savings.

We offer comprehensive resources on these subjects on our three websites: www.Pumps.org, www.PumpSystemsMatter.org and www.PumpLearning.org. We'd welcome DOE's support to encourage more pump end-users, engineering consulting firms and others to take full advantage of these invaluable resources.

HI welcomes further expansion of our working relationship with DOE along these avenues to economically improve pump systems efficiency for pump users throughout the U.S.

Sincerely,

Robert K. Asdal
Executive Director

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