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FINAL STAFF REPORT

Analysis of Efficiency Standards and Marking for Spas

2018 Appliance Efficiency Rulemaking for Spas

Docket Number 18-AAER-02

California Energy Commission

Edmund G. Brown Jr., Governor

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PREFACE

On March 14, 2012, the California Energy Commission issued an order instituting rulemaking to begin considering standards, test procedures, labeling requirements, and other efficiency measures to amend the *Appliance Efficiency Regulations* (California Code of Regulations, Title 20, Sections 1601 through Section 1609). In this order, the Energy Commission identified appliances with the potential to save energy and/or water. The goal of the rulemaking is to develop proposed appliance efficiency standards and measures to realize these savings opportunities.

On March 25, 2013, the Energy Commission released an invitation to participate to provide interested parties the opportunity to inform the Commission about the products, markets, and industry characteristics of the appliances identified. The Commission reviewed the information and data received and hosted workshops May 28 through 31, 2013, to publicly vet this information.

On June 13, 2013, the Energy Commission released an "invitation to submit proposals" to seek proposals for standards, test procedures, labeling requirements, and other measures to improve the efficiency and reduce the energy or water consumption of the identified appliances.

On May 28, 2014, the Energy Commission released a notice to request additional information from interested parties to develop standards for network equipment, commercial clothes dryers, portable electric spas, and pool pumps and motors.

On January 28, 2016, the Energy Commission published a draft staff report, proposing performance standards for pool pump motors, and revised performance standards and labeling requirements for portable electric spas. On February 18, 2016, a staff workshop was held to review the report with interested parties and to gather public comment.

On June 16, 2016, the Energy Commission revised the report based on comments received at the workshop and in writing in the Commission docket. On July 13, 2016, the Commission held a staff workshop to review the revised report with interested parties and to gather public comment.

On July 12, 2017, the Energy Commission revised the report for portable electric spas based on comments received at the workshop and in writing in the Commission docket. On August 3, 2017, the Commission held a staff workshop to review the staff reports with interested parties and to gather public comment.

The Commission reviewed all the information received. This report contains the proposed regulations for portable electric spas with updates based on comments received at the workshop and in writing in the Energy Commission docket.

ABSTRACT

This report discusses proposed updates to the portable electric spa standards in the *Appliance Efficiency Regulations* (California Code of Regulations, Title 20, Sections 1601 to 1609). These proposed updates are part of the 2015 Appliance Efficiency Pre-Rulemaking (Docket #15-AAER-02). California Energy Commission staff analyzed the cost-effectiveness and technical feasibility of proposed efficiency standards for portable electric spas. Statewide energy use and savings and related environmental impacts and benefits are also included.

The proposed standby power standard and label requirement for portable electric spas would take effect on June 1, 2019. Staff also proposes to add and amend definitions in congruence with the proposed test method and efficiency standard. The proposed updates for standard, exercise, and combination spas would save about 19 gigawatt-hours the first year the standard is in effect. By 2028, when the year that stock turns over, the proposed standards would have an annual savings of about 218 gigawatt-hours. This equates to roughly $40 million in annual savings to California businesses and individuals. The inflatable spa proposal would save a total of 7.4 gigawatt-hours the first year, and a total of 23.8 gigawatt-hours when stock turns over in 2021, equivalent to $4.4 million in annual savings.

Staff analyzed available market data and concluded that the updates to the efficiency standards for portable electric spas would significantly reduce energy consumption and are technically feasible and cost effective.

Keywords: Appliance efficiency regulations, appliance regulations, energy efficiency, portable electric spas

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EXECUTIVE SUMMARY

This report presents the California Energy Commission staff's analysis of proposed efficiency standards and labeling requirement for portable electric spas.

Staff proposes to update standards for portable electric spas. The existing scope includes all types of portable electric spas, such as standards spas, exercise/swim spas, combination spas, and inflatable/collapsible spas. Staff proposes to adopt a uniform standby power performance standard for standard spas, exercise spas, and combination spas, and a separate uniform standby power performance standard for inflatable spas. In addition, staff proposes new test requirements for exercise spas and new label requirements for all portable electric spas. The standby power standard for standard, exercise, and combination spas will tighten power consumption on larger spas while providing modest relief on smaller spas. The proposed test method elaborates on existing requirements for test setup and measurements. The label requires manufacturers to display the standby power and list the spa cover(s) used during testing to achieve the reported standby power. The label will help consumers make informed choices based on energy use, boosting energy savings. The proposed standards would take effect June 1, 2019.

The estimated standby power savings for standard, exercise, and combination spas after complete stock turnover in 2028 is 95.4 gigawatt-hours per year, equivalent to $17.7 million in annual cost savings. The label requirement will yield additional energy savings estimated at 123 gigawatt-hours per year with $22.8 million of cost savings after complete stock turnover in 2028.

The estimated standby power savings for inflatable spas after complete stock turnover in 2021 is 22.5 gigawatt-hours per year, equivalent to $4.2 million in annual cost savings. The label requirement will yield an additional savings of about 1.3 gigawatt-hours per year with $0.2 million of cost savings after complete stock turnover in 2021.

Total savings from the proposed standards for portable electric spas are 242 gigawatt-hours per year after stock turnover for total consumer cost savings of $45 million per year.

CHAPTER 1: Legislative Criteria

Section 25402(c)(1) of the California Public Resources Code mandates that the California Energy Commission reduce the inefficient consumption of energy and water on a statewide basis by prescribing efficiency standards and other cost-effective measures[1] for appliances that require a significant amount of energy and water to operate. Such standards must be technologically feasible and attainable and must not result in any added total cost to the consumer over the designed life of the appliance.

In determining cost-effectiveness, the Energy Commission considers the value of the water or energy saved, the effect on product efficacy for the consumer, and the life-cycle cost of complying with the standard to the consumer. The Commission also considers other relevant factors including, but not limited to, the effect on housing costs, the statewide costs and benefits of the standard over the lifetime of the standard, the economic impact on California businesses, and alternative approaches and the associated costs.

1 These include energy and water consumption labeling, fleet averaging, incentive programs, and consumer education programs.

CHAPTER 2: Efficiency Policy

The Warren-Alquist Act[2] establishes the California Energy Commission as California's primary energy policy and planning agency. The act mandates that the Commission reduce the wasteful and inefficient consumption of energy and water in the state by prescribing statewide standards for minimum levels of operating efficiency for appliances that consume a significant amount of energy or water.

For nearly four decades, California has regularly increased the energy efficiency requirements for new appliances sold and new buildings constructed in the state. Through the Appliance Efficiency Program, appliance standards have shifted the marketplace toward more efficient products and practices, reaping significant benefits for California's consumers. The state's Title 20 Appliance Efficiency Regulations, along with federal appliance standards encompassing a variety of appliance types, saved an estimated 30,065 GWh[3] of electricity in 2015 alone, resulting in about $4.84 billion in savings[4] to California consumers. In the 1990s, the California Public Utilities Commission (CPUC) decoupled the utilities' financial results from their direct energy sales, promoting utility support for efficiency programs. These efforts have reduced peak load needs by more than 8,645 MW and continue to save about 32,594 GWh per year of electricity.[5] The potential for additional savings remains by increasing the energy efficiency and improving the use of appliances.

Reducing Electrical Energy Consumption to Address Climate Change

Appliance energy efficiency is identified as a key to achieving the greenhouse gas (GHG) emission reduction goals of Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006)[6] and Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016)[7], as well as the recommendations contained in the California Air Resources Board's *Climate Change Scoping Plan.*[8] Energy efficiency regulations are also identified as key components in reducing electrical energy consumption in the *2015 Integrated Energy Policy Report*

2 The Warren-Alquist State Energy Resources Conservation and Development Act, Division 15 of the Public Resources Code, § 25000 et seq., available at http://www.energy.ca.gov/2017publications/CEC-140-2017-001/CEC-140-2017-001.pdf.
3 California Energy Commission, *California Energy Demand 2016-2026 Revised Electricity Forecast*, January 2016, available at http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-03/TN207439_20160115T152221_California_Energy_Demand_20162026_Revised_Electricity_Forecast.pdf
4 Using current average electric power and natural gas rates of: residential electric rate of $0.164 per kilowatt-hour, commercial electric rate of $0.147 per kilowatt-hour. This estimate does not incorporate any costs associated with developing or complying with appliance standards.
5 California Energy Commission, *California Energy Demand 2016-2026 Revised Electricity Forecast*, January 2016, available at http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-03/TN207439_20160115T152221_California_Energy_Demand_20162026_Revised_Electricity_Forecast.pdf.
6 AB 32, California Global Warming Solutions Act of 2006, available at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200520060AB32.
7 SB 32, California Global Warming Solutions Act of 2006, available at https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB32.
8 *Climate Change Scoping Plan* available at http://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf.

(*IEPR*)[9] and the 2011 update to the CPUC's *Energy Efficiency Strategic Plan*.[10] Finally, Governor Edmund G. Brown Jr. and the Legislature have identified appliance efficiency standards as a key to doubling the energy efficiency savings necessary to put California on a path to reducing its GHG emissions to 80 percent below 1990 levels by 2050,[11] a commitment made to the Subnational Global Climate Leadership Memorandum of Understanding (Under 2 MOU) agreement along with 167 jurisdictions representing 33 countries.[12]

On October 7, 2015, the Governor signed the Clean Energy and Pollution Reduction Act of 2015, or Senate Bill 350 (De León, Chapter 547, Statutes of 2015), requiring the Energy Commission to establish annual targets for statewide energy efficiency savings and demand reduction that will achieve a doubling of energy savings from buildings and retail end uses by 2030.[13] Appliance efficiency standards will be critical in meeting this goal.[14] In addition, the Energy Commission adopted the *Existing Buildings Energy Efficiency Action Plan* in September 2015 and updated it in December 2016 to transform existing residential, commercial, and public buildings into energy-efficient buildings. [15] Appliance efficiency standards are essential to reducing the energy consumption in existing buildings from plug-in loads.

Loading Order for Meeting the State's Energy Needs

California's loading order places energy efficiency as the top priority for meeting energy needs. The *Energy Action Plan II* strongly supports the loading order, which describes the priority sequence for actions to address increasing energy needs. Energy efficiency and demand response are the preferred means of meeting the state's growing energy needs.[16]

For the past 30 years, while per capita electricity consumption in the United States has increased by nearly 50 percent, California's per capita electricity use has been nearly flat. Continued progress in cost-effective building and appliance standards and ongoing enhancements to efficiency programs implemented by investor-owned utilities (IOUs), publicly owned utilities, and other entities have contributed significantly to this achievement.[17]

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9 California Energy Commission, *2015 Integrated Energy Policy Report*, 2015, available at http://energy.ca.gov/2015_energypolicy/.

10 CPUC, *Energy Efficiency Strategic Plan*, updated January 2011, available at http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf.

11 Gov. Edmund G. Brown Jr., 2015 Inaugural Address, available at http://gov.ca.gov/news.php?id=18828.

12 Subnational Global Climate Leadership Memorandum of Understanding, available at http://under2mou.org/background/.

13 *2016 Integrated Energy Policy Report Update*, available at http://docketpublic.energy.ca.gov/PublicDocuments/16-IEPR-01/TN216281_20170228T131538_Final_2016_Integrated_Energy_Policy_Report_Update_Complete_Repo.pdf

14 Jones, Melissa, Michael Jaske, Michael Kenney, Brian Samuelson, Cynthia Rogers, Elena Giyenko, and Manjit Ahuja. 2017. Senate Bill 350: Doubling Energy Efficiency Savings by 2030. California Energy Commission. Publication Number: CEC-400-2017-010-CMF, available at http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR-06/TN221631_20171026T102305_Senate_Bill_350_Doubling_Energy_Efficiency_Savings_by_2030.pdf.

15 *California's Existing Buildings Energy Efficiency Action Plan – 2016 Update*, available at http://docketpublic.energy.ca.gov/PublicDocuments/16-EBP-01/TN214801_20161214T155117_Existing_Building_Energy_Efficency_Plan_Update_Deceber_2016_Thi.pdf.

16 *Energy Action Plan II*, available at http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF , p. 2.

17 *Energy Action Plan II*, available at http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF, p. 3.

Zero-Net-Energy Goals

The *California Long-Term Energy Efficiency Strategic Plan*,[18] adopted in 2008 by the CPUC and developed with the Energy Commission, the California Air Resources Board (CARB), the state's utilities, and other key stakeholders, is California's roadmap to achieving maximum energy savings between 2009 and 2020, and beyond. It includes four "big, bold strategies" as cornerstones for significant energy savings with widespread benefit for all Californians:[19]

- All new residential construction in California will be zero-net energy (ZNE) by 2020.
- All new commercial construction in California will be ZNE by 2030.
- Heating, ventilation, and air conditioning will be transformed to ensure that energy performance matches California's climate.
- All eligible low-income customers will have the opportunity to participate in the low-income energy efficiency program by 2020.

These strategies were selected based on the ability to achieve significant energy efficiency savings and bring energy-efficient technologies and products into the market.

On April 25, 2012, Governor Brown further targeted ZNE consumption for state-owned buildings. Executive Order B-18-12[20] requires ZNE consumption for 50 percent of the square footage of existing state-owned buildings by 2025 and ZNE consumption from all new or renovated state buildings beginning after 2025.

To achieve these goals, the Energy Commission has committed to adopting and implementing building and appliance regulations that reduce wasteful energy and water consumption. The *Long-Term Energy Efficiency Strategic Plan* directs the Commission to develop a phased and accelerated "top-down" approach to more stringent codes and standards.[21] It also calls for expanding the scope of appliance standards to plug loads, process loads, and water use. The Commission adopted its detailed plan for fulfilling these objectives in the *2013 Integrated Energy Policy Report (IEPR)*.[22]

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18 California Energy Commission and CPUC, *Long-Term Energy Efficiency Strategic Plan*, updated January 2011, available at http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf.

19 California Energy Commission and CPUC, *Long-Term Energy Efficiency Strategic Plan*, available at http://www.cpuc.ca.gov/NR/rdonlyres/14D34133-4741-4EBC-85EA-8AE8CF69D36F/0/EESP_onepager.pdf , p. 1.

20 Office of Edmund G. Brown Jr., Executive Order B-18-12, April 25, 2012, available at https://www.gov.ca.gov/news.php?id=17508.

21 California Energy Commission and CPUC, *Long-Term Energy Efficiency Strategic Plan*, p. 64.

22 California Energy Commission, *2013 IEPR*, pp. 21-26.

Governor's Clean Energy Jobs Plan

On June 15, 2010, as a part of his campaign, Governor Brown proposed the *Clean Energy Jobs Plan*,[23] which directed the Energy Commission to strengthen appliance efficiency standards for lighting, consumer electronics, and other products. The Governor noted that energy efficiency is the cheapest, fastest, and most reliable way to create jobs, save consumers money, and cut pollution from the power sector. He also stated that California's efficiency standards and programs have triggered innovation and creativity in the market. Today's appliances are not only more efficient, but they are less expensive and more versatile than ever due, in part, to California's leadership in the area.

23 Office of Edmund G. Brown Jr., *Clean Energy Jobs Plan,* available at http://gov.ca.gov/docs/Clean_Energy_Plan.pdf.

PORTABLE ELECTRIC SPAS

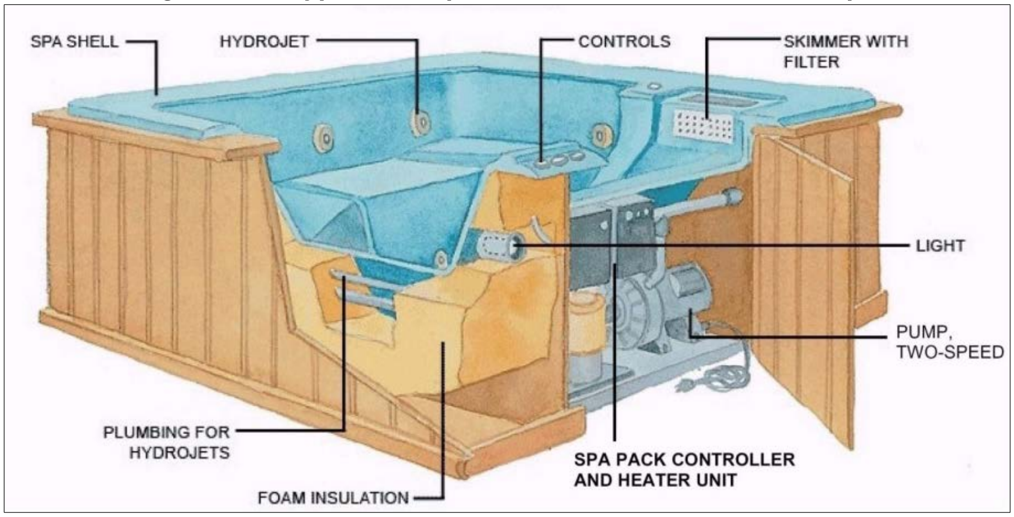
CHAPTER 3: Product Description

Portable electric spas are factory-built, free-standing electric spas or hot tub units that can be rigid, flexible, or inflatable. They are characterized as above-ground units that are electrically heated and not permanently installed in the ground or attached to a pool. They are supplied with pumps, heaters, and jets for heating, circulation, filtration, and maintenance, all of which result in significant energy consumption statewide.

According to the 2009 Residential Appliance Saturation Study, more than one million California residents own a spa, and of these spas approximately 42 percent are portable electric spas.[24] In 2015, the Association of Pool and Spa Professionals (APSP) estimated 15,000 inflatable spas were sold in California.[25] Uses vary from recreational to health and fitness. There are various comfort features and configurations of the heating system, the pumping system, and the filtering system for portable electric spas, making them one of the highest residential electrical loads.[26] The typical components in portable electric spas include a heating element, a pump and motor combination, a filter, insulation, a shell or tub wall, an exterior cabinet, jets, and a spa cover. [27] (See **Figure 3-1**.) These components provide opportunities for energy efficiency improvements. The average lifetime of a portable electric spa is 10 years, while a spa cover has an average lifetime of five years.[28] Inflatable spas have an estimated average lifetime of three years.[29]

24 California Energy Commission's 2009 Residential Appliance Saturation Study, http://www.energy.ca.gov/appliances/rass/.
25 APSP's presentation at staff workshop on February 18, 2016. Docket 15-AAER-02, TN 210390, February 17, 2016.
26 Davis Energy Group, Energy Solutions, (2004), *Analysis of Standards Options for Portable Electric Spas*. California: PG&E.
27 Hamill, A. I. (2012). *Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas*. California Polytechnic State University, San Luis Obispo, Mechanical Engineering . San Luis Obispo: Andrew Ian Hamill.
28 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, PG&E. California Statewide Utility Codes and Standards Program. Retrieved July 2015.
29 APSP's presentation at staff workshop on February 18, 2016. Docket 15-AAER-02, TN 210390, February 17, 2016.

Figure 3-1 : Typical Components in a Portable Electric Spa



Source: The Spa Guys, "How Hot Tubs Work"

As of March 2017, the Energy Commission's modernized appliance efficiency database system (MAEDBS) lists 1,334 certified portable electric spa entries. For this report, four types of portable electric spas were analyzed: standard, exercise, combination, and inflatable. Using the certified portable electric spa manufacturers in the MAEDBS as sources, the key differences among standard, exercise, combination, and inflatable spas are the volume capacity (or water surface area), the features, and the intended use.

Standard Spas

Standard spas are intended mostly for recreational use and provide the user with a comforting warm-water massage by electrically heating and aerating the water.[30] Standard spas may include hydrotherapy or therapeutic features that use a jet system that projects streams of water at different pressure outputs in multiple locations. Standard spas can be rigid bodied or non-rigid, containing separable structural components for easier storage and relocation, and range from requiring assembly to requiring no assembly. Examples of standard spas are shown in **Figure 3-2**. Example (1) shows a spa where the interior shell is acrylic, the exterior shell is a synthetic wood cabinet, and it is fully insulated with foam;[31] (2) shows a spa where the entire shell is made of a polyethylene (plastic) mold and is fully insulated with foam;[32] (3) shows a spa where the entire shell is made of textured vinyl and is fully insulated with a

30 Jacuzzi. (2011, November 30). "Jacuzzi Hot Tubs Lists the Most-Wanted Hot Tub Feature." Retrieved from Jacuzzi: http://www.jacuzzi.com/hot-tubs/about/press-releases/jacuzzi-hot-tubs-lists-most-wanted-hot-tub-feature/.

31 Jacuzzi Inc. (2017). Our Brand - Quality. Retrieved May 2017, from Jacuzzi: https://www.jacuzzi.com/en-us/hot-tubs/our-brand/quality.

32 The Home Depot. (2017). Lifesmart - Key Largo HD. Retrieved May 2017, from HomeDepot.com: http://www.homedepot.com/p/Lifesmart-Key-Largo-DLX-4-Person-Hot-Tub-Spa-with-Upgraded-20-Jet-Package-Includes-Free-Energy-Savings-Value-Package-and-Delivery-Key-Largo-HD/205326535.

patented foam blend;[33] and (4) shows an easy-assembly spa where the exterior shell is made of wooden panels and is lined with three-layered PVC vinyl.[34]

Figure 3-2: Portable Electric Spas – Standard Spas

Sources: (1) Jacuzzi Spas, Jacuzzi.com, (2) Lifesmart, HomeDepot.com, (3) Softub, Inc., Softubplus.com, (4) Comfort Line Products, Amazon.com

The volume capacity for portable spas can range from 120 gallons to more than 800 gallons.[35] Standard spas whether rigid or easily-stored, typically have a temperature range between 60°F and 104°F.[36] Sorting by volume range, there are 906 standard spas ranging from 110 to 850 gallons certified to MAEDBS.

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33 Softub. (2016). Softub 140. Retrieved May 2017, from Softub: https://www.softub.com/models-features/softub-140/.

34 Stellar Goods. (2017). Portable Spas: Spa-N-A-Box Deluxe Edition. Retrieved May 2017, from Stellar Goods: http://www.stellargoods.com/spa-n-a-box-deluxe-edition-with-real-wood-panels-hardcover/.

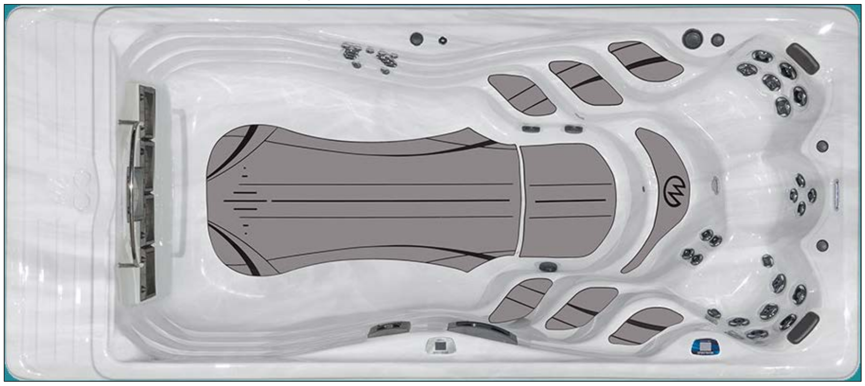
35 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, PG&E. California Statewide Utility Codes and Standards Program. Retrieved July 2015.

36 Energy Commission-certified portable electric spa manufacturers: Catalina Spas, Masters Spas Inc., Sundance, Dimension One Spas.

Exercise Spas

Exercise spas are intended for health, fitness, and recreation. (See **Figure 3-3**.) Health and fitness uses include swimming, aquatic fitness or exercise, and hydrotherapy. The swimming mode uses a propulsion system to create a current of rushing water the user can swim against. The therapeutic mode offers hydrotherapy configurations for exercising or for physical therapy, thus requiring a larger volume or water surface area.[37] USA Swimming and the Aquatic Exercise Association recommend a water temperature range of 78°F to 82°F for competitive swimming, 83°F to 88°F for aquatic exercise, and 90°F to 95°F for aquatic therapy. Most exercise spas have a built-in temperature range of 60°F to 104°F[38] and are capable of meeting those recommendations. Users can still select the temperature of their choice. Exercise spas range in capacity from 900 gallons to 2,500 gallons.[39]

Figure 3-3: Exercise Spa



Source: Michael Phelps Swim Spas

By filtering spa data in MAEDBS using the volume ranges stated above for exercise spas, there are 48 certified exercise spas ranging from 924 gallons to 2,400 gallons.

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37 Hartey, M. (2013). "Swim Spa Basics." Retrieved from Pool & Spa Outdoor: http://www.poolspaoutdoor.com/hot-tubs-swim-spas/swim-spas/articles/swim-spa-basics.aspx.

38 Energy Commission-certified portable electric spa manufacturers: Catalina Spas, Masters Spas Inc., Sundance, Dimension One Spas.

39 Various exercise spa manufacturers: Artic Spas, Dimension One Spas, and Master Spas Inc.

Combination Spas

Exercise spas that are designed to have two separate bodies of water at different temperatures are *combination spas*, with one body of water for swimming (swim portion) and the other for hydrotherapy (spa portion).[40] (See **Figure 3-4.**) Because of the two different temperatures and uses, it is important to separately characterize the energy consumption characteristics of each portion of a combination spa.

Figure 3-4: Combination Spa

Source: Grand Cayman Dual Zone Swim Spa

Although the Energy Commission does not collect data to distinguish exercise spas from combination spas, staff researched the certified entries in MAEDBS and determined there were nine certified combination spa models ranging from 1,620 gallons to 2,325 gallons.

Inflatable Spas

Like standard spas, inflatable spas are intended mostly for recreational use and provide the user with a comforting warm-water massage by electrically heating and aerating the water. Inflatable spas are typically non-rigid, easily stored, and require little or no assembly. **Figure 3-5** shows an inflatable spa, where the entire shell is made of three-layered polyvinyl chloride (PVC) vinyl and is filled with air to produce the structure of the spa, with an external, detachable pumping and heating system.[41]

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40 Poolandspa.com. (2015, August 21). "What Is a Swim Spa?" Retrieved from poolandspa.com: http://www.poolandspa.com/page6210.htm.
41 The Home Depot. (2017). Bestway - SaluSpa Miami. Retrieved May 2017, from HomeDepot.com: http://www.homedepot.com/p/Bestway-SaluSpa-Miami-4-Person-Inflatable-Hot-Tub-with-Heater-54124E/207052767.

Figure 3-5: Inflatable Spa

Source: Coleman SaluSpa, Bestwaycorp.us.

The volume capacity for inflatable spas can range from 130 gallons[42] to more than 260 gallons.[43] Inflatable spas are intended for seasonal use (6-7 months)[44] due to possible damage to the inflatable spa material when outdoor temperatures are below 40°F.[45] However, the California average minimum temperature is above 40°F, allowing these units to operate beyond seasonal use in some regions[46] and are sometimes used indoors.[47] Also, Canadian Spa Company, an inflatable spa manufacturer, markets inflatable spas that can function year-round.[48] Like standard spas, inflatable spas typically have a temperature range between 60°F and 104°F.[49] Inflatable spas are typically sold at a lower price point, thereby providing a lower budget, temporary, and movable option for consumers. Currently, there are no inflatable spas certified to MAEDBS as they are unable to meet the current standby power requirements.

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42 Amazon.com. SaluSpa Siena AirJet Inflatable Hot Tub. Retrieved March 16, 2017, from Amazon.com: https://www.amazon.com/SaluSpa-Siena-AirJet-Inflatable-Hot/dp/B01KQ2XAKS/ref=sr_1_8?ie=UTF8&qid=1491507649&sr=8-8&keywords=inflatable+spa .

43 The Home Depot. (n.d.). Canadian Spa Company Swift Current 5-Person Portable Spa. Retrieved March 16, 2017, from The Home Depot: http://www.homedepot.com/p/Canadian-Spa-Company-Swift-Current-5-Person-Portable-Spa-KP-10002/205523856.

44 APSP's presentation at staff workshop on February 18, 2016. Docket 15-AAER-02, TN 210390, February 17, 2016.

45 Bestway. (2017). SaluSpa Owner's Manual. Retrieved April 2017, from Bestway http://www.bestwaycorp.us/Product/ProductForm?productId=606#manuallink.

46 Western Regional Climate Center. (April 2017). Climate Anomaly Maps and Tables - Western U.S. Retrieved April 2017, from Western Region and State ACIS Maps: http://www.wrcc.dri.edu/anom/, See Appendix B for Monitoring Map.

47 Amazon.com customer reviews. Retrieved October 2017 from https://www.amazon.com/Intex-77-Inches-PureSpa-Portable-Massage/dp/B00HHO0IEU/ref=sr_1_2?ie=UTF8&qid=1509734776&sr=8-2&keywords=inflatable+spas&dpID=41j4eT16Q8L&preST=_SY300_QL70_&dpSrc=srch

48 Canadian Spa Company. (2017). Rio Grande Portable Spa. Retrieved November 7, 2017, from Canadian Spa Company: http://www.canadianspacompany.com/hot-tub-manufacturer-products/rio-grande-portable-spa/.

49 "Best Inflatable Hot Tub Reviews: Easier Way to Compare." *Inflatable Hot Tub Report.* (2016). http://www.inflatablehottubreport.com/.

Heating System

Portable electric spas heat water electrically. The heating system accounts for the majority of the energy consumption. Most heating systems use electric resistance heaters and, in some cases, waste heat from the pump system to heat and maintain the water at a set temperature.[50] Electric resistance heaters are 100 percent energy-efficient because all the electricity is converted to heat.[51] In practice, resistance heaters in portable electric spas can have efficiencies of 98 percent or more.[52] Thus, the energy efficiency is already high for heaters in a portable electric spa. While the electric heating element is efficient, a large amount of energy is required for initial startup heating and standby maintenance due to heat loss through the shell and cover.

According to a 2012 Cal Poly study, the heater is used during startup, standby, and active use. During startup mode, recently filled water is heated to a set temperature or temperature range with the spa cover on. The startup mode can take from 5 to more than 24 hours to reach a water temperature of 102°F for standard portable electric spas.[53] According to the owner's manual for the Bestway's Saluspa inflatable spa model, the startup mode can take from 9 to 32 hours or depending on the starting water temperature and ambient temperature, or 2-3 ° F per hour with an ambient temperature of 77°F to reach a water temperature of 104°F.[54] Duration of the startup is affected by multiple factors including, but not limited to, the insulation (or lack thereof) and ambient air temperature if used in colder climates.

After the water has reached the set temperature, the unit is put into standby mode to maintain the set temperature, and to circulate and filter the water. Most spas are kept in standby mode year-round when not in use, since startup mode requires a lot of time and energy.[55] More than half of the energy consumed during standby mode is due to maintaining heat. Over the lifetime of a standard unit, the standby mode represents typically 75 percent of the energy consumed by a portable electric spa compared to other modes and is thus considered representative of the efficiency of the spa.[56]

For smaller-volume, easy-storage units, such as inflatable spas, some are designed with a heating mode that includes an automatic shutoff switch after the spa has operated for 72 hours or will shut off if the desired temperature is not reached during the first 72 hours of operation.[57]

There are many configurations of the heating system; however, the heating function is generally the same. The pump draws water from the footwell through a suction fitting and/or from the surface through a

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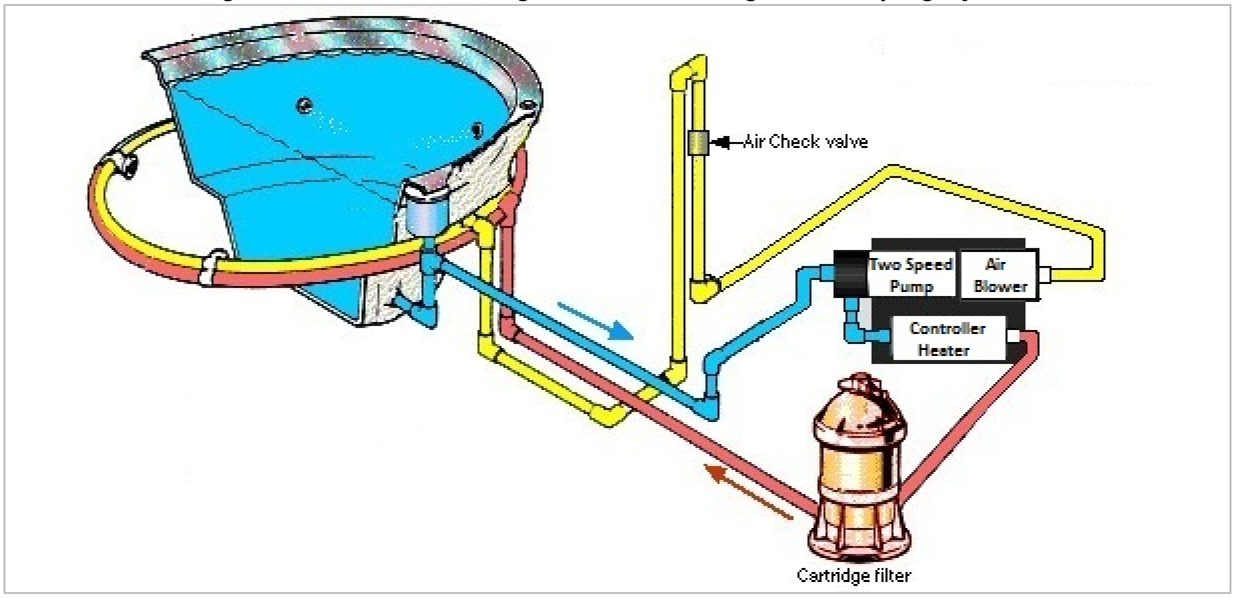
50 Davis Energy Group, Energy Solutions. (2004). *Analysis of Standards Options for Portable Electric Spas*. California: PG&E.
51 U.S. DOE. (2015). "Electric Resistance Heating." Retrieved from Energy.gov: http://energy.gov/energysaver/articles/electric-resistance-heating.
52 Davis Energy Group, Energy Solutions. (2004). *Analysis of Standards Options for Portable Electric Spas*. California: PG&E.
53 Hamill, A. I. (2012). *Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas*. California Polytechnic State University, San Luis Obispo, Mechanical Engineering. San Luis Obispo: Andrew Ian Hamill.
54 Bestway. (2017). SaluSpa Owner's Manual. Retrieved April 2017, from Bestway http://www.bestwaycorp.us/Product/ProductForm?productId=606#manuallink.
55 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, PG&E. California Statewide Utility Codes and Standards Program. Retrieved July 2015.
56 Davis Energy Group, Energy Solutions. (2004). *Analysis of Standards Options for Portable Electric Spas*. California: PG&E.
57 Intex Recreation Corp (2015). *PureSpa 77" Manual*. http://www.intexcorp.com/support/28403e.html.

skimmer/filter and pumps it to the heater. The warm water is returned to the spa through the jets or a main return. The water can be filtered before or after reaching the heater. **Figure 3-6** shows a general configuration

Figure 3-6: General Configuration of Heating and Pumping System



Source: Spa Plumbing Diagrams, PoolSpasHelp.com

Pumping System

After the heating system, the pumping system is the most energy-intensive integrated part of a portable electric spa and can account for 25 to 50 percent of the total energy consumed by the unit, depending on how often different features are used. Most portable electric spas have at least one pump for filtering, circulating, aerating, and jet action.[58] For example, some spas have a two-speed pump motor where the low-speed option is used during filtration and circulation modes, and the high-speed option is used for operating the jets. These two-speed pumps are not very efficient in any mode, especially during standby, because the motor is lightly loaded and running at low efficiency.[59] Instead of using a low-speed option on a two-speed pump, a small circulator pump can save more energy. Circulator pumps are designed to optimally run at low flows. The Codes and Standards Enhancement (CASE) Team observed many of the more affordable or entry level spas only have one two-speed pump, whereas more medium to high-end spas are using circulator pumps to save energy.[60] Other models include a separate small pump for

58 Davis Energy Group, Energy Solutions. (2004). Codes and Standards Enhancement Initiative - Analysis of Standards Options for Portable Electric Spas. Pacific Gas and Electric Company.

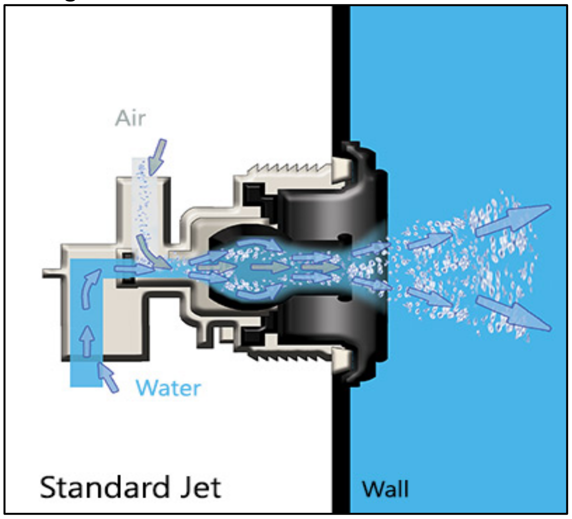
59 Western Area Power Administration. (2009). "What Goes Into an Energy-Efficient Spa or Hot Tub?" Lakewood: Western Area Power Administration, available at https://www.wapa.gov/EnergyServices/Documents/HotTubs.pdf.

60 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, PG&E. California Statewide Utility Codes and Standards Program. Retrieved July 2015

filtration and circulation, to save energy over the low-speed option on a larger pump.[61] Larger spas, like exercise spas, typically have multiple pumps. There are several ways of configuring the pumping system, which can result in variable energy use.[62]

Although the layout of the pumping system may differ, the heating and filtering process is similar. Water is pumped into the heating element or the filter, and then returned to the unit through the jets or a main return. For other maintenance duties and features, such as aeration, circulation, and hydrotherapy, the pumping system supplies water and air to the jets at varying pressures.[63] The type of jets within a system can vary as well. Some supply air and water separately, but most are a combination of air and water. (See **Figure 3-7**.) Portable electric spas that are marketed as hydrotherapy spas have multiple jets of different types. Increasing the number of jets increases the power demand of the pumping system. Thus, some units include a separate pump for jets and circulation.[64] Increasing the number of jets also increases the number of hoses which can act as heat exchangers with the surrounding air, losing heat and increasing heating energy requirements.[65]

Figure 3-7: Standard Jet Cross-Section



Source: H2X Swim Spas, Master Inc.

61 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, PG&E. California Statewide Utility Codes and Standards Program. Retrieved July 2015.

62 Davis Energy Group, Energy Solutions. (2004). Codes and Standards Enhancement Initiative - Analysis of Standards Options for Portable Electric Spas. Pacific Gas and Electric Company.

63 Hamill, A. I. (2012). *Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas*. California Polytechnic State University, San Luis Obispo, Mechanical Engineering . San Luis Obispo: Andrew Ian Hamill.

64 Western Area Power Administration. (2009). "What Goes Into an Energy-Efficient Spa or Hot Tub?" Lakewood: Western Area Power Administration.

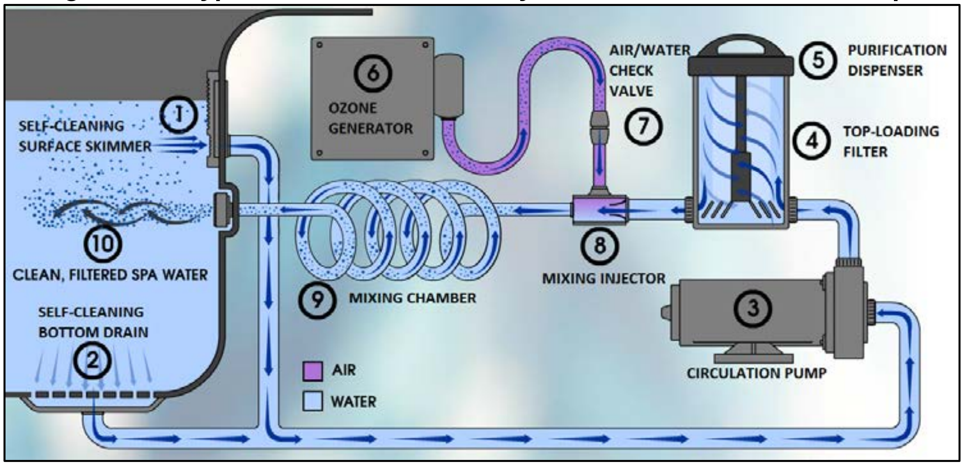
65 Davis Energy Group, Energy Solutions. (2004). Codes and Standards Enhancement Initiative - Analysis of Standards Options for Portable Electric Spas. Pacific Gas and Electric Company.

Water Treatment

The water treatment system includes the pumping system since water treatment requires circulation and suctioning of water through the filtration unit. Filtration cycles can vary from programmed settings to continuous settings. The filtration system can have various configurations and can include different types of water treatment mechanisms to improve water quality, such as pleated cartridge filters, media filters, skimmers, an ozonator, ultraviolet (UV) system, and the addition of minerals and sanitizing chemicals.[66] A cartridge filter is the most common filtration system for smaller spas. Larger spas typically have a cartridge filter and an ozone treatment system paired together. (See **Figure 3-8**.)

Untreated water is suctioned through the cartridge filter, where large particles and contaminants are removed.[67] For units that include an ozone treatment system, the filtered water is injected and mixed with ozone (O_3), an oxidizing-agent that effectively treats organic and inorganic contaminants. The treated water is then returned to the water through the jets or a main return.[68]

Figure 3-8: Typical Water Treatment System in a Portable Electric Spa



Source: Baja Spas

66 The Spa Depot. (2015). "Hot Tub Maintenance." Retrieved from SpaDepot.com: http://www.spadepot.com/spacyclopedia/hot-tub-maintenance.htm.
67 National Academy of Sciences. (2007). "Filtration Systems - Technologies." Retrieved from Safe Drinking Water is Essential: http://www.koshland-science-museum.org/water/html/en/Treatment/Filtration-Systems-technologies.html#tech4.
68 National Academy of Sciences . (2007). "Chemical Disinfection/Oxidants - Technologies." Retrieved from Safe Drinking Water is Essential: http://www.koshland-science-museum.org/water/html/en/Treatment/Chemical-Disinfection-Oxidants-technologies.html#tech3.

Insulation and Spa Covers

Since portable electric spas circulate and heat water, reducing the heat loss presents an opportunity to save energy. To this end, manufacturers use good insulation and spa covers to combat heat and water loss. Insulation minimizes heat loss during operating and idle periods, while a spa cover minimizes heat loss and water loss through evaporation. Ensuring that a spa cover is being used and improving the cover and insulation reduce the work of the heater and the pump motor needed to maintain a set temperature during idle periods.

The spa unit insulation and spa cover offer the greatest opportunity to save energy, since they help retain the heat in the water by the design and construction materials. Insulation is used within the walls of the spa unit and within the spa cover. The insulation used within the walls or the cavity between the tub wall and the cabinet enclosure is usually either foam or fiberglass. There are various ways to insulate a hot tub. One way involves insulating the perimeter of the cabinet and sometimes the floor with spray foam (polyurethane) or flat panel rigid foam boards (polystyrene), while keeping the inner cabinet free of foam to produce an air barrier (See **Figure 3-9**). The air barrier acts as an insulator and can also transfer heat from the pumps or heating equipment to the plumbing of the hot tub.[69] Another type of heat loss barrier is a reflective foil barrier, which reflects the heat back into the hot tub. This is typically an additional layer to the foam barrier.[70] Full foam insulation means the entire cabinet or the majority of the cabinet is completely lined with foam. Areas around the heating equipment and areas surrounding the plumbing system are not typically insulated to allow access for maintenance and to avoid overheating.[71] Although according to the Energy Commission database, 100 percent of spas listed are fully insulated, the insulation application and insulation type varies, resulting in variable energy use.[72]

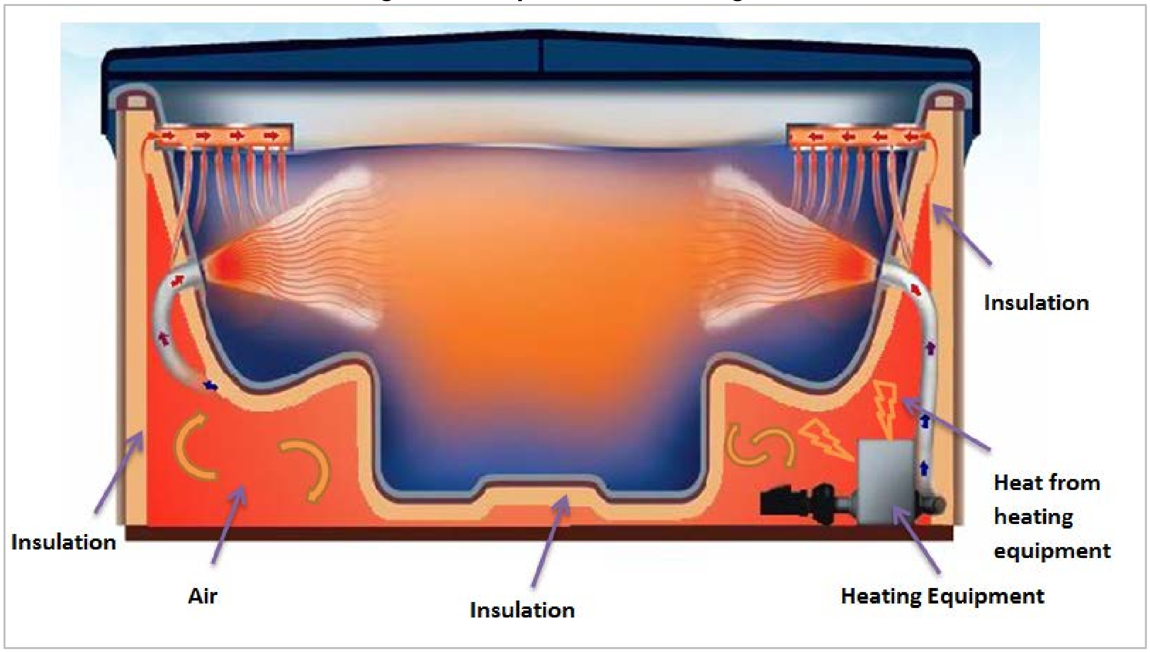
69 HotTubSpaTips.com. (2015). Hot Tub Insulation - Smoke and Mirrors. Retrieved November 3, 2017, from Hot Tub Spa Tips: http://hottubspatips.com/hot-tub-insulation-smoke-and-mirrors-best-hot-tubs/.

70 HotTubSpaTips.com. (2015). Hot Tub Insulation - Smoke and Mirrors. Retrieved November 3, 2017, from Hot Tub Spa Tips: http://hottubspatips.com/hot-tub-insulation-smoke-and-mirrors-best-hot-tubs/.

71 HotTubSpaTips.com. (2015). Hot Tub Insulation - Smoke and Mirrors. Retrieved November 3, 2017, from Hot Tub Spa Tips: http://hottubspatips.com/hot-tub-insulation-smoke-and-mirrors-best-hot-tubs/.

72 California Energy Commission. (December 6, 2017). MAEDBS. Retrieved from Appliance Search http://maedbs/Pages/ApplianceSearch.aspx.

Figure 3-9: Spa Insulation Diagram



Source: Hotubspatips.com, modified by Energy Commission staff.

Storable or easy-assembly spas are either fully insulated or partially insulated. A fully insulated storable spa is either assembled with foam walls (see **Figure 3-10a**) or a one-piece fused foam wall (see **Figure 3-2, spa 3**). Other easy-assembly spas are insulated with foam within the wooden panels that make the structure of the spa (see **Figure 3-10b**).

Figure 3-10: Insulation of Easy-Assembly Spas

Source: Canadian Spa Company

Inflatable spas are spas with a collapsible structure, where the structure is designed to be filled with air to form the body of the spa (See **Figure 3-11**). The design of the air chambers and the material that makes the structure of the spa varies by manufacturer and by the general shape of the inflatable spa. The material of the spa is usually made of PVC vinyl[73], textured vinyl, or different layered materials.[74] The air and the material act as an insulation barrier.

Figure 3-11: Inflatable Spa Structure

Source: Walmart.com, Intex 120 Bubble Jets 4 Person Octagonal PureSpa

Spa covers conserve heat by reducing heat flow due to conduction, convection, radiation, and evaporation. The design and insulation used in spa covers vary. Most portable electric spas use foam in combination with other barriers. The foam core within the spa cover acts as a thermal insulator, reducing heat transfer from the warm water to the colder air outside (**Figure 3-12**). The thermal resistance of the insulating material, in this case the foam core, is measured or rated by the R-value, which depends on the insulation type, thickness, and density. A high R-value indicates greater resistance to heat flow.[75] The arrows in **Figure 3-12** indicate heat loss dissipating through the foam core.

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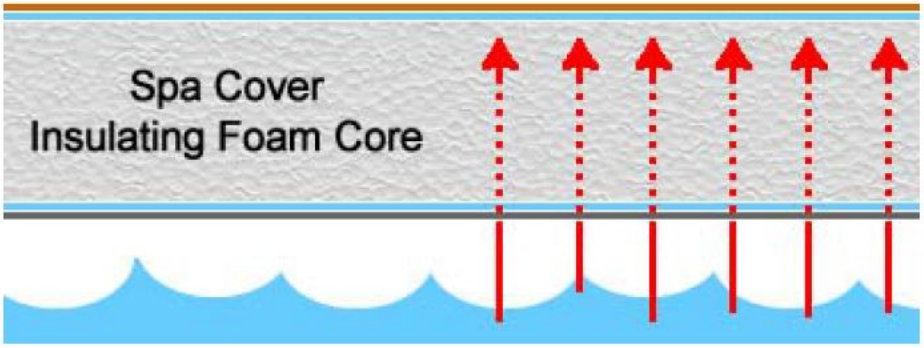
73 Amazon.com. (n.d.). Coleman Lay Z Spa Inflatable Hot Tub. Retrieved November 7, 2017, from Amazon.com: https://www.amazon.com/Coleman-Lay-Spa-Inflatable-Hot/dp/B00NB3P98G/ref=sr_1_4?ie=UTF8&qid=1510079057&sr=8-4&keywords=inflatable+spa.

74 M Spa. (n.d.). Innovation & Technology. Retrieved November 7, 2017, from M Spa: http://www.the-mspa.com/h-col-118.html.

75 U.S. DOE. (2015, April 27). *Insulation*. Retrieved from Energy.Gov: http://energy.gov/energysaver/articles/insulation.

Figure 3-12: Cross-Section of a Spa Cover



Source: Duratherm, The Spa Depot

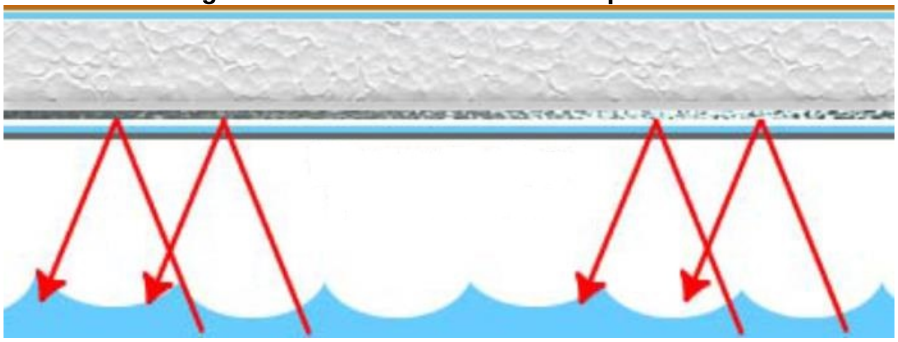
The foam core is typically made of polystyrene.[76] Polystyrene is a colorless, transparent thermoplastic.[77] Two types of rigid polystyrene are used as foam cores for spa covers: expanded polystyrene (EPS) and extruded polystyrene (XPS). EPS is composed of small plastic beads that are fused together by heat and pressure, leaving open voids between the beads, whereas XPS begins as a molten material that is extruded into a closed cell matrix (no spaces between cells). Both have different performance properties due to the manufacturing process for each.

Most spa covers are made of EPS foam as they are able to provide enough insulation and keep a rigid structure while being resistant to mold, mildew, or bacteria growth.[78] They are also lightweight and require only one person to apply or remove. XPS are also lightweight and resistant to mold, mildew, or bacteria growth but is less water-absorbent than EPS. The voids in EPS allow a significant amount of water to be absorbed. When the foam absorbs water, the insulation loses nearly all its thermal resistance. Water can also freeze and thaw, compromising the structural integrity of the foam. XPS also has a higher R-value than EPS when dry or wet. Dry EPS R-value ranges from 3.1 to 4.3 per inch, depending on the density. The density for EPS is related to the void space. The smaller the voids, the higher the density; increasing the R-value. The R-value for XPS is a uniform 5 per inch regardless of density, since the cell structure has no voids.[79] There is a significant opportunity to improve the insulation of the spa cover with efficient XPS insulation already in the market.

76 Hamill, A. I. (2012). *Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas*. California Polytechnic State University, San Luis Obispo, Mechanical Engineering . San Luis Obispo: Andrew Ian Hamill.
77 U.S. Department of Energy. (April 27, 2015). "Insulation Materials." Available at Energy.Gov. http://energy.gov/energysaver/articles/insulation-materials.
78 The Foam Factory. (January 18, 2012). *Insulate and Protect Your Hot Tub With a Custom Polystyrene Cover*. Retrieved from The Foam Factory at https://www.thefoamfactory.com/blog/index.php/insulate-and-protect-your-hot-tub-with-a-custom-polystyrene-cover.
79 Owens Corning Foam Insulation, LLC. (2013). "Technical Bulletin: For Foam Plastic Insulation, Extrusion Matters Performance Equals Resisting Water XPS Performs Better Than EPS." Toledo: Owens Corning.

The typical portable electric spa cover consists of a foam core typically wrapped with vinyl. To further increase the effectiveness of spa covers, a waterproof barrier (polyethylene plastic wrap) and a radiant barrier may be added to enclose the foam insulation.[80] The plastic wrap prevents water absorption (waterlogging) and exposure to water treatment chemicals. A radiant barrier uses a highly reflective material that re-emits heat rather than absorbing it (**Figure 3-13**).[81]

Figure 3-13: Radiant Barrier in a Spa Cover

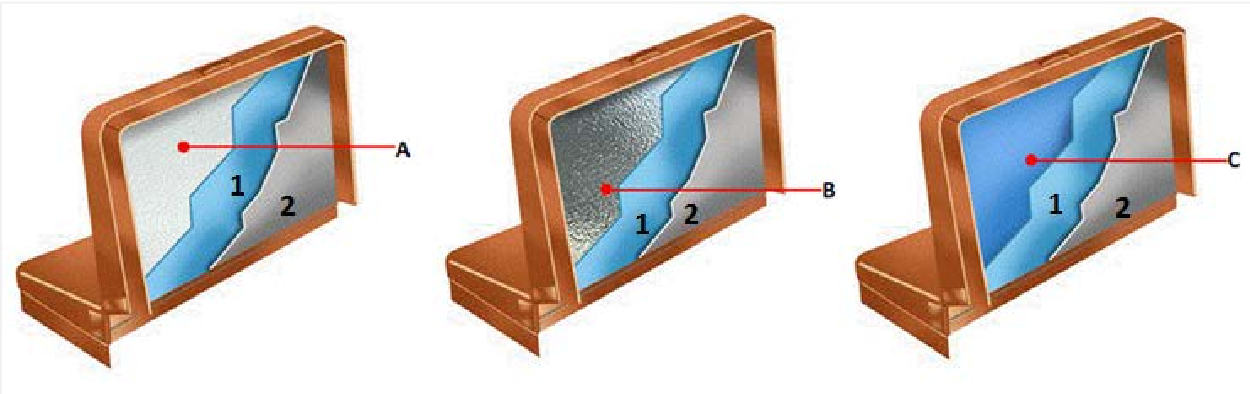


Heat flow being reflected from the radiant barrier.

Source: Duratherm, The Spa Depot

Examples of the type of enclosures and combination of barriers are shown in **Figure 3-14**. Each of these use a vinyl wrap, a moisture barrier (1), and a heavy-duty liner (2). From left to right, the first option shows the foam core (A) being enclosed by barriers (1) and (2); the second encloses the foam core with a reflective barrier (B) and barriers (1) and (2); and the third option encloses the foam with a another moisture barrier (C) and barriers (1) and (2).

Figure 3-14: Types of Spa Cover Enclosures

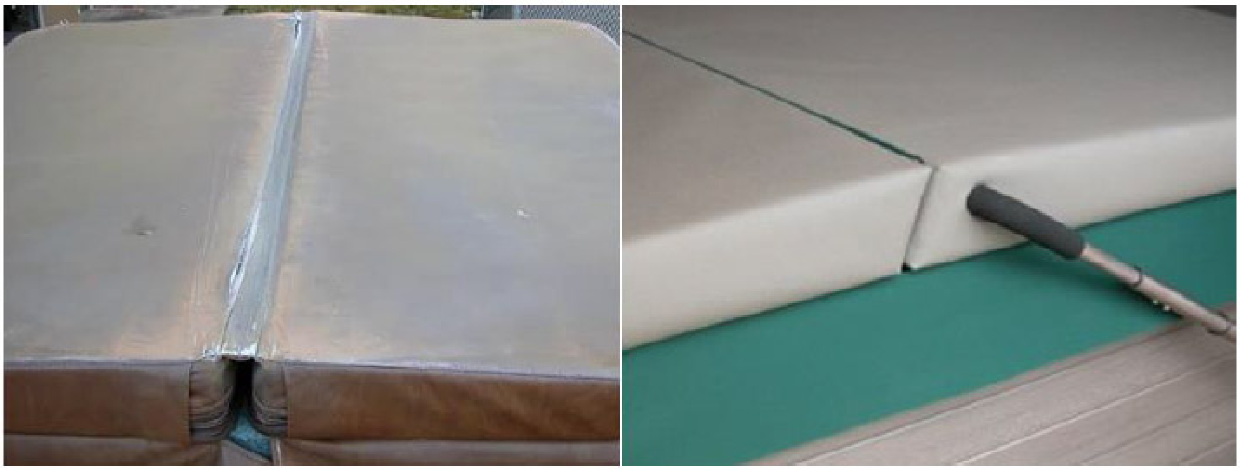


Source: Duratherm, The Spa Depot

80 Hamill, A. I. (2012). *Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas.* California Polytechnic State University, San Luis Obispo, Mechanical Engineering . San Luis Obispo: Andrew Ian Hamill.
81 U.S. DOE. (2015, April 27). *Insulation Materials*. Retrieved from Energy.Gov: http://energy.gov/energysaver/articles/insulation-materials.

The design and construction of spa covers vary depending on size and shape, but most covers are designed with a double-hinge or dual-hinge down the middle that allows the cover to fold in half. This hinge is typically not insulated, about two inches wide, and runs the entire length of the cover, making it easy to fold but allowing for significant heat loss.[82] Using a single-hinge design can greatly reduce the heat loss of spas. A single-hinge design eliminates the gap or insulates the gap preventing heat loss, as shown in **Figure 3-15**.[83]

Figure 3-15: Dual-Hinge and Single-Hinge Spa Covers



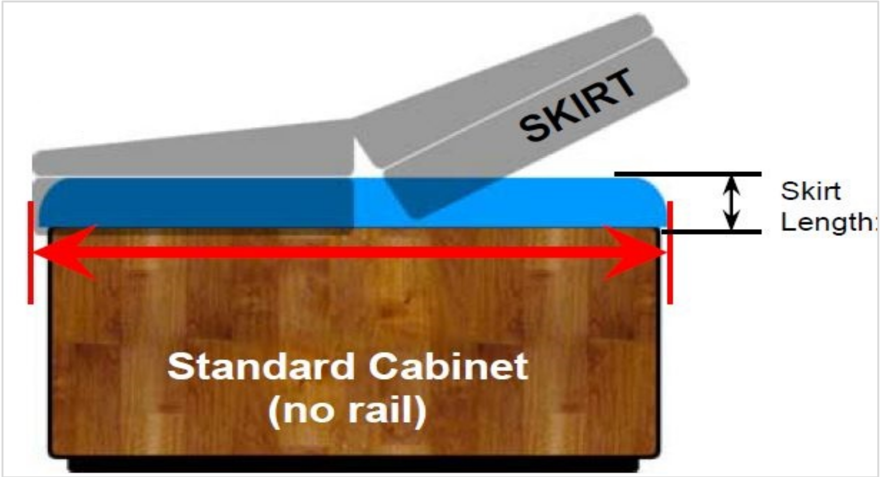
A single-hinge avoids heat loss by elminating the gap at the hinge compared to a dual-hinge.

Source: Portable Electric Spas CASE Report 2014

Another design factor creates a seal between the spa cover and the surface of the unit exterior. Most spa covers have a vinyl skirt around the perimeter that overlaps the exterior of the unit to reduce water and heat losses, as shown in **Figure 3-16.**[84]

82 Hamill, A. I. (2012). *Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas.* California Polytechnic State University, San Luis Obispo, Mechanical Engineering. San Luis Obispo: Andrew Ian Hamill.
83 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, PG&E. California Statewide Utility Code s and Standards Program. Retrieved July 2015.
84 Hamill, A. I. (2012). *Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas.* California Polytechnic State University, San Luis Obispo, Mechanical Engineering. San Luis Obispo: Andrew Ian Hamill.

Figure 3-16: Spa Cover Skirt



Source: Duratherm, The Spa Depot

Another source of reducing energy and water consumption is the use of a floating blanket, as shown in **Figure 3-17**. The floating blanket reduces moisture and chemical contact with the underside of the spa cover. It also acts as another barrier to prevent heat loss and evaporation.[85]

Figure 3-17: Spa Floating Blanket

Source: Duratherm, The Spa Depot

Inflatable spas use spa covers made of the same material as the spa, such as PVC vinyl or a combination of PVC vinyl cover and an inflatable lid.[86] Some inflatable spa manufacturers use an inflatable bladder[87] that sits on the water to prevent heat loss and evaporation (See **Figure 3-18**). Another common accessory is a ground cover mat or a heat preservation bubble mat used under the inflatable spa (See **Figure 3-18**).

85 Lara, D. (April 10, 2014). "Increasing the Energy Efficiency of Your Hot Tub or Spa." Retrieved from Hot Tub Works: http://www.hottubworks.com/blog/increasing-the-energy-efficiency-of-your-hot-tub-or-spa/.

86 Bestway, Intex, M-Spa, Canadian Spa Company, NetSpa, Lifesmart

87 M Spa. (n.d.). Value Added Accessories. Retrieved November 7, 2017, from M Spa: http://www.the-mspa.com/h-pr--0_363_29_-1.html.

The ground cover mat serves multiple purposes: (1) prevents the spa from being punctured, (2) provides additional padding to the user, (3) and prevents heat loss.

Figure 3-18: Common Inflatable Spa Components

Source: Value Added Accessories, www.the-mspa.com

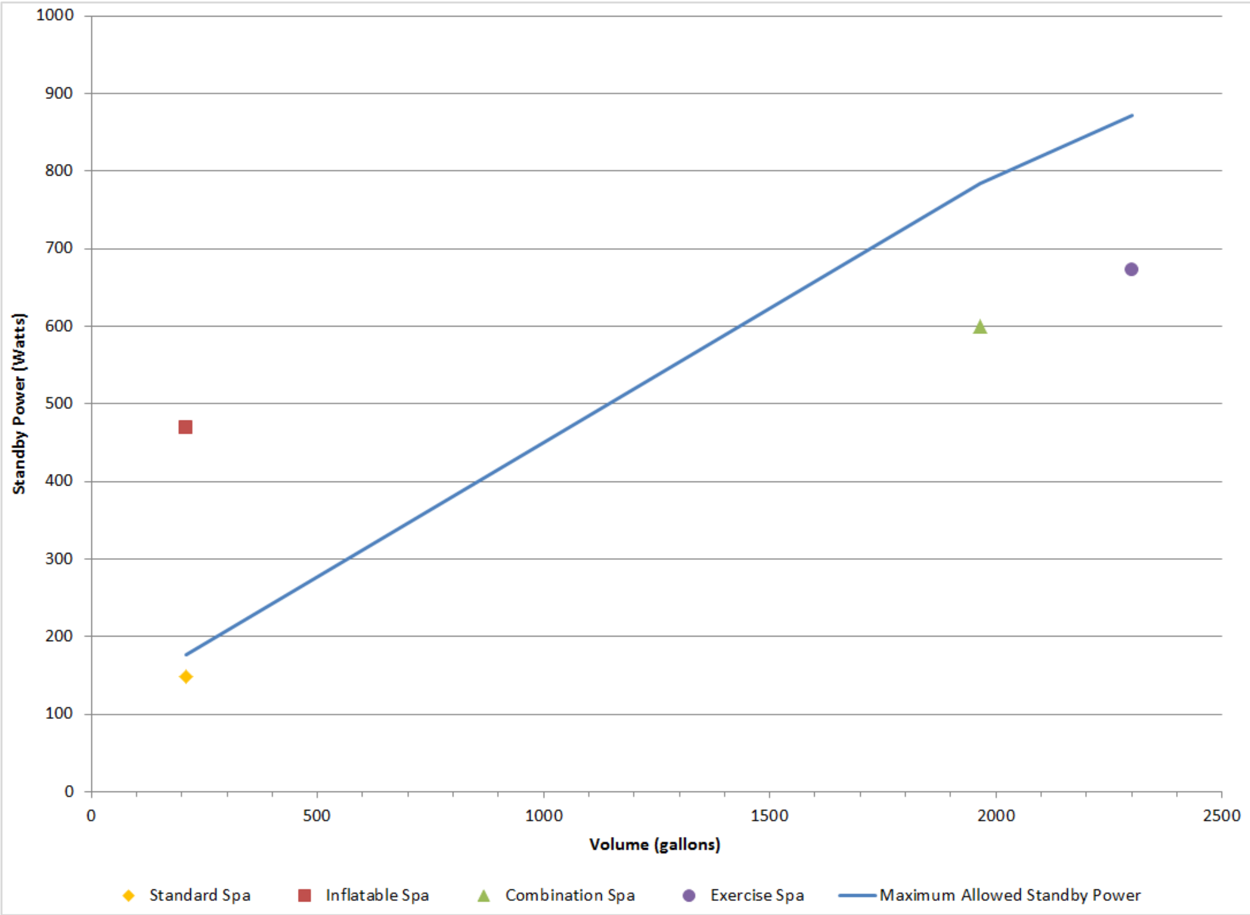
Consumers need to be made aware that a spa cover is a key component to their system, and to know which spa cover can produce the expected energy savings from their portable electric spa.

Energy Use

The total energy use of portable electric spas, according to the current Title 20 test method, is the total energy consumed during the default operation mode over a 72-hour period, with the spa cover that comes with the unit in use.[88] The total energy use is multiplied by the difference in the average water temperature and the average air temperature during the test, and then divided by the theoretical difference between the water temperature and the air temperature resulting in the normalized standby power. **Figure 3-19** compares the normalized standby power determined in the test procedure for four types of portable electric spas. (See **Appendix A** for details.) Again, the startup mode can take anywhere from 5 to 36 hours (See the section Heating System earlier in this chapter) and uses more power than during standby mode to reach the designated temperature. Thus, consumers are more likely to run the spa on standby mode rather than turning the spa off and on to save time, water, and energy. Therefore, the measuring the standby power is the best representation of spa usage since most spas are operated in standby mode longer than startup mode.

88 California Energy Commission, *2015 Appliance Efficiency Regulations*. Title 20, Section 1604(g)(2). May 2014.

Figure 3-19: Standby Mode Power Comparison across Different Portable Electric Spas



Source: MAEDBS, Energy Commission staff assumptions, and Intex's docketed test report (15-AAER-02 TN 212386)

Andrew Ian Hamill of California Polytechnic State University was able to determine which modes and cycles contribute most to the total standby power by analyzing 27 portable electric spas using the Title 20 test method. The modes, or cycles, were categorized in four groups: heater cycle, filtration cycle, pulses cycle, and constant filtration cycle. The heater cycle uses the heater along with the pumps to maintain the water at a set temperature range. The filtration cycle uses the pumps to draw the water into the filter and circulate the water to keep the water clean for a set period. The pulses cycle uses the pumps to circulate the water for a short period to get an accurate reading of the water temperature, to prevent possible freezing in the pipes, or to prevent bacterial growth in the pipes if left stagnant. The constant filtration cycle uses the pumps to continuously circulate water, providing filtration and preventing bacterial growth. Hamill's results indicate that an average of 72 percent of the heater cycle contributes to the total standby power. The percentage contribution to the standby power using the heater cycle ranged from 8 to 100 percent of total power. The average operating time during the heater cycle is 113 minutes per day. The power demand for the heater cycle ranged from 706 to 4,331 watts, with a median demand of 3,141 watts. The testing was of spas with capacities ranging from 142 to 470 gallons, typical of a standard spa. [89]

It is important to note the volume capacity range of the units tested because there are more than 185 portable electric spas with a volume between 470 and 2,400 gallons that would have a greater power demand during the heating cycle. Some of these are standard spas (up to roughly 900 gallons), while others are exercise or combination spas.

89 Hamill, A. I. (2012). *Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas*. California Polytechnic State University, San Luis Obispo, Mechanical Engineering . San Luis Obispo: Andrew Ian Hamill.

CHAPTER 4: Regulatory Approaches

Current Title 20 Standards

In 2004, the Energy Commission adopted standards and test procedures for portable electric spas that took effect in 2006.[90] These standards require that the standby power of a spa must not exceed a sliding scale of wattage as a function of the volume of a spa: [5 x Volume$^{2/3}$].

Federal Approaches

There is no federal standard and no ENERGY STAR specification for portable electric spas.

Industry Standards

The spa industry, represented by the Association of Pool and Spa Professionals (APSP), has accepted the American National Standard for Portable Electric Spa Energy Efficiency, which was approved by the American National Standard Institute (ANSI) on January 4, 2011, and published in partnership with the International Code Council (ICC). [91] The standard is referenced as ANSI/APSP/ICC-14 2011. A revision of the standard was approved by ANSI on September 12, 2014 and the reference was updated to ANSI/APSP/ICC-14 2014. The standard requires a more stringent standby power limit of [3.75 x Volume$^{2/3}$ +40] for spas and a standby power limit of [5 x Volume$^{2/3}$] for exercise spas. The standard provides specific testing requirements for exercise spas and combination spas. In addition, the standard requires labels on all spas to include information on spa volume, standby power, the maximum standby power allowed, total annual consumption in standby mode, annual standby energy cost, specified cover manufacturer, specified cover model number, spa manufacturer, and spa model number. The label will be printed on a removable adhesive-backed label and must remain adhered to the spa until point of sale to the consumer. Lastly, the standard requires all testing laboratories to be qualified by an accredited certification body to ensure the testing facility, testing equipment, and personnel are able to perform the tests in the standard.[92] The ANSI/APSP/ICC-14 standards represent best industry practice but are not mandatory or enforced. In general, the ANSI/APSP/ICC-14 2014 standard is similar to the Energy Commission's Title 20 standard with a few exceptions.

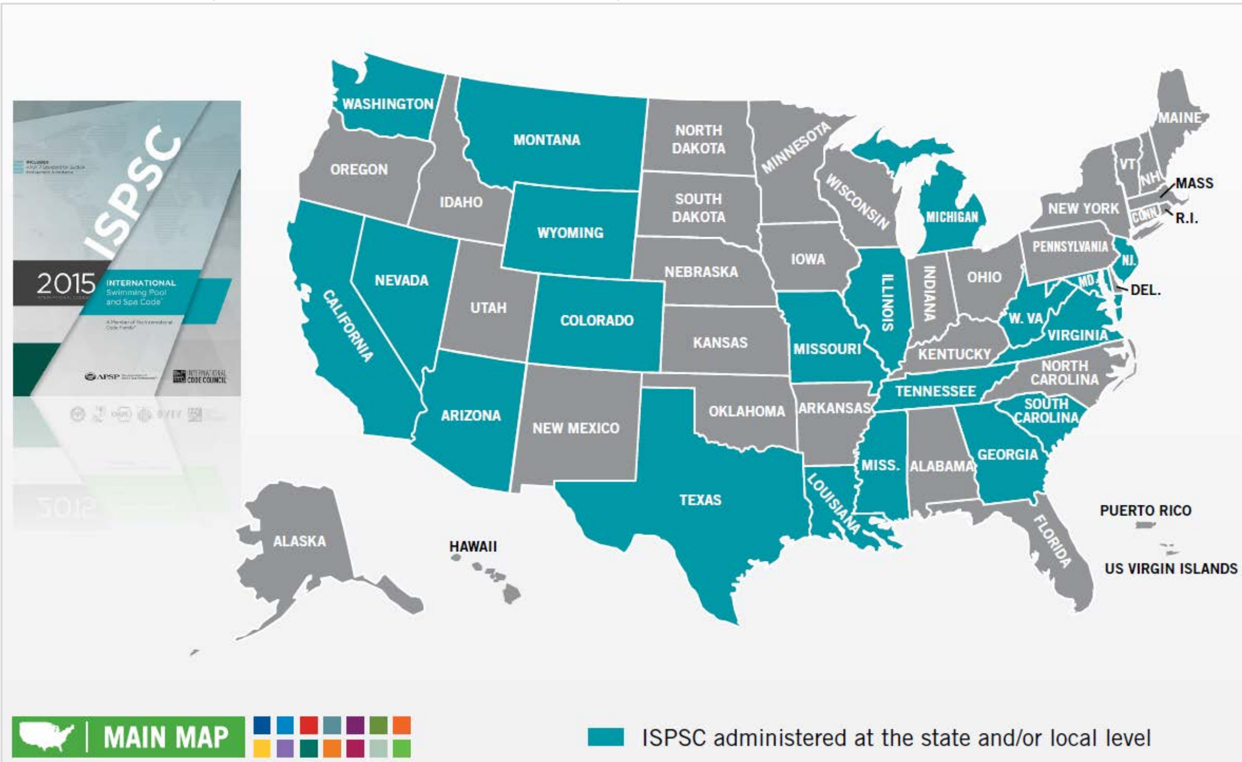
The 2015 International Swimming Pool and Spa Code (ISPSC) and the 2015 International Energy Conservation Code developed by the International Code Council (ICC) adopted the energy consumption

90 California Energy Commission, *2015 Appliance Efficiency Regulations*. Title 20. May 2014.
91 APSP, American National Standards Institute. (2014). American National Standard for Portable Electric Spa Energy Efficiency. Alexandria: APSP.
92 APSP, American National Standards Institute. (2014). American National Standard for Portable Electric Spa Energy Efficiency. Alexandria: APSP.

requirements of ANSI/APSP/ICC-14 2011.[93] The 2018 version of ISPSC will be updated to match the language of ANSI/APSP/ICC-14 2014.[94]

As of May 2017, the International Swimming Pool and Spa Code is in use or has been adopted by local governments and/or statewide in 21 states and the District of Columbia (**Figure 4-1**), and the International Energy Conservation Code is in use or adopted in all states (except California and Indiana), the District of Columbia, Puerto Rico, and the U.S Virgin Islands.[95]

Figure 4-1: International Swimming Pool and Spa Code Adoption Map



Source: International Code Council

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93 2012 and 2015 International Swimming Pool and Spa Code, available at http://shop.iccsafe.org/codes.html

94 Scott Younker, *Spa Efficiency Standard Calls for Labeling* (May 5,2015) available at http://www.poolspanews.com/how-to/codes/spa-efficiency-standard-calls-for-labeling_o.

95 International Codes- Adoption by State list, available at http://www.iccsafe.org/international-code-adoptions/ .

Other State Approaches

Oregon, Connecticut, Washington, and Arizona require portable electric spas to meet the same requirements as California's current efficiency standards in Title 20, Section 1605.3.[96,97,98, 99]

The CASE Report

In July 2013, the IOUs and the Natural Resources Defense Council submitted a CASE report in response to the Energy Commission's invitation to submit proposals.[100] In May 2014, they submitted a revised proposal for portable electric spa standards.[101] The proposal recommends adopting the test procedures, test room requirements, and the lower standby power limit [3.75 x Volume$^{2/3}$ + 40 watts] stated in the ANSI/APSP/ICC-14 2014 standard. In addition, the CASE report recommends adding requirements for original equipment and third-party spa covers and requiring labels on spa units that will inform consumers of the tested standby power consumption, maximum allowable standby power consumption, and the spa cover make and model used during testing to achieve the displayed standby performance.

The CASE team estimates that implementing the proposal would result in a reduction of about 6 GWh the first year the standards are in effect and a savings of about 64 GWh after full-stock turnover in 10 years.[102]

96 Appliance Standards Awareness Project, Portable Electric Spas (2017), Retrieved from https://appliance-standards.org/product/portable-electric-spas.

97 Connecticut General Assembly. Chapter 298, Title 16, Section 16a-48. Retrieved from http://search.cga.state.ct.us/dtsearch_pub_statutes.html.

98 Washington State Legislature. Title 19, Chapter 19.260, Section 19.260.040. Retrieved from http://app.leg.wa.gov/RCW/default.aspx?cite=19.260.040.

99 Arizona State Legislature. Title 44, Chapter 9, Article 19, 1375.02. Retrieved from http://www.azleg.gov/FormatDocument.asp?inDoc=/ars/44/01375-02.htm&Title=44&DocType=ARS.

100 CASE Report, *Pools & Spas* (July 29, 2013). Retrieved from http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2F_Residential_Pool_Pumps_and_Replacement_Motors/California_IOUs_Response_to_the_Invitation_to_Submit_Proposals_for_Pool_and_Spas_2013-07-29_TN-71756.pdf.

101 CASE Report, *Portable Electric Spas.* (May 15, 2014). Retrieved from http://www.energy.ca.gov/appliances/2013rulemaking/documents/comments/12-AAER-2G_Portable_Electric_Spa_Labeling/12-AAER-2G_Portable_Electric_Spas_Final_CASE_Report_2014-05-15_TN-73027.pdf.

102 CASE Report, Portable Electric Spas. (May 15, 2014). Retrieved from http://www.energy.ca.gov/appliances/2013rulemaking/documents/comments/12-AAER-2G_Portable_Electric_Spa_Labeling/12-AAER-2G_Portable_Electric_Spas_Final_CASE_Report_2014-05-15_TN-73027.pdf.

CHAPTER 5: Alternative Considerations

State standards for four scenarios were considered: (1) maintaining current Title 20 standards, (2) a 25 percent more stringent standby power standard for all portable electric spas, (3) a 25 percent more stringent standby power standard for all portable electric spas except inflatable spas, and (4) a more moderate standby power standard for standard, exercise, and combination spas, and a separate standby power standard for inflatable spas. Comments from interested parties made during three staff workshops (February 18, 2016; July 13, 2016; and August 3, 2017) and to the Energy Commission docket were also reviewed.

Alternative 1: Maintaining Current Title 20

Title 20 requires portable electric spas to meet a standby requirement and report results to the Energy Commission, but it does not require labeling of spas to help consumers choose between products based on efficiency levels. Visits to residential spa show rooms at the California State Fair in 2013 revealed spas that were offered for sale carried labels that described the products as “efficient” without any explanation of why or how they were rated. This type of labeling leaves consumers without any means to make an educated purchase related to the efficiency of the unit.

Original spa covers purchased by dealers are not verified, and customers have no direct means to ensure they are receiving original spa covers. This raises the concern that the performance integrity of the spa (as tested and certified) may be compromised. This could undermine the effectiveness of the current portable electric spa standard and the requirements found in Section 1608(a) (3) of the California Code of Regulations.

Moreover, spas have improved techniques for insulation and covers that will lead to lower standby energy consumption, presenting an opportunity to improve spa efficiency in the marketplace. For these reasons, staff believes the Title 20 performance standards must be updated.

Alternative 2: More Stringent (25 Percent More Efficient Standby Standard, Modified Test Procedure, Spa Cover Reporting, and Spa Unit Labeling)

Alternative 2 would establish a 25 percent more stringent energy consumption standard for portable electric spas (including exercise spas, combination spas, and inflatable spas), modify the current Title 20 test procedure, add requirements for specific effective spa covers, and add a labeling requirement to provide consumers with tools for informative purchases. Specifically, the proposal recommends the following:

- Portable electric spas would maintain the existing broad definition that includes standard, storable/inflatable, exercise, and combination spas.
- Spas would be made more efficient by lowering the standby power consumption limit by 25 percent. The current standard of [$5xVolume^{2/3}$] would be changed to [$3.75xVolume^{2/3}$] for all types of portable electric spas.
- The current Title 20 test method would be modified to accommodate exercise spas and combination spas. The water temperature for all portable electric spas shall be at least the maximum water temperature available on the unit but no greater than 104°F and no less than 85°F for the duration of the test. For combination spas, each reservoir will be powered on simultaneously and heated to the appropriate temperature for the entire duration of the test.
- ANSI/APSP/ICC-14 2014 would be incorporated as the basic labeling template, with the following modifications: (1) The label shall display the manufacturer and model number of the spa cover(s) used during certification testing and be allowed for sale with the unit in accordance with Section 1608(a)(3) of the California Code of Regulations; (2) The normalized standby watts displayed on the label shall represent the spa unit-cover combination that yields the maximum energy consumption; and (3) For combination spas, clarify that each reservoir, or spa portion, shall be labeled appropriately.
- The model number of the spa cover used during testing shall be reported to MAEDBS.

This proposal presents a significant opportunity for energy savings. The proposed standard treats all spas equally, providing no relief to smaller spas. That is, both a spa with a volume of 200 gallons and a spa with a volume of 1,600 gallons will need to be 25 percent more efficient. Achieving 25 percent efficiency would dramatically increase incremental costs. Staff believes the incremental costs to achieve this approach would be approximately $200 per inflatable spa, $650 per standard spa, and $1,495 per exercise and combination spa.[103] Larger spas have more energy-saving opportunities and higher related costs than smaller spas through the design, controls, and insulation. Although, 23 percent of portable electric spas currently in the database meet this proposed standard, it may not be cost effective (see **Figure 5-1**). Consumers may accumulate fewer benefits through energy savings due to the higher cost to comply. More than 90 percent of the market is comprised of standard spas and under this alternative

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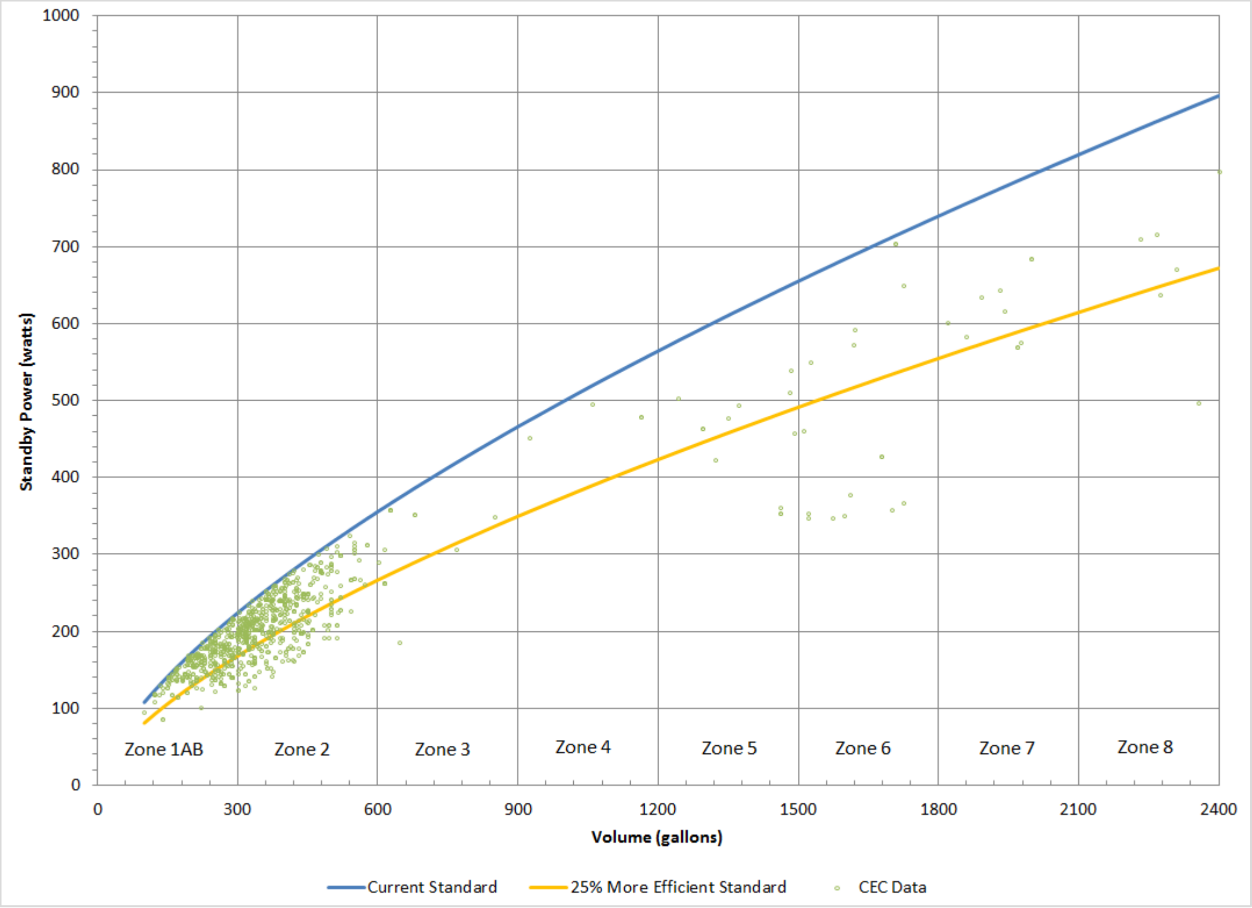
103 Median cost of exercise spa is $15,000 and median cost for mid-tier standard spas is $6,500, resulting in a ratio of 2.3. The incremental cost of exercise and combination spas is 2.3 times the incremental cost of standard spas.

approximately 22 percent would comply, reducing product availability and variety. Testing portable electric spas at their maximum water temperature, higher than the current requirement, would increase the resulting normalized standby power making it difficult to meet the proposed standard. In addition, this alternative would continue to eliminate inflatable spas from the market. For these reasons, staff believes this alternative is not a viable proposal at this time.

Figure 5-1: Proposed 25 Percent More Efficient Standard versus Current Standard



Source: MAEDBS, California Energy Commission

Alternative 3: More Stringent Standard but Exempt Inflatable Spas

Staff considered another alternative that would allow inflatable spas to be sold or offered for sale in California. This proposal would be the same as Alternative 2, except that for inflatable spas there would be no performance or design requirement.

Since no performance data would be tested and reported during certification, the Energy Commission's ability to pursue any future, potential energy savings opportunities for inflatable spas would be inhibited.

For example, a 210 gallon inflatable spa, as currently designed, would yield a normalized standby power that is 2.7 times the current standby power limit (See **Figure 7-3**).[104] Inflatable spas cannot meet the current standby power performance standard preventing them from being sold in California, resulting in a baseline energy consumption of 0 GWh.[105] Exempting inflatable spas from a new performance standard would allow them to be sold in California, thereby increasing the energy consumption over the baseline by 35.5 GWh per year (as detailed in **Appendix A**).

This alternative would introduce an inefficient appliance to the market and in doing so increase energy consumption statewide; staff believes that it is not a viable proposal for efficiency standards.

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104 Intex Inflatable Portable Electric Spa Test Report, IAPMO EGS, Docket 15-AAER-02 TN 212386, July 16, 2016

105 The Association of Pool and Spa Professionals (APSP) estimated that, in 2015, 15,000 inflatable spas were sold in California. APSP's presentation at staff workshop on February 18, 2016. Docket 15-AAER-02, TN 210390, February 17, 2016

Alternative 4: Moderate Standby Standard for Standard, Exercise, and Combination Spas; Separate Standard for Inflatable Spas

Alternative 4 clarifies the scope, and includes recommendations similar to the CASE team's proposal[106] but clarifies the testing and labeling requirements, which accommodates the other spa types (exercise and combination spas) that fall within the existing Title 20 scope and definition. This alternative includes a separate standby standard for inflatable spas based on collaborative efforts with the inflatable spa industry.

- Portable electric spas would maintain the existing broad definition that includes standard, storable, inflatable, exercise, and combination spas.
- The parent definition of portable electric spas would be modified to apply when the heating and circulating equipment may be supplied separately or at a later time for subsequent attachment to the spa.
- Several definitions would be added to provide clarity, to elaborate the scope, to support data submittal requirements, and label requirements.
- The current standard of [$5xV^{2/3}$] would be changed to [($3.75xV^{2/3}$) + 40] for standard spas, exercise spas, and combination spas.
- For inflatable spas, a separate standard of [$7xV^{2/3}$] would be established.
- ANSI/APSP/ICC-14 2014 would be incorporated as the new test method, with the following clarifications: (1) for combination spas, each reservoir will be powered on simultaneously and heated to the appropriate temperature, according to the test procedure, for the entire duration of the test, (2) exercise spas capable of maintaining a minimum water temperature of 100°F shall be tested the same as standard spas, (3) and for all portable electric spas with a skimmer, that the spa be filled to the halfway point between the bottom of the skimmer and the top of the skimmer, rather than to the overflow level of the spa.
- ANSI/APSP/ICC-14 2014 would be incorporated as the basic labeling template, with the following modifications: (1) The label shall display the manufacturer and model number of the spa cover(s) used during certification testing and be allowed for sale with the unit in accordance with Section 1608(a)(3) of the California Code of Regulations; (2) The normalized standby watts displayed on the label shall represent the spa unit-cover combination that yields the maximum energy consumption; (3) The volume on the label shall represent the rated volume; and (4) For combination spas, clarify that each reservoir or spa side shall be labeled appropriately.
- New data submittal requirements in Section 1606(a)(3)(c) Table X, or data reported to MAEDBS, will include most of the label descriptors and data needed to validate the efficiency of the portable

106 CASE Report, Portable Electric Spas. (May 15, 2014). Retrieved from http://www.energy.ca.gov/appliances/2013rulemaking/documents/comments/12-AAER-2G_Portable_Electric_Spa_Labeling/12-AAER-2G_Portable_Electric_Spas_Final_CASE_Report_2014-05-15_TN-73027.pdf.

electric spas. These new requirements include the spa cover manufacturer, spa cover model, rated volume, fill volume, and normalized standby power for each type of portable electric spa. Other informative data submittal requirements will include voltage, rated capacity, and whether both the spa cover and the spa enclosure are insulated.

- New test lab report requirements in addition to Section 5 of ANSI/APSP/ICC-14 2014.

This alternative would allow consumers to purchase a spa cover of their choice since each unit-and-cover tested combination would have been reported and certified in MAEDBS. Prior to purchase, the consumer would be informed of what cover should be bought with the unit to achieve the standby performance that was labeled and reported for certification and sale in California. This proposal also provides energy savings opportunities in the exercise spa market that could further benefit California's efforts in energy efficiency and greenhouse gas reductions. This alternative is both cost effective and technically feasible and achieves a significant amount of energy savings. Furthermore, staff believes this proposal for inflatable spas will provide consumers with a more efficient product.

CHAPTER 6: Proposed Standards for Portable Electric Spas

Staff analyzed the cost-effectiveness and technical feasibility of the fourth alternative approach. Based on this information, as well as analysis on all known spa types, staff proposes the ANSI/APSP/ICC-14 2014 test procedure with some modifications, updated standby performance standards, and some modifications for labeling and testing spa covers. The proposed standards are for all portable electric spas (including inflatable, standard, exercise spas, and combination spas) manufactured on or after June 1, 2019, or one year from the adoption date, whichever is later.

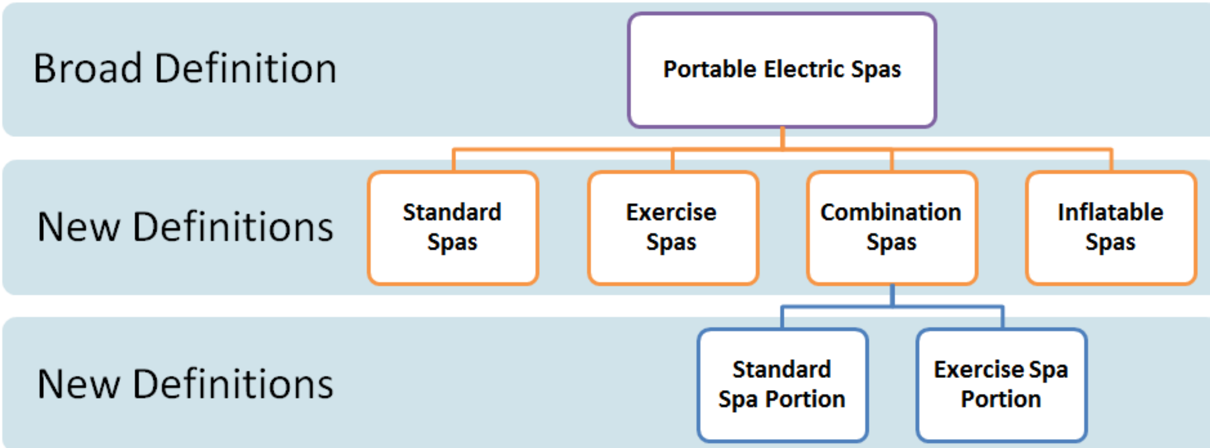
Based on independent analysis of the best available data, staff concludes that the proposed regulations are both cost-effective and technically feasible and will save a significant amount of energy statewide. Staff assumptions and calculation methods are provided in **Appendix A**.

Scope

Staff will maintain the current scope of portable electric spas and clarify the inclusion of inflatable spas, storable/easy-assembly spas, exercise/swim spas, and combination spas. Staff recommends modifying the portable electric spa definition in Section 1602(g) of Title 20 of the California Code of Regulations, by adding wording to apply when the heating and circulating equipment may be supplied separately or at a later time for subsequent attachment to the spa.

Staff recommends adding definitions to provide clarity to the scope. The definition of portable electric spas will become the root definition and maintain the broad scope of all types of portable electric spas. The new spa definitions are meant to expand the root definition, and to determine the appropriate standard and test procedure (See **Figure 6-1**). The remaining definitions such as fill volume, skimmer, and rated capacity are meant to support data submittal requirements, label requirements, and test procedure clarifications. Note, the proposed definitions will become effective as soon as the proposed regulations are adopted and published in Title 20 of the California Code of Regulations. Manufacturers will be required to list portable electric spas under one of the four spa subcategories (See **Figure 6-1**) for new data submittal certifications to the appliance efficiency database.

Figure 6-1: Scope Clarification Chart



Source: Energy Commission staff

Test Procedure

Staff recommends all portable electric spas be tested in accordance with ANSI/APSP/ICC-14 2014 with modifications. In addition staff recommends an exception to the swim spa standby consumption limit in Section 8.2 of the test procedure for portable electric spas manufactured on or after June 1, 2019. Combination spas and exercise spas are addressed separately in the test procedure to ensure that the lower temperature for the swim/exercise portion of the spas is reflected in the test results. Staff would clarify for combination spas that each reservoir shall be powered on simultaneously and heated to the appropriate temperature, according to the test procedure, for the entire duration of the test.

Staff also recommends adding a conditional water temperature setting for exercise spas during testing based on the maximum water temperature set by the manufacturer. Exercise spas with a maximum temperature greater than or equal to 100°F shall be tested as a standard spa and those with a maximum temperature below 100°F shall be tested as an exercise spa. The conditional water temperature setting accommodates exercise spas that have a maximum water temperature setting below 100°F while exercises spas with a maximum water temperature setting above 100°F can continue to be tested under similar current testing conditions. The modification for exercises spas and combination spas ensures the highest standby power water temperature settings can meet the standby power limit.

Staff believes the method for filling the spa for testing needs to be clarified by stating, if there is a skimmer, the spa be filled halfway between the bottom of the skimmer and the top of the skimmer, rather than between the bottom of the skimmer and the overflow level of the spa. The overflow level, in some cases, may be above the top of the skimmer opening.

The test procedure ANSI/APSP/ICC-14 2014 is based on a collaborative effort dating back to 2005. This effort included the APSP, leading portable spa manufacturers, the Energy Commission, Davis Energy Group, and the IOUs. The test procedures in this standard are based on that effort and the test method for portable spas described in Section 1604 of Title 20, California Code of Regulations, as amended December 3, 2008. To further support the claims in this standard, the portable electric spa manufacturers, working through APSP, researched and tested the energy efficiency of portable spas. The standard was prepared in accordance with ANSI.[107]

Standby Power Consumption

A standby consumption limit will be applied to all portable electric spa types (See **Table 6-1**). Standard spas, exercise spas, and each reservoir of combination spas shall not exceed the normalized standby power consumption of [(3.75xVolume$^{2/3}$) + 40]. As a result of conversations with spa manufacturers, Energy Commission staff believes the proposed standard will tighten the standard on larger spas while providing some relief to smaller spas, a concern that the industry had with the existing standard.[108] Inflatable spas would have a less stringent standard than other spas, with a normalized standby power of [7xVolume$^{2/3}$].

Table 6-1: Proposed Standby Power Standards for Portable Electric Spas

Spa Type	Standby Power Standard	Effective Date
Standard Spas, Exercise Spas, Combinations Spas (each spa portion)	(3.75xVolume$^{2/3}$) + 40	June 1, 2019
Inflatable Spas	7xVolume$^{2/3}$	June 1, 2019

Source: Energy Commission staff

Test Lab Report Requirements

In addition to ANSI/APSP/ICC-14 2014 requirements, all portable electric spa manufacturers would be required to develop a test lab report that includes: raw data results, test results to verify the standard, a copy of the label(s), and data submittal requirements required for certification to the Energy Commission for all portable electric spas manufactured on or after June 1, 2019.

Labeling Requirements

The label shall meet the design and specifications listed in Section 7 of the ANSI/APSP/ICC-14 2014, with wording modifications (See **Figure 6-2**) for all portable electric spas manufactured on or after June 1, 2019. The spa shall be marked by the manufacturer and easily visible on the shell or front skirt panel during the point of sale. The marking shall be on a removable adhesive backed label and shall be removed only by the consumer.[109] Combination spas would bear two labels, one for each portion of the spa.

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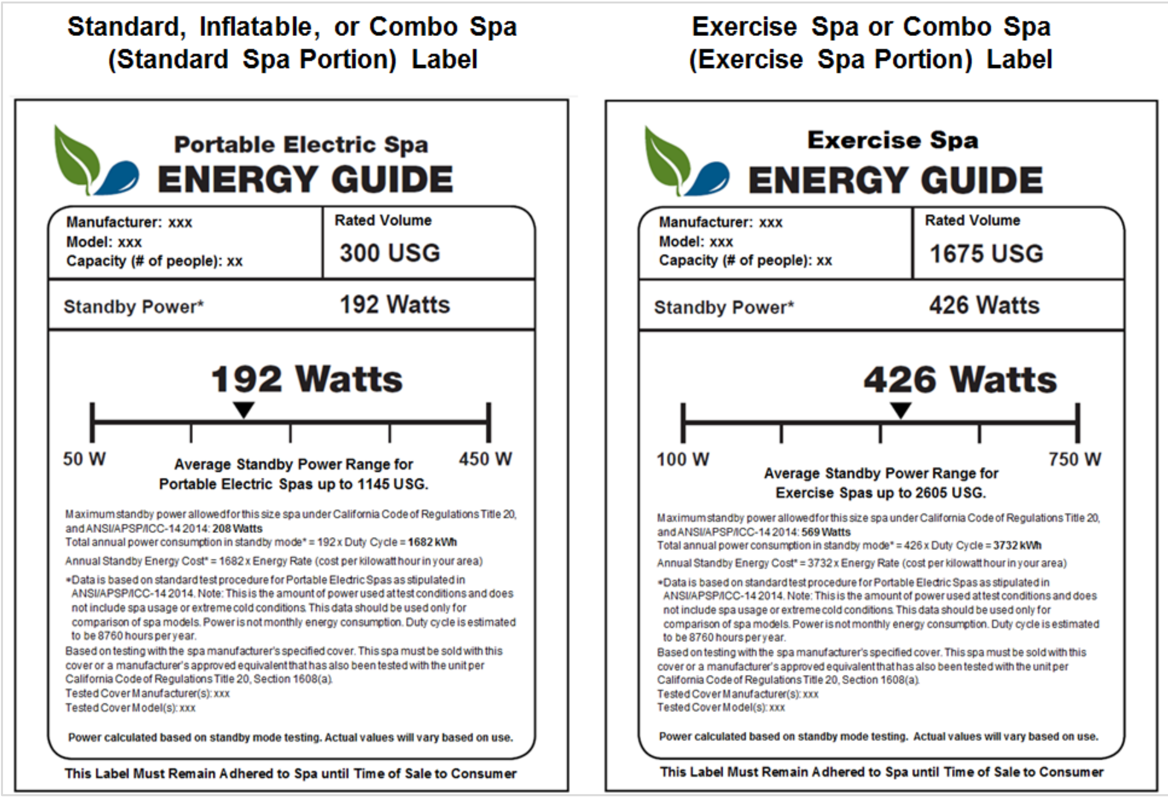
107 APSP, American National Standards Institute. *American National Standard for Portable Electric Spa Energy Efficiency*. Alexandria: APSP, 2014.

108 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, Pacific Gas and Electric Company. California Statewide Utility Codes and Standards Program. Retrieved July 2015.

109 APSP, American National Standards Institute. (2014). *American National Standard for Portable Electric Spa Energy Efficiency*. Alexandria: APSP.

Figure 6-2: Sample of Labels for Portable Electric Spas

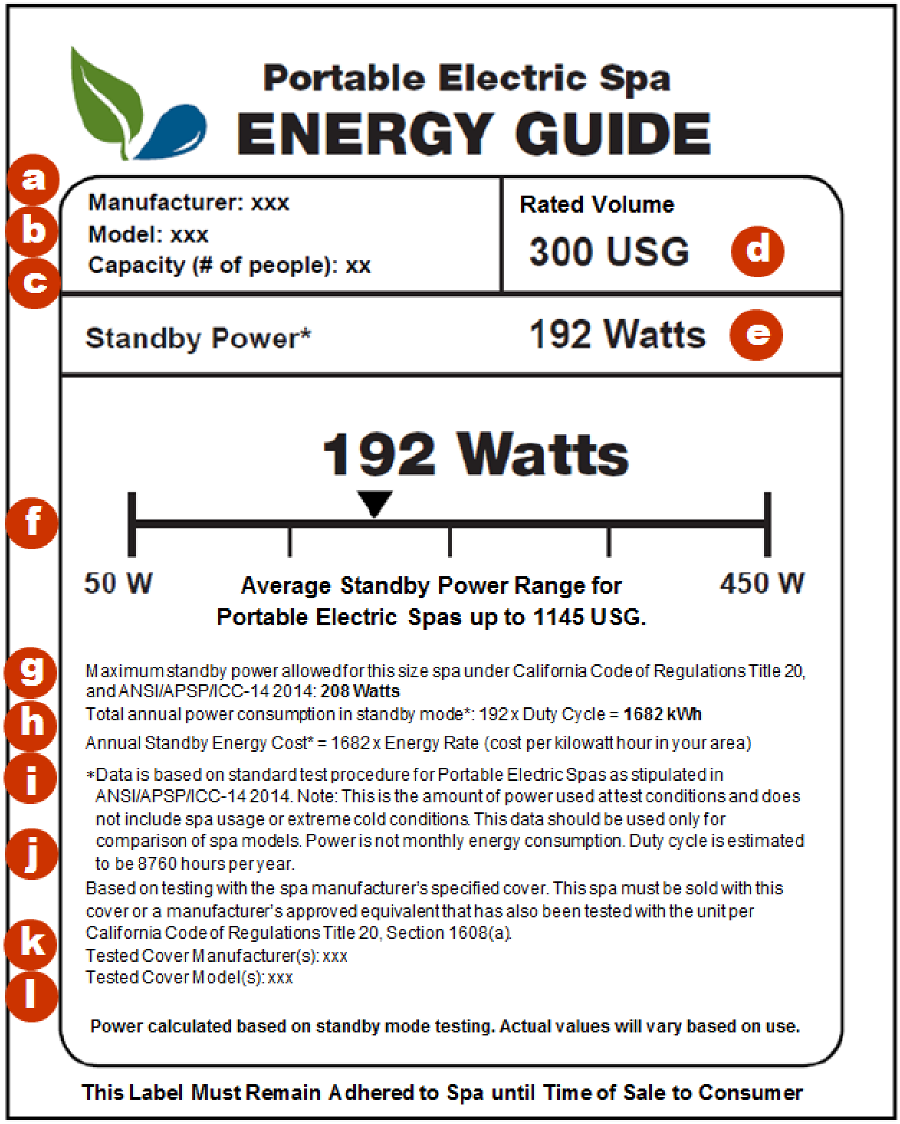


Source: Section 7 of the ANSI/APSP/ICC-14 2014 with staff modifications.

Staff proposes using a continuous label rather than a categorical label for portable electric spas. A *categorical label* uses a ranking system that allows consumers to tell how energy-efficient a model is by using multiple classes or categories that progress from least efficient to most efficient or most energy-consuming to least energy-consuming. A continuous label uses a performance bar or line scale that allows consumers to see where the unit fits into the range of similar models. The CASE team collaborated with the standard writing committee and designed a spa energy label similar to the example shown in **Figures 6-3** and **6-4**, which are staff's modified versions.[110] The standby power scale for portable electric spas (standard spas, inflatable spas, and the standard spa portion of combination spas) will have a range from 50 watts to 450 watts, whereas, the standby power scale for exercise spas (and the exercise spa portion of combination spas) will have a range from 100 watts to 750 watts.

110 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, Pacific Gas and Electric Company. California Statewide Utility Codes and Standards Program. Retrieved July 2015.

Figure 6-3: Label Design



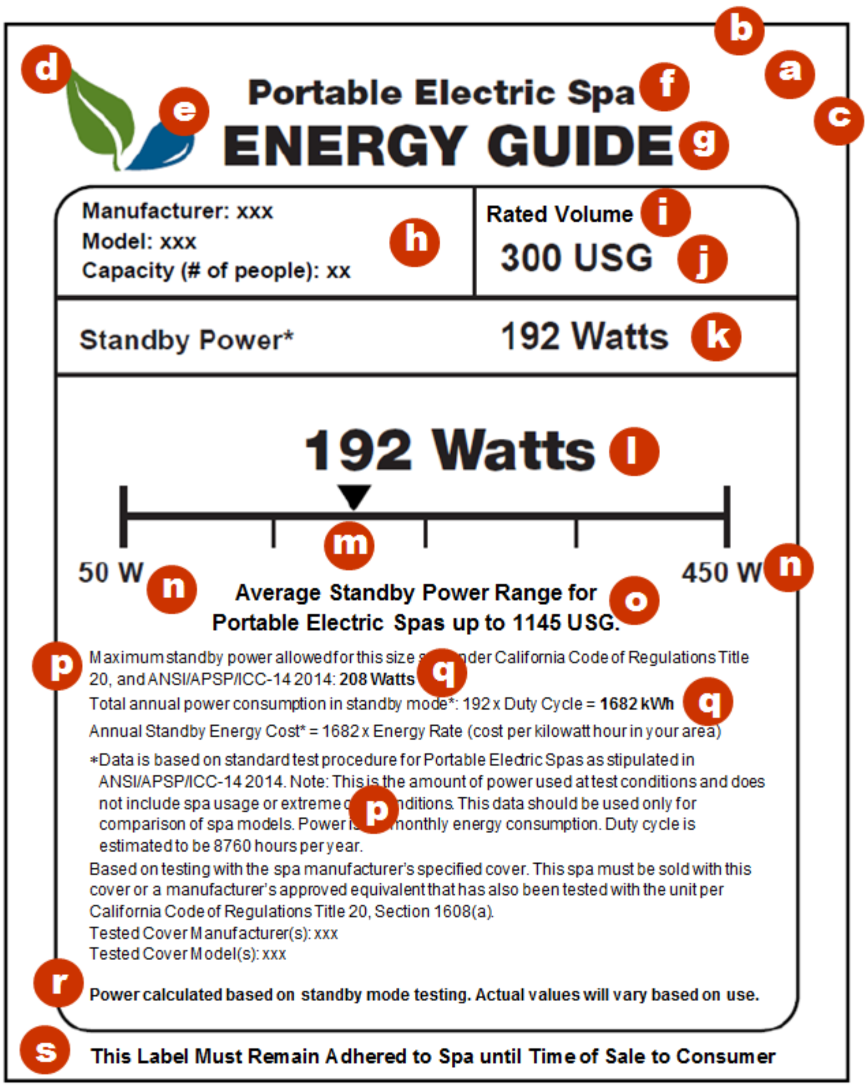
Source: Modified from Figure 7.2 in ANSI/APSP/ICC-14 2014

Figure 6-3 shows the basic label design and requirements.

- Codes:
  a. Spa manufacturer
  b. Spa model number
  c. Spa capacity (number of people)
  d. Spa rated volume
  e. Tested standby power
  f. Standby power scale, chart arrow location, and tested standby power value
  g. Maximum standby power allowed
  h. Total annual power consumption in standby mode
  i. Total annual power consumption in standby mode for the annual standby energy cost formula

j. Duty cycle
k. Specified cover manufacturer
l. Specified cover model

Figure 6-4: Label Specifications



Source: Modified from Figure 7.3 in ANSI/APSP/ICC-14 2014

Figure 6-4 shows the design specifications for the label format.

- Label shall be printed on a removable adhesive-backed white polymer label or the equivalent.
- Text color shall be black; leaf color shall be equivalent to Pantone 363 green (also permitted to be black); water color shall be equivalent to Pantone 7691 blue (also permitted to be black).
- Label codes:
  a. Shall be printed on a white label with black text.
  b. Minimum label width: 5 inches.

c. Minimum label height: 6.25 inches.

d. Leaf color: equivalent to Pantone 363 green (also permitted to be black).

e. Water drop color: equivalent to Pantone 7691 blue (also permitted to be black).

f. Font: Helvetica Neue Black; character height shall not be less than 15 point type. For standard spas, inflatable spas, and the standard spa portion of combination spas the text shall state the following: Portable Electric Spa. For exercise spas and the exercise spa portion of combination spas, the text shall state the following: Exercise Spa.

g. Font: Helvetica Neue Black; character height shall not be less than 24 point type. Text shall state the following: ENERGY GUIDE.

h. Font: Arial Bold; character height shall not be less than 9.5 point type. Text shall state the following:

   Manufacturer: [insert name of manufacturer here]

   Model: [insert model number here]

   Capacity (# of people): [insert number of people here]

i. Font: Arial Bold; character height shall not be less than 9.5 point type. Text shall state the following: Rated Volume

j. Font: Arial Bold; character height shall not be less than 16 point type. The text shall state the value of the rated volume in U.S. gallons and shall state the units of the rated volume.

k. Font: Arial Bold; Character height shall not be less than 16 point type. The text shall state the following: Standby Power* [insert tested standby power value here]

l. Font: Helvetica Neue Black; character height shall not be less than 24 point type. The text shall state the tested standby power value in watts and shall state the units of the tested standby power.

m. The standby power chart arrow shall be scaled at the appropriate location between the minimum and maximum power range using the standby power value for the spa which is being installed. The minimum standby power shall be 50 watts, and the maximum standby power shall be 450 watts for standard spas, inflatable spas, and the standard spa portion of combination spas. The minimum standby power shall be 100 watts and the maximum standby power shall be 750 watts for exercise spas and the exercise spa portion of combination spas.

n. Font: Arial Bold; Character height shall not be less than 12 point type.

o. Font: Arial Bold; Character height shall not be less than 9.5 point type. For standard spas, inflatable spas, and the standard spa portion of combination spas, the text shall state "Average standby Power Range for Portable Electric Spas up to 1145 USG." For exercise spas and the exercise spa portion of combination spas, the text shall state "Average standby Power Range for Exercise Spas up to 2605 USG."

p. Font: Arial; Character height shall not be less than 8 point type, and may be horizontally scaled to no less than 85 percent. The text shall state the following:

Maximum standby power allowed for this size spa under California Code of Regulations Title 20, and ANSI/APSP/ICC-14 2014: [insert normalized standby power value based on fill volume here, rounded to a whole number] Watts

Total annual power consumption in standby mode*: [insert tested standby power value here, rounded to a whole number] x Duty Cycle = [insert calculated value of total annual power consumption in standby mode here, rounded to a whole number] kWh

Annual Standby Energy Cost* = [insert total annual power consumption value here, rounded to a whole number] x Energy Rate (cost per kilowatt hour in your area)

*Data is based on standard test procedure for Portable Electric Spas as stipulated in ANSI/APSP/ICC-14 2014. Note: This is the amount of power used during test conditions and does not include spa usage or extreme cold conditions. This data should be used only for comparison of spa models. Power is not monthly energy consumption. Duty cycle is estimated to be [insert duty cycle value in hours here. For standard spas, exercise spas, and combinations spas insert 8,760 hours per year. For inflatable spas, insert 5,040 hours per year] hours per year.

Based on testing with the spa manufacturer's specified cover. This spa must be sold with this cover or a manufacturer's approved equivalent that has also been tested with the unit per California Code of Regulations Title 20, Section 1608(a).

Tested Cover Manufacturer(s): [insert name of manufacturer here]

Tested Cover Model(s): [insert cover model number here]

q. Font: Arial Bold. Character height shall not be less than 8 point type and may be horizontally scaled to no less than 85 percent.

r. Font: Arial Bold; Character height shall not be less than 8 point type, and may be horizontally scaled to no less than 85 percent. The text shall state the following: Power calculated based on standby testing @ 60°F (air temperature). Actual values will vary based on use.

s. Font: Arial Bold; Character height shall not be less than 8 point type, and may be horizontally scaled to no less than 85 percent. The text shall state the following: This Label Must Remain Adhered to Spa until Time of Sale to Consumer.

In addition to these labeling requirements, all spas must continue to be marked, permanently, legibly, and in an accessible place, with the manufacturer name, brand name, or trademark; the model number; and the date of manufacture, as required under Section 1607(b) of Title 20 of the California Code Regulations.

Spa Cover Labeling and Reporting Requirements

With the current Title 20 test method, portable electric spas are tested with the "standard cover that comes with the unit." The standard cover of the spa unit is typically sold with the purchase of a new spa as required under Section 1608(a) (3) of Title 20 of the California Code of Regulations. The cover that is sold with the unit is sometimes made by a third party. However, it must be the same model cover used during the test.

To reinforce this requirement, staff proposes that the same model number of the tested spa cover displayed on the label be required to be reported during data submittal and certification to the appliance efficiency database for portable electric spas manufactured on or after June 1, 2019. Where there are multiple compatible covers that were tested with the unit, the standby watts on the comparison spectrum on the label shall represent the most recent spa unit-cover combination that yielded the maximum energy consumption, and all covers that allowed the unit to pass the standby test must be included in separate listings of the unit within MAEDBS and have a unique set of tested performance data.

Any cover (the manufacturer's or a third party's) that is tested with the unit and yields a failed standby test or any cover that was not used in the standby test cannot be sold with the unit to the consumer. Covers differing in color or other non-energy-impacting features are the exception and can be sold as long as they have the same basic model number as the test cover and were made by the same manufacturer. However, any cover (manufacturer's, third party, or replacement) sold as a stand-alone purchase is acceptable because it is not within the scope of these regulations.

If multiple covers passed a standby test, customers will likely base their purchasing choice on the lowest retail price of the possible spa unit-cover combinations, which can have an unrealized, negative effect on energy consumption and operating costs.[111] Thus, labeling the unit with the highest consuming cover result, as well as the other compatible cover model numbers in accordance with the listings in MAEDBS, allows dealers to better inform customers what the opportunities are while presenting the worst-case scenario. Consumers will be educated by the energy consumption and yearly cost formula on the label, which can lead to more energy-efficient purchasing decisions.[112]

111 Western Area Power Administration. (2009). "What Goes Into an Energy-Efficient Spa or Hot Tub?" Lakewood: Western Area Power Administration.
112 Ibid.

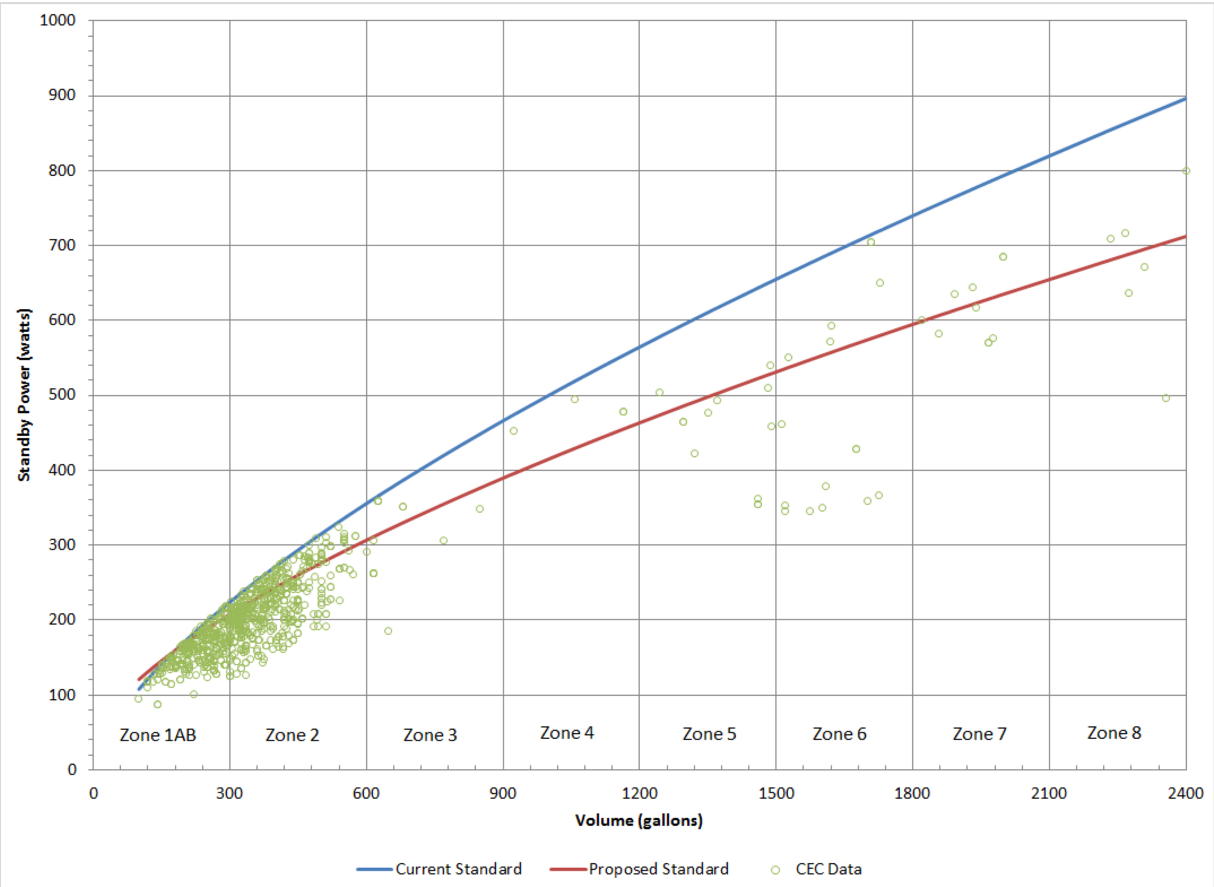
CHAPTER 7: Technical Feasibility

Standard, Exercise, and Combination Spas

As of March 2017, the Energy Commission database lists 1,334 portable electric spas, not including inflatable spas. Due to irregularities in the dataset, 963 certified models were used for this analysis. More than 75 percent of these models would meet the proposed standards. **Table 7-1** shows a breakdown of the compliance rate for the portable electric spas in the MAEDBS. The quantity and variety of compliant spas available for sale indicate that compliant products are technically feasible to make and readily available in California.

As **Figure 7-1** demonstrates, a significant number of existing spas would meet the proposed standard, demonstrating that it is technically feasible. The data points below the red curve are portable electric spas that would comply with the proposed standard.

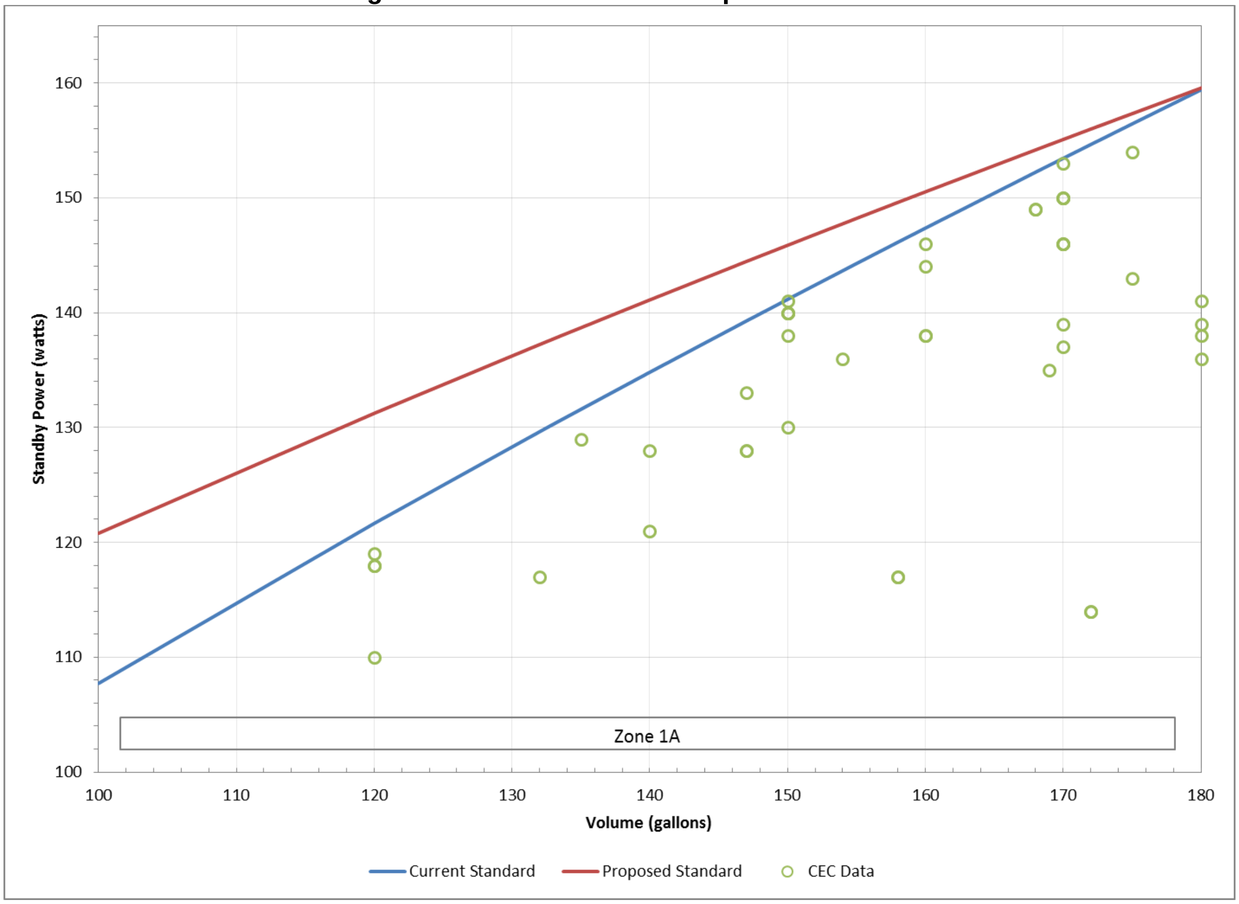
Figure 7-1: Portable Electric Spas in the MAEDBS



Source: MAEDBS, California Energy Commission

In addition, as **Figure 7-2** demonstrates, the proposed standard will provide a modest relief to smaller spas ranging from 100 gallons to 180 gallons. This is the point to the left where the proposed standard curve and the current standard curve intersect, providing slightly greater standby allowance for small spas.

Figure 7-2: Portable Electric Spas in Zone 1A



Source: MAEDBS, California Energy Commission

Table 7-1 details the compliance rate illustrated in **Figure 7-1**. The CASE report stated 29 percent of the portable electric spas in the MAEDBS would not meet the proposed standard limit, which is similar to the results found in July 2015. **Table 7-1** shows the total number of certified spas in MAEDBS, which has increased since then.

Table 7-1: Compliance Rate of Portable Electric Spas

	Zones	Water Capacity Range (gallons)	Compliant (%)	Noncompliant (%)
Standard Spas	1AB to 3	0-900	79	21
Exercise Spas	4 to 8	901-2,400	58	42
Combo Spas	-	1,600-2,400*	44	56
All Certified Units			77	23

***Based on total water capacity.**

Source: MAEDBS, California Energy Commission

Using the same test temperature (102°F ± 2°F) under the existing Title 20 test method, 23 percent of portable electric spas would be noncompliant with the proposed normalized standby power standard. However, ANSI/APSP/ICC-14 2014 reduces the standby power test temperature for standard spas to a minimum of 100°F and for exercise spas to a minimum of 85°F. This change in the test procedure will likely result in more portable electric spas complying with the proposed standards. In addition, there are 48 exercise spas and 9 combination spas currently certified to the Energy Commission, demonstrating exercise spas would meet the conditional water temperature setting in the proposed test procedure. The energy consumption of portable electric spas can be enhanced by employing better insulation, better-designed covers, and the use of a more efficient pump for circulation and filtration.

Insulation

Most manufacturers of standard, exercise, and combo spas already insulate the shell and base of spas using high R-value insulation materials. According to the Energy Commission database, more than 99 percent of spas listed are fully insulated.

Staff found that units with the same volume capacity have very different standby energy consumption values, up to 150 watts. The cause of this difference is in the method and materials of insulation. For example, hit-and-miss spots at the shell and base of spas can largely reduce the effectiveness of insulation. Therefore, improvements on the method of applying uniform insulation would improve efficiency. Implementing this improvement would decrease energy use by up to 30 percent for an average- to low-efficiency spa. This is the easiest method to implement, requiring little additional engineering and design work.[113] The CASE report also identified that manufacturers use a combination of closed cell foam and radiant barriers, instead of fiberglass, which can help reduce the heat loss.[114]

In addition, reducing the length and number of plumbing pipes and hoses where possible, which act as heat exchangers with the surrounding air, will also reduce heat loss.

Spa Covers

Improvements to spa covers, such as using high R-value and less water-absorbent insulation, adding radiant barriers, and using better sealing covers, can reduce heat and water loss from the spa and already exist in the industry. Improving the construction and design work of the spa cover, such as using single-hinged or insulated hinge covers instead of double-hinged, can yield additional efficiency savings.[115]

Pump and Motor

Manufacturers have used waste heat from circulation pumps to replace separate heating or to supplement heating of water, which can greatly improve spa efficiency.[116] Most spa manufacturers of large portable electric spas add a separate low-wattage circulation pump to run specific cycles. This addition can save nearly 15 percent of the energy consumption and up to half of the pumping energy used for circulation

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113 Davis Energy Group, Energy Solutions. (2004). *Analysis of Standards Options for Portable Electric Spas*. California: PG&E.
114 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, PG&E. California Statewide Utility Codes and Standards Program. Retrieved July 2015.
115 Ibid.
116 Ibid.

and filtering. Other options include improved pump efficiency with advanced multispeed motor designs and using variable-speed motors and controls. Options like these would require manufacturers to invest in product development and design, which would most likely begin after insulation improvement.[117]

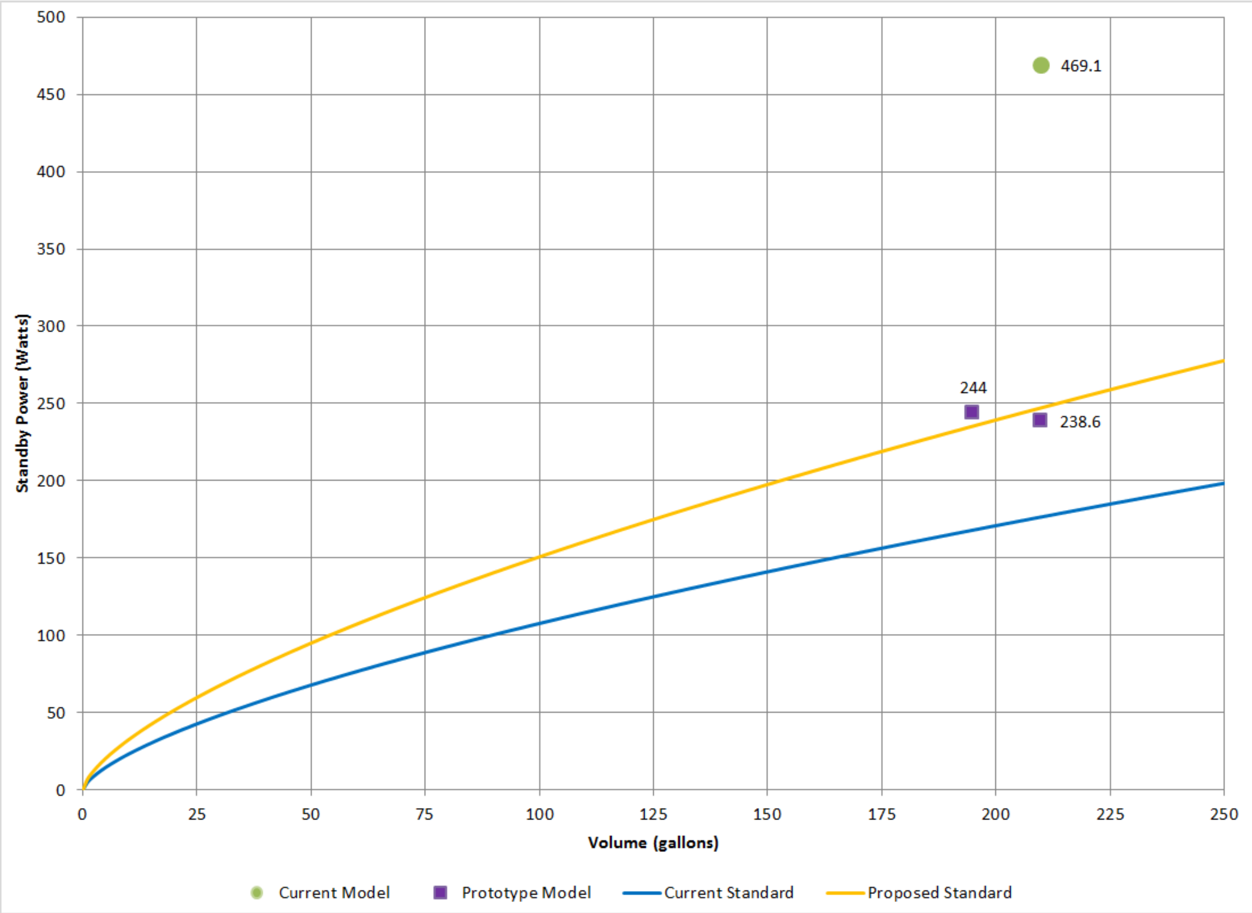
Inflatable Spas

As of November 2017, MAEDBS has no listings of inflatable spas. An inflatable spa with a capacity of 210 gallons, under its current design, yields a normalized standby power that is 2.7 times the current standby power limit (see **Figure 7-3**).[118] The current model was tested with all the contents that are sold with the unit. The contents include: an external pump, heater, and blower system; a PVC vinyl cover; inflatable bladder; and a ground cover mat.[119,120] The spa cover and the inflatable shell for this model is not designed with foam or radiant barriers. The inflatable spa industry recently developed and tested two prototype inflatable spas that are approximately 1.5 times the current standby power limit for a spa with a capacity of 210 gallons by simply improving either the spa cover or the structure of the spa (See **Figure 7-3**).[121,122] This recent development and discussions with the inflatable spa industry lead to a separate standard proposal for inflatable spas.

The proposal will provide inflatable spa manufacturers time to innovate, develop, and test inflatable spas that will meet the proposed standard ($7xV^{2/3}$). **Figure 7-3** demonstrates the proposed standard is technically feasible.

117 Davis Energy Group, Energy Solutions. (2004). *Analysis of Standards Options for Portable Electric Spas*. California: PG&E.
118 Intex Inflatable Portable Electric Spa Test Report, IAPMO EGS, Docket 15-AAER-02 TN 212386, July 16, 2016
119 Intex. (2013, October 18). Owner's Manual for a PureSpa SSP-10-1 & SSP-H-10.
120 Intex Inflatable Portable Electric Spa Test Report, IAPMO EGS, Docket 15-AAER-02 TN 212386, July 16, 2016
121 Intex Electric Spa Test Report, Docket 15-AAER-02 TN 220978-1, August 31, 2017
122 Bestway Electric Spa Test Report, Docket 15-AAER-02 TN 220978-2, August 31, 2017

Figure 7-3: Standard for Inflatable Spas



Source: Docketed Inflatable Spa Test Lab Reports[123,124,125]

Staff believes improving the insulation of inflatable spas can be achieved while maintaining an inflatable structure. Some manufacturers are incorporating a thin layer of foam to the body of the spa. For example, the inflatable spa manufacturer, Canadian Spa Company, has integrated a padded thermal base into their spa to prevent heat loss.[126] Insulating the external pump and heating system will also reduce heat loss. Other possibilities include adding foam to the inner or outer shell, adding a radiant barrier, increasing the thickness of shell material, or restructuring the air chambers. Supplementing an improved design with a combination of insulation technologies would produce a compliant product. In addition to reducing heat loss and time to heat, improving the insulation of inflatable spas will extend life design of the product, increase protection from wear and tear, and prevent users from modifying their spas to use during the winter.

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123 Intex Inflatable Portable Electric Spa Test Report, IAPMO EGS, Docket 15-AAER-02 TN 212386, July 16, 2016

124 Intex Electric Spa Test Report, Docket 15-AAER-02 TN 220978-1, August 31, 2017

125 Bestway Electric Spa Test Report, Docket 15-AAER-02 TN 220978-2, August 31, 2017

126 Canadian Spa Company. (2017). Rio Grande Portable Spa. Retrieved November 7, 2017, from Canadian Spa Company: http://www.canadianspacompany.com/hot-tub-manufacturer-products/rio-grande-portable-spa/.

There is also a great opportunity to improve the spa covers for inflatable spa covers, since most covers are made of PVC vinyl. Adding radiant barriers, incorporating a thin layer of foam, extending the length of the cover, increasing the thickness of the spa cover material, and adjusting the buckles for a tighter fit reduces heat loss. Some of these techniques are currently being used in the inflatable spa industry. For example, an inflatable spa manufacturer has incorporated a radiant barrier and increased the thickness of the vinyl material to prevent further heat loss.[127] A combination of these possible improvements and design creativity will result in a more efficient product and compliance with the proposed standard.

127 NetSpa. (n.d.). NetSpa Technology. Retrieved November 7, 2017, from NetSpa: http://www.netspa.eu/en/page/netspa-technology.

CHAPTER 8: Savings and Cost Analysis

The proposed updated standards for portable electric spas would significantly reduce energy consumption and are both cost-effective and technically feasible. **Table 8-3** through **Table 8-6** summarize the potential energy savings of the proposed standards for portable electric spas. Energy savings are further separated into first-year savings and stock savings. First-year savings mean the annual energy reduction associated with annual sales, one year after the standards take effect. Annual stock turnover savings mean the annual energy reduction achieved after all existing stock in use complies with the proposed standards. Staff's calculations and assumptions used to estimate the first-year savings and the stock change savings are provided in **Appendix A**.

Incremental Costs for Portable Electric Spas

Incremental costs are additional costs the manufacturer imparts on the consumer for producing a non-compliant product to a compliant product. The CASE team reported no incremental cost increase in implementing the proposed standard. However, the label could lead to improved spa covers or more efficient spa covers to go with a manufacturer's unit. Thus, staff believes there would be incremental costs from improving the spa cover and the structure of the unit, and implementing the standby energy consumption requirement.

When the current standby power limit standard was being proposed in 2004, various sources estimated incremental costs for portable electric spas, shown in **Table 8-1**. Staff believes that over time these costs have decreased significantly. The most recent estimated incremental costs of $100 by Nadel, deLaski, Eldridge, and Kleisch in 2006 will be used. Since exercise spas are roughly two times[128] more expensive than standard portable electric spas,[129] an assumed incremental cost of $230 will be used for these units.[130]

An inflatable spa with a capacity of 210 gallons, under its current design, yields a normalized standby power that is 2.7 times the current standby power limit.[131] Industry recently developed and tested more efficient inflatable spas that are now 1.5 times the current standby power limit for a spa with a capacity of 210 gallons.[132,133] The incremental cost transitioning from a spa that is 2.7 times the current standby power limit to 1.5 times the current standby power limit would be $100 per unit, based on conversations that staff has had with the inflatable spa industry.

128 Purch. (2017). The Best Swim Spas of 2017. Retrieved May 8, 2017, from Top Ten Reviews : http://www.toptenreviews.com/home/outdoor/best-swim-spas/.

129 Bullfrog Spas. (2014). How much does a hot tub cost? Retrieved May 8, 2017, from Bullfrog Spas: http://www.bullfrogspas.com/blog/how-much-do-hot-tubs-cost/.

130 Median cost of exercise spa is $15,000 and median cost for mid-tier spas is $6,500, resulting in a ratio of 2.3.

131 Intex Inflatable Portable Electric Spa Test Report, IAPMO EGS, Docket 15-AAER-02 TN 212386, July 16, 2016

132 Intex Electric Spa Test Report, Docket 15-AAER-02 TN 220978-1, August 31, 2017

133 Bestway Electric Spa Test Report, Docket 15-AAER-02 TN 220978-2, August 31, 2017

Table 8-1: Estimated Incremental Costs for Current Standard

Source	Incremental Cost	
Pope, Rainer, Fernstrom, & Eilert, 2002	$750	
Davis Energy Group, Energy Solutions, 2004	**Measure**	**Incremental Cost**
	Improved Cover	$100
	Improved Spa Insulation	$200
	Improved Motor Configurations and Efficiency	$300
	Improved Controls	$50
	Total	$650
Douglas Mahone & Heschong Mahone Group Inc., 2005	$300	
Nadel, deLaski, Eldridge, & Kleisch, 2006	$100 for portable electric spas	
Staff assumption based on price difference between product types in 2016	$230 for exercise and combination spas	
Staff assumption based on discussions with the inflatable spa industry	$100 for inflatable spas	

Source: Modified from CASE report table[134]

The CASE report estimates a minimal cost to labeling portable electric spas with a removable sticker. Using the sources and assumption in the CASE report for determining labeling costs, staff has estimated the per label cost to be $0.34 per label for single reservoir portable electric spas, and $1.51 for combination spas.[135] Staff has added in estimates for inflatable spas, which were not considered in the CASE Report, and are based on the assumptions presented in **Table A-6**.[136] The estimated per label cost for inflatable spas is $0.83 per unit. Details of these estimates are shown in **Table 8-2.**

134 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, PG&E. California Statewide Utility Code s and Standards Program. Retrieved July 2015.

135 Western Area Power Administration. (2009). "What Goes Into an Energy-Efficient Spa or Hot Tub?" Lakewood: Western Area Power Administration.

136 Matthew Vartola, Presentation – Title 20 Impact on the Inflatable Spa Market and Consumer, Sept. 1, 2017, http://docketpublic.energy.ca.gov/PublicDocuments/15-AAER-02/TN221012_20170901T150259_Presentation__Title_20_Impact_on_the_Inflatable_Spa_Market_and.pdf.

Table 8-2: Label Costs for Portable Electric Spas

One Time Set-Up Costs			**Units**
Engineer/Designer Time		40	Hours
Engineer/Designer Hourly Wage	$	44.36	Dollars/Hour
Setup Cost to Each Manufacturer	$	1,774	Dollars
Number of Manufacturers			
Standard Spas & Exercise Spas		46	Manufacturers
Combination Spas		5	Manufacturers
Inflatable Spas		6	Manufacturers
Total Set-up Cost Statewide for Standard & Exercise Spas	**$**	**81,622**	Dollars
Total Set-Up Cost Statewide for Combination Spas	**$**	**8, 872**	Dollars
Total Set-Up Cost Statewide for Inflatable Spas	**$**	**10,646**	Dollars
Material Cost			**Units**
2019 Estimated Stock		936,315	Units
2019 Standard Spa & Exercise Spa Stock		924,565	Units
2019 Combo Spa Stock		8,751	Units
2019 Estimated Inflatable Spa Stock		18,233	Units
Printing Costs for Standard, Inflatable, & Exercise Spas	$	0.22	Dollars/Label
Printing Costs for Combination Spas	$	0.44	Dollars/Label
Total Printing Costs to Label Standard & Exercise Spa Stock	**$**	**204,064**	Dollars
Total Printing Costs to Label Combination Spa Stock	**$**	**3,850**	Dollars
Total Printing Costs to Label Inflatable Spas Stock	**$**	**4,011**	Dollars
Labor Costs to Apply Label			**Units**
Time to Adhere Each Label per unit		8	Seconds
Time to Adhere Each Label to a Combination Spa unit		16	Seconds
Total Time to Adhere Label to Standard & Exercise Spa Stock		2,061	Hours
Total Time to Adhere Label to Combination Spa Stock		34	Hours
Total Time to Adhere Label to Inflatable Spa Stock		39	Hours
Packaging and Filling Machine Operators Hourly Wage	$	13.44	Dollars/Hour
Total Labor Costs for Spa & Exercise Spa Stock	**$**	**27,703**	Dollars
Total Labor Costs for Combination Spa Stock	**$**	**523**	Dollars
Total Labor Costs for Inflatable Spa Stock	**$**	**545**	Dollars
Total			**Units**
Total Cost to Label Spa & Exercise Spa Stock	$	313,390	Dollars
Total Cost to Label Combination Spa Stock	$	13,245	Dollars
Total Cost to Label Inflatable Spa Stock	$	15,202	Dollars
Label Cost per Standard Spa/Exercise Spa Unit	**$**	**0.34**	
Label Cost per Combination Spa Unit	**$**	**1.51**	
Label Cost per Inflatable Spa Unit	**$**	**0.83**	

Source: Energy Commission staff calculation using information from Portable Electric Spas CASE Report 2014

Standard, Exercise, and Combination Spa Proposal Savings

Standby Power Efficiency Savings

As summarized in **Table 8-3**, if all portable electric spas (excluding inflatable spas) complied with the proposed standards (annual stock turnover savings), California would save about 95 GWh of energy per year. Using a residential rate of $0.1855 per kWh of electricity,[137] implementation of the proposed standards for portable electric spas would achieve an estimated $18 million a year in reduced utility costs after full stock turnover. Exercise spas contribute 27.3 GWh of energy savings per year and $5.1 million per year in reduced utility costs after full stock turnover. Combo spas contribute almost 8 GWh of energy savings per year and $1.5 million per year in reduced utility costs after full stock turnover. Due to a lack of market inventory and a potential lack of operational data for exercise spas, these estimates could underrepresent the actual energy savings, as the only data used were from the 48 exercise spas certified in MAEDBS.

Table 8-3: Standby Power Standard Statewide First-Year and Stock Turnover Savings

Spa Type	First-Year Savings - 2019		Complete Turnover Savings - 2028	
	Energy Consumption (GWh/yr)	Savings ($M)	Energy Consumption (GWh/yr)	Savings ($M)
Standard Spas	5.0	0.9	60.1	11.1
Exercise Spas	2.3	0.4	27.3	5.1
Combination Spas	0.7	0.1	7.9	1.5
Total	**8.0**	**1.4**	**95.4**	**17.7**

Source: Energy Commission staff calculation; see Appendix A

Spa Labeling Savings

The MAEDBS shows that units with the same volume capacity have very different standby energy consumption values. The range can go up to 150 watts for units with the same volume capacity.[138] This wide range of standby power consumption is affected by factors such as the spa cover, construction materials, and design of the unit. Consumers may be unaware that a wide range exists and must rely on the information given by the seller and manufacturer. Thus, consumers can benefit from having a label affixed to the unit to inform them of the energy consumption and energy savings. Labeling programs such as ENERGY STAR and "EnergyGuide" have proven to succeed in providing consumers with energy-saving information, which can lead to purchasing decisions that increase energy efficiency. In addition to a spa

137 Energy Information Administration – Residential electricity prices for 2017 through February 2017, retrieved May 4, 2017. http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_b.
138 California Energy Commission. (2015). "Modernized Appliance Efficiency Database System." Retrieved from Appliance Search: http://maedbs/Pages/ApplianceSearch.aspx.

model number being listed in the MAEDBS, a label will inform the consumer at the point of sale that the unit meets California's appliance efficiency standards and is certified to be sold in California.[139]

Labeling portable electric spa units will lead to energy savings by educating consumers to choose a more efficient unit. However, determining how many consumers will choose a more efficient unit, how much more efficient a unit they choose, and how the label affects that decision is more of an art than a science. Staff estimates that the potential savings are equivalent to about 5 percent of the total energy consumption under the proposed standard. This estimate is based on half of the 10 percent improvement in sales-weighted average efficiency for refrigerators using the categorical European Union (EU) Label scheme.[140] **Table 8-4** presents the savings when affixing a label to portable electric spas.[141]

Table 8-4: Statewide Annual Stock Savings Adjusted for Label Effect

Spa Type	First-Year Savings - 2019		Complete Turnover Savings - 2028	
	Energy Consumption (GWh/yr)	Savings ($M)	Energy Consumption (GWh/yr)	Savings ($M)
Standard Spas	6.7	1.2	77.4	14.4
Exercise Spas	3.0	0.6	35.3	6.5
Combination Spas	0.9	0.2	10.2	1.9
Total	**10.6**	**2.0**	**122.9**	**22.8**

Source: Energy Commission staff calculation; see Appendix A

The compliance rate, as a group, for standard, exercise, and combination spas is 77 percent, which is relatively high. That is, the majority of the spas already meet the proposed standard. Thus, the savings achieved under the proposed standard alone is lower than the label savings.

Standby Power Efficiency and Spa Label Savings

The total savings for the standard, exercise, and combination spas is summarized in **Table 8-5**, (a summation of **Table 8-3** and **Table 8-4**). The total savings includes the savings from a non-compliant spa to a compliant spa, and the potential label savings. California would save a total of about 218.2 GWh per year after full stock turnover in 2028. Using a residential rate of $0.1855 per kWh of electricity, implementation of the proposed standards would achieve an estimated $40.5 million a year in reduced utility costs after full stock turnover.

139 Worth, C., and G. Fernstrom. (2014). *Codes and Standards Enhancement (CASE) Initiative for PY 2012: Title 20 Standards Development- Analysis of Standards Proposal for Portable Electric Spas*. Energy Solutions, PG&E. California Statewide Utility Code s and Standards Program. Retrieved July 2015.
140 Bertoldi, Paolo. *Energy Efficient Equipment Within SAVE: Activities, Strategies, Success and Barriers*. Brussels: European Commission, 2000.
141 "European Union Efforts to Promote More Efficient Use of Electricity: the PACE Programme." *1996 Summer Study on Energy Efficiency in Buildings*. Washington, D.C.: American Council for an Energy-Efficient Economy, 1996.

Table 8-5: Total Statewide Savings

Spa Type	First-Year Savings - 2019		Complete Turnover Savings - 2028	
	Energy Consumption (GWh/yr)	Savings ($M)	Energy Consumption (GWh/yr)	Savings ($M)
Standard Spas	11.7	2.1	137.5	25.5
Exercise Spas	5.3	1.0	62.6	11.6
Combo Spas	1.6	0.3	18.1	3.4
Total	**18.6**	**3.4**	**218.2**	**40.5**

Source: Energy Commission staff calculation, see Appendix A.

Inflatable Spa Proposal Savings

The savings for the inflatable spa proposal is summarized in **Table 8-6**. California would save a total of about 24 GWh per year after full stock turnover in 2021. Using a residential rate of $0.1855 per kWh of electricity, implementation of the proposed standards for inflatable spas would achieve an estimated $4.4 million a year in reduced utility costs after full stock turnover. **Table 8-6** breaks down the total savings by the savings as a result of the standby power standard proposal, and the savings when affixing a label to inflatable spas.[142] The savings for inflatable spas follows the same savings method as the other types of portable electric spas.

Table 8-6: Inflatable Spa Statewide Savings

Savings Type	First-Year Savings - 2019		Complete Turnover Savings - 2021	
	Energy Consumption (GWh/yr)	Savings ($M)	Energy Consumption (GWh/yr)	Savings ($M)
Standby Power Savings	6.8	1.3	22.5	4.2
Label Savings	0.6	0.1	1.3	0.2
Total	**7.4**	**1.4**	**23.8**	**4.4**

Source: Energy Commission staff calculation; see Appendix A

In the case for inflatable spas, the majority of the savings are achieved from the proposed standby power standard alone, under the assumption that one third of inflatable spas will be compliant in 2019. The compliance rate for inflatable spas is much lower than the compliance rate for other types of portable electric spas.

142 “European Union Efforts to Promote More Efficient Use of Electricity: the PACE Programme." *1996 Summer Study on Energy Efficiency in Buildings*. Washington, D.C.: American Council for an Energy-Efficient Economy, 1996.

Lifecycle Benefits and Costs for Portable Electric Spas

Lifecycle costs and benefits of the proposed standard for portable electric spas, exercise spas, and combo spas are shown in **Table 8-7**. Lifecycle costs are based on the estimated incremental costs for improving the standby efficiency of the unit and labeling costs. The lifecycle benefit represents the savings the consumer should receive over the life of the appliance. Staff based lifecycle benefits by comparing the standby power consumption under the current standard with respect to the proposed standard plus the label impact. In conclusion, the proposed standard is cost-effective, as the compliant product has a high benefit-to-cost ratio.

Table 8-7: Unit Energy Savings and Lifecycle Benefits

Spa Type	Design Life (years)	Electricity Savings (kWh/year)	Lifecycle Costs ($/unit)	Lifecycle Benefit ($/unit)	Lifecycle Benefit/Cost Ratio
Standard Spas	10	307	$ 100.34	$ 569	6
Exercise Spas	10	1,426	$ 230.34	$ 2,645	11
Combination Spas	10	1,643	$ 231.51	$ 3,047	13
Inflatable Spas	3	1,180	$100.83	$ 657	7

Source: Energy Commission staff calculation; see Appendix A

CHAPTER 9: Environmental Impacts

Spas are generally replaced at their end of the useful lives. Replacement with more efficient spas would not present an additional impact to the environment beyond the natural cycle. Staff has not identified any additional potential adverse environmental impacts from the proposed regulations.

The proposed standards will lead to improved environmental quality in California. Saved energy translates to fewer power plants built, and less pressure on the limited energy resources, land, and water use associated with it. In addition, lower electricity consumption results in reduced greenhouse gas and criteria pollutant emissions, primarily from lower generation in hydrocarbon-burning power plants, such as natural gas power plants.

APPENDIX A:
Staff Assumptions and Calculation Methods

Appendix A discusses the information and calculations used to characterize portable electric spas in California, the current energy use, and the potential savings. The source of much of this information is the CASE report submitted to the Energy Commission. All calculations were based on the assumption of an effective date of June 1, 2019. After careful review, staff has altered some of the figures from the CASE report as appropriate to fit staff's approach to energy consumption and savings.

Table A-1: Summary of Values and Assumptions

Value	Description	Source
5.0%	Average percentage of new units in California	APSP, 2012-2013 and 2015 (see Table B-2)
44.0%	Average percentage of California spa owners that own an outdoor, above-ground spa	KEMA, 2010 (see Table B-3)
5.0%	Label impact rate savings	Assumption by CASE Team, Portable Electric Spas CASE Report 2014
5,040 hrs./yr.	Inflatable spa seasonal duty cycle	APSP, Docketed Comments, Docket 15-AAER-02 TN 212761, 08/12/16
8,760 hrs./yr.	Standby mode operating hours for standard, exercise, and combination spas	Worth & Fernstrom, 2014
5	Number of manufacturers who have certified combination spas in MAEDBS	MAEDBS October 2017
11	Number of combination spas certified in MAEDBS (6 of these models are certified with two separate values, one for each spa portion)	MAEDBS October 2017
9	Number of combination spa models used in staff calculations after removing irregularities from data set	Data altered by Staff based on MAEDBS October 2017 data
46	Number of manufacturers who have certified portable electric spas in the MAEDBS	MAEDBS March 2017
1,334	Number of certified entries in MAEDBS	MAEDBS March 2017
963	Number of models used in staff calculations after removing irregularities from data set	Data altered by staff based on MAEDBS March 2017 data
6	Number of inflatable spa manufacturers used in staff analysis	Staff research, November 2017
15,000	Estimated sales in 2015 for inflatable spas	APSP, docketed workshop presentation, Docket 15-AAER-02, TN 210390, February 17, 2016
0.1855 $/kWh	Average residential retail price in California for electricity	U.S. Energy Information Administration, February 2017, retrieved May 4, 2017

Source: California Energy Commission

Stock and Sales

Table A-2 lists annual stock and annual sales for spas in the United States and in California during 2012, 2013, and 2015 exclusively from APSP members. These include commercial, in-ground, and above-ground spa units.

Table A-2: Stock and Sales of Spa Units in California

Market Report Year	Stock in the United States	Stock in California	Percentage of Stock in California	New Units Sold/Installed in California	Percentage of New Units in California
2012	7,442,000	1,488,016	20.0%	71,525	4.8%
2013	5,823,000	1,142,352	19.6%	58,922	5.2%
2015	5,639,264	1,197,471	21.2%	-	
		Average	20.3%	Average	5.0%

Source: APSP - U.S. Swimming Pool and Hot Tub 2012, 2013 and 2015 Market Reports

Table A-3 lists additional annual stock data for all spas in the United States from the U.S. Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS) database. The table below also lists an estimate of existing stock in California after applying the 5 percent sales rate derived in **Table A-2**.

Table A-3: Additional Stock Data for Spas

Year	Number of Units in the United States	Estimate Number of Units in California
1993	2,800,000	567,908
1997	3,900,000	791,015
2001	4,400,000	892,427
2005	6,700,000	1,358,923
2009	6,400,000	1,298,076
2015	8,400,000	1,703,724

Source: Residential Energy Consumption Survey, U.S. Energy Information Administration

Table A-4 lists the number of outdoor, above-ground spas by building type in California from the 2003 and 2009 Residential Appliance Saturation Study (RASS) administered by the Energy Commission. Respondents selected either “outside, in-ground”, or “outside, above-ground”, or “indoor” for the location of the spa. Staff assumed outside and above-ground was equivalent to portable electric spas. From the results, staff estimated 48 percent of outdoor and above-ground spas are in California.

Table A-4: Outdoor and Above-Ground Spas in California

Building Type	2003	2009
Single family	356,265	443,731
Townhouse, duplex, row house	8,368	5,725
Apt condo 2-4 units	2,002	5,498
Apt condo 5+ units	531	3,877
Mobile home	6,181	8,162
Other	1,366	227
Total outdoor and above-ground spas	374,713	467,221
Total of California residents that own a spa	753,964	1,019,342
Percentage of California spa owners that own an outdoor, above-ground spas	50%	46%
Average	48%	

Source: California Statewide Residential Appliance Saturation Study, California Energy Commission

Table A-5 shows the estimated annual stock and sales in California. Using the California stock estimates from the Residential Energy Consumption Survey database from 1993 to 2015, APSP U.S. Swimming Pool and Hot Tub Market Reports, and Residential Appliance Saturation Study, staff calculated the rate of change to estimate the stock for all spas beyond 2015 in California (see **Table A-5**). Staff applied the 48 percent average of outdoor and above-ground spas in California, derived in **Table A-4**, to the total stock of all spas to estimate the stock of portable electric spas in California (see **Table A-5**). Staff then applied a 10 percent sales rate based on a design life of 10 years, to estimate the annual sales stock in California (see **Table A-5**). The California stock estimate for 2015, derived in **Table A-3**, is used as the initial starting point to estimate the stock beyond 2015.

Table A-5: Estimated Annual Stock and Sales for Portable Electric Spas

Year	Stock of Spas in California[1]	Stock of Portable Electric Spas in California[2]	Annual Sales
2015	1,703,724	813,864	81,386
2016	1,743,921	873,616	87,362
2017	1,784,118	895,795	89,579
2018	1,824,315	916,102	91,610
2019	1,864,512	936,315	93,632
2020	1,904,709	956,524	95,652
2021	1,944,906	976,733	97,673
2022	1,985,103	996,942	99,694
2023	2,025,300	1,017,151	101,715
2024	2,065,497	1,037,360	103,736
2025	2,105,694	1,057,569	105,757
2026	2,145,891	1,077,778	107,778
2027	2,186,088	1,097,987	109,799
2028	2,226,285	1,118,195	111,820

[1]Stock includes commercial, in-ground, and above-ground units
[2]Stock of units outdoor and above-ground using RASS esimates

Source: Energy Commission staff calculation, **Table A-2**, **Table A-3**, and **Table A-4**

Table A-6 lists the estimated annual stock and sales for inflatable spas. The baseline stock for 2015 was derived from an estimate APSP provided for inflatable spas.[143] The stock for inflatable spas was estimated by applying the 5 percent sales rate, derived in **Table A-2**. Annual sales for inflatable spas were estimated by applying a 33 percent sales rate, based on a design life of 3 years, to the total stock.

Table A-6: Estimated Annual Stock and Sales for Inflatable Spas

Year	Stock of Inflatable Spas	Annual Sales
2015	15,000	4,950
2016	15,750	5,198
2017	16,538	5,457
2018	17,364	5,730
2019	18,233	6,017
2020	19,144	6,318
2021	20,101	6,633

Source: APSP's workshop presentation on February 17, 2016 (Docket 15-AAER-02, TN 210390) and Table A-2

143 APSP's presentation at staff workshop on February 18, 2016. Docket 15-AAER-02, TN 210390, February 17, 2016.

Design Life

The design life is an estimate of the length of the typical operation usefulness of a product. The design life figures were taken from the CASE report and from APSP's docketed comments and are shown in **Table A-7**.

Table A-7: Estimated Design Life of Portable Electric Spas

Spa Type	Design Life (years)
Spa cover (for standard spas, exercise spas, and combination spas)	5
Standard spas, exercise spas, and combination spas	10
Inflatable spas and spa cover	3

Source: Portable Electric Spa CASE Report 2014 and APSP's docketed comments (Docket 15-AAER-02, TN 210390)

Duty Cycle

The duty cycle of an appliance is an estimate of consumer behavior for that particular appliance. It is directly tied to how often the appliance is used and for how long. In the context of this report, the duty cycle is the usage of the regulated standby mode or cycle of the unit. The duty cycle used in this report (see **Table A-8**) is taken directly from the CASE report and APSP's docketed comments and applied to standard, exercise, and combo spas; and inflatable spas, respectively.

Table A-8: Duty Cycle

Unit	Operating Hours
Standard spas	8,760 hrs/yr
Combination spas	8,760 hrs/yr
Exercise spas	8,760 hrs/yr
Inflatable spas	5,040 hrs/yr

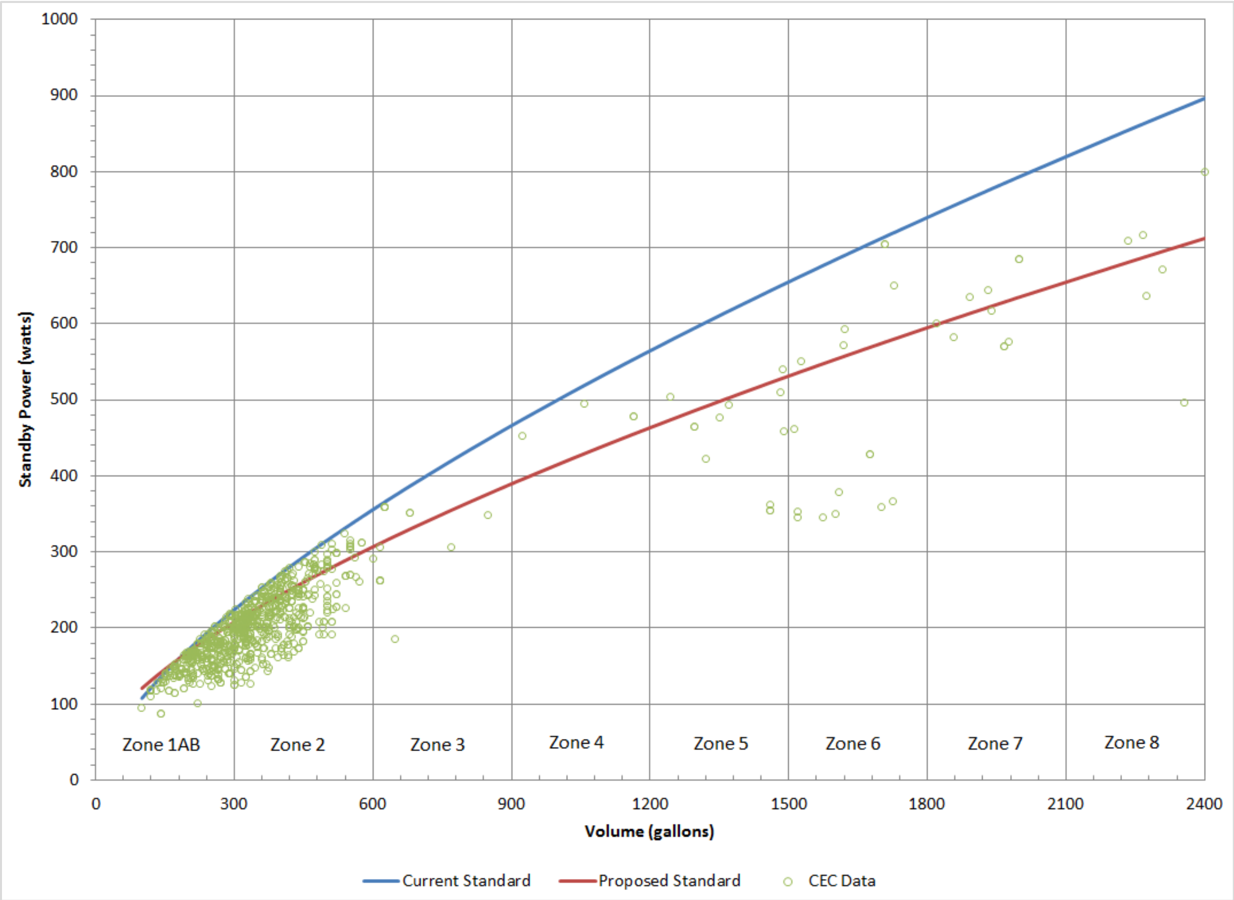
Source: Portable Electric Spas CASE Report 2014 and APSP's docketed comments (Docket 15-AAER-02, TN 210390)

Analysis for Standard, Exercise, & Combination Spas

Compliance Rates

The standard for portable electric spas is a powered function where the variable is the volume of portable electric spas. That is, as the volume (input) increases, the standby power (output) increases. **Figure A-1** shows the portable electric spas certified to MAEDBS as of March 2017. Note, there are no inflatable spas currently certified in MAEDBS.

Figure A-1: Portable Electric Spas in MAEDBS



Source: MAEDBS March 2017, California Energy Commission

Averaging the volume sizes of the portable electric spas in MAEDBS to a single value would not result in a representative analysis; since the chart shows a high saturation of data in the lower left corner (see **Figure A-1**). To produce a more representative weighted average, staff grouped the portable electric spas that are certified to MAEDBS into zones by volume range to reflect the function of the standard and the variability of spa sizes (see **Table A-9**) for this analysis. Combination spas were classified as a separate group because the data in MAEDBS was entered either separately for each spa portion or for the whole unit. Standard spas are represented by zones 1 to 3, and exercise spas are represented by zones 4 to 8. The zones are shown in **Figure A-1** on the horizontal axis of the chart.

Table A-9: Volume Range Grouped into Zones

Spa Type	Zone	Volume Range (gallons)
Standard spas	1A	100-180
	1B	181-300
	2	301-600
	3	601-900
Exercise spas	4	901-1,200
	5	1,201-1,500
	6	1,501-1,800
	7	1,801-2,100
	8	2,101-2,400
Combination spas		1,600 -2,400*

***Based on total water capacity.**

Source: Energy Commission staff calculation

Compliance rate is the percentage of compliant units over the total of units. **Table A-10** lists the estimated or reported compliance rates for standard spas, exercise spas, and combo spas. A compliance rate percentage indicates the ratio of compliant appliances to the total market or stock. Thus, a compliance rate of 40 percent means that 40 percent of that particular appliance already meets the proposed standard.

Table A-10: Compliance Rate for Portable Electric Spas

	Zones	Water Capacity Range (gallons)	Compliant (%)	Non-Compliant (%)
Standard spas	1AB to 3	100-900	78.6	21.4
Exercise spas	4 to 8	901-2,400	58.3	41.7
Combo spas	-	1,600-2,400*	44.4	55.6
All Certified Units			77.3	22.7

***Based on total water capacity**

Source: MAEDBS, California Energy Commission

The compliance rate for combination spas was determined as follows: if either the spa portion or the exercise portion of the combination spa *did not* meet the proposed standard, then the entire unit did not meet the proposed standard as shown in **Table A-11**.

Table A-11: Compliance Rate for Combination Spas

Model	Standard Spa Portion Meets Proposed Standard	Exercise Spa Portion Meets Proposed Standard	Whole Unit Meets Proposed Standard
1	PASS	PASS	PASS
2	PASS	PASS	PASS
3*	PASS	PASS	PASS
4	PASS	PASS	PASS
5*	PASS	FAIL	FAIL
6	FAIL	PASS	FAIL
7	FAIL	PASS	FAIL
8	FAIL	PASS	FAIL
9	FAIL	PASS	FAIL
		Total Fail	4 (44.4%)
		Total Pass	5 (55.6%)

***Volume of each portion was estimated as the volume for this model was entered for the entire unit.**

Source: MAEDBS October 2017, California Energy Commission

Table A-12 lists the estimated compliances rates for each zone and combination spas. The unit per zone percentage will be used later in the analysis to assign a sales weighted savings calculation. The compliance rates in the table below are derived from data entries submitted in March 2017. Although data entries are continuously being updated, the compliance rates have relatively stayed the same.

Table A-12: Unit Population and Compliance Rate for Each Zone

Zones	Volume Range (gallons)	Compliant Units	Non-Compliant Units	Total Units	Units per Zone (%)	Compliant (%)	Non-Compliant (%)
1A	100-180	47	0	47	4.9	100	0
1B	181-300	269	30	299	31.0	90	10
2	301-600	388	158	546	56.7	71	29
3	601-900	8	6	14	1.5	57	43
4	901-1,200	0	4	4	0.4	0	100
5	1,201-1,500	10	2	12	1.2	83	17
6	1,501-1,800	10	6	16	1.7	63	37
7	1,801-2,100	5	5	10	1.0	50	50
8	2,101-2,400	3	3	6	0.6	50	50
Combo spas	1,600 -2,400	4	5	9	0.9	44	56
Total	-	744	219	963	100	77	23

Source: MAEDBS March 2017, California Energy Commission, and staff assumptions

Baseline Energy Use

The baseline energy consumption represents the energy consumption under the scenario in which the current standard remains unchanged. Averaging the normalized standby power of the portable electric spas in MAEDBS to a single value would not result in a representative analysis since the chart shows a high saturation of data in the lower left corner (see **Figure A-1**). There could also be instances where current units will be upgraded or discontinued, therefore being removed from MAEDBS. These cases will modify the data. Thus, using an average of the normalized standby power of the units in the database as the base for calculations would inaccurately represent the energy consumption. Instead of using a weighted average of the normalized standby power consumption, a weighted average of the maximum allowable standby power from the current and proposed standard equations will be used. Thus, staff grouped the portable electric spas that are certified to MAEDBS into zones by volume range to reflect the function of the standard and the variability of spa sizes (see **Table A-9**) for this analysis.

The current standby power limit equation is as follows:

$$P_{CSTD} = 5 \times V^{2/3} \qquad \text{(Equation \#1)}$$

Where

P_{CSTD} = current maximum allowable standby power (watts)

V = volume (gallons)

The proposed standby power limit equation is as follows:

$$P_{PSTD} = \left(3.75 \times V^{2/3}\right) + 40 \qquad \text{(Equation \#2)}$$

Where

P_{PSTD} = proposed maximum allowable standby power (watts)

V = volume (gallons)

Table A-13 lists the volume used in the equations above and the average volume of the volume range in each zone. For combination spas, the average volume is not the average of the volume range, but rather the average of the volume capacity of the combination spas in MAEDBS.

Table A-13: Average Volume used for Calculations

Zone	Volume Range (gallons)	Average Volume (gallons)
1A	100-180	140
1B	181-300	240
2	301-600	450
3	601-900	750
4	901-1,200	1,050
5	1,201-1,500	1,350
6	1,501-1,800	1,650
7	1,801-2,100	1,950
8	2,101-2,400	2,250
Combo spas	1,600 -2,400*	1,965

***Based on total water capacity**

Source: Energy Commission staff calculation

The baseline average energy consumption of the appliance is the estimate of energy consumed by the market-representative percentage of compliant and noncompliant units. **Table A-14** lists the annual energy consumption of non-*compliant* portable electric spas which is calculated by multiplying the duty cycle by the *current* maximum allowable standby power and by the compliancy rate for each zone.

Table A-14: Baseline Non-Compliant Energy Use

Zones	Maximum Allowable Standby Power (watts) per Zone	No. of Non-Compliant Units (%)	Non-Compliant Energy Use (Wh/yr)
1A	135	0.0	0
1B	193	10.0	169,719
2	294	28.9	744,298
3	413	42.9	1,549,547
4	517	100.0	4,524,810
5	611	16.7	891,686
6	698	37.5	2,293,479
7	780	50.0	3,418,224
8	859	50.0	3,760,386
Combo spas	784	55.6	3,817,479

Source: Energy Commission staff calculation

Sample Calculations (Zone 2, Volume = 450 gallons):

Note, rounding may result in a slight variation from the results in the table.

Non-Compliant Energy Use:

$$EU_{Non-compliant} = P_{CSTD} \times (Duty\ Cycle) \times (Compliancy\ Rate\ \%) \qquad \text{(Equation \#3)}$$

Solve equation #1 for a volume of 450 gallons, and substitute into equation #3.

$$EU_{Non-Compliant} = (294\ watts) \times \left(8{,}760\frac{hr}{yr}\right) \times (0.289) \approx 744{,}302\ Wh/yr$$

Table A-15 lists the annual energy consumption of compliant portable electric spas which is calculated by multiplying the duty cycle by the average *proposed* maximum allowable standby power and by the compliancy rate for each zone.

Table A-15: Baseline Compliant Energy Use

Zones	Maximum Allowable Standby Power (watts) per Zone	No. of Compliant Units (%)	Compliant Energy Use (Wh/yr)
1A	141	100.0	1,236,102
1B	185	90.0	1,456,606
2	260	71.1	1,619,830
3	350	57.1	1,749,776
4	427	0.0	0
5	498	83.3	3,635,823
6	564	62.5	3,085,848
7	625	50.0	2,738,868
8	684	50.0	2,995,490
Combo spas	628	44.4	2,446,221

Source: Energy Commission staff calculation

Sample Calculations (Zone 2, Volume = 450 gallons):

Note, rounding may result in a slight variation from the results in the table.

Compliant Energy Use:

$$EU_{Compliant} = P_{PSTD} \times (Duty\ Cycle) \times\ (Compliancy\ Rate\ \%) \qquad \text{(Equation \#4)}$$

Solve equation #2 for a volume of 450 gallons, and substitute into equation #4.

$$EU_{Compliant} = (260\ watts) \times \left(8{,}760 \frac{hr}{yr}\right) \times\ (0.711) = 1{,}619{,}374\ Wh/yr$$

The total baseline energy use is calculated by summing the total non-compliant energy use (see **Table A-14**) and the compliant energy use (see **Table A-15**). **Table A-16** list the sales weighted average energy consumption calculated by multiplying the total energy use per zone by the percentage of units per zone.

Table A-16: Baseline Energy Consumption

Zones	Total Energy Use (Wh/yr)	Zone Population (%)	Sales Weighted Average Energy Consumption (Wh/yr)
1A	1,236,102	4.9	60,329
1B	1,626,326	31.0	504,955
2	2,364,128	56.7	1,340,409
3	3,299,323	1.5	47,965
4	4,524,810	0.4	18,795
5	4,527,509	1.2	56,418
6	5,379,327	1.7	89,376
7	6,157,092	1.0	63,937
8	6,755,876	0.6	42,093
Combo spas	6,263,700	0.9	58,539

Source: Energy Commission staff calculation

Sample Calculations (Zone 2, Volume = 450 gallons):

Note, rounding may result in a slight variation from the results in the table.

Total Energy Consumption for Zone 2:

$$Total\ EU = (EU_{Non-Compliant} + EU_{Compliant}) \qquad \text{(Equation \#5)}$$

Sum the total non-compliant and compliant energy use for zone 2 (see **Table A-14** and **Table A-15**)

$$Total\ EU = \left(744{,}302\frac{Wh}{yr} + 1{,}619{,}374\frac{Wh}{yr}\right) = 2{,}363{,}676\frac{Wh}{yr}$$

The baseline weighted average energy consumption was calculated by multiplying the total energy use by the percentage of units in each zone.

Sample Calculations (Zone 2):

Note, rounding may result in a slight variation from the results in the table.

$$Average\ Energy\ Consumption_{Zone} = (Total\ EU\ per\ Zone) \times (Unit\ Population\ \%_{Zone}) \quad \text{(Equation \#6)}$$

$$Average\ Energy\ Consumption_{Zone2} = (2{,}363{,}676\ Wh/yr) \times (0.567) = 1{,}340{,}204\ Wh/yr$$

Table A-14 lists the total stock energy consumption when the standard goes into effect (2019) and after full stock turnover (2028). The statewide energy consumption is calculated by multiplying the weighted average energy consumption per zone (see **Table A-16**) by the stock in 2019 and in 2028. The stock in 2019 is 936,315 units and in 2028 the stock is 1,118,195 (see **Table A-5**).

Table A-17: Baseline Stock Energy Consumption

	Stock Energy Consumption (GWh/yr)	
Zones	**2019**	**2028**
1A	56	67
1B	473	565
2	1,255	1,499
3	45	54
4	18	21
5	53	63
6	84	100
7	60	71
8	39	47
Combo spas	55	65

Source: Energy Commission staff calculation

Sample Calculations (Zone 2, 2019):

Note, rounding may result in a slight variation from the results in the table.

The annual stock energy consumption for portable electric spas is the product of average energy consumption and the annual stock in 2019.

$$Stock\ Energy\ Consumption_{Zone} = (Ave.Energy\ Consumption_{Zone}) \times (2019\ Stock) \times 10^{-9} \quad \text{(Equation \#7)}$$

$$Stock\ Energy\ Consumption_{Zone} = \left(1{,}340{,}204\ \frac{Wh}{yr}\right) \times (936{,}315\ units) \times 10^{-9} = 1{,}255\ \frac{GWh}{yr}$$

The total annual stock energy consumption is the addition of the annual stock energy consumption for each zone (see **Table A-17**). **Table A-18** lists the baseline total annual stock energy consumption for 2019 and 2028. Calculations for 2028, when full stock turnover is complete, are similar. Note the total annual stock energy consumption for standard spas is the total from zones 1 to 3 and for exercise spas the total is from zones 4 to 8 (derived from **Table A-17**)

Table A-18: Baseline Energy Use by Spa Type

	Total Annual Stock Energy Consumption (GWh/yr)	
Spa Type	**2019**	**2028**
Standard spas	1,829	2,185
Exercise spas	253	303
Combination spas	55	65
Total	**2,137**	**2,553**

Source: Energy Commission staff calculation

Compliant Energy Use

The compliant energy consumption represents the energy consumption under the scenario in which the proposed standard goes into effect in 2019. The energy consumption of compliant products is estimated based on minimum requirements to meet the proposed regulations. The total annual stock energy consumption is calculated using the same method as baseline energy use, except the compliancy rates change at a rate of ±10 percent. That is, one divided by the design life (10 years). In 2019, the non-compliant rates in **Table A-14** will decrease by 10 percent while the compliant rates in **Table A-15** increase by 10 percent every year until full stock turnover in 2028, where the compliant rates are 100 percent. **Table A-19** lists the compliant total annual stock energy consumption for 2019 and 2028.

Table A-19: Compliant Energy Use

	Total Annual Stock Energy Consumption (GWh/yr)	
Spa Type	**2019**	**2028**
Standard spas	1,824	2,125
Exercise spas	251	275
Combination spas	54	58
Total	**2,129**	**2,457**

Source: Energy Commission staff calculation

Cost and Savings

Table A-20 lists the energy savings once the proposed standard becomes effective in 2019 and when complete stock turnover has occurred in 2028. The energy savings are calculated by subtracting the compliant energy use (see **Table A-19**) from the baseline energy use (see **Table A-18**).The cumulative energy and costs savings when the proposed standard has reached complete stock turnover are the summation of savings from each year beginning in 2019 and ending in 2028.

Table A-20: Standby Power Standard Statewide Annual Stock Savings

	First-Year Savings - 2019		Complete Turnover Savings - 2028	
	Energy Consumption (GWh/yr)	Savings ($M)	Energy Consumption (GWh/yr)	Savings ($M)
Standard spas	5.0 (63%)	0.9	60.1 (63%)	11.1
Exercise spas	2.3 (29%)	0.4	27.3 (29%)	5.1
Combination spas	0.7 (8%)	0.1	7.9 (8%)	1.5
Total	**8.0 (100%)**	**1.4**	**95.4 (100%)**	**17.7**

Source: Energy Commission staff calculation

Sample Calculations (Total First-Year Savings):

Note, rounding may result in a slight variation from the results in the table.

$$E_{Savings} = E_{Baseline} - E_{Compliant} \qquad \text{(Equation \#8)}$$

Where,

$E_{Savings}$ = savings from implementing the proposed standard (GWh/yr)

$E_{Baseline}$ = baseline energy consumption (GWh/yr)

$E_{Compiant}$ = compliant energy consumption (GWh/yr)

Sample Calculation:

$$E_{Savings} = E_{Baseline} - E_{Compliant}$$

$$E_{Savings} = (2{,}137 - 2{,}129)\frac{GWh}{yr} = 8\ \frac{GWh}{yr}$$

The cost savings (benefits) are calculated by multiplying the annual energy savings by $0.1855 per kWh.

Sample Calculation (Total First-Year Savings):

Note, rounding may result in a slight variation from the results in the table.

$$B_{Savings} = \frac{\$0.1855}{kWh} \times E_{\ Savings} \qquad \text{(Equation \#9)}$$

Substitute results from equation #8 into equation #9.

$$B_{Savings} = \frac{\$0.1855}{kWh} \times 8\frac{GWh}{yr} \times \frac{10^6 kWh}{1GWh} \approx \$1.4\ Million$$

Table A-21 lists the potential energy savings for labeling standard spas, exercise spas, and combination spas once the label becomes effective in 2019. Since, the label goes hand-in-hand with the proposed standard, the potential label savings are equivalent to about 5 percent of the total compliant energy use in

2019 and in 2028. This estimate is based on half of the 10 percent improvement in sales-weighted average efficiency for refrigerators using the categorical European Union (EU) label scheme.[144]

Table A-21: Total Statewide Annual Stock Savings Adjusting for Label Impact

	First-Year Savings - 2019		Complete Turnover Savings - 2028	
	Energy Consumption (GWh/yr)	Savings ($M)	Energy Consumption (GWh/yr)	Savings ($M)
Total	10.6	2.0	122.9	22.8

Source: Energy Commission staff calculation

The total energy savings are calculated by applying the 5 percent potential label savings to the total compliant annual energy consumption for 2019 and 2028 (**Table A-19**).

Sample Calculation (Total First-Year Savings):

Note, rounding may result in a slight variation from the results in the table.

$$E_{Label\ Savings\ FY} = E_{Compliant\ FY} \times 100\%\ Standard\ Implementation \times 5\%\ Label\ Savings \times Stock\ Compliancy\ Rate_{FY}$$

(Equation #10)

Where,

$E_{Label\ Savings\ FY}$ = first-year potential label savings (GWh/yr)

$E_{Compliant\ FY}$ = compliant energy consumption in the first year (GWh/yr)

Stock Compliancy $Rate_{FY}$ = 10 percent[145] compliance rate in the first year

Sample Calculation:

$$E_{Label\ Savings\ FY} = E_{Compliant} \times 100\%\ Standard\ Implementation \times 5\%\ Label\ Savings \times Stock\ Compliancy\ Rate_{FY}$$

$$E_{Label\ Savings\ FY} = 2{,}129\frac{GWh}{yr} \times \frac{100\%}{100} \times \frac{5\%}{100} \times \frac{10\%}{100} \approx 10.6\frac{GWh}{yr}$$

Sample Calculation (Total Full Stock Turnover Savings):

Note, rounding may result in a slight variation from the results in the table.

$$E_{Label\ Savings\ FS} = E_{Compliant\ FS} \times 100\%\ Standard\ Implementation \times 5\%\ Label\ Savings \times Stock\ Compliancy\ Rate_{FS}$$

(Equation #11)

144 Bertoldi, Paolo. *Energy Efficient Equipment Within SAVE: Activities, Strategies, Success and Barriers*. Brussels: European Commission, 2000.

145 Compliancy rate in the first year = 1 / design life = 1/10 = 10 percent

Where,

$E_{Label\ Savings\ FS}$ = full-stock turnover potential label savings (GWh/yr)

$E_{Compliant\ FS}$ = compliant energy consumption after full stock turnover (GWh/yr)

Stock Compliancy $Rate_{FS}$ = 100 percent, full stock turnover

Sample Calculation:

$$E_{Label\ Savings\ FS} = E_{Compliant\ FS} \times 100\%\ Standard\ Implementation \times 5\%\ Label\ Savings \times Stock\ Compliancy\ Rate_{FS}$$

$$E_{Label\ Savings\ FS} = 2{,}457 \frac{GWh}{yr} \times \frac{100\%}{100} \times \frac{5\%}{100} \times \frac{100\%}{100} \approx 122.9 \frac{GWh}{yr}$$

From the total label savings staff was able to calculate the potential label savings for standard spas, exercise spas, and combination spas. Staff applied the percentage of savings for each spa type, derived from the energy savings from implementing the standby power standard (see **Table A-20**), to the total potential label savings (see **Table A-21**). **Table A-22** summarizes the savings percentage for each spa type.

Table A-22: Percentage of Savings from the Proposed Standby Power Standard Only

Type	Percentage
Standard spas	63%
Exercise spas	29%
Combination spas	8%

Source: Energy Commission staff calculation

Tables A-23 presents the savings when affixing a label to standard spas, exercise spas, and combination spas.

Table A-23: Statewide Annual Stock Savings Adjusting for Label Impact

	First-Year Savings - 2019		Complete Turnover Savings - 2028	
	Energy Consumption (GWh/yr)	Savings ($M)	Energy Consumption (GWh/yr)	Savings ($M)
Standard spas	6.7 (63%)	1.2	77.4 (63%)	14.4
Exercise spas	3.0 (29%)	0.6	35.3 (29%)	6.5
Combination spas	0.9 (8%)	0.2	10.2 (8%)	1.9
Total	**10.6 (100%)**	**2.0**	**122.9 (100%)**	**22.8**

Source: Energy Commission staff calculation

Sample Calculation (Total Full Stock Turnover Savings):

Note, rounding may result in a slight variation from the results in the table.

$$Standard\ Spa\ \ Label\ Savings = Total\ Label\ Savings \times 63\% \quad \text{(Equation \#12)}$$

$$Exercise\ Spa\ Label\ Savings = Total\ Label\ Savings \times 29\% \quad \text{(Equation \#13)}$$

$$Combination\ Spa\ \ Label\ Savings = Total\ Label\ Savings\ \times 8\% \quad \text{(Equation \#14)}$$

Sample Calculation:

$$Exercise\ Spa\ Label\ Savings = 122.9\ \frac{GWh}{yr} \times \frac{29\%}{100} \approx 35.6 \frac{GWh}{yr}$$

The cost savings are calculated by multiplying the energy consumption savings by the California retail price of electricity (see Equation #9).

Sample Calculation (Total Full Stock Turnover Savings):

Note, rounding may result in a slight variation from the results in the table.

$$B_{Savings} = \frac{\$0.1855}{kWh} \times 122.9 \frac{GWh}{yr} \times \frac{10^6 kWh}{1GWh} \approx \$22.8\ Million$$

Label Costs

Table A-24 lists the label costs for standard spas, exercise spas, and combination spas.

Table A-24: Label Costs

Spa Type	Label Costs ($/unit)
Standard spas	$ 0.34
Exercise spas	$ 0.34
Combination spas	$ 1.51

Source: Energy Commission staff calculation

The label costs were calculated by the following steps:

1. The total setup cost is calculated by multiplying the setup cost for each manufacturer by the number of manufacturers in the MAEDBS.

$$Total\ Setup\ Cost\ Statewide = (Engineer\ Time) \times (Engineer\ Hourly\ Wage) \times (No. of\ Manufacturers)$$

2. The total printing costs to label stock are calculated by multiplying the printing cost per label by the stock in 2018.

$$Total\ Printing\ Costs\ to\ Label\ Stock = (printing\ cost\ per\ label) \times (2019\ stock)$$

3. The total labor costs are calculated by multiplying the total time to adhere labels to the entire stock by the packaging and filling machine operators' hourly wage.

$$Total\ Labor\ Costs = (2019\ Stock) \times (Time\ to\ adhere\ label) \times (Operator\ Hourly\ Wage)$$

4. The total cost to label stock is the addition of total setup cost, total printing costs, and total labor costs.

$$Total\ Cost = (Total\ SetUp\ Cost) + (Total\ Printing\ Costs) + (Total\ Labor\ Costs)$$

5. The label cost for each portable electric spa is calculated by dividing the total cost to label stock by the 2019 stock.

$$Label\ Cost\ per\ Unit = \frac{Total\ Cost\ to\ Label\ Stock}{2019\ Stock}$$

Lifecycle Cost and Benefits

Table A-25 lists the energy savings, lifecycle costs, and lifecycle benefit. The calculation for energy savings per unit is the difference between the baseline and compliant consumption per unit and adjusting for the impact of the label. The lifecycle cost includes the incremental cost and the label cost. The lifecycle benefit is the product of the energy savings per unit, the life of the unit, and the average retail price of electricity.

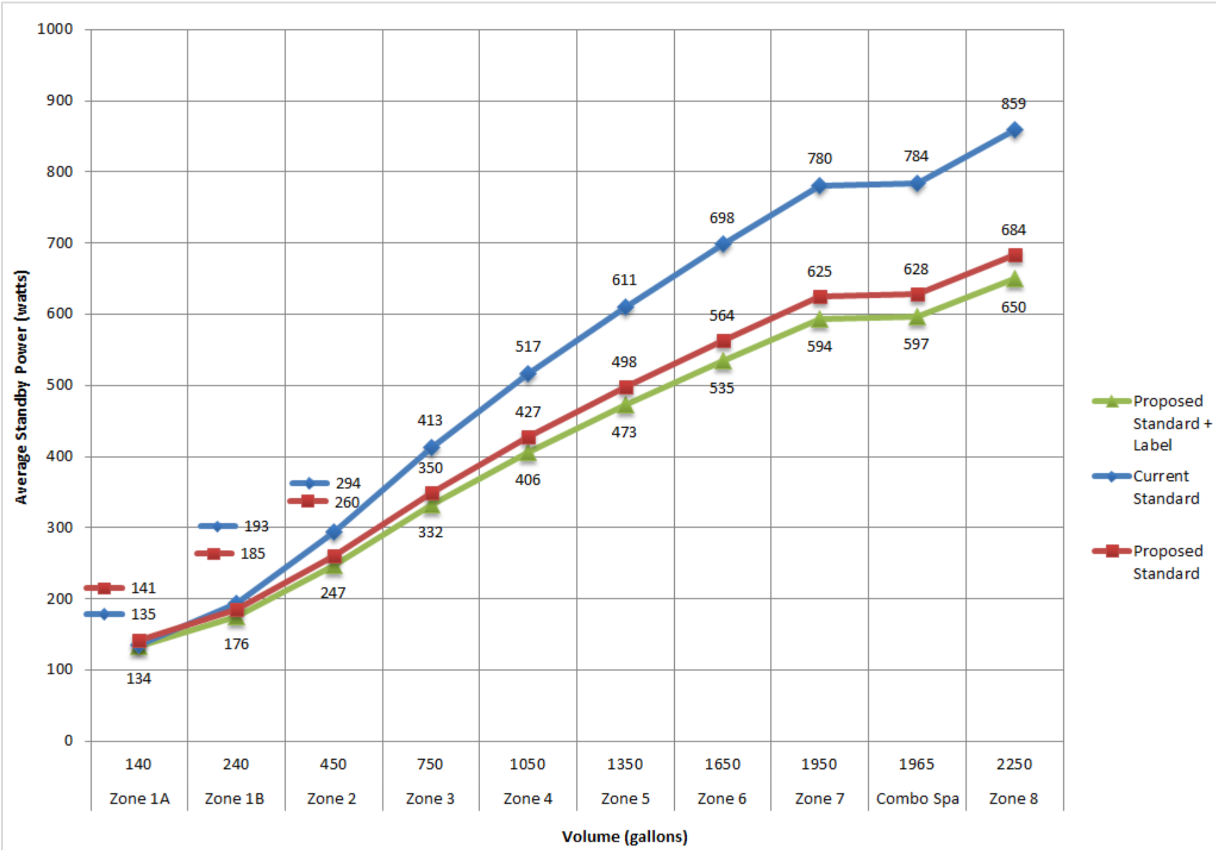
Table A-25: Weighted Unit Energy Savings and Lifecycle Benefits/Costs

Spa Type	Design Life (years)	Energy Savings per Unit (kWh/year)	Lifecycle Costs ($/unit)	Lifecycle Benefit ($/unit)	Lifecycle Benefit/Cost Ratio
Standard spas	10	307	$ 100.34	$ 569	6
Exercise spas	10	1,426	$ 230.34	$ 2,645	11
Combo spas	10	1,612	$ 231.51	$ 3,047	13

Source: Energy Commission staff calculation

To calculate the weighted energy savings per unit, staff first calculated the standby power under the current standard and the proposed standard, and the proposed standard while accounting for the label effect. **Figure A-2** displays the results of inputting the average volume of each zone into the standby power limit equation for the current and proposed standard. The graph also displays the standby power limit for the proposed standard when applying the 5 percent potential savings as a result of adding a label to portable electric spas.

Figure A-2: Maximum Allowable Standby Power per Zone



Source: Energy Commission staff calculation

Sample Calculation (Zone 2, V = 450 gallons):

Current Standard (Equation #1):

$$P_{CSTD} = 5 \times V^{2/3}$$

$$P_{CSTD} = 5 \times (450\ gallons)^{2/3} \approx 294\ watts$$

Proposed Standard (Equation #2):

$$P_{PSTD} = \left(3.75 \times V^{2/3}\right) + 40$$

$$P_{PSTD} = \left(3.75 \times (450\ gallons)^{2/3}\right) + 40 \approx 260\ watts$$

Proposed Standard + Label:

$$P_{PSTD+Label} = P_{PSTD} - P_{Label\ Savings} \qquad \text{(Equation \#15)}$$

Where,

$$P_{Label\ Savings} = P_{PSTD} \times 5\%\ Potential\ Savings \qquad \text{(Equation \#16)}$$

$$P_{PSTD} = \left(3.75 \times V^{2/3}\right) + 40 \qquad \text{(Equation \#2)}$$

Substitute equation #2 and equation #17, into equation #16.

$$P_{PSTD} = \left(3.75 \times (450\ gallons)^{2/3}\right) + 40 \approx 260\ watts$$

$$P_{Label\ Savings} = 260\ watts \times 5\%\ Potential\ Savings \approx 13\ watts$$

$$P_{PSTD+Label} = 260 - 13 \approx 247\ watts$$

Table A-26 lists the weighted unit energy consumption (UEC) savings, the energy consumption under the current standard, and under the proposed standard while taking into account the potential savings of the label. The UEC is calculated by multiplying the standby power, derived in **Figure A-2**, by the duty cycle. The UEC savings is calculated by subtracting the UEC of the proposed standard plus the label from the UEC of the current standard.

Table A-26: Unit Energy Consumption Savings

Spa Type	Zone	Unit Energy Consumption for the Current Standard (kWh/yr)	Unit Energy Consumption for the Proposed Standard + Label (kWh/yr)	Unit Energy Consumption Savings (kWh/yr)	Weighted Unit Energy Consumption Savings (kWh/yr)
Standard spas	Zone 1A	1,181	1,174	7	0.3
	Zone 1B	1,691	1,538	153	51
	Zone 2	2,572	2,165	407	245
	Zone 3	3,616	2,909	707	11
Exercise spas	Zone 4	4,525	3,557	968	81
	Zone 5	5,350	4,145	1,205	301
	Zone 6	6,116	4,690	1,426	475
	Zone 7	6,836	5,204	1,632	340
	Zone 8	7,521	5,691	1,830	229
Combination spas		6,872	5,229	1,643	1,643

Source: Energy Commission staff calculation

Sample Calculation (Zone 2, Volume = 450 gallons):

Note, rounding may result in a slight variation from the results in the table.

Unit Energy Consumption for the Current Standard:

$$UEC_{Current} = Duty\ Cycle\ \times P_{CSTD}\quad \text{(Equation \#17)}$$

Solve equation #1 for a volume of 450 gallons and substitute into equation #17.

$$UEC_{Current} = Duty\ Cycle\ \times P_{CSTD}$$

$$UEC_{Current} = 8{,}760\,\frac{hours}{year} \times 294\ watts = 2{,}575\,\frac{kWh}{yr}$$

Unit Energy Consumption for the Proposed Standard + Label:

$$UEC_{Proposed+Label} = Duty\ Cycle\ \times P_{PSTD+Label}\ \text{(Equation \#18)}$$

Solve equation #15 for a volume of 450 gallons and substitute into equation #18.

$$UEC_{Proposed+Label} = Duty\ Cycle\ \times P_{PSTD+Label}$$

$$UEC_{Proposed+Label} = 8{,}760\,\frac{hours}{year} \times 247\ watts = 2{,}164\,\frac{kWh}{yr}$$

Unit Energy Consumption Savings:

$$UEC_{Savings} = UEC_{Current} - UEC_{Proposed+Label}\ \text{(Equation \#19)}$$

Solve equation #18 and equation #19 for a volume of 450 gallons, and substitute into equation #20.

$$UEC_{Savings} = UEC_{Current} - UEC_{Proposed+Label}$$

$$UEC_{Savings} = 2{,}572\,\frac{kWh}{yr} - 2{,}165\,\frac{kWh}{yr} = 407\,\frac{kWh}{yr}$$

The UEC saving is then weighted by the percentage of units per zone per spa type. **Table A-27** lists the weighted percentages that were applied to the UEC savings for standard spas and exercise spas. Combination spas were weighted at 100 percent since they are grouped separately.

Table A-27: Weighted Unit Energy Consumption Percentages

Standard Spas			Exercise Spas		
Zone	**Total Units**	**Percentage**	**Zone**	**Total Units**	**Percentage**
Zone 1A	47	5.2	Zone 4	4	8.3
Zone 1B	299	33.0	Zone 5	12	25.0
Zone 2	546	60.3	Zone 6	16	33.3
Zone 3	14	1.5	Zone 7	10	20.8
Total	906	100	Zone 8	6	12.5
			Total	48	100

Source: Energy Commission staff calculation

Sample Calculation (Zone 2, Volume = 450 gallons):

Note, rounding may result in a slight variation from the results in the table.

$$Weighted\ UEC_{Savings} = Percentage_{Zone} \times UEC\_Savings\ \text{(Equation \#20)}$$

$$Weighted\ UEC_{Savings} = 0.603 \times 407\,\frac{kWh}{yr} = 245\,\frac{kWh}{yr}$$

Table A-28 lists the weighted UEC by spa type (as shown in **Table A-25**). The weighted UEC values from zones 1 to 3 in **Table A-26** were summed to produce the weighted UEC for standard spas. The weighted UEC values from zones 4 to 8 in **Table A-26** were summed to produce the weighted UEC for exercise spas.

Table A-28: Weighted Unit Energy Consumption by Spa Type

Type	Zone	Weighted Unit Energy Consumption (kWh/yr)
Standard spas	Zone 1-3	307
Exercise spas	Zone 4-8	1,426
Combination spas		1,643

Source: Energy Commission staff calculation

The lifecycle benefit as shown in **Table A-25** is calculated by multiplying the weighted UEC in **Table A-28** by the design life and California average retail price of electricity.

Sample Calculation (Standard Spas):

Note, rounding may result in a slight variation from the results in the table.

$$Lifecycle\ Benefit = Weighted\ UEC_{Savings} \times Design\ Life \times Retail\ Price\ of\ Electrcity$$

(Equation #21)

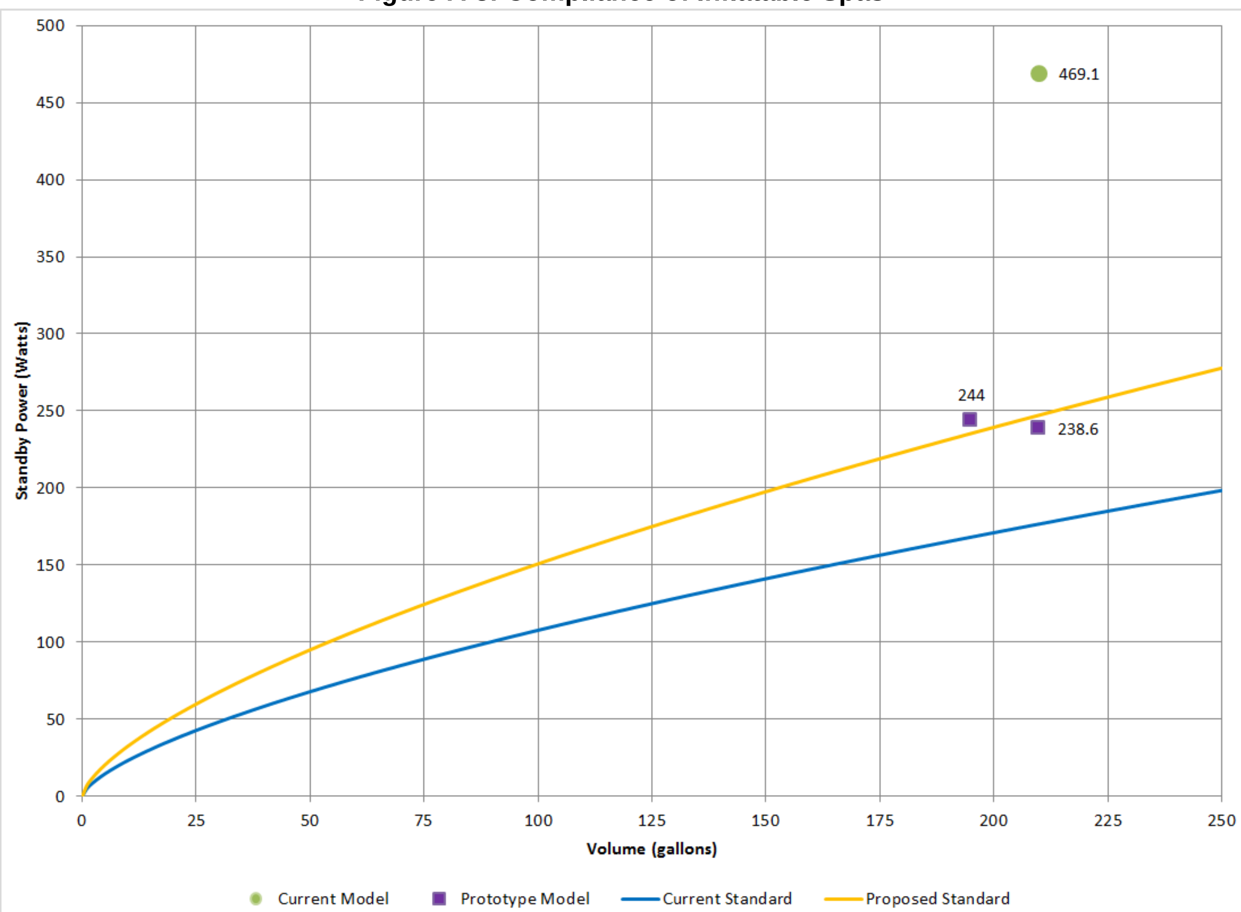
$$Lifecycle\ Benefit\ = 307\frac{kWh}{yr} \times 10\ years\ \times \frac{\$0.1855}{kWh} \approx \$569\ per\ unit$$

Analysis for Inflatable Spas

Compliance Rates for Inflatable Spas

The standard for portable electric spas is a powered function where the variable is the volume of portable electric spas. That is, as the volume (input) increases, the standby power (output) increases. **Figure A-3** compares the compliance of inflatables spas currently in the market and the prototypes the inflatable spa industry has developed. Note, there are no inflatable spas currently certified in MAEDBS. Data for this analysis relies on the docketed test lab reports for inflatable spas.

Figure A-3: Compliance of Inflatable Spas



Source: Docketed inflatable spa test lab reports [146, 147, 148]

Table A-29 lists the estimated compliance rate for inflatable spas. A compliance rate percentage indicates the ratio of compliant appliances to the total market or stock. Thus, a compliance rate of 40 percent means that 40 percent of that particular appliance already meets the proposed standard. As

146 Intex Inflatable Portable Electric Spa Test Report, IAPMO EGS, Docket 15-AAER-02 TN 212386, July 16, 2016

147 Intex Electric Spa Test Report, Docket 15-AAER-02 TN 220978-1, August 31, 2017

148 Bestway Electric Spa Test Report, Docket 15-AAER-02 TN 220978-2, August 31, 2017

Figure A-3 illustrates, one in three inflatable spas will be compliant when the proposed standard goes into effect.

Table A-29: Compliance Rate for Inflatable Spas

Year	Compliant (%)	Non-Compliant (%)
Baseline (Present)	0	100
Effective Year	33	67
Full Stock Turnover	100	0

Source: Energy Commission staff assumption

Baseline Energy Use of Inflatable Spas

The baseline energy consumption represents the energy consumption under the scenario in which the current standard remains unchanged. In the case for inflatable spas, the baseline energy consumption represents the current marketplace. The baseline energy use for inflatable spas is calculated using the same method as the baseline energy use for other spa types in this study. The baseline average energy consumption of the appliance is the estimate of energy consumed by the market-representative percentage of compliant and noncompliant units. For inflatable spas, a water capacity of 210 gallons will be the representative spa size for this analysis.

The current standby power for inflatable spas is 469.1 watts, based on the docketed test lab for an inflatable spa with a volume water capacity of 210 gallons.[149]

$$P_{CSTD-IS} = 469.1\ watts \qquad \text{(Equation \#22)}$$

The proposed standby power limit equation is as follows:

$$P_{PSTD-IS} = 7 \times V^{2/3} \qquad \text{(Equation \#23)}$$

Where,

$P_{PSTD-IS}$ = proposed maximum allowable standby power for inflatable spas (watts)

V = volume (gallons)

Table A-30 lists the annual energy consumption of a *non-compliant* inflatable spa which is calculated by multiplying the duty cycle by the *current* standby power and by the compliancy rate.

149 Intex Inflatable Portable Electric Spa Test Report, IAPMO EGS, Docket 15-AAER-02 TN 212386, July 16, 2016

Table A-30: Baseline Non-Compliant Energy Use for Inflatable Spas

Non-Compliant Standby Power (watts)	No. of Non-Compliant Units (%)	Non-Compliant Energy Use (Wh/yr)
469.1	100	2,364,264

Source: Energy Commission staff calculation

Sample Calculation:

Note, rounding may result in a slight variation from the results in the table.

Non-Compliant Energy Use:

$$EU_{Non-compliant} = (Current\ Model\ Standby\ Power) \times (Duty\ Cycle) \times (Compliancy\ Rate\ \%)$$

(Equation #24)

$$EU_{Non-Compliant} = (469.1\ watts) \times \left(5{,}040 \frac{hr}{yr}\right) \times (1) \approx 2{,}364{,}264\ Wh/yr$$

Table A-15 lists the annual energy consumption of a *compliant* inflatable spa which is calculated by multiplying the duty cycle by the *proposed* maximum allowable standby power and by the compliancy rate.

Table A-31: Baseline Compliant Energy Use for Inflatable Spas

Compliant Standby Power (watts)	No. of Compliant Units (%)	Compliant Energy Use (Wh/yr)
247	0	0

Source: Energy Commission staff calculation

Sample Calculations:

Note, rounding may result in a slight variation from the results in the table.

Compliant Energy Use:

$$EU_{Compliant} = P_{PSTD-IS} \times (Duty\ Cycle) \times (Compliancy\ Rate\ \%) \qquad \text{(Equation \#25)}$$

Solve equation #23 for a volume of 210 gallons, and substitute into equation #25.

$$EU_{Compliant} = (247\ watts) \times \left(5{,}040 \frac{hr}{yr}\right) \times (0) = 0\ Wh/yr$$

Table A-32 lists the total baseline energy use for inflatable spas. The total baseline energy use is calculated by summing the total non-compliant energy use (see **Table A-30**) and the compliant energy use (see **Table A-31**).

Table A-32: Baseline Energy Consumption for Inflatable Spas

Non-Compliant Energy Use (Wh/yr)	Compliant Energy Use (Wh/yr)	Total Energy Use (Wh/yr)
2,364,264	0	2,364,264

Source: Energy Commission staff calculation

Table A-33 lists the total stock energy consumption when the standard goes into effect (2019) and after full stock turnover (2021). The statewide energy consumption is calculated by multiplying the weighted total energy use per unit (see **Table A-32**) by the stock in 2019 and in 2021. The stock in 2019 is estimated to be 18,233 units and in 2021 the stock is estimated to be 20,101 units (see **Table A-6**).

Table A-33: Baseline Stock Energy Use for Inflatable Spas

First-Year Total Energy Use (GWh/yr)	Complete Stock Turnover Total Energy Use (GWh/yr)
43.1	47.5

Source: Energy Commission staff calculation

Sample Calculations:

Note, rounding may result in a slight variation from the results in the table.

$$Stock\ Energy\ Use = (Total\ Energy\ Use\ per\ Unit) \times (2019\ Stock) \times 10^{-9} \quad \text{(Equation \#26)}$$

$$Stock\ Energy\ Use = \left(2{,}364{,}264\ \frac{Wh}{yr}\right) \times (18{,}233\ units) \times 10^{-9} = 43.1\ \frac{GWh}{yr}$$

Compliant Energy Use for Inflatable Spas

The compliant energy consumption represents the energy consumption under the scenario in which the proposed standard goes into effect in 2019. The energy consumption of compliant products is estimated based on minimum requirements to meet the proposed regulations. The total stock energy consumption is calculated using the same method as baseline energy use, except the compliancy rates change at a rate of ±33 percent. That is, one divided by the design life (3 years). In 2019, the baseline non-compliant rates in **Table A-29** will decrease by 33 percent while the baseline compliant rate in **Table A-29** increases by 33 percent every year until full stock turnover in 2021, where the compliant rates are 100 percent. **Table A-34** lists the compliant total stock energy consumption for 2019 and 2021.

Table A-34: Compliant Stock Energy Use for Inflatable Spas

First-Year Total Energy Use (GWh/yr)	Complete Stock Turnover Total Energy Use (GWh/yr)
36.3	25.1

Source: Energy Commission staff calculation

Cost and Savings for Inflatable Spas

Table A-20 lists the energy savings once the proposed standard becomes effective in 2019 and when complete stock turnover has occurred in 2021. The energy savings are calculated by subtracting the compliant energy use (see **Table A-34**) from the baseline energy use (see **Table A-33**).

Table A-35: Standby Power Standard Statewide Annual Stock Savings for Inflatable Spas

First Year - 2019		Full Stock Turnover - 2028	
Total Annual Energy Consumption (GWh/yr)	Savings ($M)	Total Annual Energy Consumption (GWh/yr)	Savings ($M)
6.8	1.3	22.5	4.2

Source: Energy Commission staff calculation

Sample Calculations (Total First-Year Savings):

Note, rounding may result in a slight variation from the results in the table.

$$E_{Savings} = E_{Baseline} - E_{Compliant} \qquad \text{(Same as Equation \#8)}$$

Where,

$E_{Savings}$ = savings from implementing the proposed standard (GWh/yr)

$E_{Baseline}$ = baseline energy consumption (GWh/yr)

$E_{Compiant}$ = compliant energy consumption (GWh/yr)

Sample Calculation:

$$E_{Savings} = E_{Baseline} - E_{Compliant}$$

$$E_{Savings} = (43.1 - 36.3)\frac{GWh}{yr} = 6.8\ \frac{GWh}{yr}$$

The cost savings (benefits) are calculated by multiplying the annual energy savings by $0.1855 per kWh.

Sample Calculation (Total First-Year Savings):

Note, rounding may result in a slight variation from the results in the table.

$$B_{Savings} = \frac{\$0.1855}{kWh} \times E_{\ Savings} \qquad \text{(Same as Equation \#9)}$$

Substitute results from equation #9 into equation #10.

$$B_{Savings} = \frac{\$0.1855}{kWh} \times 6.8 \frac{GWh}{yr} \times \frac{10^6 kWh}{1GWh} \approx \$1.3\ Million$$

Table A-36 lists the potential energy savings for labeling inflatable spas once the label becomes effective in 2019. Since, the label goes hand-in-hand with the proposed standard, the potential label savings are equivalent to about 5 percent of the total compliant energy use in 2019 and in 2021. This estimate is based on half of the 10 percent improvement in sales-weighted average efficiency for refrigerators using the categorical European Union (EU) Label scheme.[150]

Table A-36: Total Statewide Annual Stock Savings Adjusting for Label Impact for Inflatable Spas

First Year - 2019		Full Stock Turnover - 2028	
Total Annual Energy Consumption (GWh/yr)	Savings ($M)	Total Annual Energy Consumption (GWh/yr)	Savings ($M)
0.6	0.1	1.3	0.2

Source: Energy Commission staff calculation

The total energy savings are calculated by applying the 5 percent potential label savings to the total compliant annual energy consumption for 2019 and 2021 (**Table A-34**).

Sample Calculation (Total First-Year Savings):

Note, rounding may result in a slight variation from the results in the table.

$$E_{Label\ Savings\ FY} = E_{Compliant\ FY} \times 100\%\ Standard\ Implementation \times 5\%\ Label\ Savings \times Stock\ Compliancy\ Rate_{FY}$$

(Same as Equation #11)

Where,

$E_{Label\ Savings\ FY}$ = first-year potential label savings (GWh/yr)

$E_{Compliant\ FY}$ = compliant energy consumption in the first year (GWh/yr)

Stock Compliancy $Rate_{FY}$ = 33 percent[151] compliance rate in the first year

Sample Calculation:

$$E_{Label\ Savings\ FY} = E_{Compliant} \times 100\%\ Standard\ Implementation \times 5\%\ Label\ Savings \times Stock\ Compliancy\ Rate_{FY}$$

$$E_{Label\ Savings\ FY} = 36.3 \frac{GWh}{yr} \times \frac{100\%}{100} \times \frac{5\%}{100} \times \frac{33\%}{100} \approx 0.6 \frac{GWh}{yr}$$

150 Bertoldi, Paolo. *Energy Efficient Equipment Within SAVE: Activities, Strategies, Success and Barriers*. Brussels: European Commission, 2000.

151 Compliancy rate in the first year = 1 / design life = 1/3 = 33 percent

Sample Calculation (Total Full Stock Turnover Savings):

Note, rounding may result in a slight variation from the results in the table.

$$E_{Label\ Savings\ FS} = E_{Compliant\ FS} \times 100\%\ Standard\ Implementation \times 5\%\ Label\ Savings \times Stock\ Compliancy\ Rate_{FS}$$

(Same as Equation #12)

Where,

$E_{Label\ Savings\ FS}$ = full-stock turnover potential label savings (GWh/yr)

$E_{Compliant\ FS}$ = compliant energy consumption after full stock turnover (GWh/yr)

Stock Compliancy $Rate_{FS}$ = 100 percent, full stock turnover

Sample Calculation:

$$E_{Label\ Savings\ FS} = E_{Compliant\ FS} \times 100\%\ Standard\ Implementation \times 5\%\ Label\ Savings \times Stock\ Compliancy\ Rate_{FS}$$

$$E_{Label\ Savings\ FS} = 25.1 \frac{GWh}{yr} \times \frac{100\%}{100} \times \frac{5\%}{100} \times \frac{100\%}{100} \approx 1.3\ \frac{GWh}{yr}$$

Label Costs

The label cost for inflatable spas is $0.83 per unit. The calculation steps are equivalent to the label cost calculations for the other spas (See Analysis for Standard, Exercise, and Combination Spas – Label Costs).

Lifecycle Cost and Benefits

Table A-37 lists the energy savings, lifecycle costs, and lifecycle benefit. The calculation for energy savings per unit is the difference between the baseline and compliant consumption per unit and adjusting for the impact of the label. The lifecycle cost includes the incremental cost and the label cost. The lifecycle benefit is the product of the energy savings per unit, the life of the unit, and the average retail price of electricity.

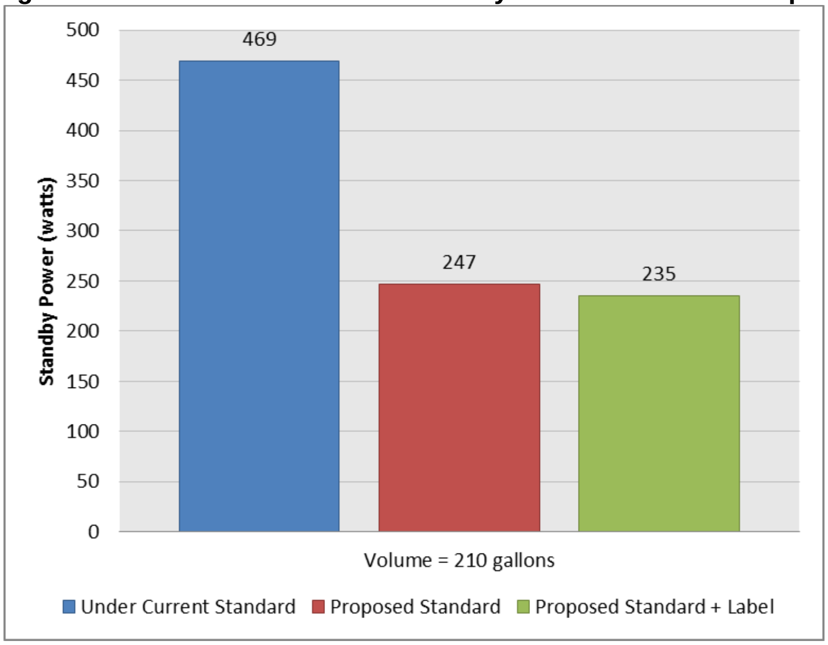
Table A-37: Unit Energy Savings and Lifecycle Benefits/Costs for Inflatable Spas

Spa Type	Design Life (years)	Electricity Savings (kWh/year)	Lifecycle Costs ($/unit)	Lifecycle Benefit ($/unit)	Lifecycle Benefit/Cost Ratio
Inflatable spas	3	1,180	$100.83	$ 657	7

Source: Energy Commission staff calculation

To calculate the energy savings per unit, staff used the standby power for an inflatable spa currently in the market to represent the non-compliant standby power. Staff then calculated the standby power under the proposed standard, and the standby power under proposed standard while accounting for the label effect. **Figure A-4** displays the standby power for inflatable spas currently in the market and the standby power under the proposed standby power standard for a volume water capacity of 210 gallons and the. The graph also displays the standby power limit for the proposed standard when applying the 5 percent potential savings as a result of adding a label to inflatable spas.

Figure A-4: Maximum Allowable Standby Power for Inflatable Spas



Source: Energy Commission staff calculation

Sample Calculation:

The current standby power for inflatable spas is 469.1 watts, based on the docketed test lab for an inflatable spa with a volume water capacity of 210 gallons.[152]

Proposed Standard:

$$P_{PSTD-IS} = 7 \times V^{2/3} \quad \text{(Same as Equation \#23)}$$

$$P = 7 \times (210\ gallons)^{2/3} = 247.31\ watts \approx 247\ watts$$

Proposed Standard + Label:

$$P_{PSTD-IS+Label} = P_{PSTD-IS} - P_{Label\ Savings} \qquad \text{(Equation \#27)}$$

Where,

$$P_{Label\ Savings} = P_{PSTD-IS} \times 5\%\ Potential\ Savings \qquad \text{(Equation \#28)}$$

$$P_{PSTD-IS} = 7 \times V^{2/3} \qquad \text{(Same as Equation \#23)}$$

Substitute equation #22 and equation #26, into equation #25.

152 Intex Inflatable Portable Electric Spa Test Report, IAPMO EGS, Docket 15-AAER-02 TN 212386, July 16, 2016

$$P = 7 \times (210\ gallons)^{2/3} = 247.31\ watts \approx 247\ watts$$

$$P_{Label\ Savings} = 247\ watts \times 5\%\ Potential\ Savings \approx 12\ watts$$

$$P_{PSTD+Label} = 247 - 12 \approx 235\ watts$$

Table A-38 lists the UEC savings, the energy consumption under the current standard, and under the proposed standard while taking into account the potential savings of the label. The UEC is calculated by multiplying the standby power, derived in **Figure A-4**, by the duty cycle. The UEC savings is calculated by subtracting the UEC of the proposed standard plus the label from the UEC of the current standard.

Table A-38: Unit Energy Consumption Savings for Inflatable Spas

Unit Energy Consumption for the Current Standard (kWh/yr)	Unit Energy Consumption for the Proposed Standard + Label (kWh/yr)	Unit Energy Consumption Savings (kWh/yr)
2,364	1,184	1,180

Source: Energy Commission staff calculation

Sample Calculation:

Note, rounding may result in a slight variation from the results in the table.

Unit Energy Consumption for the Current Standard:

$$UEC_{Current} = Duty\ Cycle\ \times P_{CSTD-IS} \quad \text{(Equation \#29)}$$

Where,

$$P_{CSTD-IS} = 469.1\ watts$$

$$UEC_{Current} = Duty\ Cycle\ \times P_{CSTD-IS}$$

$$UEC_{Current} = 5{,}040\frac{hours}{year} \times 469.1\ watts = 2{,}364\frac{kWh}{yr}$$

Unit Energy Consumption for the Proposed Standard + Label:

$$UEC_{Proposed+Label} = Duty\ Cycle\ \times P_{PSTD-IS+Label} \quad \text{(Equation \#30)}$$

Solve equation #27 for a volume of 210 gallons and substitute into equation #39.

$$UEC_{Proposed+Label} = Duty\ Cycle\ \times P_{PSTD+Label}$$

$$UEC_{Proposed+Label} = 5{,}040\frac{hours}{year} \times 235\ watts = 1{,}184\frac{kWh}{yr}$$

Unit Energy Consumption Savings:

$$UEC_{Savings-IS} = UEC_{Current} - UEC_{Proposed+Label} \quad \text{(Equation \#31)}$$

Solve equation #29 and equation #30 for a volume of 210 gallons, and substitute into equation #31.

$$UEC_{Savings} = UEC_{Current} - UEC_{Proposed+Label}$$

$$UEC_{Savings} = \ 2{,}364\frac{kWh}{yr} - 1{,}184\frac{kWh}{yr} = 1{,}180\frac{kWh}{yr}$$

The lifecycle benefit as shown in **Table A-37** is calculated by multiplying the UEC in **Table A-38** by the design life and California average retail price of electricity.

Sample Calculation:

Note, rounding may result in a slight variation from the results in the table.

$$Lifecycle\ Benefit = Weighted\ UEC_{Savings} \times Design\ Life \times Retail\ Price\ of\ Electrcity$$

$$Lifecycle\ Benefit\ = 1{,}180\frac{kWh}{yr} \times 3\ years\ \times \frac{\$0.1855}{kWh} \approx \$657\ per\ unit$$

Sample Calculations for Alternative 3

Staff considered an alternate approach that would allow inflatables spas to comply if there was no efficiency standard requirement.

The reintroduced statewide energy consumption following an inflatable spa exemption on the January 1, 2019, effective date is determined by assuming how many hours per season (each year) and how many heating watts are required for the standby mode.

$$First - Year\ Energy\ Consumption = (Heating\ Power) \times (Estimated\ Duty\ Cycle) \times (Estimated\ Annual\ Stock)$$

Where,
Heating Power ≈ 469 (watts/unit)[153]
Duty Cycle=5,040 (hours/year)
Estimated Annual Sales (used from 2015) ≈ 15,000 (units)[154]

$$First - Year\ Energy\ Consumption = 469\ \frac{watts}{unit} \times \frac{5{,}040\ hours}{1\ year} \times \frac{1GWh}{10^9 Wh} \times 15{,}000\ units \approx 35.5\ GWh/yr$$

153 Intex Inflatable Portable Electric Spa Test Report, IAPMO EGS, Docket 15-AAER-02 TN 212386, July 16, 2016
154 APSP's presentation at staff workshop on February 18, 2016. Docket 15-AAER-02, TN 210390, February 17, 2016.

Background Information for Comparing the Normalized Standby Power for Portable Electric Spas

Figure 3-19 compares the normalized standby power (normalizes the measured standby power to the ideal difference and the measured difference between the water and ambient temperatures) under the current Title 20 test method of different types of portable electric spas.

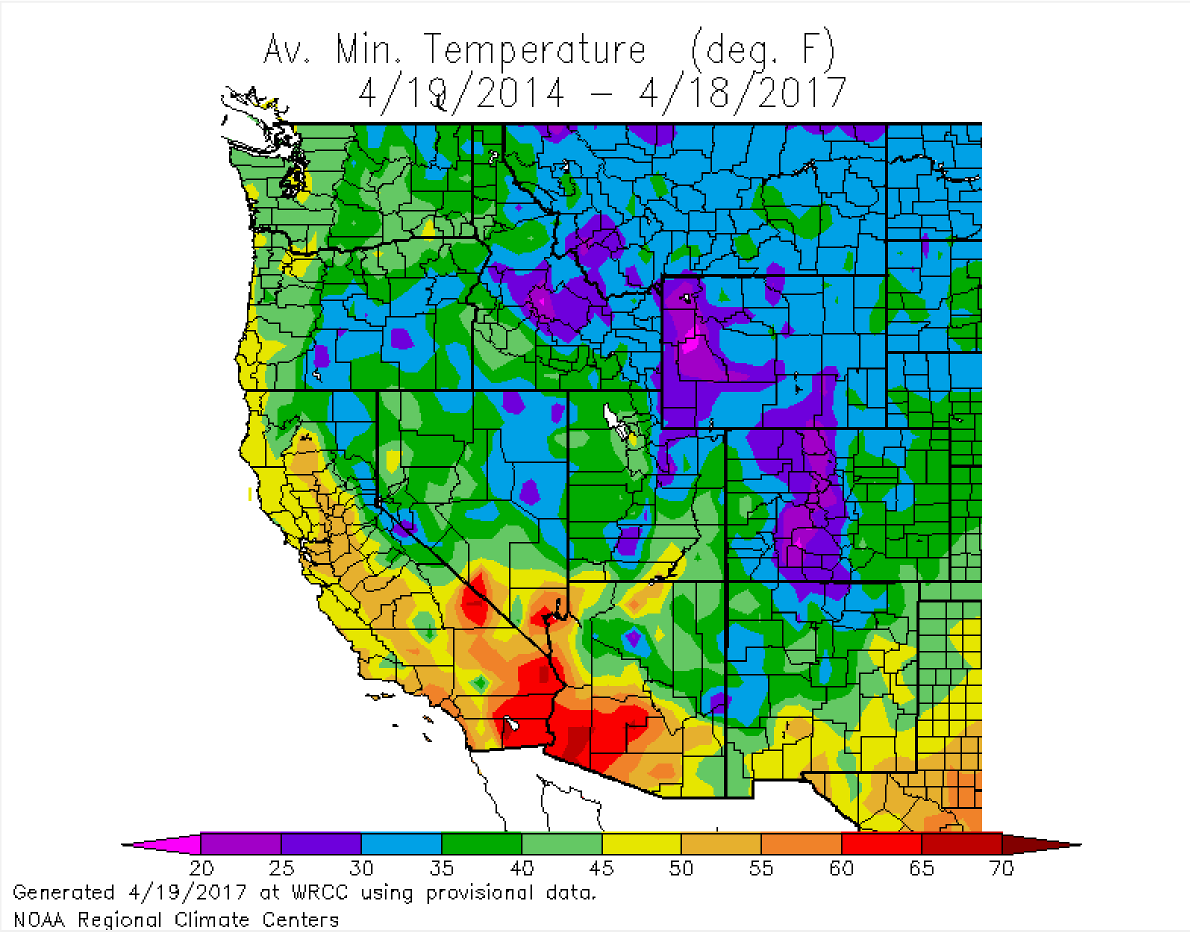
The normalized standby power for:

- The standard spa is an average of 12 spas in MAEDBS with a volume of 210 gallons,
- The inflatable spa is taken from the docketed test lab report submitted by IAPMO EGS for an Intex model with a volume of 210 gallons,
- The exercise spa is the average for all Zone 8 models with an average volume of 2,300 gallons, and
- The combination spa is the average of all combination spas in MAEDBS with an average volume of 1,965 gallons.

Average Temperatures in California

Figure A-5 shows the average minimum temperature for the last 36 months in the western region of the United States as of April 18, 2017. The figure also shows the majority of California has an average minimum temperature that is above 40°F.

Figure A-5: Average Minimum Temperature in the Western Region



Source: Western Regional Climate Center

APPENDIX B: Acronyms

Acronym	Description
AB	Assembly Bill
ANSI	American National Standards Institute
APSP	The Association of Pool & Spa Professionals
CARB	California Air Resources Board
CASE Team	Codes and Standards Enhancement Team
CPUC	California Public Utilities Commission
CSA	Canadian Standards Association
DOE	Department of Energy
EPS	Expanded Polystyrene
GHG	Greenhouse Gas
GPM	Gallons per minute
GWh	Gigawatt-hour
ICC	International Code Council
IEPR	Integrated Energy Policy Report
IOU	Investor-Owned Utility
ISPSC	International Swimming Pool and Spa Code
kWh	Kilowatt-hour
MAEDBS	Modernized Appliance Efficiency Database System
MW	Megawatt
MWh	Megawatt-hour
PG&E	Pacific Gas and Electric
PVC	Polyvinyl chloride
RASS	Residential Appliance Saturation Study
RECS	Residential Energy Consumption Survey
SB	Senate Bill

SCE	Southern California Edison
SDG&E	San Diego Gas & Electric
UEC	Unit Energy Consumption
UV	Ultraviolet
XPS	Extruded Polystyrene
ZNE	Zero Net Energy