May 2, 2013

Via E-Mail: Pumps2011STD0031@ee.doe.gov

Ms. Brenda Edwards
U.S. Department of Energy
Building Technologies Program
Mailstop EE-2J
1000 Independence Ave., S.W.
Washington, DC 20585-0121

Re: Submission of Comments on Framework Document for Commercial and Industrial Pumps; Docket EERE-2011-BT-STD-0031; RIN 1904-AC54

Dear Ms. Edwards:

The Hydraulic Institute, Inc. (HI) submits the following comments in response to the Department of Energy's (Department) Framework Document for Commercial and Industrial Pumps, and the Department's notices of February 1, 2013 soliciting comments (78 Fed. Reg. 7304) and February 21, 2013 (78 Fed. Reg. 11996), extending the comment deadline to May 2, 2013.

The Hydraulic Institute, which was established in 1917, represents the pump manufacturing industry in North America. HI is a recognized authority with regard to pumps and pumping systems and is an American National Standards Institute (ANSI) accredited standards developing organization. HI's membership includes 105 pump manufacturers and leading suppliers to the pump industry. Further to the comments that we provided on February 20, 2013 during the Framework public meeting, HI welcomes the opportunity to submit additional comments in response to the Department's Framework Document.

Recommendations

HI appreciates the Department's recognition of the complexity of the pump industry and the technical knowledge that HI has already provided to the Department and energy efficiency advocate partners in productive discussions that have been underway for nearly two years. Those discussions have been undertaken in an effort to develop a consensus that best serves the statutory goals of adopting energy conservation standards that achieve meaningful efficiency gains while being technologically feasible and economically justified. Thus, HI reiterates its commitment to working with the Department and efficiency advocates to achieve these objectives.

HI's comments herein provide responses to the questions raised in the Department's Framework Document, as well as further information that will be useful to the Department's analysis. In this regard, HI offers the Department the means to achieve the greatest energy savings by a balanced, two-prong approach, that reduces the 41 TWhr/yr (see Appendix B for details) energy consumption in the United States related to pumping, doing so on the basis of:

A. Minimum Efficiency Index (MEI), whereby the U.S. should align with current standards that have been adopted in the European Union (EU), by eliminating from the market the most inefficient pumps based on a statistical methodology validated in Europe and prove the MEI methodology will work in the U.S. The analysis done by HI is documented in this letter (see pages 6, 7, 8, and 9).

B. Extended Product (EP), whereby the greatest energy savings are achieved by optimizing the efficiency of the combination of pump, driver and control technologies. The EP Approach is a methodology for calculating the Energy Efficiency Index (EEI) of the Extended Product using load profiles. Pumps included in an extended product package (EP) shall be certified to meet MEI (0.10) minimum efficiency levels.

To achieve the greatest energy savings that are technologically feasible and economically justified, these two methodologies should be utilized together.

As the Hydraulic Institute has pointed out in its previous communications to the Department, in HI's letters of July 11, 2011 and September 16, 2011 (which we incorporate by reference herein), pumps are inherently efficient machines. The HI approach we are recommending, however, recognizes that within the population of pumps sold into the market to serve a particular Flow Rate (Q) and at a Specific Speed (N_s) there is a range of pumps with different Best Efficiency Points (BEP). Given that this is the case, to improve the entire population of pumps sold in the marketplace, as recommended by the Hydraulic Institute, it is possible using the MEI approach to eliminate the least efficient pumps by type category. Doing so in a manner consistent with what has been adopted in the EU provides a logical and consistent path forward for U.S. manufacturers who have international operations and who export product from the U.S. to markets worldwide.

Significantly greater energy savings can be achieved using the Extended Product Approach (EP). In HI's previous communications to DOE in 2011, as well as in meetings with DOE consultants during 2012, HI pointed out that in multiple DOE studies (cited in the RFI published in the Federal Register on June 13, 2011) the cited data points repeatedly point to the fact:

1. The greatest gains in energy savings, in absolute numbers, are to be found in pump systems efficiency improvements and not in improvement of the efficiency of the pump component itself.

2. The most cost-effective gains in energy savings are to be found in pump systems efficiency improvements.

The Department has been a leader in advocating for a *systems approach* to energy efficiency, doing so through the DOE's Energy Efficiency and Renewal Resources programs and initiatives. Similarly, HI through its standards, guidelines and Pump Systems Matter (PSM) organization has long advocated for pump systems optimization, and HI/PSM offer extensive resources, a guidebook and training on this subject.

Beyond these overarching principles HI submits the following key recommendations, based on HI's extensive knowledge and analysis of commercial and industrial pump production, process, markets, and pump and pumping systems technology.

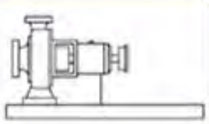
1. Alignment with the European Union's approach on scope to maximize effective results and trade harmonization

The Hydraulic Institute advocates the pursuit of pump products that will lead to the reduction of energy consumption in the United States. Analysis of the U.S. pump market confirms that the variety of existing products and numerous market segments, each with unique requirements, is wide and complex as similar designs cross multiple market segments and are applied differently, resulting in a large number of unique product variations.

In order to capture the largest population of pumps that cost-effectively produce the greatest energy savings, HI recommends aligning with the European Union directive EU No. 547/2012. The EU directive focuses on non-engineered/non-specialized pumps, in standard design, applied in clean water only applications for the broadest scope.

The pump types covered by the EU Directive 547/2012 include the following types of pumps: flexibly coupled horizontal frame and foot-mounted centrifugal (ESOB, equivalent to OH0 and OH1); close coupled single stage (end suction) (ESCC, equivalent to OH7); flexibly and rigidly coupled vertical, in-line centrifugal (ESCCI, equivalent to OH3 and OH4); close coupled vertical, in-line centrifugal, in-line casing diffuser (MS, equivalent to VS8); and close coupled, submersible diffuser centrifugal, 4" or 6" bowl diameter (MSS, equivalent to VS0). These pump types are summarized in the following table:

PUMP TYPES

	EU Nomenc.	ANSI/HI Nomenc.	Description
	ESOB	OHO	Flexibly Coupled Horizontal, Frame Mounted Centrifugal
		OH1	Flexibly Coupled Horizontal, Foot Mounted Centrifugal
	ESCC	OH7	Close Coupled Single Stage, End Suction
	ESCCI	OH3	Flexibly Coupled Vertical, In-Line Centrifugal
		OH4	Rigidly Coupled Vertical, In-Line Centrifugal
	No eqv.	OH5	Close Coupled Vertical, In-Line Centrifugal
	MS	VS8	In-line casing diffuser
	MSS	VSO	Close Coupled, Submersible Diffuser Centrifugal 4" or 6" Bowl Diameter Only

Included in the scope of the above table are pump products defined as the following:

1- Only standard pumps of non-engineered/non-specialized design

2- Only clean water, (including grey water)
3- 26 GPM and greater, up to a maximum 459* feet Total Head (H)
4- HP range 1-200
5- Pumps designed to operate in a temp range from -10° C to +120 ° C

*Note: 295' is incorrectly stated as the maximum head in the DOE Framework document (see page 8 for incorrect references. Should be 459' H). Pumps and liquids specifically excluded from the scope: Positive Displacement; Fire Pumps; Self Priming & Waste Water (no solids handling) and Circulators.

The specific advantages of this approach to the scope of coverage are that it:

a. Offers the greatest breadth of unit volumes for pumps in the marketplace.
b. Offers the greatest possibility of energy savings.
c. Offers global alignment with EU Directive 547/2012.
d. Offers the most expeditious path forward for implementation. This is particularly relevant as the pump market is international in scope and manufacturers are already moving toward compliance with the EU's Directive.
e. Supports Executive Order #13609 (May 1, 2012), directing federal agencies to seek international regulatory cooperation and avoid imposing unnecessary costs through inconsistent regulation.
f. Aligns and supports the EISA (Energy Independence and Security Act) based on motor ranges with defined National Electrical Manufacturers Association (NEMA) efficiencies with pumps.

2. Consistency with the EU's adoption of a Minimum Efficiency Index

For the same reasons as noted above, HI recommends that the Department adopt the Minimum Efficiency Index (MEI) that is central to the EU 547/2012 Standard as proposed in EU Lot 11.

The MEI equation should be used with the EU coefficients for a, b, c, d, and e as set forth in the Department's Framework Document at [Appendix C, p. 110, p. 116, et al.], remaining consistent with the EU Directive, but with updating of the EU's coefficient "C" and the Department's coefficient "f" [equivalent to the "C" value in the EU regulations] to reflect the proper efficiency cutoff values that result in specified minimum efficiency thresholds, based on HI's more current data.

Seventeen member companies participated in a survey that HI conducted, soliciting data on 2,124 pump models. This database is roughly statistically equal to the size of the European database that was used to create the European Lot 11 Standard (2,390 pumps) (Europump study). The European database was the basis for the equation that is the backbone of the Minimum Efficiency Index (MEI) Standard. The equation describes a 3-dimensional quadratic surface, representing the minimum efficiency threshold of pumps that can be sold in the EU market. Minimum efficiency thresholds ($\boldsymbol{\eta_{Bot}}$) are established in using the same equation as developed for the EU pump efficiency regulation:

$$\boldsymbol{\eta_{Bot} = -11.48x^2 - 0.85y^2 - 0.38xy + 88.59x + 13.46y - C}$$

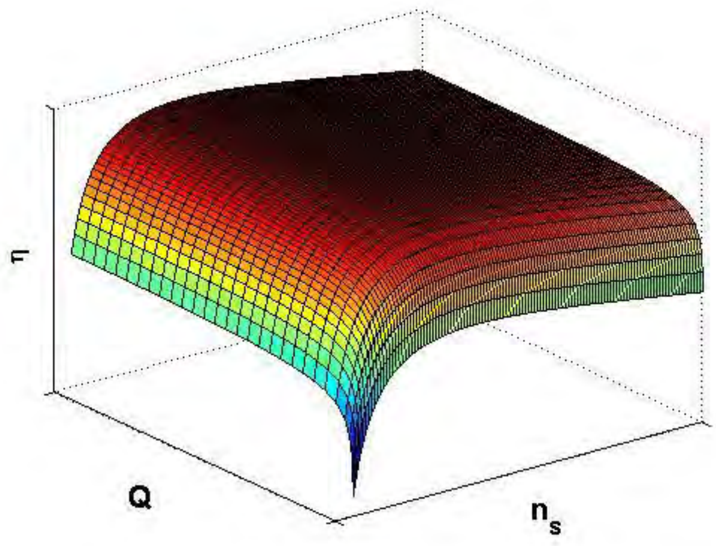


Figure 1: 3D Plot of the MEI Equation.

The plot can be moved up and down vertically along the efficiency (η) axis by changing the constant "C" at the end of the equation. It is this "C" factor that allows the equation to be fitted to the various pump types and different operating speeds.

HI urges that the "C" coefficient alone be used to modify the efficiency cut off level (thresholds) for each MEI level, as was done in the EU. HI recognizes, based on its analysis, that better data fits could be obtained through the use of changing the "a" through "e" coefficients in the three dimensional quadratic polynomial equation or that completely different forms of equation may provide more precise data fits. HI does not, however, believe that the complexity of these options is warranted and submits that it will not yield significant improvement in the ability of the equation to represent a cut off level for pump efficiency. Further, doing so places significantly greater regulatory burdens on the U.S. pump manufacturing industry, restricts export opportunities to markets and countries that adopt the EU standard and/or regulation, and creates increased compliance issues for imported pump products that are subject to different efficiency metrics while only serving to disadvantage U.S. pump manufacturers and their competitive position globally.

The purpose of this equation is not to precisely predict the efficiency of pumps in a certain product class. The equation was created as a tool to allow regulators to remove the bottom X% of pumps from the marketplace. These pumps due to their low efficiency would require the highest level of energy input per volume pumped in that equipment class. Removing them from the market place would reduce the amount of power being consumed by the remaining population of pumps being sold into the marketplace.

Due to a limited data set for some pump types, a significant dead band exists, such that when changing the "C" coefficient no subsequent change in the percentage of pump failures is observed. This is a function of the small number of models available in that particular pump type. If more models for that pump class were included, should they exist in the marketplace, it would again change the equation that fits that data. The problem with trying to develop a precise data fit to some of these pump types is that the limited number of models available in that pump type, along with the spread of the data, lead to a level of uncertainty making a precise data fit unlikely. Further, complicating the equation will not serve to improve this precision and will make uniform implementation of the regulation more difficult.

As noted above, the Europump study was based on a population of 2,300+ pumps and the HI survey of U.S. pump manufacturers was based on a population of 2,124 pumps. The HI study was based on the same scope of equipment specified in the EU directive. In the DOE Framework document, on page 8, the Department states that a total of 27,000 pump types were analyzed. HI questions the validity and source of this number, which does not appear to match the proposed scope of the pump efficiency rule-making. HI is aware that its member survey did not absolutely capture the complete marketplace. However, by comparison with DOE's reference to 27,000 pump types, HI is confident that the market is not 13 times larger than the 2,124 pumps that HI identified in the pump companies that were surveyed. This conclusion is strengthened by the fact that most of the major corporations identified in the DOE Framework document are represented in the HI survey.

HI's data analysis sought to ascertain whether U.S. pump industry failure rates match European failure rates. The European "C" factors were used to determine what failure rates were found for the HI survey universe. Aggregate failure rates were close to the 10% and 40% failure rates, as predicted by the equation for "C" values of 0.1 and 0.4, respectively. The survey of 17 manufacturers, however, yielded far different results in some of the pump categories. A failure rate for each pump category was developed and the results are shown in Table 1 below. HI believes this anomaly is due to the fact that failure rates for all of the categories combined in this initial analysis, which was based on averaging, would be different when each pump type was compared individually within its cohort group.

Table 1: North American Pump MEI Failure Rates using European "C" Values.

Pump Type	European MEI=0.1 "C" Value	North American Database Failure Rate MEI=0.1	European MEI=0.4 "C" Value	North American Database Failure Rate MEI=0.4
ESOB 4-Pole	132.58	0.1607	128.07	0.4363
ESOB 2-pole	135.60	0.1034	130.27	0.4115
ESCC 4-Pole	132.74	0.0633	128.46	0.2454
ESCC 2-pole	135.93	0.0599	130.77	0.2318
ESCCI 4-Pole	136.67	0.0288	132.30	0.0905
ESCCI 2-pole	139.45	0.0216	133.69	0.1439
MS 4-Pole	134.45	0.3421	130.38	0.5526
MS 2-pole	138.19	0.0306	133.95	0.1633
MSS 2-pole	134.31	0.1731	128.79	0.5577

To evaluate the same pumps again, on the basis of varying only the "C" factors in the equation, HI was able to obtain the respective 10% and 40% failure rates for the U.S. pump data. The "C" factors were changed to obtain the anticipated failure rates, and the data was then consistent with 10% and 40% failure rates. (See Table 2 below).

Table 2: North American Pump MEI Failure Rates using Modified "C" Values

Pump Type	Modified "C" value for North American Data. MEI=0.1	NA Database Failure Rate MEI=0.1	Modified "C" value for North American Data. MEI=0.4	NA Database Failure Rate MEI=0.4
ESOB 4-Pole	134.39	0.1002	128.48	0.4008
ESOB 2-pole	136.15	0.1034	130.55	0.4033
ESCC 4-Pole	131.5	0.1003	126.77	0.4011
ESCC 2-pole	134.04	0.1068	128.77	0.4023
ESCCI 4-Pole	131.75	0.0988	128.70	0.4033
ESCCI 2-pole	134.95	0.1007	129.77	0.4029
MS 4-Pole	140.87	0.1053	134.00	0.3947
MS 2-pole	135.00	0.1020	127.00	0.3980
MSS 2-pole	135.63	0.0962	131.15	0.4038

Based on the differences in failure rates and "C" factors, HI determined how well the MEI Equation used in the EU standard applied to the U.S. data set. Each data set was plotted and visually compared to the shape of the MEI Equation's 3D surface plot.

A quantitative analysis of the goodness of fit for the equation is difficult because the equation is not meant to represent a fit to the data, but instead a threshold value that X% of the data should be above. Even plotting a MEI=0.5 with 50% of the data points above and 50% of the points falling below the surface does not necessarily represent the best fit of the equation to the data due to the non-uniform distribution of the data set.

Other equations were found that fit the data better, but they would be complicated to modify for the multiple pump categories as well as the 2 and 4 pole operating speeds. The variation of the constant "C" in the MEI 3-dimensional quadratic equation represents a good data fit as well as a simple way to adapt the equation for various categories and operating speeds.

The modified "C" values to fit the North American data represent different efficiency thresholds that the U.S. pumps would need to meet compared to their European counterparts. The percent efficiency difference for each pump type is shown in the table below (Table 3). The values in parenthesis are values where the European efficiency was greater than the North American efficiency.

Table 3: Difference in MEI Threshold Efficiencies Using Modified "C" Values in North America vs. European "C" Values

Pump Type	% Efficiency Difference (North American -European) @ MEI=0.1	% Efficiency Difference (North American - European) @ MEI=0.4
ESOB 4-Pole	(1.81)	(0.40)

ESOB 2-pole	(0.55)	(0.30)
ESCC 4-Pole	1.24	1.7
ESCC 2-pole	1.89	2.10
ESCCI 4-Pole	4.92	5.10
ESCCI 2-pole	4.50	3.90
MS 4-Pole	(6.42)	(3.60)
MS 2-pole	3.19	6.90
MSS 2-pole	(1.32)	(2.70)

Based on the analysis that HI has done, the MEI equation is a good fit to both the U.S. and European data. The equation requires the adjustment of the "C" factor to correctly represent the proper threshold efficiencies for the various pump types and appears to be only slightly different for the European and North American data sets. This approach achieves global harmonization of pump efficiency standards and provides a methodology that appears to be both technologically feasible and economically justified.

Significantly, HI believes that the data set collected by DOE and its consultants is unrealistic, and includes many pumps of product classes that are currently regulated by other entities; it would pose a danger to public health and safety if these other pumps were forced to meet efficiency regulations that compromise the mechanical integrity of a pump, contrary to the primary application or purpose of such pumps. Examples include pumps used in such services as chemical processing, oil, gas, fire pumps, etc. Well-established standards for such pumps, including ANSI B.73, API 610 and NFPA 20, address the unique characteristics and service of these pumps – which are not associated with pumping clean water (in the case of ANSI B.73 and API 610) or are focused on reliability needed for fire protection, where such pumps are rarely used, and only in the event of a fire in the case of NFPA 20. In these cases, such pumps would not be used for clean water service for a variety of reasons, not the least of which is the higher cost associated with their unique designs.

One of HI's member companies, Engineered Software (ESI) has asked the DOE consultants a number of questions about "*how data was both collected from PUMP-FLO and how the data was used.*" HI believes that this fundamental question is at the core of the concerns with the methodology and approaches used in the Framework document. It is HI's view that the analytical approach used on the data obtained by DOE consultants is flawed. As ESI noted in its letter to DOE, dated March 11, 2013, "*Based on our review of the Framework Document and our conversation with LBNL, we have the following concerns with regard to the research conducted by LBNL and their conclusions:*

1) *The only point used to validate whether or not a pump fell within the market segment for analysis was Best Efficiency Point (BEP) at max impeller.*

2) *Allowable selection area was not used in the analysis. Allowable selection area is defined by each pump manufacturer for each pump model, and pumps can be selected for operation anywhere within that area.*

3) *Due to the methods used to collect data, 75% and 110% BEP data were interpolated from a curve made up of 5 or less data points not based on actual performance curve data (as*

data was gathered by manually looking at the data sheets). Interpolation on a curve constructed from a limited number of points is prone to error. This data should be gathered explicitly from tested performance points, not interpolated.

4) *The curves in item 3 were not built using actual performance data points, but data that had been rounded and possibly unit converted prior to display. Rounding applied to the source data would result in an additional deviation from catalog data.*

5) *Motor slip at different flow rates along a given curve can result in varying performance. Data used in the analysis may or may not have been normalized to a fixed speed. To determine true bare pump efficiency, any normalization should be accounted for in the data analysis.*"

The data used by HI in the analysis of 2,124 pumps was based on test results of three efficiency points at 75%, 100% and 110% of Best Efficiency Point (BEP) flow. HI methodology is consistent with the EU approach. As noted above, the analysis done by DOE and its consultants used only one point on the pump curve: BEP. One point is not representative of the efficiency of the pump over its operating range – best represented by 75%, 100% and 110% of BEP flow.

As previously communicated to the Department, HI is sharing the data set and analysis of 2,124 pumps, which is made part of and submitted with this letter to substantiate our written testimony that the MEI approach that HI is recommending both works and is statistically valid.

Also, HI believes that the stated possible efficiency gains shown in sections 3.3.1 to 3.3.8 of the Framework document are overly optimistic if being applied to the entire population of pumps subject to an efficiency regulation. These gains may be possible in the very worst of class products, but products with such low efficiencies would hold such a small market share that the impact on overall reduction in energy consumption would be miniscule. Additionally, some of these predicted gains would not meet persistence of savings criteria. HI continues to study the issues of persistence of savings and can provide substantiating input to the Department if that additional industry analysis is deemed to be of further value.

3. Adoption of an <u>Extended Product Approach</u>

HI further recommends that the Department adopt an Extended Product (EP) approach, a methodology that allows calculation of the Energy Efficiency Index (EEI) of an extended product, incorporating load profiles. The EP consists of physical products, such as a pump, driver, and control methods to enable the most efficient operation in response to demand. It consists of a pump (or pumps) driven by an electric motor (or motors) with a closed-loop feedback control system for either:

- Adjustable speeds drive performance of the pump to operate at variable speeds. This arrangement maintains efficient performance of the pump over a broad range of operating load conditions, and should be used in applications with variable operating requirements.

- A constant speed controlled operation. This arrangement can maintain efficient energy usage of the pump in applications with constant operating load.

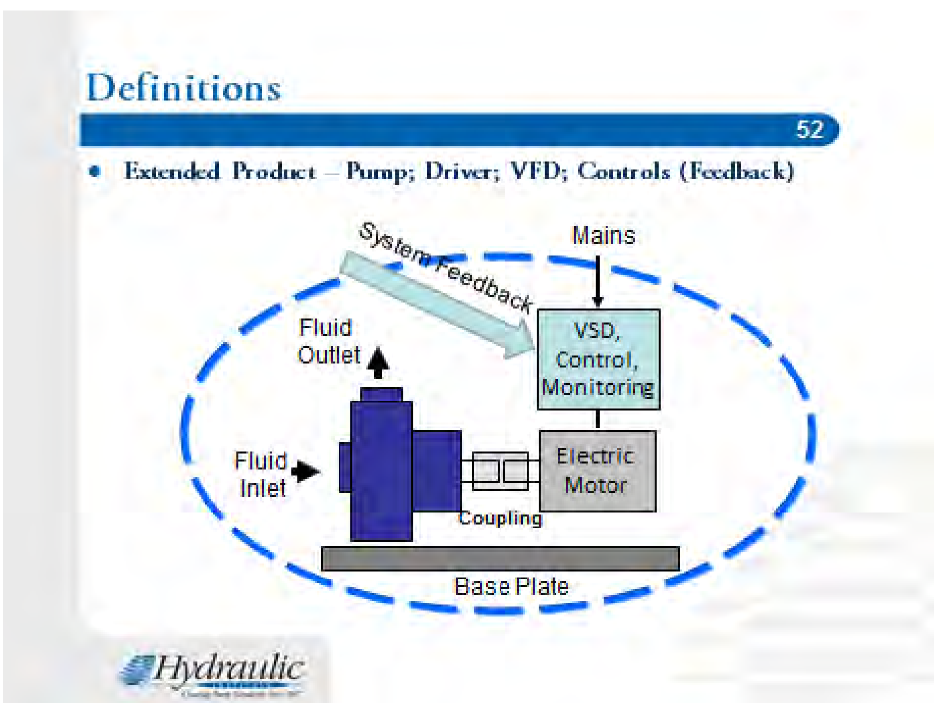
The above-noted definition aligns with the current Europump definition and criteria, and responds positively to the DOE comments, as indicated on page 11 of the Framework document, if a pump and the motor can be considered an EP.

The EP should be used in all pump applications to provide the lowest energy consumption for a load profile. The load profiles envisioned could be Agricultural/Irrigation, Building HVAC, and Water Distribution and Water Boosting. The EP approach can be applied to 100 per cent of the markets for pump applications. HI is not aware of any applications for which an EP should not be recommended.

The energy saved by using the EP approach is significant. For the scope of products for which an "extended product" approach on applications with variable load and low static head applies, the Hydraulic Institute estimates, based on the average load calculations, savings of 9.70TWhr/yr.

When energy savings associated with the MEI approach are combined with the EP approach, HI estimates a savings of 1.90 TWhr/yr for pump savings based on MEI + 9.70 TWhr/yr based on the EP approach for a total of 11.60 TWhr/yr. The ASAP-8/ACEEE-A123 Report estimated pump and pump systems savings of 14 TWhr/yr (by 2035).

As part of its proposal, HI has also agreed to pursue a scheme to label "extended product" water pumps (i.e. a package including the pump, motor, drive, and controls), which could facilitate the increased adoption of products that can provide significant energy savings because purchasers could readily see the larger energy savings available. HI is also considering the potential for developing energy conservation standards for "extended product" water pumps. HI is currently exploring the technical and legal issues associated with this approach with ASAP and energy efficiency advocates.



In the DOE Framework Document, Page 10, 2nd paragraph, the document states "VSDs are best applied to pumps and primarily in applications with variable load and relatively low static head." HI agrees that variable speed drives (VSDs) can provide benefits in systems with variable loads. However, systems with high static head conditions can benefit significantly from controlled systems, such as those using VSDs. The concept of an Extended Product is not limited to systems with relatively low static head.

HI further notes that most pumping systems are uncontrolled and throttled to meet operating conditions. This indicates that there is a large opportunity to save energy by minimizing the throttling using controlled pumping systems, which are defined as Extended Products.

4. Testing, Pump Test Lab Accreditation and Pump and EP Labeling

HI is developing an edited version of the ANSI/HI standard 14.6 for pump testing, which HI submits should be the accepted methodology for the Department's minimum efficiency regulation. Under this testing approach, the manufacturer would self-certify compliance to the proposed minimum efficiency regulatory requirement. HI would conduct annual audits of and certify laboratories to HI 14.6 - DOE (the new HI standard).

All pumps within the scope of the new standard would be labeled with the MEI number certified by the manufacturer, showing the Index Level that the product meets. This approach would allow the buyer and end-use customer to select the most efficient product available.

All extended products (as a package) – pump and motor, or pump, motor, and variable speed drive (VSD) and control that are within the scope of EP products would be labeled with an Energy Efficiency Index (EEI) certified by the manufacturer, showing the EEI that the EP meets. Again, this labeling would allow the consumer to choose the most efficient available product.

In HI's view, these recommendations would produce the greatest energy savings and EP efficiency that are technologically feasible and economically justified. HI and its members have, over the past two years, provided substantial information to the Department on HI's regulatory concerns regarding commercial and industrial pumps. All of HI's previous communications are included, by reference, in this letter. We have stated our concerns, and offered multiple solutions in this regard.

In summary, the MEI approach coupled with an extended product approach, will achieve the greatest energy savings possible in the marketplace. Appendices A and B provide additional information beyond HI statements made during the framework hearing on February 20, 2013.

HI continues to offer its expertise, through its industry standards and guidelines and technical committees, to support a sensible rule that is both technically feasible and economically justified.

Sincerely,

Robert K. Asdal
Executive Director

Appendix A

This section addresses HI's responses to questions raised in the Framework Document and provides additional information that will assist the Department in its rulemaking efforts.

Item 1-1: DOE seeks comment on its proposal to cover only clean water pumps in this rulemaking. (Reference Page 3)

> EU Definition: Clean water means water with a max non-absorbent free solid content of 0.25 kg/m3 and with a max dissolved solid content of 50 kg/m3, provided the total gas content of the water does not exceed the saturation volume. Any additives that are needed to avoid water freezing down to -10C shall not be taken into account.

HI Response: The Hydraulic Institute believes that focusing on "clean water" pumps covers the broadest range of standard design pumps, offers the best opportunity for energy savings and presents the best opportunity to get compliant products in the market quickly.

Based upon the Hydraulic Institute's (HI) analysis of the 2012 European Industrial Forecast (EIF) and the most recent MA333P, Pumps and Compressors report, HI estimates the clean water market in the U.S. to be between $876M and $1,063B in size. The focus on clean water allows for non-engineered/non- specialized pumps, in standard design, which represent the largest unit volume of usage, to be included under the proposed scope.

Item 1-2: DOE requests comment on whether it should rely on a definition of 'clean water' to determine coverage of pumps, as in the EU, or if, instead, the definition of 'clean water pumps' should include physical characteristics that distinguish pumps designed for clean water or exclude pumps designed for other purposes. (Reference Page 4)

HI Response: HI believes that to stay focused on energy efficiency savings, it is best to use a broad descriptor like "clean water pumps" to obtain a uniform standard and then specifically exclude pumps based on application (rather than material of construction).

Item 1-3: DOE seeks comment on the list of physical differences that may exist between pumps designed for clean water and pumps designed for other substances. Specifically, (1) is the list accurate and exhaustive, (2) do the differences impact efficiency, and (3) do the differences have increased cost? (Reference Page 4)

- metallurgy,
- Sealing (or sealless) technology (depending on pressure and temperature limits)
- impeller type (*i.e.,* slurry, vortex, recessed impeller),
- replaceable wear plates,
- barrel casing, and
- center-line support.

HI Response: The members of the Hydraulic Institute would like to confirm that:

1.) No, the list is not accurate and exhaustive.
2.) Yes, the differences definitely impact efficiency.

3.) Yes, the differences will definitely lead to an increased cost.

The Hydraulic Institute will elaborate further in additional information provided in this summary response to Item 1-4, 1-5, 1-6, and 1-7 as follows:

Item 1-4: DOE seeks comment on whether it should consider standards for pumps designed for non-water liquids that contain limited solids in this rulemaking. DOE is specifically interested in ANSI chemical process pumps, API 610 pumps, seal-less (magnetic drive, canned, or cantilever) pumps, sanitary pumps, refrigerant pumps, and general industrial pumps. When suggesting pump types for which standards should not be considered, please be specific as to the reason why. (Reference Page 4)

HI Response: Pumps designed for non-water liquids should be exempt from the efficiency regulations because they are typically designed to comply with other key requirements such as safety and reliability. For example, to assure better safety and reliability, these pumps could be designed with wider internal clearances, oversized shafts and oversized bearings. All of these could lead to reduced efficiencies. The following are some more specific details about ANSI and API pumps:

ANSI Pumps - These pumps are designed for Chemical process services as per ANSI/ASME B73.1 Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process. Such pumps are designed for chemical applications and thus include many specific features such as open impellers for liquids with solids present. These pumps also include complex sealing arrangements for hazardous chemicals. The ANSI B73.1 specification requires specific physical dimensions of the pump. ANSI pumps are designed for high temperatures (500F+) well above the 248F limit in the DOE proposal. These pumps are also designed for high levels of reliability and safety due to the nature of the liquids the pump is designed to handle. These pumps are typically offered in a wide variety of materials that are not offered by water pumps. ANSI pumps have larger bearings to handle the higher pressures developed by these pumps. ANSI pumps typically have open impellers with adjustable clearances to ensure a high efficiency over the life of the pump due to wear and corrosion. It may be helpful to engage the ANSI B73 committee to better understand the features required of pumps that comply with B73 specification. Due to all of the above, ANSI pumps are more expensive to produce and do not compete directly with clean water pumps.

API Pumps are Centrifugal Pumps are designed for Petroleum, Petrochemical and Natural Gas Industries as per API Standard 610 ISO13709. This International Standard specifies requirements for centrifugal pumps, (including pumps running in reverse as hydraulic power recovery turbines), for use in petroleum, petrochemical and gas industry process services. The standard covers a wide and comprehensive range of product categories which are designed for use on a wide range of processes and applications. The requirements of this standard have been derived by global industry experts with focus on safety and reliability. Certain categories of API pumps are designed for process conditions with temperatures up to 800 F. These pumps are also designed for high levels of reliability and safety due to the nature of the liquids the pump is designed to handle. Such pumps are typically offered in a wide variety of materials that are not offered by clean water pumps. In high energy applications pumps are often custom engineered to optimize safety, performance and energy efficiency. Due to all of the above, API pumps are more expensive to produce and do not compete directly with clean water pumps.

Item 1-5: DOE requests comment on whether any design changes made to standard clean water pumps would carry through to pumps designed for other applications. (Reference Page 4)

HI Response: HI does believe that it is possible that a small number of design changes to standard clean water pumps would carry through to pumps designed for other applications. The reason is that some pump manufacturers have modular designs that could span models used in other applications. Otherwise, designs in alternate applications are very dependent on requirements for efficiency, safety and reliability.

Item 1-6: DOE seeks comment on its proposal to consider standards for Rotodynamic pumps and not positive displacement pumps. In particular, DOE requests comment on the extent of the overlap between Rotodynamic and positive displacement pumps and whether there are certain categories of Rotodynamic pumps (pump types and ranges of flow and specific speed) for which positive displacement pumps could be a direct replacement. (Reference Page 4)

HI Response: The Hydraulic Institute wishes to confirm that positive displacement pumps represent a small percentage of the overall pump market and are generally used for niche applications such as viscous or shear-sensitive liquids. Because Positive displacement and Rotodynamic pumps provide different application solutions, economic issues generally prevent overlap of these two pump designs.

Item 1-7: DOE seeks comment on its proposal to consider standards for pumps not covered in the EU. (Reference Page 5)

HI Response: Analysis of the U.S. pump market confirms that the variety of existing products and numerous market segments, each with unique requirements, is too wide and complex to make coverage of the full breadth of types realistic, as similar designs cross multiple market segments and are applied differently resulting in a large number of unique product variations. In order to capture the largest population of potential energy savings, HI recommends aligning with the European Union directive EU No. 547/2012. The EU directive focuses on non-engineered/ non-specialized pumps, in standard design, applied in *clean water* only applications for the broadest scope.

Expansion beyond the original EU directive parameters will add complexity and cost to the task of the manufacturers and create a more significant financial burden without commensurate added benefit. Specifically, with respect to Double Suction Pumps and Vertical Turbines (beyond 6" bowl assemblies) – HI recommends that these two models be excluded from the first phase of the DOE rule to stay in alignment with EU specifications and avoid undue financial burden on pump manufacturers. Double Suction Pumps and Vertical Turbines (beyond 6" bowl assemblies) could be added in a subsequent Phase II addition to capture additional energy savings (exception to Double Suction Pumps used in Fire Pump applications). Specifically, fire pumps operate in a stand-by mode so they do not consume energy. They are also covered under existing performance, listing and operation standards (UL, FM and NFPA) already globally accepted by insurance regulators. Any attempt to redesign would be a very costly and time consuming endeavor if the DOE were to include them in energy efficiency standards.

Item 1-8: DOE seeks comment on its development of pump equipment categories and whether these categories provide an appropriate basis for developing equipment classes. (See section 3.2.) (Reference Page 6)

HI Response: See Item 1-7 above.

Item 1-9: DOE seeks comment on whether standards for any additional pump categories should be considered. In particular, DOE is interested in pump categories that may have significant potential for energy savings. (Reference Page 6)

HI Response: In HI's view, some additional categories may have the potential for energy savings, but are poor candidates due to economic constraints such as: cost to re-design, engineering constraints, market acceptability to changes, etc. HI's recommended approach is meant to generally align with the EU's scope and is designed to focus on off-the-shelf pumps and to exempt pumps with low flow and fractional horsepower that have little opportunity for efficiency improvement and energy savings, thus maximizing the overall benefit for a reasonable cost.

***Item 1-10**:* DOE seeks comment on the pump types as described by ANSI/HI nomenclature that fall into the equipment categories set forth in Table 1.1. For example, pump type OH1 would be classified as an end suction frame mounted pump. For ANSI/HI pump types that would not fall into the categories in Table 1.1, please provide a specific reason, such as "solids-handling only." (Reference Page 6)

HI Response: The pump type categories defined by HI as recommended for inclusion in a new energy efficiency specification present the greatest opportunity to implement energy efficiency savings quickly. The reference made to Table 1.1 is in the DOE Framework document, entitled: "*Rotodynamic Clean Water Pump Equipment Overview and Proposed Coverage.*"

The scope of the products that HI has recommended for inclusion in the DOE rule-making are those that most closely align with the EU regulation. These pump types are non-engineered, standard design, off-the-shelf pumps. These are summarized in the table on page 3 of this letter, with further details (provided from ANSI/HI pump standards) provided below.

As noted on page 3 of this letter, the pump types covered by the EU Directive 547/2012 include the following types of pumps: flexibly coupled horizontal frame and foot-mounted centrifugal (ESOB, OH0 and OH1); close coupled single stage (end suction) (ESCC OH7); flexibly and rigidly coupled vertical, in-line centrifugal (ESCCI, OH3 and OH4); close coupled vertical, in-line centrifugal, in-line casing diffuser (MS, VS8); and close coupled, submersible diffuser centrifugal, 4" or 6" bowl diameter (MSS, VS0). These are not designations that are commonly used in the U.S., however, there are equivalent pumps – based on ANSI/HI designations – that HI has recommended be included in the scope of covered products.

The ANSI/HI designations, as noted in the "ANSI/HI" column of the table on page 3 of this letter) are commonly used in the United States. Pump manufacturers, distributors, engineering consulting firms and, most importantly, pump users are accustomed to using these standard U.S. designations. HI affirms the importance of any rule-making using ANSI/HI designations and nomenclature vs. using European references in a DOE rule-making.

These points were also made during the public hearing on Wednesday, February 20, 2013, with regard to the use of ANSI/NI nomenclature. See page 82, lines 7-14.

Further information, in this regard, will be instructive to understanding both the alpha-numeric designations (e.g. OH0, OH1, etc.) as well as the definitions, derived from ANSI/HI standards. While the illustration on page three of this letter shows a small example of cross-sectional diagrams of the various pump types, further explanation will be helpful to understand the proposed included products.

ESOB, OH0 and OH1: Within the European designation of ESOB ANSI/HI classifications include two pump types that are designated OH0 and OH1. The OH0 and OH1 references are from on page 70 of "*ANSI/HI 1.1–1.2-2008: American National Standard for Rotodynamic (Centrifugal) Pumps for Nomenclature and Definitions*," as follows:

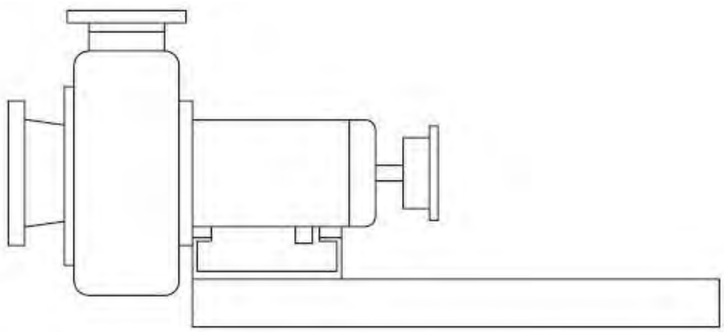


Figure 1.2.9.1.2 — Pump type OH0: Horizontal, frame mounted, flexibly coupled, single stage, overhung design

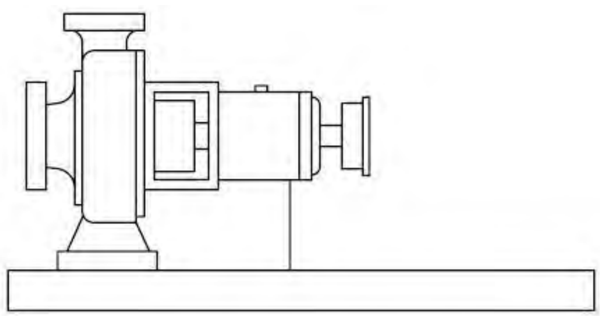
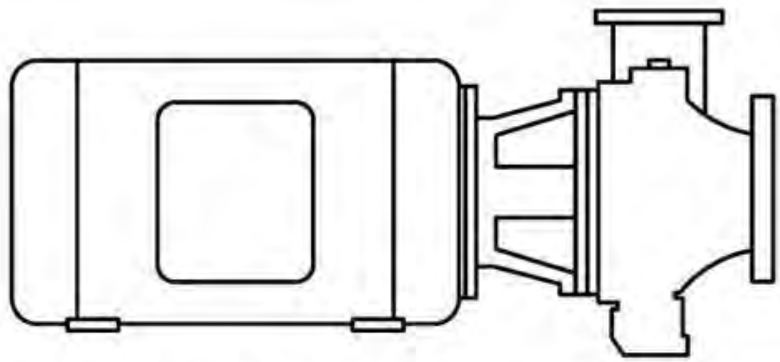


Figure 1.2.9.1.3 — Pump type OH1: Horizontal, foot mounted, single stage, overhung design

ESCC: Within the European designation of ESCC, ANSI/HI classifications include one pump type that are designated OH7. This reference is from page 2 of "*ANSI/HI 1.3-2009 : American National Standard for Rotodynamic (Centrifugal) Pumps for Design and Application*."



Pump type OH7: Overhung Impeller, Close-Coupled, Single-Stage, End Suction

<u>ESCCI, OH3 and OH4</u>: Within the European designation of ESCCI, ANSI/HI classifications include two pump types that are designated OH3 and OH4. This reference is from page 71 of "*ANSI/HI 1.1–1.2-2008: American National Standard for Rotodynamic (Centrifugal) Pumps for Nomenclature and Definitions*."

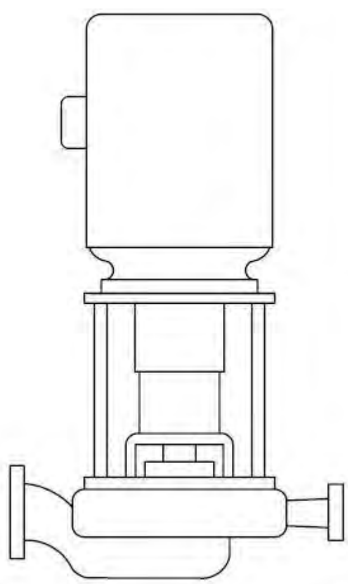


Figure 1.2.9.1.5 — Pump type OH3: Vertical, in-line mounted, single stage, with integral bearing bracket

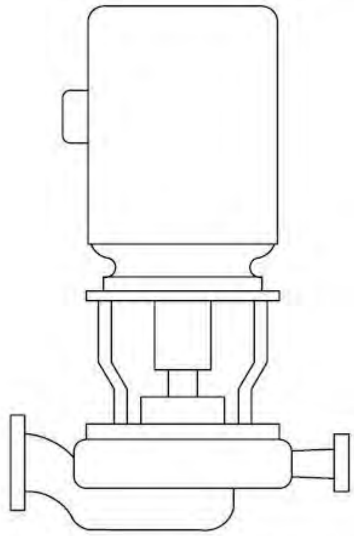


Figure 1.2.9.1.6 — Pump type OH4: Vertical, in-line mounted, single stage, rigidly coupled to the driver shaft

While there is not equivalent designation associated with a Close Coupled Vertical, In-Line Centrifugal pump in the EU scope of covered product, the ANSI/HI classification includes such as pump types that is designated OH5. This reference is from ANSI/HI standard page 72 of "*ANSI/HI 1.1–1.2-2008: American National Standard for Rotodynamic (Centrifugal) Pumps for Nomenclature and Definitions*."

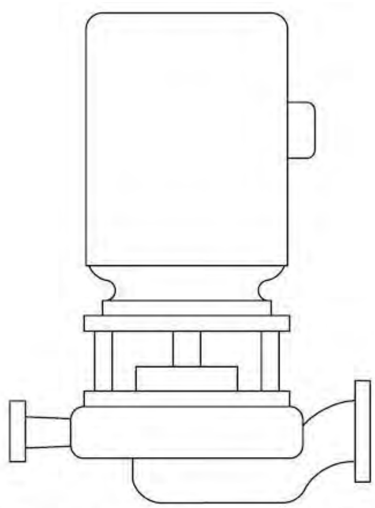


Figure 1.2.9.1.7 — Pump type OH5: Vertical, in-line mounted, single stage, close coupled to the driver shaft

<u>MS and VS8</u>: Within the European designation of MS, ANSI/HI classifications include two pump types that are designated VS8. This reference is from page 36 of "*ANSI/HI 2.1–2.2-2008: American National Standard for Rotodynamic (Vertical) Pumps for Nomenclature and Definitions.*"

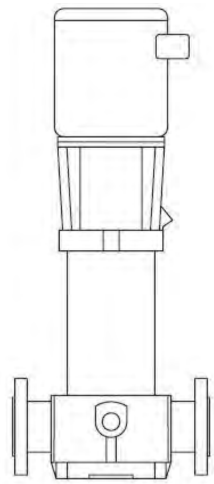


Figure 2.2.9.3.1 — Vertically suspended – in-line casing – multistage diffuser (VS8)

<u>MSS and VS0</u>: Within the European designation of MSS, ANSI/HI classifications include two pump types that are designated VS0. This reference is from page 32 of "*ANSI/HI 2.1–2.2-2008: American National Standard for Rotodynamic (Vertical) Pumps for Nomenclature and Definitions*."

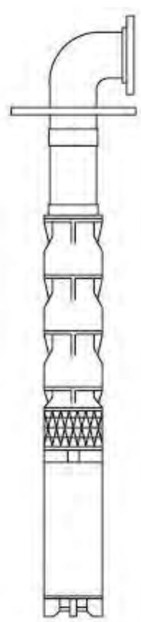


Figure 2.2.9.1.1.1 — Submersible turbine (VS0)

HI's in-scope pump classifications are designed to focus on off-the-shelf pumps that are, as close as possible, aligned with the EU pump efficiency regulation as noted previously. For the reasons that HI cites elsewhere in this letter (see items 1-11, 1-13, 1-15) and, further, relevant comments were made by HI delegates who attended the public meeting on Wednesday, February 20, 2013. See citations in the transcript of that meeting on page 74, lines 7-22 and page 75, lines 1-6 on the reasons to exempt pumps designed for non-water liquids (e.g. ANSI B.73 and API 610 type pumps) as well as page 78, lines 20-22 and page 79 lines 1-4. Regarding positive displacement pumps see page 80, lines 12-21. See citations in the transcript of the public meeting with regard to aligning the scope with current EU regulations, as cited on page 84, lines 20-22 and on page 85, lines 1-22 and page 94, lines 4-22. Regarding double suction and vertical turbine pumps, see page 86, lines 1-11 as well as page 88, lines 3-12.

The DOE Framework requested a response to the question: "For ANSI/HI pump types that would not fall into the categories in Table 1.1, please provide a specific reason, such as "solids-handling only." HI cites the following specific disadvantages of expanding the scope beyond what HI has recommended as:

a. Does not offer the greatest breadth of unit volumes for pumps in the marketplace.
b. Does not offer the greatest possibility of energy savings.
c. Does not offer global alignment with EU directive #547/2012.
d. Does not offer the most expeditious path forward for implementation. This is particularly relevant as the pump market is international in scope and manufacturers are already moving toward compliance with the EU's Directive.
e. Does not support Executive Order #13609 (May 1, 2012), directing federal agencies to seek international regulatory cooperation and avoid imposing unnecessary costs through inconsistent regulation.
f. Does not align and support EISA (Energy Independence and Security Act) based on motor ranges with defined National Electrical Manufacturers Association (NEMA) efficiencies with pumps.

Item 1-11: DOE seeks comment on whether wet-running circulator-type pumps should be covered in this rulemaking. (Reference Page 6)

HI Response: The Hydraulic Institute defines a "Circulator Pump" as a single-stage impeller pump, with or without an in-line pump housing, which has the rated hydraulic output power up to 3 Hp. The Circulator Pump housing is connected to the piping system with the primary pump design criteria being low head, quiet and vibration free operation.

Circulators are available in the following designs:

a) Wet rotor (seal less with canned motor) means a circulator with the motor rotor directly coupled to the impeller and immersed in the pumped medium. Up to and including 3 Hp.
b) A standard mechanical seal pump that can be either:
    i. Close-coupled to a motor (Compact Circulators) with Mechanical Seal, 2 piece and direct coupled, up to and including 3 Hp.
    ii. Flexibly coupled to a motor (Three Piece Circulators) with Mechanical Seal, Separate motor, bearing assembly and pump, up to and including 3 Hp.

Circulators are commonly applied in:

a) Hydronic, closed loop systems to provide flow by overcoming system friction loss. Hydronic means the use of water (or water and glycol) as a heat-transfer medium in heating and cooling systems. Circulators may also be used in similar applications in Solar Thermal, Geothermal, and other similar systems.

b) Potable water (intended for human consumption) recirculation to provide hot water from a source on demand. These circulators provide flow by overcoming system friction loss.

The Hydraulic Institute surveyed all seven (7) North American manufacturers of Circulator Pumps and found that approximately 1.7 million units were sold in 2012 and estimates that these pumps consumed 0.285 Terawatts of electricity in 2012. Comparing this to the 41.64 Terawatts of energy consumed by the Centrifugal Pumps included in the scope of the HI recommendation to the Department of Energy, the Hydraulic Institute maintains that Circulators represent a small amount of overall energy consumption and recommends that they not be included in the DOE Pump Efficiency Rulemaking.

***Item 1-12**:* DOE seeks comment on the market size for wet-running circulators in the United States, including the split between commercial and residential applications in terms of physical size or other features, as well as the potential for growth of the market for circulators in commercial applications. (Reference Page 6)

HI Response: Per the information cited above, the Hydraulic Institute surveyed all seven (7) North American manufacturers of Circulator Pumps and found that approximately 1.7 million units were sold in 2012. The Hydraulic Institute and its members do not have specific detail on the split between commercial and residential applications, however the consensus amongst manufacturers is that approximately 70% are used in residential applications and 30% go into commercial applications. Since the product is identical, no specific physical size or other features can be used to differentiate what goes into this split.

Item 1-13: DOE requests comment on which parameters, if any, should be added to this rulemaking. For each parameter proposed, please include the rationale and the type of pump that the parameter is designed to exclude from standards. Comments may address those translated from the EU or those proposed by stakeholders, but do not have to be limited to those proposals. DOE especially seeks comments on parameters that should be added to exclude pumps used primarily in residential applications. DOE also seeks comment on whether, if using power as a coverage parameter, hydraulic power would be more appropriate than shaft power. (Reference Page 9)

HI Response: HI recommends that the DOE follow HI's proposed parameters to align with the EU Directive 547/2012 and focus on non-engineered, standard model pumps as this will produce the greatest energy savings benefit in the shortest amount of time.

HI requests detailed information on DOE's information shown in Table 1.4.

Item 1-14: DOE requests comments on the estimates of pumps that would be excluded based on the stakeholders' proposed parameters. (Reference Page 9)

HI Response: Due to the number of assumptions required, this is complicated question as to which HI does not have a current estimate, but would be willing to cooperate with the DOE to develop a response.

Item 1-15: DOE requests comment on the technical features and applications for fire-fighting pumps and self-priming pumps that would allow it to determine whether these pumps should be covered. (Reference Page 9)

HI Response: Firefighting pumps should not be covered due to issues regarding public safety and technical aspects that should exempt them from consideration (hours of use, premium cost).

Technical features and application practices for Rotodynamic fire pumps are typically not conducive to optimal pump efficiency; however, because of minimal operating times for pumps in this category they offer minimal potential energy savings by requiring optimal design efficiency and there is therefore no compelling case for change. To the contrary, requiring efficiency-optimized fire pumps would actually increase the pump input horsepower required, increasing the size of the motor, controller and wiring. This results in increased cost and power consumption, and increases the energy consumption for this category. This defeats the intent of the DOE energy savings initiative. Furthermore, the requirement for optimally-efficient fire pumps is projected to create a major economic disruption in the market due to the number of pumps that would need redesign and the associated cost for not only the redesign and development of each pump, but also the associated design review, testing, and approval process by the fire pump approval organizations, all of which has little justification as it pertains to energy savings.

The consideration of low initial equipment cost dominates the fire pump market. This is a major design consideration in the development of new pumps as the various manufacturers strive to be more competitive. Higher pump speeds that result in smaller, lighter pumps and drivers (typically electric motors or diesel engines) typically maintain a competitive pricing advantage over slower speed pumps that involve larger, heavier pumps and drivers. This drives many fire pump applications to utilize higher speeds. Also, fire pumps have specific and demanding suction performance requirements at 150% of the rated flow. In order to meet this requirement for the competitive higher speeds, frequently the impeller designs must be optimized for suction performance, especially involving the pumps with higher flow rates. This results in higher impeller suction specific speeds that typically have lower efficiencies than impellers optimized for efficiency. Additionally, because drivers for fire pumps are required to be selected based on the NOL power at any point on the curve, a pump with a lower NOL power value for a particular rating that results in a smaller driver size for that rating has a competitive advantage. This market pressure drives the head-flow performance curves to be optimized for minimal non-overloading (NOL) power, typically resulting in steep curves that are not optimal for efficiency.

A requirement for optimal fire pump efficiency would drive the need for more normal pump head-flow curve characteristics, thereby increasing the NOL power and for many ratings increasing the driver size selection. The impact of the larger driver size will be to increase the wasted energy when operating at the rated condition under part load conditions, thereby defeating the reason for the requirement of optimal pump efficiencies.

The current fire pump designs available reflect the responses to these commercial pressures over a period of several decades, with each design having undergone a relatively lengthy, demanding, and expensive review and approval process by the fire pump approval organizations. UL and FM are the basic domestic organizations; however, manufacturers also have significant investments in approvals by the various other overseas approval bodies for many of the same pump designs. It should be noted that while pumps optimized for efficiency may be used in fire pump applications (if they succeed in the bidding process against designs not so designed), such designs present no particularly desirable trait to the market due to the minimal time of operation, which is only during a fire or during required periodic testing. The resulting inefficiencies of fire pumps having optimal fire pump design characteristics imposed by competitive pressures described above are readily tolerated by the market for the same reason. It should also be noted that fire pumps having optimal fire pump design characteristics are rarely tolerated in markets involving normal running time scenarios that tend to place an emphasis on pump efficiency.

Finally, a requirement for fire pumps to be optimized for efficiency is projected to have a significant negative economic impact due to the approval testing and approval process cost of approximately $100,000 per pump model <u>exclusive of the design development cost</u> in order to replace existing models.

<u>FIRE PUMP STANDARDS</u>

		Factory Mutual	Underwriters Laboratories	National Fire Protection Association
Pump Type	Split Case	Class Number 1311	UL 448	NFPA-20
	Vertical Inline	Class Number 1312		
	End Suction	Class Number 1319		
	In-Line	Class Number 1371		

Based-upon HI experience, HI asserts that all self-priming pumps, solids-handling pumps, and priming assisted pumps should be excluded from this rulemaking. In the case of solids-handling pumps, there are many compromises to the design to allow for application requirements - each of which lowers the efficiency of the pump as already outlined in Item 1-3. Self-priming pumps are designed for specific operating conditions and are generally equipped with a semi-open impeller to pass solids. Casing design, water capacity, and suction design are all formulated for quick self-priming not high efficiency. Self-priming and priming-assist pumps find uses in three main types of applications. The first is in situations where being on a suction lift is advantageous for maintenance reasons. The second main type of application is when they are used as portable pumps that are moved from one location to another. Finally, when NPSH requirements cannot be met with a standard pump, one specifically designed for low NPSHR is required.

Self-priming and priming-assisted pumps are designed to operate on what is known as a suction lift, which is when the pump is located higher than the source of the liquid on the suction side. In all pump applications there is a phenomenon referred to as Net Positive Suction Head (NPSH). The Net Positive Suction Head that is available (NPSHA) at the pump suction compared to the Net Positive Suction Head required by the pump (NPSHR) is a comparison that is critical to the longevity of the pump in question. If NPSHA > NPSHR then the pump application should be one that could last for years to come without any suction cavitation. Suction cavitation is a phenomenon where if there is not enough NPSHA then the water will actually flash to vapor as it enters the pump. Once inside the pump impeller the water vapor collapses back into a liquid. This is called cavitation and the results can be very damaging to the pump. Cavitation is named such as the location of where the bubbles implode actually creates a cavity in the impeller where material was removed. In addition to "eating away" at the impeller itself (cavitation is sometimes described as iron worm holes), cavitation causes unwanted noise and vibration which can lead to problems with other components such as seals, bearings, and shafts. Self-priming pumps and priming-assisted pumps are specially designed to have very low NPSHR so that they can operate on a suction lift. It has been established that there is a direct correlation between NPSHR and efficiency. The impact of NPSHR is recognized by Hydraulic Institute in their standard "Rotodynamic (Centrifugal and Vertical) Pump Efficiency Prediction," HI 20.3-2010. Section 20.3f of the referenced HI standard. "High suction specific speed...reduce the attainable efficiency available." Suction specific speed is a very similar calculation to specific speed, except for the substitution of NPSHR of H in the equation. Thus, because NPSHR is in the denominator of the equation, suction specific speed varies inversely with NPSHR. As NPSHR decreases, suction specific speed increases.

HI believes that a proposed standard that does not take into account the impact that NPSHR can have on efficiency will likely lead to pumps with higher NPSHR is short-sighted. The resulting higher NPSHR that will be required to meet the same efficiency levels as standard clean water pumps that are not designed for use on suction lifts will result in more cavitation which will lead to increased downtime, increased repair expenses, overall shortened life of the pump, and increased operating noise from the pumps.

Prime-assist and self-priming pumps are also designed with the knowledge that there will be times during their operation when they will be rotating without a full casing of fluid. This condition is known as running dry. In order to accommodate these times of running dry, both types of pumps will often incorporate what are known as dry running clearances where the gaps between the impeller and the wear ring or the wear plate are enlarged. These enlarged gaps permit more recirculation when the pump is dynamic and pumping, but are necessary to ensure that improper contact between the impeller and the wear ring or wear plate does not occur. Hydraulic Institute recognizes this impact in HI 20.3- 2010 "Rotodynamic (Centrifugal and Vertical) Pump Efficiency Prediction." Figures 20.3i and 20.3j in the referenced standard show the impact on efficiency due to increases in wear ring clearances.

Another category to consider excluding are chopper pumps. In the case of chopper pumps, the pump is being used to serve two purposes: first to move the solids within the liquid and second to reduce the size of those solids. Given the additional functions being accomplished by the chopper pump, it would seem to fall outside of the bounds of normal pump operation. HI's response to which power to use in establishing a cutoff for which pumps are covered: shaft power or hydraulic power, somewhat connects with which option is selected with regard to how efficiencies are to be determined. Since hydraulic power is value that can be determined for all pumps, it might be a better selection than shaft power. Consider a close-coupled end suction pump, there is no way to measure the shaft power, but hydraulic power can be measured. The same would be true for pumps driven directly on an engine shaft or by a hydraulic motor. We would also suggest that any power cutoff within any regulations be defined as the power required at the pump's BEP.

In addition to the considerations regarding NPSHR explained in Item 1-13, HI would also like to point out that there is more time and expense in developing tooling and testing for self-priming pumps than for standard clean water pumps. In addition to the same kinds of testing that standard clean water pumps are exposed to, self-priming pumps must be tested under more varied conditions. A new self- priming pump must undergo priming tests to determine its priming capability at a wide range of speeds and impeller diameters. Priming is not something that can be simulated through a computer program such as Computational Fluid Dynamics (CFD), it requires individual physical prototypes to be produced to verify its performance. Tooling for a self-priming pump is also much more complicated and expensive than for a standard clean water pump. A set of pattern equipment for a typical standard clean water pump volute would consist of a cope, a drag, and one two-piece core box. Self-priming volutes, however, require a cope, a drag, and up to six separate two-piece core boxes. In addition, a self-priming volute is significantly heavier than a standard clean water volute, increasing the expense of prototyping and production. As already alluded to, self-priming pumps are more expensive than standard clean water pumps. As such, they are not likely to be applied outside of where the self-priming feature itself - or the very low NPSHR - is actually required. This was acknowledged within the DOE framework document itself.

Another consideration in pump efficiency relates to surface finish. DOE recognizes the potential benefit of smoother surfaces within the Framework document, as does "*HI 20.3-2010: Rotodynamic (Centrifugal and Vertical) Pump Efficiency Prediction*" (see 20.3b and Figures 20.3g and 20.3h). Due to the low quantities of self-priming pumps produced, sand castings have been the most economical method of production. In addition to the downside of increased labor expenses in the foundries that produce the sand castings is that the surface finish of the components are often rougher than those found from other modes of production. While DOE does suggest the possibility of investigating the use of coatings, one must also consider how those coatings could be applied. In the case of a self-priming pump volute, HI's recent investigation into their use on HI's products indicate that they would need to be hand applied as there is not enough "line of sight" to apply a coating to all of the required surfaces in any other manner. Hand applied coatings are very labor intensive and will not result in an even coating being applied, which would in turn lead to inconsistency from one part to another. Other styles of pump might be more capable of having coatings applied by "line of sight" processes, but to achieve similar gains by improvements in surface finish within a self-priming volute may be cost prohibitive.

Item 1-16: DOE requests data on how pumps are sold by pump manufacturers. Specifically DOE requests data on market share of pumps 1) sold by themselves, 2) sold attached to or integrated with motors only, 3) sold attached to or integrated with both motors and VSDs, 4) sold physically separate from but priced together with a motor only, or 5) sold physically separate from but priced together with both a motor and VSD. DOE seeks these data by size, equipment category (see Section 3.2), and application.

HI Response: The Hydraulic Institute does not have that data in all of the categories listed available. Acquiring accurate data in all of the listed categories would require that a comprehensive market survey be completed. It is HI's opinion that the pump with motor combination as sold by pump manufacturers would substantially be the largest segment. Since it is HI's opinion that this combination is the largest combination sold, it would indicate that there is a large opportunity to save energy through the un-served service area by applying the VSD to the pump with motor combination.

***Item 1-17*:** DOE requests data and information on whether pumps are more often combined with motors, VSDs, or both by the pump manufacturer or by distributors.

HI Response: HI does not have that data in all of the categories listed available. Acquiring accurate data in all of the listed categories would require that a comprehensive market survey be completed.

The pump with motor and VSD can be supplied through various channels such as the pump manufacturers, pump distributors, VSD distributors, or contractors. It is HI's opinion that the majority of the pumps with motors are sold by the pump manufacturer. It is also HI's opinion that the multiple means of supply and the fragmentation of this supply channel results in a less than optimum selection of the pumping equipment.

Reference the DOE Framework Document, Page 10, 2nd paragraph: The document states "VSDs are best applied to pumps and primarily in applications with variable load and relatively low static head."

HI agrees that VSDs can provide benefits in systems with variable loads. However, systems with high static head conditions can benefit significantly from controlled systems, such as those using VSDs. The concept of an Extended Product is not limited to systems with relatively low static head.

The Hydraulic Institute would state that most pumping systems are uncontrolled and throttled to meet operating conditions. This indicates that there is a large opportunity to save energy by minimizing the throttling by using controlled pumping systems, which are defined as Extended Products.

***Item 1-18*:** DOE requests information on how often and in what circumstances the intended application of the pump is known when the pump is sold.
HI Response: The Hydraulic Institute does not have that data in all of the categories listed available. Acquiring accurate data in all of the listed categories would require that a comprehensive market survey be completed.

It is HI's opinion that the general application of the pump is known a majority of the time by the pump manufacturer. However, the end user understands the application all of the time. Therefore, incorporating an Extended Product Index would assist the end user in selecting the proper Extended Product to provide an energy efficient installation.

Item 1-19: DOE understands that VSDs are not very effective without system feedback. DOE seeks comment on the need for considering feedback in any extended product-type definition for pumps.

HI Response: The Hydraulic Institute agrees that feedback control is necessary to effectively operate Extended Products.

Item 1-20: DOE requests comment on the benefits and drawbacks of the options presented above. For options 2 and 3, DOE seeks comment on whether these options could increase the beneficial use of VSDs in the field, and whether these options could result in the use of a VSD in an application for which it is not suited.

HI Response: The Extended Product proposal will increase the beneficial use of VSDs. The Extended Product (EP) proposal establishes the method to define the Energy Efficiency Index (EEI) for each of several load profiles. The EP as defined by HI shall be used in pump applications to provide the lowest energy consumption for a given load profile. There are no applications when an EP is not recommended to use based on the definition of the EP as stated above.

This EEI is a dimensionless number that defines the ratio of the potential energy usage of the controlled system (an EP) versus the uncontrolled system operation. The EEI value is index, with a lower number indicating a larger potential for energy savings of the operation of the EP. The EEI is not an efficiency value for the EP.

Specific duty profiles can be developed for multiple applications and classes. However, there can and will be differences in the actual operation of the EP as compared to the duty profile. In addition, having multiple load profiles can cause confusion as to which profile an EP should be evaluated with, and could allow EPs to be evaluated over multiple profiles. Therefore, it is proposed that a single duty profile be used in the evaluation of the EEI. The load profile will be set at the values of 100%, 75%, 50% and 25% of the BEP flow. For each load profile defined, the minimum EEI would be defined, and that level must be met or exceeded. The market will determine the appropriate EP for the application based on the labeled index values. For EPs that have an EEI index above the minimum level the market will have the information to determine the appropriate EP for the application. Therefore, the improper application of the EP would be limited.

Item 1-21: DOE seeks comment on the market share of pumps by category that would be used in applications that would benefit from VSDs, as well as those where use of a VSD could result in increased energy use.

HI Response: The Hydraulic Institute does not have that data in all of the categories listed available. Acquiring accurate data in all of the listed categories would require a comprehensive market survey be completed.

It is HI's opinion that a large majority of systems, both existing and potential, can benefit from the use of VSDs on pumping systems that currently do not have a controlled operation. The benefit would be by minimizing throttling or compensating for over-sized pumps on un-controlled systems.

The application where VSDs would result in increased energy use would be very limited if a feedback control system is used. The energy saving benefit of using a VSD and operating a controlled pump application greatly outweighs the circumstance where a VSD could increase energy usage.

Item 1-22: DOE seeks comment on the market share and applications of pumps by category driven by equipment other than an electric motor.

HI Response: The Hydraulic Institute does not have that data in all of the categories listed available. Acquiring accurate data in all of the listed categories would require that a comprehensive market survey be completed.

It is HI's opinion that a great majority of the pumps sold are driven by electric motors and do believe that the statement made in the Framework Document that 10% of the pumps are driven by methods other than electric motors is a high estimate. HI believes that the percentage of pumps driven by other methods than an electric motor would be 3 to 5%.

Item 1-23: DOE requests comment on the suggested definitions for pumps.

HI Response: The Hydraulic Institute has clearly identified HI/ANSI definitions for pumps that are considered standards in the industry by pump manufacturers and their constituents. HI does not agree that DOE should initiate the use of another set of definitions for this rule-making. In the three letters that HI wrote to the Department in 2011, included by reference herein, HI offered details and specifics in this regard. Further details on industry standards definitions, nomenclature, definitions and cross-sectional diagrams are included in ANSI/HI pump standards.

Item 1-24: DOE requests input on whether the definitions proposed by DOE are sufficient to allow manufacturers to determine whether their pumps are covered in which category their equipment falls.

HI Response: Please see response to Item I-23.

Item 1-25: Item 1-25 DOE requests comment on what minimum specific speed should define the axial/propeller and mixed flow water pump.

As can be seen in ANSI/HI Figure 1.1.4.1, mixed-flow pumps begin at approximately 4500 specific speed, and axial-flow propeller pumps start at approximately 8000 specific speed.

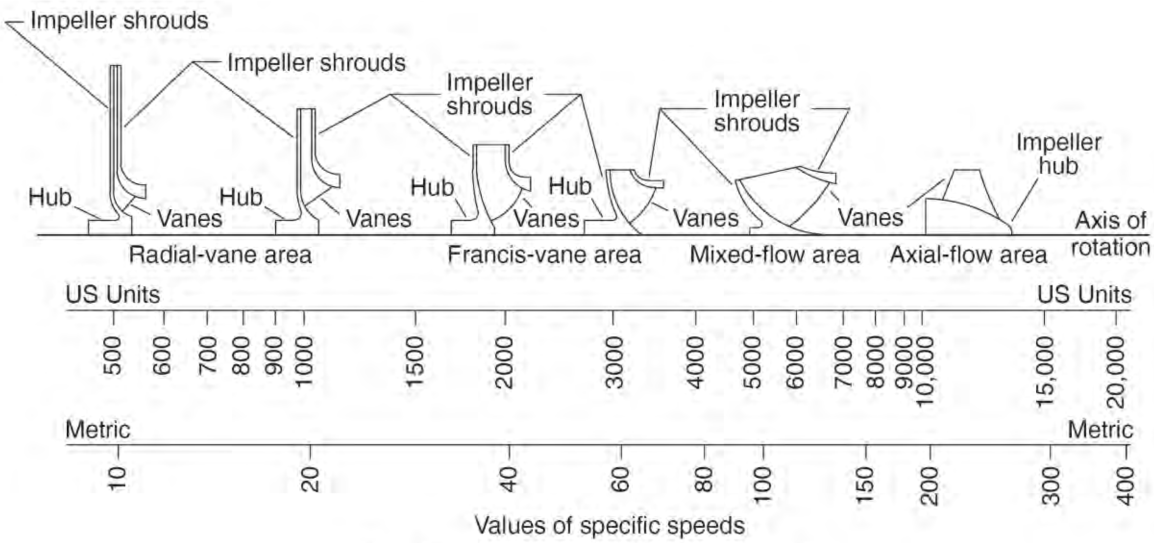


Figure 1.1.4.1 — General impeller types

Item 1-26: DOE requests comment on the definition of 'clean water.' DOE specifically requests input on the translation of wording and units to those typically used in the United States, such as parts per million limits for suspended and dissolved solids. DOE also seeks comment on the appropriateness of the proposed limits. DOE requests clarification on whether mixtures including water with freezing points above -10°C should be considered clean water for the purposes of this definition and rulemaking. (Reference Page 14)

HI Response: The EU ISO 9906 definition states that clean water means water with a max non-absorbent free solid content of .25 kg/m3 and with a max dissolved solid content of 50 kg/m3, provided the total gas content of the water does not exceed the saturation volume. Any additives that are needed to avoid water freezing down to -10C shall not be taken into account.

HI believes that covering "clean water" pumps covers the broadest range of standard design pumps, offers the best opportunity for energy savings and presents the best opportunity to get compliant products in the market quickly.

Item 1-27: DOE requests comment on whether maximum solids diameter, which is a parameter provided with many pump curves, could be used in the definition of 'clean water' (Reference Page 14)

HI Response: The members of the Hydraulic Institute wish to clarify that consideration for "Solids Diameter" is not used in any definition of clean water pumping.

Item 1-28: DOE requests comment on its proposal to follow the EU approach using pump efficiency if pumps are defined without the motor or controls. DOE is especially interested in whether a pump should have to meet a standard at multiple load points, or if a weighted average metric should be developed.

HI Response: HI believes that the Minimum Efficiency Index (MEI) should be applied at three (3) specified operating points of 75%, 100% and 110% of the Best Efficiency Point (BEP) flow rate. This flow range corresponds closely with the Preferred Operating Region (POR) specified in ANSI/HI 9.6.3-2012 Allowable Operating Region (ARO) Guideline, the American Petroleum Institute API 610 – 11th Edition, and Europump's Lot 11 document- EU No. 547/2012. This also would keep both the European and US standards aligned in accordance with Executive Order # 13609.

Item 1-29: DOE requests comment on the selection of 75% BEP flow as the part-load point and 110% as the overload point and whether these are the most appropriate points to encourage broad pump efficiency curves.

HI Response: Please see the response to Item 1-28.

Item 1-30: DOE requests comment on whether the use of an overall efficiency metric for submersible pumps would cause problems for manufacturers, as the EU metric is pump efficiency.

HI Response: HI supports the European position that the MEI is based on the efficiency of the pump itself. Using the overall efficiency of the pump for this category of pump would be difficult because this class of motor is not regulated. Pump manufacturers may have several suppliers for these motors, which would increase the testing burden on the manufacturer. Testing is not typically done to determine the overall efficiency of the pump and motor combination, and this would not be in accordance with the ANSI/HI-11.6 and this would move out of alignment with the current EU Directive.

Item 1-31: DOE requests comment on whether the metric for vertically suspended pumps should be bowl efficiency rather than pump efficiency.

HI Response: When testing vertically suspended pumps the bowl efficiency of the pump should be used. These pumps can be sold with a variety of column lengths that will add to the losses of the pump depending on the pump depth and discharge configuration. The ANSI/HI 14.6 Standard specifies that the manufacturer should report the bowl efficiency. Manufacturers commonly only supply the bowl assembly in these pump configurations, with a distributor often supplying the intermediate shafting and column lengths. Also the testing of complete units could prove overly burdensome on the manufacturer, requiring the development of infinitely deep test sumps to facilitate the testing of complete units.

Item 1-32: DOE requests comment on its proposal to adapt the EU standard metric to overall efficiency for pumps sold with both motors and VSDs. DOE is also interested in whether additional test points should be added below 75% of BEP flow to address more of the operating range of pumps with VSDs.

The test points of BEP, 75% of BEP and 110% of BEP are used in the evaluation of the Minimum Efficiency Index (MEI) for the pump itself. The pump used in the EP would be required to meet the defined MEI.

The listed test points of BEP, 75% BEP and 110% BEP are not applicable for the development of the Energy Efficiency Index (EEI) value. A defined load profile will determine the operational points in which the EP will be evaluated. A set number of operational points (potentially 4 points) would be defined for the load profile. An equally weighted average method for the four points would be used for the development of the EEI.

The load profile would be based on the following operational values; 100%, 75%, 50% and 25% of the BEP flow rate. These values would evaluate the EP over the great majority of the operating range of the EP, and each point would be equally weighted in the EEI evaluation.

Item 1-33: DOE requests comment on the appropriate metric to capture the energy efficiency impacts of VSDs. DOE is interested in whether test points at BEP, 75% BEP flow, and 110% BEP flow are appropriate for this metric and whether additional test points should be added below 75% BEP flow to address more of the operating range of pumps with VSDs.

HI Response: The listed test points of BEP, 75% BEP and 110% BEP are not applicable for the development of the Energy Efficiency Index (EEI) value. The defined load profiles will determine the operational points in which the EP will be evaluated, and these points will vary based on the specific load profile chosen. A set number of operational points (potentially 4 points) would be defined for each load profile. The weighted average method would be used for the development of the EEI since there are multiple operation points that the EP would be evaluated against.

The test points of BEP, 75% of BEP and 110% of BEP are used in the evaluation of the Minimum Efficiency Index (MEI) for the pump itself. The pump used in the EP would be required to meet a defined MEI.

Item 1-34: DOE requests comment on whether the metric for regulatory option 2 and 3 should include an overload test point based on over-speeding. (Regulatory Option 2 would have one set (equipment class) for pumps sold without a VSD and one set for pumps sold with a VSD. Regulatory Option 3 would be one set for pumps sold without a motor and one set for pumps sold with a motor).

HI Response: The Energy Efficiency Index (EEI) would not include a test point based on over-speeding since the defined load profiles will define the points at which the EP is evaluated and the designated operation points do not extend beyond 100% of operation.

Item 1-35*:* DOE recognizes that the same pump may in some cases be sold alone or may be sold in conjunction with a motor or motor/control package. DOE seeks comment on any issues that may result from having different metrics for pumps sold alone and pumps sold with motors or VSDs.

HI Response: The Hydraulic Institute does not anticipate any issues arising from different metrics for pumps sold alone and pumps sold with motors or VSDs since all pumps shall meet the Minimum Efficiency Index (MEI) whether they are sold alone or sold in an Extended Product configuration. The Energy Efficiency Index (EEI) would define the minimum index to be met for the Extended Product.

Item 1-36: DOE seeks comment regarding the implementation methodology described in this section, including whether basing efficiency on flow and specific speed is appropriate and, if so, whether the EU surface should be used as is, with adjusted Cs, or with modified shapes (adjustment of all coefficients). The last option would allow type- and efficiency level-specific surfaces. DOE also seeks comment on whether other parameters or combinations of parameters would be more appropriate or easier to implement, such as flow and head (instead of specific speed).

HI Response: HI supports the adjustment of only the "C" coefficients in the MEI equation. When reviewing the data that we obtained in a member survey, HI found that member company's pumps did have different failure rates when each individual pump type was looked at. A new set of "C" coefficient values were proposed in the HI "Minimum Efficiency Index Pass/Fail Rate Calculations," published January 8, 2012. The MEI equation provided a good fit to the shape of the data, and provided a simple method that the equation could be manipulated to determine the proper pass/fail rate. Better data fits were found but added to the complexity of manipulating the equation without significant improvement in the data fit. HI believes that it is better to stay with the simpler equation, and continue to align closely with the EU Directive.

It must be stressed that the MEI is not intended to be an efficiency prediction tool. It was developed as a method to calculate and index level that would cause a certain percentage of pumps to be eliminated from the marketplace because they failed to meet the minimum efficiency level at one or more specified operating points. By eliminating the lowest performing pumps from the marketplace overall pump energy consumption decreases by some percentage.

Finally, HI sees a need for clarification regarding the statement on page 25 in paragraph 1.4.5.1 of the framework document, "The efficiency of a pump is primarily determined by (1) size, (2) speed, and (3) ratio of the casing throat diameter to the impeller diameter [19]. The last parameter can be represented by specific speed. Research has shown that flow can be used as a proxy for the influence of the first two parameters, size and speed [19]."

In consideration of future similar discussions, HI recommends reference to "specific speed" in lieu of "ratio of the casing throat diameter to the impeller," as consensus within the HI pump community is more likely concerning use of the former term (and concept) than the latter since HI efficiency studies have always involved specific speed.

This approach has practical advantages as well, in that if the pump performance (and BEP) characteristics are known, specific speed is easily determined by a simple calculation, whereas a pump would need to be opened to allow measurements of the impeller diameter and casing throat or the manufacturer would need to be contacted for this information.

Item 1-37: DOE requests data that would help it improve its database, specifically performance data (i.e., head, flow, power, and efficiency at BEP and multiple additional points) for clean water pumps from catalogs not available on PUMP-FLO.

HI Response: HI has agreed to provide data on 2,124 water pumps that were reported in a member survey done in the 3rd quarter of 2012. The data is being supplied to the Department with this letter.

Item 1-38: DOE seeks comment on how to calculate specific speed (with regard to flow) for double suction axial split pumps and axially split multi-stage pumps with a double-suction first stage (i.e., whether to use total flow or one-half the flow).

HI Response: The calculation of specific speed in the U.S. marketplace is dependent on the context of how it will be used. Regarding the evaluation of efficiency, the specific speed of any double suction pump is done by using one-half of the total flow through the pump, as is the practice in Europe.

Item 1-39: DOE seeks test data for pumps at 75% and 110% BEP flow points that would allow it to better analyze potential efficiency levels for these points. (Reference Page 30)

HI Response: The Hydraulic Institute, as stated in the Framework hearing, agreed to provide DOE with the MEI survey data, based on the submissions of seventeen HI members that manufacture the pumps covered within the scope of the survey. The data that will be supplied is actual pump test data on 2,124 water pumps; it was submitted and analyzed at 75% BEP, 100% BEP and 110% BEP flow points. HI's survey data is provided to DOE on a confidential basis in response to the Department's need to verify HI's MEI calculations and approach.

Item 1-40: DOE requests comment on the appropriateness of setting a standard based on a full impeller.

HI Response: The standard should be set based on the pump's full impeller diameter. The design of the pump is conducted at the full impeller diameter. The specific speed of the pump is only valid by definition at the pumps full diameter. In many pump designs testing is only conducted at the full impeller diameter. The EU Lot 11 Directive is also based on full impeller diameter trims, which would be another discontinuity between the US and EU standards increasing the resource and financial burden on US manufacturers.

Item 1-41: DOE requests comment on standards based on certain numbers of stages for radially split multi-stage and submersible pumps. DOE also seeks comment on whether the same approach could be taken for axially split multi-stage pumps.

HI Response: The standard should be based on a set number of stages for these multistage types. It should not be set using single stage units because the intake and exit losses for the pumps will reduce the efficiency of the single stage pump to artificially low levels. HI proposes that the DOE rulemaking remain in concert with the EU directive and use 3 stages on radial split multistage designs and 9 stages for vertical submersible pumps.

Item 1-42: DOE requests data on the percent of pumps sold with a full impeller, as well as the distribution of pump sales with reduced impellers (as a percentage of full impeller).

HI Response: The Hydraulic Institute would be willing to co-operate with the DOE in the collection and analysis of marketing data relating to this subject.

Item 1-43: DOE requests comment on the use of the ANSI/HI 14.6-2011, ANSI/HI 11.6-2012, ISO 9906-2012, and ISO 5198-1999 test procedures, as well as any other test procedures, as a basis for the development of a DOE test procedure, including any modifications or additions that may be necessary.

HI Response: HI's recommendation is the norm for the United States: ANSI/HI 14.6 including future updates. ISO 9906 does not address all pump types such as vertical turbine pumps for bowl head and efficiencies. ANSI/HI 11.6 is harmonized with 14.6 for testing with the exception of wire to water efficiency. The previous version of the ANSI/HI 11.6 was based on pump efficiency and manufacturers currently still utilize this method. Generally the pumps tested per ANSI/HI 11.6 fall into the category of solid handling pumps that are outside the scope of the DOE document. ISO 5198 creates significant issue for detection level and testing along with significant investment and acceptance of this standard within the United States. The acceptance of ANSI/HI 14.6 is not only a U.S. accepted method but a worldwide standard. Consideration of other regional standards would be impractical to implement within the United States for a National Standard.

Item 1-44: DOE requests comment on the scope of each test procedure with respect to the equipment for which DOE is considering standards, as well as any limitations of these test procedures.

HI Response: ANSI/HI 14.6 covers the current scope proposed by both HI and expanded scope of the DOE with the exception of submersible pumps which is covered by ANSI/HI11.6. ISO 9906 does not currently cover the expanded DOE scope of Vertical Turbine pumps. There are no known current pump manufacturer labs or testing facility within the United States that test to the ISO 5198, which would create a burden on manufacturers and users if included in DOE's test procedure creation or adoption. ISO 5198 is based on 1999 standards which do not reflect current industry practice and the 1999 standards are not relevant standards for consideration.

Item 1-45: DOE is also interested in the pros and cons of using a thermodynamic approach to determining pump or pumping system efficiency, as in ISO 5198-1999.

HI Response: ANSI/HI 14.6 is a proven, repeatable and widely accepted method for testing of Rotodynamic Pumps. As noted above, there are no known current pump manufacturer labs or testing facility within the United States that test to the ISO 5198, which would create a burden on manufacturers and users if included in DOE standards creation [endorsement?]. ISO 5198 is based on 1999 standards which may not reflect current industries practice. The 1999 standards may not be relevant standards for consideration.

Use of ISO 5198 would require significant testing facility investment by pump manufacturers. Additional education of users, specifiers and contractors would be required to understand implementation and gain acceptance. This approach would not raise the level of accuracy for testing acceptance.

Item 1-46: DOE requests comment on use of "Grade 1" from ANSI/HI 14.6-2011 tolerances for all pump categories and whether it places any additional burden associated with performing testing requirements for all covered equipment classes.

HI Response: Currently the EU is utilizing Grade 2B for acceptance level. HI recommends continued efforts toward world harmonization on pump acceptance level at the Grade 2B level for all pumps from 13 to 200 HP. To bring all pumps to the level Grade 1 would impose significant and undue burden not only on testing equipment but the entire manufacturing process. As the ANSI/HI 14.6 states for pumps with power below 13 horsepower, HI proposes the use the formula as specified in ANSI/HI 14.6.3.4.1.

Item 1-47: DOE requests comment on the applicable test procedures for complete pump, motor, and VSD system packages.

HI Response: The complete pump, motor, and VSD represent the extended product approach. ANSI/HI 14.6 covers testing of completed pump units (string testing) in Appendix G.

Item 1-48: DOE requests comment on the accuracy of different measurement equipment used to measure pump power, input power to a motor or VSD, pump flow, head, or other parameters and their impact on the accuracy of the measured pump efficiency. DOE also requests comment on the calibration frequency required to maintain sufficient equipment accuracy.

HI Response: The instrumentation required to perform the extended product test would require an upgrade to measure the input power into a VSD. This is to compensate for the disruption of the input power by the VSD.

ANSI/HI 14.6 specifies frequency of calibration and level of accuracy of test lab equipment. HI recommends that test equipment manufacturers be contacted for comment regarding typical commercial equipment accuracy and tolerances.

Item 1-49: DOE requests comment on the applicability of calculation methods to determine rated pump efficiencies from similar, tested pump efficiencies.

DOE requests comment on the number of unique pump models manufacturers would have to test, as well as the ability for a calculation method to reduce testing burden. DOE also requests comment on the reduction in test accuracy when using a calculation method to determine rated efficiency of a unit.

HI Response: HI agrees that industry accepted calculation methods are appropriate for similar tested pump efficiencies.

The number of unique pump units tested varies with the pump type and manufacturers' practice. It is not uncommon to perform a confirmation test on a single model within a design family and calculate performance for design variations.

Experience shows that this approach yields good predictability of performance.

Item 1-50: No question**.**

Item 1-51: DOE seeks comment on whether a labeling rule would be technologically or economically feasible, result in a significant conservation of energy, or assist customers in making purchasing decisions.

HI Response: HI recommends per earlier communication the MEI approach in line with the EU standards of self-certification and labeling. All pumps within the scope of the new standard would be labeled with the MEI number certified by the manufacturer, showing the Index Level that the product meets. This approach would allow the buyer and end-use customer to select the most efficient product available.

Item 1-52: DOE seeks comment on information that it should consider requiring for display on any prospective label, as well as factors DOE should consider regarding the size, format, and placement of any such label.

HI Response: HI recommends a separate nameplate with the HI EFF Label to be applied to the product. The label would contain pump type classification in line with ANSI/HI 1.1/2.1 nomenclature as it affects MEI Level or High Efficiency.

Item 3-1: DOE requests information that would contribute to the market assessment for the pumps that would be covered in this rulemaking, especially for those equipment classes designated in section 3.2. Examples of information sought include current equipment features and efficiencies, equipment feature and efficiency trends, and historical equipment shipments and prices.

HI Response: Due to the number of assumptions required, this is complicated question, but the Hydraulic Institute is willing to work with DOE to develop a response.

Item 3-2: DOE requests input on its identification of product codes in the U.S. Census data that match the equipment classes proposed for coverage in this rulemaking. (Reference Page 45)

HI Response: The Hydraulic Institute wishes to clarify that historically, the U.S. Census data has not aligned with ANSI/HI's nomenclature descriptions so we cannot provide input on this question. Furthermore, it should be noted that the U.S. Census Data MA333 Report was an estimate with load factors applied to collected data to make it more comprehensive and also, as is noted in the Framework Document, the MA333 Report is no longer being collected by the U.S. Census Bureau and thus it is not reliable.

Item 3-3: DOE requests feedback on its estimates of the disaggregation of pump exports and imports to product codes, its estimates of the percentage of shipments of clean water pumps, and its estimates of the percent of shipments sold with motors by the pump manufacturer. (Reference Page 45)

HI Response: HI does not have data responsive to this request.

Item 3-4: DOE welcomes comments on which performance-related features or design characteristics DOE should consider to define pump equipment classes. (Reference Page 52)

HI Response: This is a complicated topic to address. The Hydraulic Institute would be willing to cooperate with the DOE in the review and assembly of data relating to this subject.

Item 3-5: DOE requests information regarding the utility of different pump categories proposed for coverage that would warrant separate equipment classes. For example, could end suction pumps be a single equipment class, or are the breakdowns shown necessary to preserve equipment utility that would affect performance? Could axially and radially split multi-stage pumps be a single equipment class? Could all vertical turbine pumps (both submersible and non-submersible) be a single equipment class? (Reference Page 53)

HI Response: HI believes that the currently defined HI scope captures the broadest categories of non-engineered pump types and presents the most significant chance of energy savings

Item 3-6: DOE requests information on whether any of the equipment proposed for coverage provides utility that requires further breakdown from the categories shown in Table 3.8. For example, do multi-stage pumps with a double suction first stage require a separate equipment class? Do vertical turbine can pumps require a separate equipment class from vertical turbine line shaft pumps? (Reference Page 53)

HI Response: Please see response to Item 3-5.

Item 3-7: DOE requests comment on whether equipment classes can be developed for pump categories that would always be used in variable load applications. (Reference Page 53)

HI Response: The members of the Hydraulic Institute wish to clarify that equipment class does not control whether or not a pump can be used in a variable load application. The particular application defines this.

Item 3-8: DOE requests comment on whether it should consider using Reynolds number instead of flow in setting minimum efficiency standards for pumps and whether this choice would prevent adding design speed as an additional parameter. DOE notes that there are multiple methods of calculating Reynolds number for pumps and that all calculations do not produce the same relative results. As a result, DOE seeks comment on the most appropriate form of Reynolds number for pumps. (Reference Page 56)

HI Response: HI agrees that H.H. Anderson's methodology to use Reynolds number for efficiency scaling can be useful when comparing pumps of the same specific speed. In fact ANSI/HI 14.6 Appendix K for model testing uses the Reynolds number in the Moody formula for efficiency scaling of geometrically identical model pumps. But applying a Reynolds number methodology cannot be done without using specific speed correction factors, which unnecessarily complicates the use of this methodology. HI recommends that the use of "Specific Speed versus Flow Rate" is the most practical approach to be used when predicting efficiency for a particular class of pump types.

Item 3-9: DOE requests comment on which method of surface fitting produces the most appropriate results for both cases: (1) a smaller pump at higher speed compared to a larger pump at lower speed; and (2) identical pumps running at two different speeds. DOE requests comment on whether these relationships are expected to differ by equipment class.

HI Response: HI believes that it is appropriate to have curves fitted to the data for the different speeds. Often a manufacturer will need to make modifications to pumps running at higher speed to allow for greater bearing loads. These may include changes to the bearing frame size or modifications to the axial thrust balancing device. This will have an effect on the efficiency of the pump. These potential modifications will vary by equipment class.

Item 3-10: DOE requests comment on the use of pump design speed as a feature that distinguishes equipment classes. In particular, DOE seeks comment on whether pumps designed for different rotating speeds perform differently enough to warrant separate equipment classes. DOE also requests comment on any physical differences between pump models offered at different speeds and the nature of those differences, including whether DOE could determine by physical inspection at what speeds a pump can safely operate.

HI Response: By following HI's recommendation that "Specific Speed versus Flow Rate" be used to predict efficiency for a particular class of pump types, the speed of operation is accounted for by the calculation of Specific Speed and the resulting rate of flow. HI's draft of HI 14.6 DOE requires that the pump be tested within +/-20% of the rated speed. A pump manufacturer offering the same pump at different speeds will have to account for any speed related efficiencies (which is normally done today in published performance curves) and determine if they are compliant with the required MEI level at all offered speeds.

HI believes that field inspection, as suggested in Item 3-10, is not practical and such an assessment would likely involve a design review by an expert in pump mechanical and hydraulic design.

Item 3-11: DOE requests comment on the testing and compliance burden on manufacturers under the approaches set forth above.

HI Response: Pumps designed for different speeds are normally tested over the range of speeds for which they will be offered. HI's draft of HI 14.6 DOE requires that the pump be tested within +/-20% of the rated speed. This is not felt to be a burden beyond which pump manufacturers are already subjecting themselves to at this time.

Item 3-12: DOE requests comment on whether it could require all pumps in a given equipment class to be tested at (a) certain speed(s) and, if so, which speed(s) is (are) most appropriate.

HI Response: As previously stated above, pumps designed for different speeds are normally tested over the range of speeds for which they will be offered. HI's draft of HI 14.6 DOE requires that the pump be tested within +/-20% of the rated speed. This is not felt to be a burden beyond which pump manufacturers are already subjecting themselves to at this time.

Item 3-13: DOE requests comment on how manufacturers in the EU are determining the minimum efficiency required for a pump offered at multiple speeds.

HI Response: The EU testing is conducted at nominal speeds for two and four pole motors at 50 Hz. HI supports using the same two and four pole nominal speeds at 60Hz in the US Regulation. In the Scope proposed by the Hydraulic Institute and the Current EU directive, the inclusion of 6, 8, etc. pole speeds is a very small percentage of units sold and represents an extremely small amount of the power being consumed by pumping systems.

Item 3-14: DOE welcomes comment on the technology options identified in this section, including further details on methods (such as lists of specific methods for each listed broad option) and potential efficiency gains, as well as information on whether the method in question is applicable to all pumps in a given equipment class or only pumps with certain design characteristics). DOE also welcomes comment on whether there are other technology options that it should also consider.

HI Response: In the experience of HI members, the improvement of 10%-12% in efficiency by hydraulic redesign would only be applicable if the very worst in class designs were brought up to the max tech level. Smoothing and surface finish have very little effect at higher specific speeds and in the range of pumps that are commonly in service with a specific speed of Ns = 600 and above member experience points to a 1% to 3% efficiency gain. Additionally this gain is non-persistent, with the surface finish quickly being degraded in most applications. The reduction in running clearances may be feasible in some applications and at some specific speeds. Lower specific speeds do experience efficiency gains when leakage rates are reduced because they have proportionately smaller through flow rate ratios than higher specific speeds. The reduced running clearances may also lead to mechanical reliability problems leading to the added expense of larger (stiffer) shafts, larger bearings, advanced or more costly wear ring materials, etc.

Item 3-15: DOE welcomes comment on the relevance of the technology options identified to pumps sold with smaller impellers than the full impeller on which DOE is tentatively proposing to base a standard. In particular, would these design options be carried through to pumps with all impeller sizes?

HI Response: Improving the pump efficiency of partially trimmed impellers in general would mean a modification to the volute, diffuser and or collector. This would prove to be very costly in practice for only a minor efficiency gain. HI does not see the benefit in pursuing this option.

Item 3-16: DOE requests information related to various impeller types used in clean water pump designs and the efficiency impacts of each type.

HI Response: In general three types of impellers are used for clean water service. The most efficient is the closed impeller design, which allows for the least amount of leakage flow and the maximum amount of control over the fluid within the impeller passages. The semi open design with a single shroud has a lower efficiency due to the leakage losses between the impeller and the fixed wear plate. It also generates more axial thrust, which leads to additional losses in the thrust balancing devices. The fully open impeller is the least efficient, with leakage around both the front and back of the impeller vane.

Item 4-1: Are there any technologies listed in section 3.3 (or others not proposed) that DOE should not consider because of any of the four screening criteria? If so, which screening criteria apply to the cited technology or technologies? (Reference Page 66)

HI Response: This question involves a number of individual case variables. Response to the above question can be obtained, in full or in major part, by reference to Hydraulic Institute's Guideline for Rotodynamic (Centrifugal and Vertical) Pump Efficiency Prediction HI 20.3-2010.

HI, however, has no data on how frequently hydraulics redesign would be the only method employed in efficiency improvement.

Item 5-1: DOE seeks input on the methods and approaches used by manufacturers to improve the efficiency of pumps and, in particular, how frequently hydraulic re-design would be the only method employed. (Reference Page 67)

HI Response: Please see response to Item 4.1.

HI, however, has no data on how frequently hydraulic redesign would be the only method employed in efficiency improvement.

Item 5-2: DOE welcomes comment from interested parties on the best methodology for scaling cost-efficiency curve results from the representative units to the representative equipment classes and extrapolating from the representative equipment classes to the remaining equipment classes not directly analyzed. (Reference Page 67)

HI Response: HI does not have data responsive to this request.

Item 5-3: DOE seeks comment on its selection of representative classes: which classes could be grouped together for this analysis, and which class should be tested. (Reference Page 67)

HI Response: Analysis of the U.S. pump market confirms that the variety of existing products and numerous market segments, each with unique requirements, is too wide and complex as similar designs cross multiple market segments and are applied differently resulting in a large number of unique product variations. HI does not have the data to respond with specific details at this time.

Item 5-4: DOE welcomes comment on the selection of representative units in terms of appropriate flow and specific speed ratings within each equipment class. (Reference Page 68)

HI Response: HI does not have data responsive to this request.

Item 5-5: DOE seeks comment on the selection and performance characteristics of baseline models for each equipment class. DOE will consider such comments in defining the characteristics of the proposed baseline models. (Reference Page 69)

HI Response: HI does not have data responsive to this request.

Item 5-6: DOE seeks input from stakeholders regarding the range of efficiency levels that should be examined as part of its analysis. (Reference Page 71)

HI Response: For the same reasons as noted above, HI recommends that the Department adopt the Minimum Efficiency Index (MEI) that is central to the EU 547/2012 Standard as proposed in EU Lot 11. HI urges that the "C" coefficient alone be used to modify the efficiency cut off level (thresholds) for each MEI level, as was done in the EU.

Item 5-7: DOE seeks input from interested parties on a methodology that would be appropriate for determining the max-tech models for each pump analyzed. (Reference Page 71)

HI Response: HI does not have data responsive to this request.

Item 5-8: For each equipment class, DOE welcomes comments on methods and approaches that DOE intends to employ to determine potential efficiency improvements for pumps. Detailed information on the pump performance and the incremental manufacturing costs (e.g., material costs, labor costs, overhead costs, building conversion capital expenditures, capital expenditures for tooling or equipment conversion associated with more efficient designs, R&D expenses, and marketing expenses) would be useful.

HI Response: The Hydraulic Institute has agreed to share the information gathered in a survey of members on the cost of redesign to meet a MEI of 0.40 for three different horsepower pumps.

Item 5-9: DOE welcomes comment on the markup approach proposed for developing estimates of manufacturer selling prices. (Reference Page 73)

HI Response: Due to antitrust implications, HI must decline to respond.

Item 5-10: DOE welcomes comment on the approach to determining the relationship between manufacturer selling price and pump efficiency. (Reference Page 73)

HI Response: Due to antitrust implications, HI must decline to respond.

Item 5-11: DOE welcomes comment on the conversion costs required to improve the efficiency of the pumps to various levels, as well as what portion of these costs would be passed on to the consumer. (Reference Page 73)

HI Response: Due to antitrust implications, HI must decline to respond.

Item 5-12: DOE welcomes comment on whether there are outside regulatory changes that DOE should consider in its engineering analysis of pumps. (Reference Page 74)

HI Response: HI does not have data responsive to this request.

Item 6-1: DOE requests information on the distribution channels under consideration. (Reference Page 75)

HI Response: Due to antitrust implications, HI must decline to respond.

Item 6-2: DOE requests comments and additional information on the appropriate way to establish distribution channel percentages across equipment classes and application (market) segments for the current rulemaking. In particular, DOE seeks information on the percentage by market segment (i.e., agriculture, municipal, commercial, industrial, and other markets) of direct sales, OEM sales, wholesaler to customer sales, wholesaler to contractor sales, and other sales. DOE seeks this information over the total market. (Reference Page 75)

HI Response: Due to anti-trust implications, HI must decline to respond.

Item 6-3: DOE seeks comment on other sources of relevant data that could be used to characterize markups for commercial and industrial pumps. (Reference Page 76)

HI Response: Due to antitrust implications, HI must decline to respond.

Item 6-4: DOE requests feedback on its proposal to use incremental distribution channel markups. (Reference Page 76)

HI Response: Due to antitrust implications, HI must decline to respond.

Item 6-5: DOE seeks comment on appropriate transportation and shipping costs to include in the analysis and whether those costs are likely to vary for higher efficiency commercial and industrial pumps. (Reference Page 76)

HI Response: Due to antitrust implications, HI must decline to respond.

Item 7-1: DOE requests input and recommendations for identifying high sales volume and large installed base application segments corresponding to specific applications for which the pumps used may have similar duty profiles. (Reference Page 77)

HI Response: HI does not have data responsive to this request.

Item 7-2: DOE welcomes recommendations on sources of data or analysis methods that would provide end-use duty profiles for each of the equipment classes of pumps covered under this rulemaking in the major application segments. (Reference Page 77)

HI Response: HI does not have data responsive to this request.

Item 7-3: DOE requests input on ways to characterize pump sizing and selection practices for different equipment classes and applications. (Reference Page 77)

HI Response: The market will determine the appropriate EP for the application based on the labeled index values. For EPs that have an EEI index above the minimum level the market will have the information to determine the appropriate EP for the application.

Item 7-4: DOE requests comment on the degree of oversizing prevalent in different application segments. (Reference Page 78)

HI Response: HI does not have data responsive to this request.

Item 7-5: DOE welcomes comment on methods for determining nominal (non-market segment specific) duty profiles for pump equipment classes considered in this rulemaking. (Reference Page 78)

HI Response: Specific duty profiles can be developed for multiple applications and classes. However, there can, and will be differences in the actual operation of the EP as compared to the duty profile. In addition, having multiple load profiles can cause confusion as to which profile an EP should be evaluated with, and could allow EPs to be evaluated over multiple profiles. Therefore, it is proposed that a single duty profile be used in the evaluation of the EEI. The load profile will be set at the values of 100%, 75%, 50% and 25% of the BEP flow. In addition, these values will be weighted evenly for the time of operation. This would mean that the EP will operate at each of the loads defined above for a total of 6 hours in a 24 hour period. Evaluating the EP using these defined loads and the equal weighting will provide consistency to the evaluation, limit any differences in comparing EPs, and aid in simplifying the evaluation.

Item 7-6: DOE welcomes comment on the current penetration level of VSDs in the installed base of equipment in each application segment for each of the equipment classes considered in this rulemaking. DOE also welcomes comment on the baseline condition for applications without VSDs, such as running at full load, use of a throttling valve, etc. (Reference Page 78)

HI Response: The general trend observed is that the penetration level is increasing in this industry and it may be worthy of future evaluation. HI does not have the data to respond in greater detail.

Item 7-7: DOE requests comment and recommendation on the range and number of sizes over which the analysis should be carried out for each specific speed in different classes of equipment. (Reference Page 79)

HI Response: HI does not have data responsive to this request.

Item 7-8: DOE requests information on current industry practices and recommendations on the selection of representative operating points for a given specific speed. DOE welcomes comment on whether the analysis should be extended to a range of operating points away from BEP. (Reference Page 79)

HI Response: HI believes that the Minimum Efficiency Index (MEI) should be applied at three (3) specified operating points of 75%, 100% and 110% of the Best Efficiency Point (BEP) flow rate. This flow range corresponds closely with the Preferred Operating Region (POR) specified in ANSI/HI 9.6.3-2012 Allowable Operating Region (ARO) Guideline, the American Petroleum Institute API 610 – 11th Edition, and Europump's Lot 11 document- EU No. 547/2012. This also would keep both the European and US standards aligned in accordance with Executive Order # 13609.

Item 7-9: DOE requests comment and estimates to establish the mean value and the ranges of likely values for transmission, motor, and motor control efficiencies, as well as the impact of a control on motor performance and efficiency. (Reference Page 79)

HI Response: HI does not have data responsive to this request.

Item 8-1: DOE welcomes comment on whether installation costs for pumps increase with higher efficiency equipment. (Reference Page 81)

HI Response: HI does not have data responsive to this request.

Item 8-2: DOE welcomes input on the proposed methodology for estimating current and future electricity prices. (Reference Page 81)

HI Response: HI does not have data responsive to this request.

Item 8-3: DOE invites comment on how repair costs may change for more efficient pumps. (Reference Page 82)

HI Response: Due to antitrust implications, HI must decline to respond.

Item 8-4: DOE welcomes comment on appropriate pump lifetimes for the equipment classes covered in this rulemaking, as well as data regarding correlation between pump end-use patterns and pump lifetime. (Reference Page 84)

HI Response: HI does not have data responsive to this request.

Item 8-5: DOE requests data on the degradation of pump efficiency over a pump's lifetime. (Reference Page 84)

HI Response: HI does not have data responsive to this request.

Item 8-6: DOE welcomes input on the proposed approaches for estimating discount rates for pump customers. (Reference Page 84)

HI Response: Due to antitrust implications, HI must decline to respond.

Item 9-1: DOE welcomes comment on the shipments projection methodology. DOE invites comments regarding the selection of appropriate economic drivers and sources of data for historical shipments and shipment breakdowns by equipment class. (Reference Page 85)

HI Response: HI does not have data responsive to this request.

Item 9-2: DOE requests historical shipments or bookings data for each of the considered equipment classes, with further breakdowns where available including, but not limited to, flow, head, specific speed, horsepower, or efficiency. (Reference Page 85)

HI Response: HI does not have data responsive to this request.

Item 9-3: DOE welcomes comment on how any standard for pumps might impact shipments of the equipment in this rulemaking. (Reference Page 85)

HI Response: HI does not have data responsive to this request.

Item 11-1: DOE welcomes comment on what, if any, user subgroups are appropriate in considering standards for pumps. (Reference Page 87)

HI Response: HI does not have data responsive to this request.

Item 12-1: DOE seeks comments on the subgroups of the pumps equipment manufacturers that it should consider in a manufacturer subgroup analysis. (Reference Page 89)

HI Response: HI does not have data responsive to this request.

Item 12-2: DOE welcomes comments on what other existing regulations or pending regulations it should consider in its examination of cumulative regulatory burden. (Reference Page 89)

HI Response: HI does not have data responsive to this request.

Item 13-1: DOE seeks input on its approach to conducting the emissions analysis for commercial and industrial pumps. (Reference Page 91)

HI Response: HI does not have data responsive to this request.

Item 14-1: DOE requests comments on the approach it plans to use for estimating monetary values associated with emissions reductions. (Reference Page 92)

HI Response: HI does not have data responsive to this request.

Item 15-1: DOE welcomes input from interested parties on its proposed approach to conduct the utility impact analysis. (Reference Page 93)

HI Response: HI does not have data responsive to this request.

Item 16-1: DOE welcomes feedback on its proposed approach to assessing national employment impacts. (Reference Page 94)

HI Response: HI does not have data responsive to this request.

-------------------- END OF APPENDIX A QUESTIONS AND HI ANSWERS --------------------

Appendix B

Additional Material Provided to the Department by the Hydraulic Institute:

Attachments:

- HI Membership Survey: MEI data, based on a population of 2,124 pumps (HI Confidential)
- HI Membership Survey: Cost of re-design survey (HI Confidential)
- Draft of HI 14.6 DOE: Proposed Test Procedure, based on ANSI/HI 14.6 (HI Confidential)
- PowerPoint presentation, summarizing highlights of HI 14.6 DOE Test Procedure (HI Confidential)
- Total power consumed by pumps sold in one year (HI Confidential)

ALL HYDRAULIC INSTITUTE APPENDIX B ATTACHMENTS ARE **HI CONFIDENTIAL**.