Pool Pumps & Motors

Codes and Standards Enhancement (CASE) Initiative
For PY 2012: Title 20 Standards Development

Data Request Response for
Pool Pumps & Motors

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1 Background

On July 29st, 2013, the California Investor Owned Utilities (Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas (SCG), San Diego Gas & Electric (SDG&E)), herein referred to as the CA IOUs, submitted a Codes and Standards Enhancement (CASE) report for pool pumps and motors. On January 15th, 2014 the California Energy Commission (CEC) hosted an online webinar to discuss the proposals it had received and what additional information was needed for CEC staff to develop their staff reports for a number of products, including pool pumps and motors. On March 3rd, 2014 CEC issued a formal data request for additional information for pool pumps and motors.[1] Below are the CA IOUs responses to this data request hoping to add clarity to the previously submitted CASE Report. Also included in this response are minor language changes and reporting requirements.

2 Data Request and Responses

1. Test Procedure

CEC REQUEST

The Energy Commission is interested in updating its test procedures for (1) pool pump motors and (2) pool pump and motor combinations to improve repeatability of results and reliability in measuring the products' relative efficiency. Specifically, staff recognizes flaws in the current test procedure's lack of standardized piping and dynamic head. Staff is interested in updating the test procedure to use a standard size piping (such as 1 1/2 inches inside diameter) in an adjustable apparatus to specific dynamic head. The output of an updated test procedure would be the energy factor of a pump at full and at half speed.

The Energy Commission requests stakeholders provide in comment:

a. A proposed updated test procedure that improves the current test procedure as described above, and a discussion of the technical merit and feasibility of the new test procedure.

b. If the improvements described above are not feasible, please provide suggestions for an alternative test procedure that more reliably identifies the efficiency of (1) pool pump motors and (2) pool pump and motor combinations.

c. Any suggested dynamic head testing points for single, double, multiple, and variable speed pumps and motors.

CA IOU RESPONSE

[1] http://www.energy.ca.gov/appliances/2013rulemaking/documents/12-AAER-2F/2014-03-05_pool_pumps.pdf

Response to a, b, & c

The CA IOUs believe the current pool pump test procedure accurately captures the efficiency of pool pumps and does not need to be changed. The CEC test procedure and CEC developed system curves A, B &C are widely accepted by the pool industry, as they have been incorporated into the ANSI-IECC–APSP-15 Standard. They are also used as the basis for ENERGY STAR and appliance standards in the states of Arizona, Washington, and Connecticut. In the CASE report, we noted some minor changes, such as updating the HI 1.6-2000: Centrifugal Pump Test procedure to HI 1.6-2011. We also proposed new testing, listing and reporting requirements which can be found in Appendix B.

However, the CA IOUs' original CASE Report mentioned that in order to measure motor efficiency at different speeds the IEEE-114-2010 test procedure would need to be modified. The current challenge is that the IEEE-114-2010 test procedure is a motor efficiency test for motors which operate at full speed. Because the torque presented to a pool pump motor follows the pump affinity laws, it is not accurate to test motors at the same torque as calculated for full speed as would be proportional for half speed, lowest speed, etc. For example, at half speed, the torque should be $1/8^{th}$ of the torque presented at full speed. The torque settings for the desired reported speeds can be calculated based on motor speed and the pump affinity laws. The CA IOUs propose that pool pump motor efficiency should be tested according to IEEE-114-2010 at the torque settings shown in Table 2.1 below.

Table 2.1: Proposed Torque Settings for Pool Pump Motors

Speed (RPMs)		Torque Settings (N-m)
S^1	Full Output Speed (RPM)	T^1
S^2	Half Speed (if applicable) (RPM)	$(S^2/S^1)^3 * T^1$ or (1/8)
S^3	Lowest Operational Speed (if applicable) (RPM)	$(S^3/S^1)^3 * T^1$
S^X	Other Preset Speeds (if applicable) (RPM)	$(S^X/S^1)^3 * T^1$

The full-load torque setting from the IEEE-114-2010 test procedure should be modified so that

$$T^l = (k*P^C)/n$$

Where

"T^l" is the torque in N-m
"n" is the motor nameplate speed (RPM)
"k" is 9.549 for T^l in N-m
P^C is the corrected motor capacity (watts)

And where: $P^C = P*(SF^N/SF^1)$

Where
"P" is the motor nameplate horsepower (W)
"SF^N" is the motor nameplate service factor
"SF^1" is the industry standard service factor of 1.15

The CA IOUs have also proposed modifying the "power" input to the torque equation to account for the unique design and use of service factor in pool pump motors. Many pool pump motors advertise service factors at upwards of 1.65 which is far greater than typical motor service factors of 1.15 for a variety of reasons, but mainly for marketing purposes. To understand the true pool pump motor capacity, the CA IOUs propose

dividing the nameplate service factor by 1.15 as this will give a more realistic representation of the full load capacity.

The CA IOUs are currently engaging with the pool pump motor industry regarding this proposal to change the motor efficiency test procedure and look forward to working with CEC staff to resolve this issue. Please see Appendix A for proposed pump and motor test procedure language for Section 1604 (g)(3)(4).

2. Additional Efficiency Data from Updated Test Procedure

CEC REQUEST

The Energy Commission is interested in collecting additional and updated efficiency data (post-2010) for pool pump motors and pool pump and motor combinations. Specifically, the Energy Commission seeks data from any updated test procedure described above. The Energy Commission is also interested in data that characterizes the efficiencies of commercial pool pump motors and pool pump and motor combinations.

CA IOU RESPONSE

The CA IOUs do not support changing the pump test procedure as the existing pump test procedure is the best for all intended purposes of Title 20. However, we do support changes to the motor efficiency test procedure, IEEE-114-2010, as is described above in Section 1. The CA IOUs have observed that some manufacturers are already testing and reporting their motor efficiency in a similar manner for speeds less than full output, whereas other manufacturers are not. We believe the changes proposed above will add clarity to the motor test procedure.

Regarding commercial pool pump motors, the CA IOUs estimate that 75% of commercial pool pump equipment is residential scale equipment and therefor the efficiency of a majority of commercial motors is captured by the CEC and APSP pool pump &motor databases. We do not propose that CEC set standards for large commercial pool pump motors at this time.

3. Proposed Efficiency Standards

CEC REQUEST

The Energy Commission seeks input on the efficiency standards and reporting requirements of a proposed pool pump standards, including:

a. New or updated performance efficiency standards recommended for motors, along with supporting documentation and feasibility of standards. Please address how the suggested standards affect different size motors.

b. Discussion of the feasibility of performance standards such as energy factor measured at a specific head for pumps and motors versus prescriptive approaches.

c. Any suggested energy factors and the corresponding dynamic head as standards for single, double, multiple, and variable speed pumps and motors.

d. Any suggested changes to the current reporting requirements (Title 20, Section 1606, Table X (G)), to ensure compliance with the standards suggested above in response to Data Request 3. a, b, and c.

CA IOU RESPONSE

Response to a

The CA IOUs continue to support replacing the current prescriptive pool pump motor design regulation with a performance-based one for single phase pool pump motors under 5HP. We propose that new and replacement dedicated purpose pool pump motors should meet minimum performance efficiency levels as follows below. The analysis supporting the development of these levels can be found in the July 29th, 2013 CASE Report.

- *Single-speed pump motors: 70 percent full-load efficiency.*
- *Dual-speed pump motors: 70 percent full-load efficiency and 55 percent efficiency at half or "low" speed.*
- *Variable-speed and multi-speed pump motors: 80 percent full-load efficiency and 70 percent efficiency at half or "low" speed.*

In terms how the standards affect the different sizes of motors, it depends on the motor design, but generally, the smaller motors are made with cheaper components and tend to be less efficient. For variable speed motors, most all models in the CEC database qualify at the proposed levels mentioned above regardless of size. For dual-speed and single speed motors, a majority of the motors which don't meet the proposed standards are smaller, though models of all sizes are impacted. Overall, the greatest savings will come from increasing the efficiency of small single-speed motors as these motors are sold in high volumes for small aboveground and in-ground pools, booster pumps and auxiliary applications. Additionally, significant savings will come from small commercial single speed pool pump motors which are single phase and under 5HP due to their long duty cycles.

Response to b & c

Currently, the CEC's two, multi, or variable speed standard for residential filtration pumps is technically a motor standard. While switching to Energy Factor could align with ENERGY STAR, at this time, we support CEC maintaining the current motor standard as Energy Factor cannot be applied to replacement motors. This will allow for simplicity and clarity in the Title 20 pool pump and motor standards.

Response to d

The CA IOUs also propose:

- *Extending the standard to cover all single phase dedicated purpose pool pump motors under 5 HP (whether new (OEM), or for replacement, whether residential or not, and whether for filtration or not)*

- *Requiring reporting of performance data (motor efficiency, energy factor, flow, apparent power, etc.) for pumps and motors (as applicable) for the following speeds[2]:*
    - *Full Load Speed (RPM)*
    - *Half Speed (if applicable) (RPM)*
    - *Lowest Operational Speed (if applicable) (RPM)*
    - *Other Preset Speeds (if applicable) (RPM)*

The CA IOUs also support the creation of two separate databases: one for replacement pool pump motors and one for pool pump and motor combinations. APSP currently organizes their databases in this format and we believe this will best serve the users of the CEC appliance database. For further details about the CA IOUs proposed reporting requirements please see Appendix B below.

4. Market for Rebuilt or Refurbished Pool Pump Motors

CEC REQUEST:

Pool pump motors are frequently rebuilt or refurbished and are cost-competitive with newer and more efficient motors. The Energy Commission is therefore interested in any data related to the volume and extent that these motors are used in the current market. The Energy Commission is interested in any suggested approaches to ensure the rebuilt or refurbished motors are efficient, and whether representative local offices could certify them to meet suggested standards.

CA IOU RESPONSE

The CA IOUs commend the CEC for looking for additional savings from pool pump motors, however we do not believe the rebuilt and refurbished pool pump motor market (single phase under 5HP) is sizeable enough to warrant attention from CEC staff and Title 20 standards at this time. We encourage the CEC to focus on the energy efficiency of new pumps and motors which are sold in California.

[2] See Appendix A for more information. Proposed speeds for which data should be tested and reported are slightly different (simplified) from original IOU CASE proposal.

APPENDIX A: Proposed Title 20 Language: 1604 (g)(3)(4)

1604 (g) Section 1604. Test Methods for Specific Appliances. Pool Heaters, Portable Electric Spas, Residential Pool Pump and Motor Combinations, and Replacement Residential Pool Pump Motors, Pool Pump Controls, and LED Pool Lights.

…

(3) Test Method for Residential Pool Pump and Motor Combinations

The test method for residential pool pumps and motor combinations is as follows:
(A) Reported motor efficiency shall be verifiable by test method described in Section1604 (g)(4).
(B) ANSI/HI 1.6-~~2000~~ 2011 shall be used for the measurement of pump efficiency.
(C) Tests shall be conducted using unmodified, manufactured, and fully assembled pump, including strainer basket when applicable.

~~(C)~~ (D) Three system curves shall be calculated:

Curve A: $H = 0.0167 \times F^2$
Curve B: $H = 0.050 \times F^2$
Curve C: $H = 0.0082 \times F^2$

Where:
H is the total system head in feet of water.
F is the flow rate in gallons per minute (gpm).

~~(D)~~ (E) For each curve (A, B, ~~or~~ and C), the pump head shall be adjusted until the flow and head lie on the curve. The following shall be tested and reported ~~(i) for each curve for single-speed pumps or (ii) for each curve at both highest and lowest speeds for two-, multi-, or variable-speed pumps for the intersect point of the pump performance curve with each system curve:~~ for the intersect point of the pump performance curve with each system curve:

Where the Energy Factor (EF) is calculated as: EF = Flow (gpm) * 60 / Power (watts)

1. Motor nominal speed (RPM)
2. Flow (gallons per minute)
3. Power and apparent power (watts and volt amps)
4. Energy Factor (gallons per watt hour)
5. Motor efficiency (percent %)

(i) For single-speed, two-speed or multi-speed pumps with fixed, non-adjustable speeds, test and report performance at the intersect point of the pump performance curve with each system curve (CEC Curves A, B and C). Intersect data shall be reported for each speed and system curve.

(ii) For two-, multi-, or variable-speed pumps with adjustable speeds, test and report performance at the intersect point of the pump performance curve with each system curve (CEC Curves A, B and C). Intersect data shall be reported for the full output, half, lowest operational, and the best efficiency speeds.

(4) Test Method for Pool Pump Motors

The test method for pool pump motors is as follows:

(A) Each pool pump motor shall be tested and in accordance with IEEE-114-2010 with modified torque settings for testing at speeds other than full output as is shown in Table X.

(i) For single-speed, two-speed or multi-speed pool pump motors with fixed, non-adjustable speeds, test and report motor efficiency for each speed (as applicable).

(ii) For two-, multi-, or variable-speed pool pump motors with adjustable speeds, test and report motor efficiency for full output, half and lowest operational speeds.

Table X: Torque Settings for Pool Pump Motors

Speed (RPMs)		Torque Settings (N-m)
S^1	Full Output Speed (RPM)	T^1
S^2	Half Speed (if applicable) (RPM)	$(S^2/S^1)^{\wedge 3} * T^1$ or (1/8)
S^3	Lowest Operational Speed (if applicable) (RPM)	$(S^3/S^1)^{\wedge 3} * T^1$
S^X	Other Preset Speeds (if applicable) (RPM)	$(S^X/S^1)^{\wedge 3} * T^1$

The full-load torque setting from the IEEE-114-2010 test procedure should be modified so that:

$T^1 = (k*P^C)/n$

Where

"T^1" is the torque in N-m
"n" is the motor nameplate speed (RPM)
"k" is 9.549 for T^1 in N-m
P^C is the corrected motor capacity (watts)

And where: $P^C = P*(SF^N/SF^I)$

Where
"P" is the motor nameplate horsepower (W)
"SF^N" is the motor nameplate service factor
"SF^I" is the industry standard service factor of 1.15

APPENDIX B: Section 1606. Filing by Manufacturers; Listing of Appliances in Database.

	Appliance	Required Information		Permissible Answers
G	Residential Pool Pump and Motor Combinations ~~and Replacement Residential Pool Pump Motors~~	Pump Motor Construction		PSC, Capacitor Start-Capacitor Run, ECM, Capacitor Start-induction run, split-phase, Permanent magnet synchronous motor, 3-phase
		Pump Motor Design		Single-speed, dual-speed, multi-speed, variable-speed
		Frame		
		Nameplate Horsepower		
		Motor Service Factor		
		Motor Capacity		
		Full Output Speed (in RPM)		
		Half Speed (if applicable, in RPM)		
		Lowest Operational Speed (if applicable, in RPM)		
		Best Efficiency Speed (if applicable, in RPM)		
		Other Preset Speeds (if applicable, in RPM)		
		Motor has Capability of Operating at Two or More Speeds with the Low Speed having a Rotation Rate that is No More than One-Half of the Motor's Maximum Rotation Rate		Yes, no
		~~Unit Type~~		~~Residential Pool Pump and Motor Combination, Replacement Residential Pool Pump Motor~~
		Pump and Motor combination includes integral controller		Yes, no
		This information must be reported for each tested speed, as	Rated Horsepower	
			Power Factor (%)	
			Motor Efficiency (%)	
			Flow for Curve 'A' (in gpm)	

		applicable.	Power for Curve 'A' (in watts)	
			Energy Factor for Curve 'A' (in gallons per watt-hour)	
			Flow for Curve 'B' (in gpm)	
			Power for Curve 'B' (in watts)	
			Energy Factor for Curve 'B' (in gallons per watt-hour)	
			Flow for Curve 'C' (in gpm)	
			Power for Curve 'C' (in watts)	
			Energy Factor for Curve 'C' (in gallons per watt-hour)	
	Replacement Pool Pump Motors	Motor Construction		PSC, Capacitor Start-Capacitor Run, ECM, Capacitor Start-induction run, split-phase, Permanent magnet synchronous motor, 3-phase
		Motor Design		Single-speed, dual-speed, multi-speed, variable-speed
		Frame		
		Nameplate Horsepower		
		Motor Service Factor		
		Motor Capacity		
		Full Output Speed (in RPM)		
		Half Speed (if applicable, in RPM)		
		Lowest Operational Speed (if applicable, in RPM)		
		Other Preset Speeds (if applicable, in RPM)		
		Motor has Capability of Operating at Two or More Speeds with the Low Speed having a Rotation Rate that is No More than One-		Yes, no

		Half of the Motor's Maximum Rotation Rate		
		This information must be reported for each speed listed above, as applicable.	Rated Horsepower	
			Power Factor (%)	
			Motor Efficiency (%)	
	Pool Pump Controllers	Standby Power Demand in Watts		
		Power Factor (%)		
		Controller has ability to control each of the following motor designs.	Variable Speed Motor	Yes, no
			Dual Speed Motor	Yes, no
			Multi-Speed Motor	Yes, no

* "Identifier" information as described in Section 1602(a).

1 = Voluntary for federally-regulated appliances