Proposal Information Template for:
Residential Pool Pump Measure Revisions

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2008 Appliance Efficiency Standards

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Purpose

This document is a report template to be used by researchers who are evaluating proposed changes to the California Energy Commission's (Commission) appliance efficiency regulations (Title 20, Cal. Code Regs,, §§ 1601 – 1608) This report specifically covers revisions to current Residential Pool Pump appliance standards which were adopted by the California Energy Commission on Oct 11, 2006.

This template covers the following 3 pool pump topics:

- Replacement pool pump motors
- High-efficiency multi-speed motor and control clarifications
- New pool pump test curve

Background

There are approximately one million above ground residential swimming pools in California, the vast majority of which use a single-speed motor to drive the filtration pump to circulate and filter swimming pool water in order to remove particulate debris and maintain clarity. Residential pump motors range in size from one half to three horsepower (hp), are operated an average of about 4.2 hours per day, but in some cases up to 10 hours per day, and draw approximately one kW per nominal horsepower.

Using pumps with 2-speed motors offer a significant opportunity for energy savings by taking advantage of pump affinity laws. Operating a pump equipped with a two-speed motor at half speed for twice as long moves the same volume of water, but in theory uses only one-quarter the amount of energy. In reality, currently available two-speed motors are less efficient at the lower speed, so energy savings are closer to 55%. Low speed operation is generally adequate for filtering, but high speed may be needed for operating pool sweeps for a few hours daily, and for reforming DE filters after backwashing.

Residential Pool Pumps were first included in the 2005 Title-20 appliance standards that were adopted at the end of 2005. Residential Swimming Pool standards are included in the 2008 Title-24 building standards which are expected adopted in April, 2008 and will become effective XXX, 2009. The 2005 Title-20 standards regulated pool pump motor types and required testing and listing of pool pump motor combinations effective January 1st, 2006. In addition, multi-speed motors and controls were required for pool pumps of greater than 1 HP effective January 1st, 2008. The 2008 Title-24 standards require pool design standards that include minimum pool turnover times and maximum flow velocities.

Since the implementation of the standards there have been ongoing discussions between PG&E and the pool industry (principally the Association of Pool and Spa Professionals, APSP) in regards to updates and revisions including the following:

- Accommodate new pool equipment such as variable-speed motors
- Clarify whether or not replacement motors are covered
- Add a third pool pump test curve to represent efficient pool piping design.

Overview

Replacement pool pump motors

The current pool pump standards do not refer to pool pumps, pool pump motors, and pool pump motor combinations consistently. In addition, pool pump motors are not explicitly identified in the scope of the standards. Because of this, it is currently the interpretation of the CEC that the standards do not cover replacement pool pump motors, although this was the intent of the those involved in writing the standards.

Description of Standards Proposal	The scope of Residential Pool Pumps should be amended to explicitly include the pump, pump motor, and replacement motors. .
California Stock and Sales	There are approximately 1.1 million private, residential, in-ground swimming pools in California, with annual sales of 34,000. Approximately 113,000 pool pump motors are replaced each year.
Energy Savings and Demand Reduction	Replacing an average 1.5 total hp single-speed pool pump motor with a 1.5 total hp two-speed motor will save 881 kWh/yr which will result in statewide savings of 497 GWh and 132 MW over the first ten years of the standard.
Economic Analysis	Installation of a two-speed replacement motor is estimated to cost $422 more than a single-speed replacement. Present value of the energy savings over the 10 year lifetime of the motor is $821, resulting in a 1.9 benefit-to-cost ratio.
Non-Energy Benefits	Operating swimming pool filtration equipment at low flow rates greatly reduces noise and can reduce entrapment issues due to high flow velocities.

Environmental Impacts	None
Acceptance Issues	Not all pool service companies have experience with two-speed motors. Increasing the cost of a pool pump motor replacement above $500 may require that it be done by a licensed contractor.
Federal Preemption or other Regulatory or Legislative Considerations	Pool pump motors are definite purpose motors and as such are not presently covered by federal efficiency regulations.

High-efficiency multi-speed motor and control clarifications

When the current standards were written the vast majority of residential pool pump motors were either single-speed or two-speed. Since then manufacturers have brought out an increasing variety of multi-speed and variable-speed motors. These can provide significant energy savings over conventional motors, but their performance is more difficult to characterize. Section 1605.3(g)(5)(B) needs to define what the lowest speed is.

New Pool Pump Test Curve

The 2008 Title-24 pool standards rely on a new pool system curve to size pumps for pools of greater than 25,000 gallons. This curve, referred to as "Curve C", was suggested by pool pump stakeholders and represents the system curve of a well designed, low pressure-drop pool. Adding Curve C to the test and listing requirements of filtration pumps will allow the data to be easily used for Title-24 compliance.

Methodology

The current appliance efficiency data base for pool pumps was used to estimate the efficiency of typical 1.5 hp single- and two-speed pumps. The data base was sorted by pump type and total horsepower and single- and two-speed pumps with close to 1.5 total hp were selected. Average energy factors for each type of pump was used to estimate annual energy use.

Two-speed motors can replace single-speed motors directly in most pumps, but they require a new two-speed controller and wiring which requires additional labor to install. Pool pump motors have an expected lifetime of 10 years, although the pump head can last much longer. We estimate that 113,000 pool pump motors are replaced each year, of these, we estimate:

- 30% will be replaced with a less than 1 hp motor and remain single-speed.
- 20% will replace the whole pump and will be covered by the current standard.
- 50% will be a motor replacement of greater than 1 hp.

Analysis and Results

12 single-speed 1.5 total hp pool pump motors were found in the current data base. 12 two-speed pumps which would work as direct replacements were found, though their high-speed power averaged 1.65 - slightly greater. Average Curve A characteristics are summarized in the Table 1.

Table1: Pool Pump Characteristics

Pump	Flow (gpm)	Power (W)	EF (gal/Wh)	Hours	Energy (kWh/yr)
Single-speed	49.0	1132	2.66	5.1	2058
Two-speed High	61.6	1810	2.05		
Two-speed Low	32.8	426	4.65	7.6	1177

The high-speed motor efficiency is lower than the single-speed efficiency due to the two-speed motor being slightly larger. In order to move 15,000 gallons of water per day the single-speed pump would need to run 5.1 hours per day and the two-speed pump would need to run 7.6 hours per day. Resulting savings is 881 kWh/yr.

Economic calculations are shown in Table 2. Incremental cost of the two-speed motor is $180, but an additional $160 is required for the controller and $80 for the added installation labor.

Table 2: Life Cycle Economics

Design Life (years)	Annual Energy Savings (kWh)	LCC ($/kWh)	Present Value of Energy Savings	Incremental Cost	Net Customer Present Value	BCR
10	881	0.931	$821	$422	$399	1.9

Statewide savings estimates are shown in Table 3. First year savings are based on one-half of required motor replacements being two-speed replacements. Full savings are realized in 2018 after all existing single-speed motors are replaced. Demand savings are based on one-third of pool pumps operating on-peak.

Table 3: Statewide Energy and Demand Savings

Annual Motor Replacements	Fraction Replaced with 2-speed	Energy Savings (GWh/year)		Demand Savings (MW)	
		First Year	2018	First Year	2018
113,000	50%	50	497	13	132

Recommendations

Replacement pool pump motors

Make the following changes in sections 1602 and 1604 to explicitly include replacement pool pump motors in the regulations:

1602(g)

"Residential pool pump" means a pump-motor combination used to circulate and filter pool water in order to maintain clarity and sanitation, and includes the centrifugal pump and the pump motor.

1604(g)

(3) Test Method for Residential Pool Pumps and Replacement Motors

(B) ANSI/HI 1.6-2000 shall be used for the measurement of pump ~~and motor combinations~~ efficiency.

High-efficiency multi-speed motor and control clarifications

Add the following definition to section 1602(g):

"Auxiliary pool load" means a feature or device that circulates pool water, in addition to that required for pool filtration, including, but not limited to, solar pool heating systems, filter backwashing, pool cleaners, waterfalls, fountains, and spas.

Make the following changes in section 1605.3(g)(5) to better accommodate high-efficiency multi-speed motors and to clarify control specifications as they relate to multi-speed products:

(B) ~~Two~~Multi-**Speed Capability**.

(i) **Pump Motors**. Pool pump motors with a capacity of greater than 1 total HP ~~or more~~ which are manufactured on or after January 1, 2008, including but not limited to those installed in existing residential pool pumps as replacement residential pool pump motors, shall have the capability of operating at two or more speeds with ~~a low~~ the lowest speed having a rotation rate that is no more than one-half of the motor's maximum rotation rate.

(ii) **Pump Controls**. Pool pump motor controls manufactured on or after January 1, 2008 that are sold for use with a two- or more speed pump shall have the following minimum capabilit~~y~~ies:

(a) The ability to operate the pool pump at two or more speeds.

(b) A filtration speed that is the default when no auxiliary pool loads are operating and is no more than one-half of the motor's maximum rotation speed.

(c) A high-speed override capability that returns to the filtration speed within twenty four hours.

New Pool Pump Test Curve

1604 (g) (3) Test Method for Residential Pool Pumps

(C) ~~Two~~ Three curves shall be calculated:
Curve A: H = 0.0167 x F2
Curve B: H = 0.050 x F2
Curve C: H = 0.0082 x F2
Where:
H is the total system head in feet of water.
F is the flow rate in gallons per minute (gpm).

(D) For each curve (A&~~,~~B&C), the pump head shall be adjusted until the flow and head lie on the curve. The following shall be reported for each curve and pump speed (two-speed pumps shall be tested at both high and low speeds). See Table V.

1606 Table V Data Submittal Requirements

	Appliance	*Required Information*	*Permissible Answers*
G	Residential Pool Pumps	Motor Construction	PSC, Cap Start-Cap Run, ECM, Cap Start-induction run, split-phase
		Motor Design	Single-speed, dual-speed, multiple-speed, variable-speed
		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
		~~Pool Pump~~ Motor Service Factor	
		Motor Efficiency (%)	
		Rated Horsepower	
		Flow for Curve 'A' (in gpm)	
		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)	

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