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California Energy Commission

DRAFT STAFF REPORT

Analysis of Testing, Certification, and Marking Requirements for Air Filters and Commercial Clothes Dryers

2017 Appliance Efficiency Pre-Rulemaking

Docket Number 17-AAER-01

California Energy Commission

Edmund G. Brown Jr., Governor

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California Energy Commission

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PREFACE

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

On March 25, 2013, the Energy Commission released an "Invitation to Participate" to provide interested parties the opportunity to inform the Energy Commission about the product, market, and industry characteristics of the appliances identified in the order. The Energy Commission reviewed the information and data received in the docket and hosted staff workshops on May 28 through 31, 2013, to vet this information publicly.

On June 13, 2013, the Energy Commission released an "Invitation to Submit Proposals" to seek proposals for standards, test procedures, marking requirements, and other measures to improve the efficiency and reduce the energy or water consumption of the appliances identified in the order.

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 March 8, 2017, the Energy Commission adopted emergency regulations to delay the effective date of labeling requirements for residential air filters. A formal rulemaking to make that delay permanent began on June 16, 2017 with the publication of a Notice of Proposed Action.

The Energy Commission reviewed all information received to determine which appliances were strong candidates for the development of efficiency standards and measures. In this draft staff report, staff proposes amendments to the testing, certification, and marking requirements for air filters used in residential ducted forced-air heating and air-conditioning systems, and new testing and certification requirements for commercial tumble clothes dryers.

ABSTRACT

This staff report discusses proposed updates to the testing, certification, and marking requirements for air filters used in residential ducted forced-air heating and air-conditioning systems, and the addition of a new test procedure and certification requirements for commercial tumble clothes dryers in the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601 to 1609). These proposed updates are part of the 2017 Appliance Efficiency Pre-Rulemaking (Docket #17-AAER-01).

The Energy Commission staff analyzed available information and market data and concluded that the proposed updates to the air filter testing, certification, and marking requirements and a testing and certification requirement for commercial tumble clothes dryers sold or offered for sale in California would provide consumers with valuable information for choosing energy efficient products and provide data to determine efficiency levels for future energy efficiency standards.

Keywords: Appliance Efficiency Regulations, appliance regulations, energy efficiency, air filters, commercial tumble clothes dryers.

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EXECUTIVE SUMMARY

This report presents the California Energy Commission staff's analysis of proposed updates to the testing, certification, and marking requirements for air filters used in residential ducted forced-air heating and air-conditioning systems and new testing and certification requirements for commercial tumble clothes dryers.

Air Filters

Air filters remove particulates from the air stream in ducted forced-air heating or cooling systems in residential and commercial buildings. The removal of particulates, such as dust, from the air stream protects heating, ventilation, and air-conditioning systems from degradation. Air filters ensure the proper operation of these systems by keeping internal components clean and free of particulate build up that causes lower system efficiency, reduced reliability, and diminished heat transfer. As an air stream passes through the filter, the air decreases its velocity due to the resistance of the air filter. If this decrease is excessive, the system performs less efficiently and restricted airflow can cause damage to equipment. Consumers need the ability to purchase replacement air filters with pressure drop performance that matches their system specifications in order to run their system efficiently and prevent damage.

The California Building Energy Efficiency Standards require the installation of air filters marked with particulate filtration efficiency and pressure drop information. As a complementary requirement, the California Appliance Efficiency Regulations require all residential air filters sold or offered for sale in California to be marked with information regarding particulate filtration efficiency and pressure drop information. The effective date of the appliance efficiency regulations was delayed until April 1, 2019, based on concerns expressed by manufacturers regarding the testing, certification, and marking requirements for air filters. To address these concerns, staff proposes to modify the regulations to clarify the requirements for air filter testing, certification, and marking.

Commercial tumble clothes dryers

Staff propose that all commercial tumble clothes dryers be tested for specific energy efficiency and performance characteristics and listed in the Energy Commission database. Staff recommends adopting the California Investor Owned Utility Codes and Standards Enhancement team test procedure developed for commercial tumble clothes dryers. The information gathered as a result of these testing and certification requirements may be used in the future to develop minimum efficiency standards.

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 or 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 from these regulations. In the 1990s, the California Public Utilities Commission (CPUC) decoupled the utilities' financial results revenue from their direct energy sales, promoting utility support for efficiency programs. These efforts have reduced peak load needs by more than 8,645 megawatts (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] (AB 32) and Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016) (SB 32)[7], as well as the recommendations contained in the ARB's *Climate Change Scoping Plan*.[8] Energy efficiency regulations are also identified as key

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.

components in reducing electrical energy consumption in the Energy Commission's *2015 Integrated Energy Policy Report* (*IEPR*)[9] and the 2011 update to the CPUC's *Energy Efficiency Strategic Plan*.[10] Finally, the Governor and 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 greenhouse gas 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 Leòn, Chapter 547, Statutes of 2015) (SB 350) 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 a critical component in meeting this goal. 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. [14] Appliance efficiency standards are an essential part of the *Action Plan's* approach 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 the state's energy needs. *Energy Action Plan II* continues the strong support for the loading order, which describes the priority sequence for actions to address increasing energy needs. The loading order identifies energy efficiency and demand response as the preferred means of meeting the state's growing energy needs.[15]

For the past 30 years, while per capita electricity consumption in the United States has increased by nearly 50 percent, California electricity use per capita 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.[16]

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 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

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

16 *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*,[17] adopted in 2008 by the CPUC and developed with the Energy Commission, the ARB, the state's utilities, and other key stakeholders, is California's roadmap to achieving maximum energy savings in the state between 2009 and 2020, and beyond. It includes four "big, bold strategies" as cornerstones for significant energy savings with widespread benefit for all Californians:[18]

- 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 (HVAC) will be transformed to ensure that energy performance is best for 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 their 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[19] 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 design 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.[20] 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 IEPR*.[21]

Governor's Clean Energy Jobs Plan

On June 15, 2010, as a part of his election campaign, Governor Brown proposed the *Clean Energy Jobs Plan*,[22] 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

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17 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.
18 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.
19 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
20 California Energy Commission and CPUC, *Long-Term Energy Efficiency Strategic Plan*, p. 64.
21 California Energy Commission, *2013 IEPR*, pp. 21-26.
22 Office of Edmund G. Brown Jr., *Clean Energy Jobs Plan*, available at http://gov.ca.gov/docs/Clean_Energy_Plan.pdf.

the power sector. He 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 cheaper and more versatile than ever, due, in part, to California’s leadership in the area.

PART A: COMMERCIAL TUMBLE CLOTHES DRYERS

CHAPTER 3: Background

Product Description

Commercial clothes dryers are appliances that are used to dry clothes, uniforms, towels, sheets, pillowcases, and other textiles in multi-family (MFL), coin-operated laundromat (COL), and on-premise laundry (OPL) facilities. The most common type of commercial clothes dryers are forced air circulation tumble dryers, also known as commercial tumble clothes dryers. Commercial tumble clothes dryers range in size from 6 cubic feet (18 pounds dry textiles) to 145 cubic feet (400 pounds dry textiles) and use heated air circulated through a rotating drum to dry the contents. These appliances range in design from units resembling residential clothes dryers to large commercial/industrial tumble clothes dryers for on-premise laundry.

Commercial tumble clothes dryers are often specified by drum volume for the smaller capacity units and by dryer weight capacity (dry weight of the largest load of textiles it is designed to dry) for the large units. The investor-owned utilities' (IOU) Codes and Standards Enhancement (CASE) team evaluated the two specification methods, and generally as the drum volume increases the allowable dry weight of clothes also increases. However, as noted in the 2013 IOU CASE report, the drum volume for 30-pound dryers varied from 7.7 to 12.5 cubic feet.[23] The CASE team attributed the variation to the filling factor or the conversion factor between drum volume and dry weight. The filling factor is the ratio of load weight, in kilograms, to drum volume, in liters.

The CASE team surveyed the California market to determine the size and quantity of commercial tumble clothes dryers. The smallest units typically have a weight capacity of 18 pounds (lbs) (very similar to residential clothes dryers) and are mostly used at laundry rooms serving multi-family housing units. Commercial "laundromats" and some facilities, such as small motels, typically use units with capacity of about 30 lbs. Dryers larger than 30 lbs and up to 650 lbs are referred to as "on-premise" dryers and are used at industrial, large commercial or institutional sites. The CASE Team estimates there are approximately 500,000 commercial dryers ranging from 18 pound to 65 pound capacity.[24]

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23 CASE Report, *Commercial Clothes Dryers.* (December 16, 2015). Available at: http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2D_Commercial_Clothes_Dryers/California_IOUs_Response_to_the_Invitation_for_Standards_Proposals_for_Commercial_Clothes_Dryers_2013-07-30_TN-71757.pdf

24 CASE Analysis of Test Procedure Proposal for (February 2, 2017). Available online at: http://docketpublic.energy.ca.gov/PublicDocuments/17-AAER-01/TN215801_20170207T123552_T20_CASE_CommercialDryerTestProtocol_FINAL.PDF

The following table summarizes these categories, the key characteristics and differences in each category.

Table 1: Clothes Dryer Characteristics

Sector	Classification	Intended User	Typical location	Size
Residential	Single Family	Personal use	Personal residence	Small
Commercial	Multi-Family	Shared use at apartment	Apartments, duplexes, multi-housing units	Small
	Coin Op	Self-serve laundromat	Laundromats	Medium
	On Premise	Employee(s)	Hotels, hospitals, nursing homes, prisons, restaurants, beauty shops,	Small to Very Large

Source: CEC Staff

Figures 1 and **2** present some randomly selected commercial dryer models to illustrate classifications and applications.

Figure 1: Commercial Clothes Dryer Examples – multi-family dryer, 30, 50, 120, and 310 lb capacity dryers (from left to right)

Source: CA IOUs 2013 commentary letter, page 6

Figure 2: Stacked Dryers 2x multi-family (left) and 2x 30 lb dryers (right)

Source: CA IOUs 2013 commentary letter, page 6

Below, **Figure 3** illustrates a typical residential clothes dryer. Residential clothes dryers closely resemble MFL commercial tumble clothes dryers and the basic method of drying textiles is consistent across all dryer weight capacities.

Commercial tumble clothes dryers are typically powered by electricity with heat provided by electricity, natural gas, or propane. Based on general market research, the IOU CASE report assumed that 95 percent of all commercial dryer sales in California are gas and the remaining 5 percent are electric resistance heating.[25]

Commercial tumble clothes dryers utilize one or more electric motors that power a draw-through fan and rotate the drum. The fan is typically located below the drum and draws air through the entire appliance from top to bottom. The air enters the dryer through an air intake port and is drawn across the heating device. The heated air is then drawn through the drum either along the length of the drum or axially through the back of the drum. The drum rotates causing a tumbling action of the textiles allowing the heated air to flow through and remove moisture. This moisture laden air is then drawn out of the drum and vented from the dryer to the exterior of the building through an exhaust duct.

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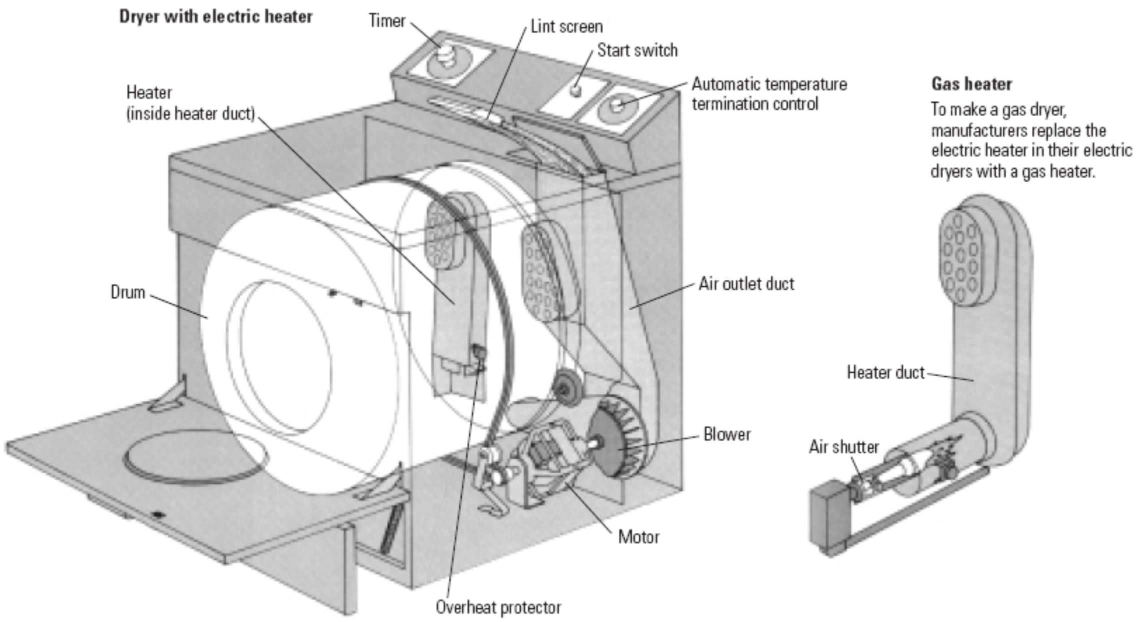
25 CASE Report, *Commercial Clothes Dryers*, pg 26 & 27, (July, 2013). Can be retrieved from: CEC Docket

Figure 3: Typical Conventional Dryer Construction



Source: ESOURCE, 2001, p.139, adapted from Reader's Digest Fix it Yourself Manual

Dryer Energy Consumption

Tumble clothes dryers consume energy through three main processes; thermal (heating), mechanical (electric motors, fans, rotating drum), and electronics (controls). **Table 2** displays the energy type, dryer components, and primary functions. The heating process is the largest consumer of energy for tumble clothes dryers. However, there are efficiency improvements available for all processes.

Table 2: Dryer Energy Consumption

Energy Type	**Dryer Component**	**Primary Function**
Thermal	Heating Element	Heat air to evaporate water from laundry
Mechanical	Electric Motor	Rotate drum and blower to agitate laundry and circulate air
Electronics	Dryer Controls	Control dryer cycle and components Accept user inputs Provide indicator lights

Source: California Energy Commission

Clothes Dryer Technology Comparison

Clothes dryers expedite the drying of laundry by applying heat to evaporate water. Since the heating process accounts for most of the energy consumption, various technologies have been researched as alternative heat sources to reduce energy consumption. Heat sources include natural gas, propane, electric heat pump, electric resistance heat, and microwave technology. Tumble clothes dryers can be separated into two main classes of dryers: vented and ventless.

Vented Clothes Dryers

Vented dryers use heated air to evaporate moisture from textiles and vent the moist air to the exterior of the building. This is the most prevalent class clothes dryers in California. This class includes electric resistance dryers, single stage natural gas and propane dryers, and modulating natural gas and propane dyers.

Microwave Clothes Dryers

One vented dryer technology is a microwave clothes dryer, which in principle works like a microwave oven. A magnetron tube converts electricity to microwave energy, which is directed to the wet clothes[26]. The microwaves excite the water molecules, increasing the water temperature. As temperature increases, water evaporates from the textiles and is then vented to the exterior of the building. The IOUs refer to prototype testing conducted by Electric Power Research Institute (EPRI) which shows that microwave dryers have the potential for high energy efficiency and shorter drying times.[27] Despite the potential for energy savings, there are concerns due to the dangers of arcing caused by metal reflecting the microwave energy.[28]

Single Stage Gas and Electric Resistance (Conventional Clothes Dryers)

Single stage gas dryers provide heat by burning fuel (natural gas or propane) using a direct combustion burner that operates at single gas firing rate (capacity) and is either on or off. Single stage electric resistance clothes dryers provide heat using an electric resistance heating element that is either on or off. **Figure 4** demonstrates the conventional clothes drying process. The drum and the exhaust fan are usually operated from one motor. The air is drawn in through the dryer cabinet by a fan and is heated via a gas burner or electric heating element before entering the clothes drum. As the hot air is drawn through the drum and across the tumbling textiles, water is evaporated from the clothes. The moisture-laden air is then drawn out of the drum and vented through a duct to the exterior of the building. In commercial applications, multiple dryers may be vented together through a common duct and may be assisted by an exhaust fan.

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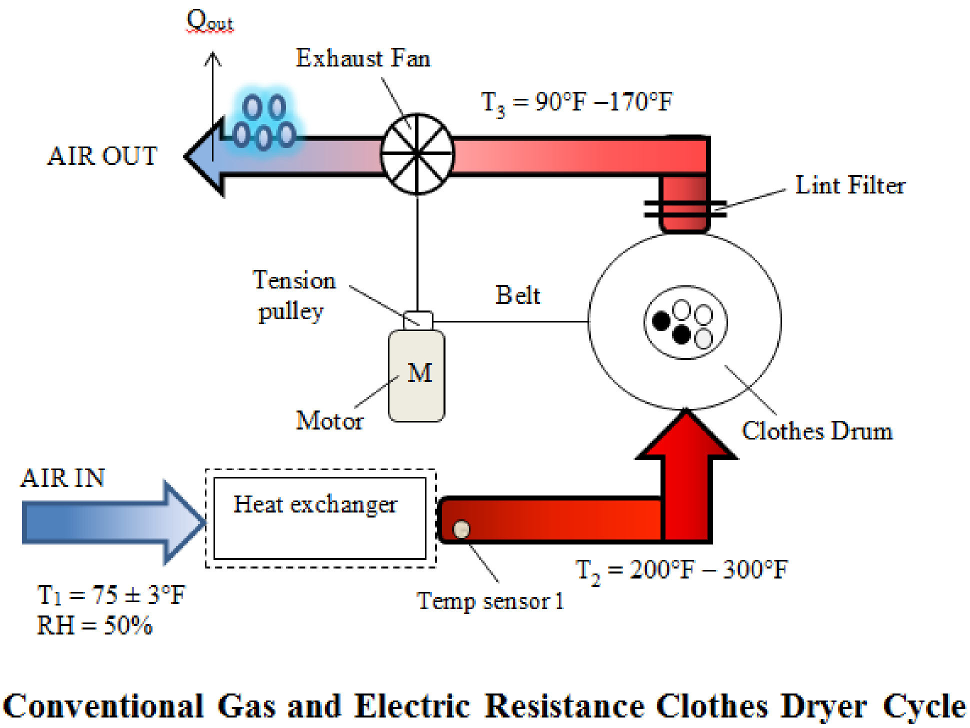
26 ECOS Report, pg. 17, prepared for NRDC. November 6, 2009.

27 CASE Report, Commercial Clothes Dryers, pg. 23. July 2013. Available at: http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2D_Commercial_Clothes_Dryers/California_IOUs_Response_to_the_Invitation_for_Standards_Proposals_for_Commercial_Clothes_Dryers_2013-07-30_TN-71757.pdf

28 J Carlton Gallawa. Microtech Factory Service website. Available at: http://www.microtechfactoryservice.com/metal_arc.html

Figure 4: Conventional Clothes Dryer Process Diagram



Source: California Energy Commission Staff Illustration

Modulating Gas Burning Clothes Dryers

Modulating gas dryers operate in the same manner as single stage gas dryers except that modulating gas dryers use multiple burners to increase and decrease the total heat input rate to vary the temperature of the air entering the drum. The burners do not vary the gas input rate itself but rather stage multiple burners each with a fixed input rate (true modulating gas valves are employed in the largest industrial clothes dryers that are outside the scope of this report). Staging the gas burners allows the dryer to better match the heat load requirement and respond more subtly to changes in dryer temperature and humidity levels. This technology has the potential to reduce energy use and drying times without subjecting clothing to overly high temperatures.[29]

Ventless Clothes Dryers

Ventless clothes dryers do not vent the moisture laden air to the outside of the building. Instead, they recirculate the air used to dry textiles in a closed loop. Ventless dryer technologies include condenser dryers, heat pump dryers, and microwave dryers.

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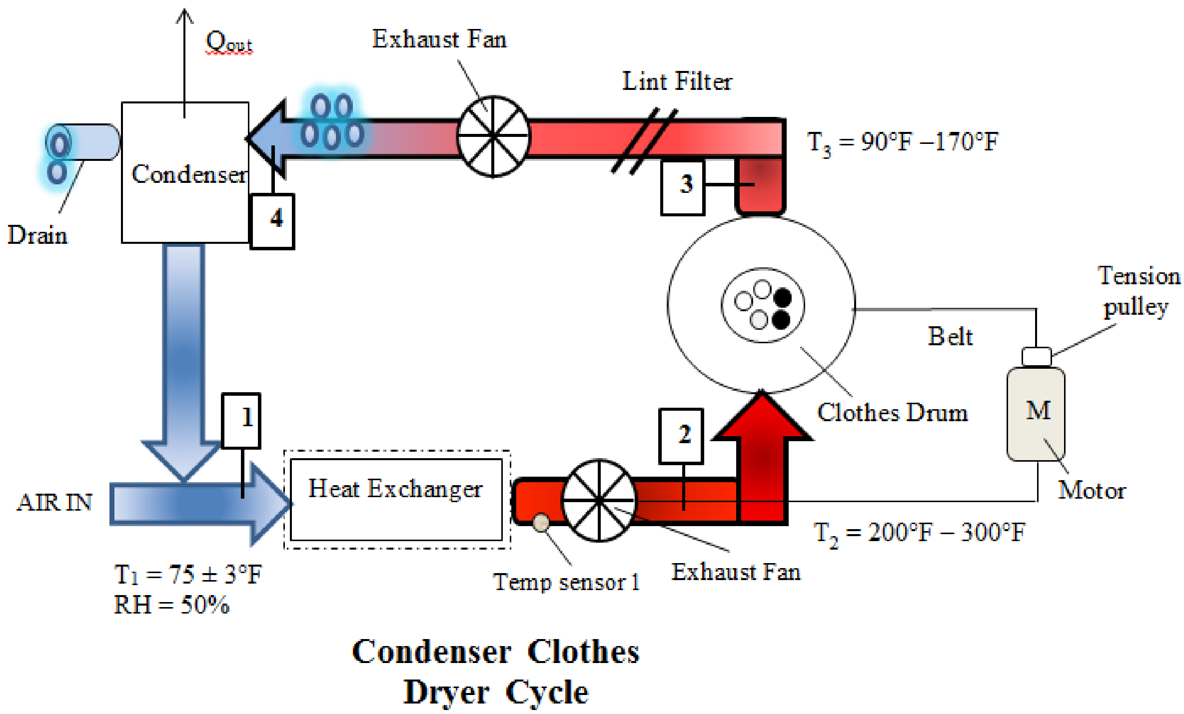
29 ECOS Report, pg. 16, prepared for NRDC. November 6, 2009.

Condenser Clothes Dryers

Condenser clothes dryers use a recirculating air loop to first heat the air prior to entering the drum. The heated air is drawn through the drum and evaporates water from the tumbling textiles, then the moisture-laden air exits the drum and is cooled using air drawn in from the surrounding room in a condenser. Cooling the air causes water to condense out of the air. The water is then collected and sent to the building drain. The air is reheated and the process repeats. Condenser clothes dryers do not require a vent to the outside and can provide space heating in the winter, however, they can be a significant building cooling load in the summer. Condenser clothes dryers are common in Europe but have limited in sales in the United States. **Figure 5** demonstrates the closed-loop cycle of a condenser clothes dryer.

Figure 5: Ventless Condenser Dryer Air Flow Diagram

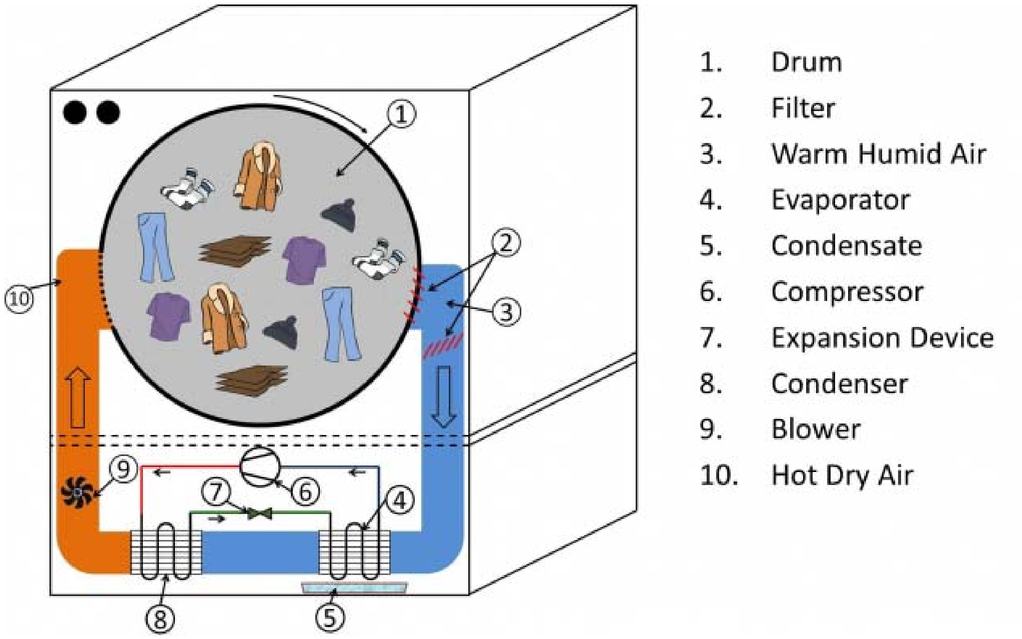


Source: California Energy Commission Staff Illustration

Heat Pump Clothes Dryers

Heat pump clothes dryers are another type of ventless dryer. They operate similar to a residential air conditioner or refrigerator by transferring heat from one location to another utilizing a vapor compression refrigeration cycle. **Figure 6** below, depicts the cycle of a heat pump clothes dryer. The air is drawn over the condenser coil and heated. The hot air is then drawn through the drum and tumbling textiles to evaporate water. The warm moist air exits the drum and is then cooled by the heat pump evaporator coil. As the air is cooled, the moisture condenses out of the air onto the evaporator coil and is sent to the building drain. The refrigeration process is driven by an electric compressor and typically operates at a coefficient of performance (COP) of 2. A COP of 2 denotes that for every 1 kWh of electricity consumed by the dryer, 2 kWh of heat is transferred to the air.[30] Compared to an electric resistance clothes dryer with a COP 1, the heat pump clothes dryer is twice as efficient.

Figure 6: How a Heat Pump Clothes Dryer Works



Source: Oak Ridge National Lab

30 ECOS Report, pg. 17, prepared for NRDC. November 6, 2009.

CHAPTER 4: Regulatory Approaches

California Regulations and Federal Regulations

There are no California or U.S. Department of Energy (DOE) standards or test procedures for commercial tumble clothes dryers. The U.S. DOE has a test procedure and minimum energy performance standard for residential clothes dryers.

Federal Regulations for Residential Clothes Dryers

In 1994, the DOE established a residential clothes dryers performance standard.[31] The DOE amended the standard to include a larger number of product classes in 2011. The product classes differentiated energy efficiency by dryer technology and heat source. The DOE set a January 1, 2015 compliance date for the updated energy efficiency standard.[32] **Table 3** and **Table 4** show the DOE's residential clothes dryer energy efficiency standards as adopted in 1994 and amended in 2011.

Table 3: Standards for Residential Clothes Dryers Manufactured On or After May 14, 1994 and Manufactured Before January 1, 2015

Product class	Energy factor(lbs/kWh)
Electric, Standard (4.4 ft^3 or greater capacity)	3.01
Electric, Compact (120V) (less than 4.4 ft^3 capacity)	3.13
Electric, Compact (240V) (less than 4.4 ft^3 capacity)	2.90
Gas	2.67

Source: 10 C.F.R. § 430.32 (h)

31 56 Federal Register 22250 (May 14, 1994).

32 76 Federal Register 52854 (August 24, 2011).

Table 4: Standards for Vented Electric Clothes Dryers, Ventless Electric Clothes Dryers, and Vented Gas Clothes Dryers Manufactured On or After January 1, 2015.

Product class	Combined energy factor(lbs/kWh)
Vented Electric, Standard (4.4 ft^3 or greater capacity)	3.73
Vented Electric, Compact (120V) (less than 4.4 ft^3 capacity)	3.61
Vented Electric, Compact (240V) (less than 4.4 ft^3 capacity)	3.27
Vented Gas	3.30
Ventless Electric, Compact (240V) (less than 4.4 ft^3 capacity)	2.55
Ventless Electric, Combination Washer-Dryer	2.08

Source: 10 C.F.R. § 430.32 (h)

The DOE established test procedures in 1998 and has amended the procedure twice. The current test procedures are available at 10 C.F.R. Part 430, Subpart B, Appendices D, D1, and D2.[33]

The CASE Report

The California IOUs submitted a CASE study report[34] on July 30, 2013 followed by a refinement to the CASE report on January 26, 2015 to the Energy Commission.[35] On February 2, 2017 the IOUs submitted CASE test procedure and CASE analysis report for commercial clothes dryers.[36,37] In the 2013 CASE report, the IOUs proposed to adopt a test standard for all tumble-type commercial clothes

33 Code of Federal Regulations. 10 CFR Part 430, Subpart B. Appendix D, and CFR Part 430.32. Can be retrieved from: http://www.ecfr.gov/cgi-bin/text-idx?SID=7687ad6ec3533c396fd30123c9d598a6&node=pt10.3.430&rgn=div5#se10.3.430_132.

34 CASE study report (July 30, 2013). Available online at: http://www.energy.ca.gov/appliances/2013rulemaking/documents/responses/Commercial_Clothes_Dryers_12-AAER-2D/California_IOUs_Response_to_the_Invitation_to_Participate_for_Commercial_Clothes_Dryers_2013-05-09_TN%2070820.pdf

35 IOUs Response: Additional Market Data and Standard Proposal Refinement. Available online at: http://www.energy.ca.gov/appliances/2014-AAER-01/prerulemaking/documents/comments_water_topics/Refinement_to_Commercial_Clothes_Dryer_CASE_Study_2015-01-21_TN-74379.pdf

36CASE Analysis of Test Procedure Proposal for (February 2, 2017). Available online at: http://docketpublic.energy.ca.gov/PublicDocuments/17-AAER-01/TN215801_20170207T123552_T20_CASE_CommercialDryerTestProtocol_FINAL.PDF

37 CASE test procedure (February 2, 2017). Available online at: http://docketpublic.energy.ca.gov/PublicDocuments/17-AAER-01/TN215802_20170207T123831_Commercial_Dryer_Test_Protocol_v25.pdf

dryers and minimum energy performance standards for gas dryers with a drum capacity less than 13 cubic feet. The CASE team later recommended to maintain the proposed test procedure that covers all commercial clothes dryers and not set a minimum efficiency standard. On February 2, 2017 the CASE team submitted a new test procedure for commercial tumble clothes dryers applicable to capacities equal to or less than 65 cubic feet of volume. The new test procedure is a rigorous test that will provide valuable data on the operation of commercial tumble clothes dryers. It tests both low-power modes and active drying modes through a series of 6 test runs per dryer in a controlled environment. The data resulting from the test procedure will include drying cycle energy, low-power mode power draw, dryer run times per test, and energy efficiency metric for comparison of appliances and future analysis of energy efficiency measures.

Industry Proposals

The Association of Home Appliance Manufacturers (AHAM) participated in the pre-rulemaking process and submitted a proposal. AHAM proposed that the Energy Commission not establish efficiency standards for commercial dryers, and pointed out the limitations in applying the DOE test procedure for residential dryers to commercial dryers.[38]

38 AHAM California Energy Commission 2013 Appliance Efficiency Pre-Rulemaking-Proposal for No Efficiency Standards for Commercial Dryer (July 29, 2013) Available online at: http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2D_Commercial_Clothes_Dryers/AHAMs_Proposal_to_the_CECs_2013_Appliance_Efficiency_Pre-Rulemaking_2013-07-29_TN-71719.pdf

CHAPTER 5:
Alternative Considerations

Staff analyzed the various proposals received to come up with three alternatives: maintain the status quo, establish a minimum efficiency standard with test procedure, or establish a test and list requirement for commercial tumble clothes dryers.

Alternative 1: No Change – Maintain Baseline

Commercial tumble clothes dryers would continue to not be subject to an energy efficiency standard or test and list regulation. Staff believes the lack of a test and list standard does not serve the commercial clothes dryer market since information is not available to support consumer choice and possible rebate programs. The opportunity exists to develop and propose a test procedure to provide information on the efficiency of the appliances.

Alternative 2: Propose Efficiency Standard

Staff evaluated proposing a commercial clothes dryer efficiency standard but does not recommend this approach until more information can be gathered to develop efficiency levels for a possible standard. To move forward with establishing a standard, the staff would need to have more market and performance data, including information about the following:

- Energy consumption for both electric and natural gas dryers as tested under a commercial clothes dryer test procedure.
- Energy savings for both electric and gas dyers resulting from efficiency improvements such as:
    - Exhaust air heat recovery
    - Heat input modulation
    - Reduced standby power consumption
    - Improved electric motor efficiency levels
- Duty cycle information for each control mode, including standby/inactive mode.
- Installation costs, annual shipments, average lifetime, and weight capacity ranges in each sector (MFL, COL, and OPL).
- Impact and feasibility of alternative clothes dryer improved efficiency technologies in the commercial setting.

Alternative 3: Develop a Test and List Requirement

Staff considered developing a test procedure and certification requirement for commercial tumble clothes dryers with capacities greater than 6 cubic feet and less than or equal to 65 cubic feet. Requiring testing and listing of commercial clothes dryers would provide the necessary performance and market data to later support potential efficiency standards. As there is not currently an industry or regulatory test procedure available for commercial tumble clothes dryers, staff proposes to adopt the IOU CASE team's "Energy Efficiency Test Procedure for Commercial Clothes Dryers" Version 2.5 December 15, 2016, with test results to be reported to the Commission's Modernized Appliance Efficiency Database System commercial tumble clothes dryers starting one year after adoption of the regulation or July 1, 2019, whichever is later.

Chapter 6: Staff Recommendation

Staff believes the test and list proposal will lead to substantial energy savings by identifying energy savings opportunities within the commercial clothes dryer market. Manufacturers will provide appliance model numbers and efficiency ratings that will establish market parameters for performance and energy consumption. Energy Commission staff will analyze the data and develop appliance efficiency regulations if it identifies that there are substantial energy savings available for the commercial tumble clothes dryer market.

Even though staff is not recommending a standard to improve the efficiency of commercial tumble clothes dryers, staff believes that a test and list requirement will allow the consumer to choose more efficient commercial clothes drying equipment. In addition, once the appliance's performance data are available, utilities can initiate incentive programs to promote energy efficient commercial clothes dryer models and additional energy savings technologies.

Scope

Staff proposes to cover commercial tumble clothes dryers with capacities greater than 6 cubic feet and less than or equal to 65 cubic feet. These include commercial dryers used in multi-family laundry, coin -operated laundromats, and on -premise laundry facilities, of any technology type.

Test Procedure

The CASE team submitted a test procedure for commercial tumble clothes dryers on February 2, 2017.[39] Staff reviewed the CASE team test procedure and analysis and recommends adopting the test procedure for a test and list standard.

Standards

Staff does not propose energy efficiency standards for commercial tumble clothes dryers at this time.

Certification

Manufacturers would be required to certify to the Commission's Modernized Appliance Efficiency Database system the data from the test results for each model of commercial dryer before the appliance may be sold or offered for sale in California. Reported information is shown in section 1606 Table X of chapter 9, Proposed Regulatory Language.

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39 CASE test procedure (February 2, 2017). Available online at: http://docketpublic.energy.ca.gov/PublicDocuments/17-AAER-01/TN215801_20170207T123552_T20_CASE_CommercialDryerTestProtocol_FINAL.PDF

Marking

Manufacturers would be required to mark the commercial dryer with manufacturer name, brand name, or trademark; model number; and date of manufacture. Staff is not proposing any additional marking requirements to this basic information.

Effective Date

The testing and certification requirements would be effective for commercial tumble clothes dryers manufactured on or after July 1, 2019, or one year after the adoption of these regulations, whichever is later.

CHAPTER 7: Savings and Cost Analysis

Cost-effectiveness is not required for a test and list requirement. Nonetheless, Energy Commission staff have analyzed the costs and potential benefits of testing and efficiency standards for commercial dryers to demonstrate the potential for cost-effective energy savings.

The IOU CASE team estimates that the total number of commercial tumble clothes dryers in California exceeds 510,000 units (all capacities) with a yearly operating cost of $440 million. Reducing dryer energy use by 20 percent has the potential to save 180 GWh electricity and 50 million therms of natural gas, saving approximately $90 million per year at full stock turnover with an expected useful life of 15 years. The CASE analysis estimated the current California stock of commercial dryers as 300,000 units for dryers with capacities less than 7.5 cubic feet, 193,500 units for dryers with capacities greater than 7.5 cubic feet and less than 13 cubic feet, 18,136 units for dryers with capacities greater than 13 cubic feet and less than 65 cubic feet.[40] According to AHAM, yearly shipments of the smallest commercial dryers, MFLs, are approximately 20,000.[41] Assuming the yearly shipment of dryers with capacities less than or equal to 7.5 cubic feet are MFL dryers (300,000 dryers) and a life expectancy of 15 years this would equate to shipments of 20,000 dryers per year. This is consistent with the AHAM proposal and results in an MFL commercial dryer yearly turnover of 6.5 percent. Energy Commission staff determined it was reasonable to assume that the yearly turnover for all commercial tumble dryers was also 6.5 percent resulting in a total unit turnover of 28,990 units.

Energy Commission staff performed a survey of commercial dryer manufacturers and estimates that there are approximately 325 models of dryers with capacities greater than 6 cubic feet and less than or equal to 65 cubic feet in production today. The CASE team performed a dryer test cost analysis and determined that the cost to perform the test procedure ranges from $560.00 to $1145.00 per dryer model.[42] The cost to test 325 dryer models at $1145.00 per dryer results in total testing cost of $372,150.00 in the first year. With an estimated yearly stock turnover of 28,990 dryers, the cost per dryer for testing is $12.84. With a yearly operating cost of $440 million, an increase in efficiency of just 1 percent would result in $4.4 million dollars operating cost savings, far exceeding the cost to perform the tests.

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40 CASE Analysis of Test Procedure Proposal for (February 2, 2017). Available online at: http://docketpublic.energy.ca.gov/PublicDocuments/17-AAER-01/TN215801_20170207T123552_T20_CASE_CommercialDryerTestProtocol_FINAL.PDF

41 AHAM California Energy Commission 2013 Appliance Efficiency Pre-Rulemaking-Proposal for No Efficiency Standards for Commercial Dryer (July 29, 2013) Available online at: http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2D_Commercial_Clothes_Dryers/AHAMs_Proposal_to_the_CECs_2013_Appliance_Efficiency_Pre-Rulemaking_2013-07-29_TN-71719.pdf

42 CA IOU CASE Cost Analysis Memo. May 10, 2017 Available online at: http://docketpublic.energy.ca.gov/PublicDocuments/17-AAER-01/TN219811_20170620T142534_Cost_estimate_to_perform_IOUproposed_commercial_tumble_dryer_pr.pdf

CHAPTER 8: Technical Feasibility

Because the Energy Commission is not proposing an efficiency standard at this time, there is nothing to analyze for technical feasibility.

To determine whether the CASE team's commercial dryer test procedure would yield repeatable, reproducible, real-world results with minimum test burden and cost, staff evaluated the definitions, testing conditions, instrumentation, measurements, and calculations of the IOU CASE test procedure. Staff expects all commercial tumble clothes dryers less than or equal to 65 cubic feet capacity will be compatible with the proposed test procedure. The test procedure will allow for both the vented and ventless product classes and does not favor one technology over another. The test procedure will be both repeatable and reproducible for testing labs. Finally, the test burden and costs, as described in the preceding chapter, are reasonable in light of the potential energy saving benefits.

CHAPTER 9: Regulatory Language

The following shows staff's proposed standards for commercial tumble clothes dryers. Underlines indicate new text and ~~strikeouts~~ indicate deleted text.

§ 1601. Scope.

(q) Residential clothes dryers that are federally-regulated consumer products; and commercial tumble clothes dryers.

§ 1602. Definitions.

(q) Clothes Dryers.

"Clothes dryer" means a cabinet-like appliance that is designed to dry fabrics in a tumble-type drum with forced air circulation and that has a drum and a blower driven by an electric motor.

"Commercial tumble clothes dryer" means a tumble clothes dryer not covered by 10 C.F.R. part 430.32(h) and that has a capacity larger than 6.0 cubic feet drum volume and less than or equal to 65 cubic feet drum volume.

"Residential clothes dryer" means a clothes dryer that is a federally-regulated consumer product.

§ 1604. Test Methods for Specific Appliances.

(q) Clothes Dryers.

(1) The test method for residential clothes dryers is 10 C.F.R. section 430.23(d) (Appendix D to Subpart B of part 430).

(2) The test method for commercial tumble clothes dryers is California Investor Owned Utilities Codes and Standards Enhancement (CASE) "Energy Efficiency Test Procedure for Commercial Clothes Dryers" Version 2.5 December 15, 2016

The following documents are incorporated by reference in Section 1604.

Number	***Title***
CALIFORNIA INVESTOR OWNED UTILITIES	
Commercial Clothes Dryers	"Energy Efficiency Test Procedure for Commercial Tumble Dryers" Version 2.5 December 15, 2016
Copies available from:	California Energy Commission Docket #17-AAER-01, TN #215802 1516 Ninth Street, MS-25 Sacramento, CA 95814 energy.ca.gov Phone: (916) 651-7100 Fax: (916) 654-4304

§ 1605.1. Federal and State Standards for Federally-Regulated Appliances.

(q) Clothes Dryers.

(3) There are no energy efficiency standards or energy design standards for commercial tumble clothes dryers.

§ 1605.2. State Standards for Federally-Regulated Appliances.

(q) Clothes Dryers.

(1) **Residential Clothes Dryers.** See Section 1605.1(q) for energy efficiency standards and energy design standards for clothes dryers that are federally-regulated consumer products.

(2) **Commercial tumble clothes dryers.** There are no energy efficiency standards or energy design standards for commercial tumble clothes dryers.

§ 1605.3. State Standards for State-Regulated Appliances.

(q) Clothes Dryers.

(a) **Residential Clothes Dryers.** See Section 1605.1(q) for energy efficiency standards and energy design standards for clothes dryers that are federally-regulated consumer products.

(b) **Commercial tumble clothes dryers.** There are no energy efficiency standards or energy design standards for commercial tumble clothes dryers.

§ 1606. Filing by Manufacturers; Listing of Appliances in Database.

Table X - Data Submittal Requirements

	Appliance	Required Information	Permissible Answers
	All Appliances	* Manufacturer's Name	
		* Brand Name	
		* Model Number	
		Date model to be displayed	
		Regulatory Status	Federally-regulated consumer product, federally-regulated commercial and industrial equipment, non-federally-regulated

Table X Continued - Data Submittal Requirements

	Appliance	Required Information	Permissible Answers
Q	Residential Clothes Dryers	*Energy Source	Gas, electric
		*Drum Capacity	
		*Voltage	120, 240, other (specify)
		Combination Washer/Dryer[1]	Yes, no
		Venting	Vented, ventless
		Combined Energy Factor	
		Constant Burning Pilot Light (Gas models only)	Yes, no
	Commercial Tumble Clothes Dryers	*Energy Source	Gas, electric, gas & electric
		Measured Drum Capacity (ft^3)	
		Load Size Drum Capacity (ft^3)	
		Load Weight Capacity (lbs)	
		Gas Heat Input (Btuh)	
		Electric Heat Input (kW)	
		*Voltage	120, 240, other (specify)
		Combination Washer/Dryer	Yes, no

		Automatic Termination Control	Yes, no
		Combined Energy Factor (CEF)	
		E_{low} (kWh)	
		P_S (W)	
		P_N (W)	
		P_W (W)	
		P_{OFF} (W)	
		Power Factor ($PF_{AVERAGE}$)	
		$W_{bone\ –Run\ AB}$ (lbs)	
		$G_{cycle\text{-}Run\ AB}$ (kWh)	
		$E_{cycle\text{-}Run\ AB}$ (kWh)	
		$T_{cycle\text{-}Run\ AB}$ (Minutes)	
		$W_{bone\ –Run\ C}$ (lbs)	
		$G_{cycle\text{-}Run\ C}$ (kWh)	
		$E_{cycle\text{-}Run\ C}$ (kWh)	
		$T_{cycle\text{-}Run\ C}$ (Minutes)	
		$W_{bone\ –Run\ D}$ (lbs)	
		$G_{cycle\text{-}Run\ D}$ (kWh)	
		$E_{cycle\text{-}Run\ D}$ (kWh)	
		$T_{cycle\text{-}Run\ D}$ (Minutes)	
		$W_{bone\ –Run\ E}$ (lbs)	
		$G_{cycle\text{-}Run\ E}$ (kWh)	
		$E_{cycle\text{-}Run\ E}$ (kWh)	
		$T_{cycle\text{-}Run\ E}$ (Minutes)	
		$W_{bone\ –Run\ F}$ (lbs)	
		$G_{cycle\text{-}Run\ F}$ (kWh)	
		$E_{cycle\text{-}Run\ F}$ (kWh)	
		$T_{cycle\text{-}Run\ F}$ (Minutes)	

		Constant Burning Pilot Light (Gas models only)	Yes/No

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

1 = Voluntary for federally-regulated appliances

PART B: AIR FILTERS

CHAPTER 10: Background

Product Description

Air filters remove particulates from the air stream in ducted forced-air heating or cooling systems in residential and commercial buildings. The removal of particulates, such as dust, from the air stream protects heating, ventilation, and air-conditioning (HVAC) systems from degradation. Air filters ensure the proper operation of these HVAC systems by keeping internal components clean and free of particulate build up that lowers system efficiency, reduces reliability, and diminishes heat transfer.

Air filters are typically placed in the return duct or adjacent to the air handler in an HVAC system, which facilitates easy installation and maintenance. The air handler pulls air through the return duct and, consequently, through the filter. Air filters are made in a range of styles, materials, and sizes. They are generally one to four inches thick, made of polyester or fiberglass, and styled in a flat or pleated pattern.

Air filters use either mechanical filtration or electrostatic filtration to remove particulates from the air. Mechanical or surface media filtration is the capture of particulates through a dense fiber medium. Typically, the air filter media are pleated, allowing more surface area to capture debris. Electrostatic filtration uses electrostatic precipitation to remove particulates. Electrostatic precipitators charge particles and pull them out of the air stream. This can be done in a one- or two-stage system. In a one-stage system, a plate or other surface charges and attracts the particles. In a two-stage system, the particles are charged in the first stage as they flow past a set of charged wires or corona fields. The charged particles are then attracted to an oppositely charged plate or grounded media filter as they flow through stage two. Some air filter models in the market combine mechanical and electrostatic filtration.

There are two elements of air filter performance: (1) the effectiveness of particulate removal from the air and (2) resistance to airflow (or pressure drop) across the filter. One measurement of an air filter's effectiveness at removing particles from the air is particle size efficiency (PSE), which is the fraction or percentage of particles captured on an air filter. Particle size efficiency is measured across three particle-size bins: 0.3 to 1.0 micrometer (μm), 1.0 to 3.0 μm, and 3.0 to 10.0 μm, as directed by either the test method in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 52.2 Standard or the test method in Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 680. When ASHRAE 52.2 is used to determine PSE, the measured values of PSE in each particle-size bin are then used to determine the Minimum Efficiency Reporting Value (MERV). MERV corresponds to a level of filtration performance ranging from 1 to 16, with higher numbers indicating an air filter that is more effective at capturing particles. Consumers need the ability to purchase air filters with particulate removal performance to select an air filter that meets their needs for adequate indoor air quality.

Pressure drop across the air filter or resistance to airflow is the other aspect of air filter performance. As the air stream passes through the air filter, its static pressure decreases due to the resistance of the air filter. This static pressure difference is measured in inches of water column (IWC) at either a specific face velocity or a specific airflow rate. The pressure drop due to resistance to airflow through a brand new air filter is called the “initial resistance” and the resistance when the air filter is fully loaded with particulates is called the “final resistance.” HVAC system designers need to know the initial pressure drop of an air filter so they can take it into account when they size HVAC equipment and related ductwork. The air filter typically accounts for 20 to 50 percent of the total HVAC system pressure drop, depending on the system configuration, filter efficiency, and loading condition.

When an HVAC system with a brushless permanent magnet blower motor is subjected to high static pressure, the motor controls increase motor speed in order to maintain system airflow. The increased motor speed causes a corresponding increase in power draw, resulting in an increase in energy consumption. When an HVAC system with a permanent split capacitor blower motor is subjected to high static pressure, the motor speed slows and system airflow cannot be maintained. Although the reduced motor speed leads to lower power draw, the failure to maintain system airflow results in a drop in the system’s cooling efficiency and cooling capacity which may result in a longer run time to cool or heat the ambient air to the thermostat’s set-point temperature. The overall effect can be an increase in energy use. Over time, excessive pressure drop can result in damage to furnaces from overheating, frozen condensing coils in air-conditioning units, and early failure of blower motors. Consumers need the ability to purchase replacement air filters with pressure drop performance that matches their HVAC system specifications in order to run their system efficiently and prevent equipment damage.

CHAPTER 11: Regulatory Approaches

Federal Regulations

There are no U.S. Department of Energy standards or test procedures for air filters. There are no Federal Trade Commission labeling requirements for air filters.

California Regulations

Effective on July 1, 2014, the California Building Energy Efficiency Standards began requiring the installation of air filters, in newly constructed residential buildings and certain alterations to residential HVAC systems, that were marked by the manufacturer to indicate particulate filtration efficiency and pressure drop. Effective for air filters manufactured on or after July 1, 2016, the California Appliance Efficiency Regulations began requiring all residential air filters sold or offered for sale in California to be certified to the Energy Commission and marked by the manufacturer to indicate particulate filtration efficiency and pressure drop. The appliance efficiency regulations were intended to harmonize with and complement the building energy efficiency standards.

In fall 2016, the Energy Commission learned that manufacturers of air filters were concerned about the testing requirements in the appliance efficiency regulations. The regulations were meant to provide manufacturers flexibility when conducting the required tests; however, manufacturers lacked information on how to identify and select which of their air filters were to be tested pursuant to the requirement to test a small, medium, and large air filter. Further, manufacturers were unclear how to apply the test results from the small, medium, and large air filters to the rest of the manufacturers' air filters in the same product family. The lack of an industry standard or accurate methodology to scale test results to different filter sizes made it difficult for manufacturers to comply with the testing, marking, and certification requirements for air filters. It became apparent that the regulations should be more specific with respect to identification and selection of a manufacturer's air filters to be tested and with respect to the application of the test results to a manufacturer's air filters which are in the same product family but of a different size.

In spring 2017, the Energy Commission adopted emergency regulations to change the date by which air filters sold or offered for sale in California must comply with the testing, marking, and certification requirements in the appliance efficiency regulations from July 1, 2016, to April 1, 2019. This delay in compliance date provides the Energy Commission time to collaborate with stakeholders to study, address, and resolve manufacturers' concerns with the existing testing requirements and allows manufacturers to continue to supply air filters to the California market. The delayed compliance date established by the emergency regulations expires on September 26, 2017, and the compliance date will revert to the original date unless the Energy Commission initiates a separate rulemaking proceeding to certify the emergency regulations and make the change in compliance date permanent. The Energy Commission initiated the certification rulemaking on June 16, 2017.

Staff has determined it is necessary to develop modifications to the appliance efficiency regulations in order to properly address the concerns that have been expressed by manufacturers about the air filter requirements. This staff report includes proposed modifications to clarify and make specific the appliance efficiency regulations for air filter testing, certification, and marking, and the rationale for those proposed modifications.

Test Methods

Two test procedures are allowed by the existing air filter regulations – AHRI 680-2009 and ASHRAE 52.2-2012. There are numerous similarities between the two test procedures; however, a value for MERV can only be determined when using ASHRAE 52.2. Electronic air filters must use AHRI 680 because they are incompatible with the conductive loading dust used in ASHRAE 52.2. Updated versions of both test procedures have been published and staff proposes to modify the regulations to allow for use of the most current versions of the test procedures. The current versions of the test procedures are ANSI/AHRI Standard 680 (I-P)-2015 2015 Standard for Performance Rating of Residential Air Filter Equipment and ASHRAE 52.2-2017 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

CHAPTER 12: Alternative Considerations

Staff analyzed the available information on air filters from the initial rulemaking that established the air filter requirements in the appliance efficiency regulations. This information was supplemented with stakeholders' comments and communications made after the initial rulemaking. The information led staff to consider three alternatives.

Alternative 1: Propose Modifications to Existing Regulations

Staff considered developing draft proposed regulations in order to address the concerns expressed by manufacturers regarding the testing, certification, and marking requirements for air filters in the appliance efficiency regulations. Draft proposed regulations would clarify and make specific the testing, certification, and marking requirements for air filters.

Alternative 2: No Change to Existing Regulations

Staff considered not modifying the existing requirements for air filters in the appliance efficiency regulations. This would not address the concerns expressed by manufacturers regarding the testing, certification, and marking requirements for air filters in the appliance efficiency regulations.

Alternative 3: Further Delay of the Compliance Date

Staff considered a further delay of the compliance date, beyond April 1, 2019, for the existing requirements for air filters in the appliance efficiency regulations. Regardless of how long the compliance date is delayed, this would not address the concerns expressed by manufacturers regarding the testing, certification, and marking requirements for air filters in the appliance efficiency regulations.

Chapter 13: Staff Recommendation

Staff has determined it is necessary to develop modifications to the appliance efficiency regulations in order to properly address manufacturers' concerns about the air filter requirements. Staff's recommended modifications to clarify and make specific the appliance efficiency regulations for air filter testing, certification, and marking and the rationale for those modifications follow.

Scope and Definitions

The scope of the air filter requirements in the building energy efficiency standards is limited to ducted systems, but the scope of the current appliance efficiency regulations is not limited to air filters intended for ducted systems. Because the requirements are meant to be complementary, staff proposes to align the scope of the appliance efficiency regulations with that of the building energy efficiency standards by defining air filters as those that are "designed for installation in residential ducted forced-air heating or cooling systems."

Staff recommends excluding air filters with adjustable dimensions because it is not possible for the manufacturer to mark the filter with all of the required information when the final face area of the filter is not a knowable quantity. Staff recommends adding a definition for basic model of an air filter to facilitate manufacturer identification of the air filters that are required to be tested. The definition for basic model of an air filter is based on the fact that air filters with the same filter media type, the same pleat characteristics (e.g., pleat depth and spacing), and the same construction (e.g., pleat support and frame pattern) will have the same pressure drop when operating at the same face velocity, even when the filters have different face areas.

Test Methods

Staff recommends updating the allowable test methods to the current version of the previously allowed test methods, specifically:

> ANSI/AHRI Standard 680 (I-P)-2015 2015 Standard for Performance Rating of Residential Air Filter Equipment
>
> ASHRAE 52.2-2017 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

Staff recommends that testing be required only for the basic model of an air filter instead of small, medium, and large size filters for each filter grade. For the filters that are represented by the basic model, meaning those with the same depth and construction but different face areas, pressure drop will be identical when the filters are operated at identical face velocity. Coupling this with the fact that air flow rate is the product of the face velocity multiplied by the face area, it is possible to develop a scaling method that would allow for calculating the information necessary for marking of the air filter. Use of a scaling method would reduce a manufacturer's testing requirements without degrading the quality of the information marked on the air filter; therefore, staff recommends requiring only each basic model of an air filter to be tested. To best align with the test procedures, the tested air filter shall be as close as possible to 24 inches wide by 24 inches long. Manufacturers can voluntarily test additional filters with other dimensions.

Certification

Product certification to the Energy Commission is required only for tested products. Because staff recommends testing only one of each basic model of air filter, only the basic model of an air filter is required to be certified to the Energy Commission. Staff recommends minor modifications to the required certification data for air filters identified in section 1606 Table X. These modifications are consistent with the use of the basic model of an air filter and with the ASHRAE 52.2-2017 test method.

Marking of Appliances and Effective Date

The appliance efficiency regulations currently require each unit of air filters, manufactured on or after April 1, 2019, and that are sold or offered for sale in California, to be marked with specific information. Staff does not recommend any modifications to the requirement that each unit of an air filter be marked, to the effective date, or to the information required for marking. Because staff's other recommendations address the concerns that have been expressed by manufacturers, further delay in effective date is not warranted.

For air filters that are required to be tested, staff recommends the resulting test data be used as the information required for marking of the air filter. For air filters that were not required to be tested, staff recommends the use of a scaling method to determine the information required for marking of the air filter. The basis for the scaling method was previously discussed in the Test Methods portion of this chapter. The detail of the proposed scaling method is in section 1607 of Chapter 16, Proposed Regulatory Language.

CHAPTER 14: Savings and Cost Analysis

Energy Commission staff previously analyzed the costs and benefits of the testing, certification, and marking requirements for air filters and found them to be cost-effective.[43] The previous analysis determined annual energy savings of approximately 30 GWh and 5.5 million therms after full stock turnover of air filters in residential ducted forced-air heating and cooling systems. Annual state monetary savings were determined to be $10.4 million with annual costs less than $600,000. Annual net statewide benefits were determined to be $9.8 million.

Individual household costs were determined to be $0.08 per year based on two filter changes per year, an average of 1.25 filters per residential HVAC system, and an incremental cost per filter of $0.03. Individual household benefits from reduced costs for energy were determined to be $1.32 per year, resulting in an annual net benefit per household of $1.24.

Although this staff report proposes minor modifications to the scope and definitions related to the air filter requirements, substantially all of the previously determined benefits and costs remain applicable because the proposed scope and definitions modifications only remove products with small market share from coverage by the regulations.

43 Singh, Harinder, Ken Rider, 2015. Staff Analysis of HVAC Air Filters, Dimming Fluorescent Ballasts, and Heat Pump Water Chilling Packages, California Energy Commission. Publication Number: CEC-400-2015-007, pp. 20-22 and pp. A1-A6, available at: http://docketpublic.energy.ca.gov/PublicDocuments/15-AAER-01/TN203717_20150220T141247_Staff_Analysis_of_HVAC_Air_Filters_Dimming_Fluorescent_Ballasts.pdf.

CHAPTER 15:
Technical Feasibility

Energy Commission staff previously analyzed the testing, certification, and marking requirements for air filters and found them to be technologically feasible.[44] This staff report does not propose any modifications that negatively impact the technological feasibility of the testing, certification, and marking requirements. This staff report proposes to reduce the number of air filters that are required to be tested by allowing scaling of tested data from one air filter to air filters of different face area but with the same depth and construction. The staff report also proposes a draft scaling method to ensure a consistent approach to data scaling is used by manufacturers. The reduced testing requirements and standardized scaling method both serve to increase the technological feasibility of the air filter requirements in the appliance efficiency regulations.

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44 Singh, Harinder, Ken Rider, 2015. Staff Analysis of HVAC Air Filters, Dimming Fluorescent Ballasts, and Heat Pump Water Chilling Packages, California Energy Commission. Publication Number: CEC-400-2015-007, pp. 22-23, available at: http://docketpublic.energy.ca.gov/PublicDocuments/15-AAER-01/TN203717_20150220T141247_Staff_Analysis_of_HVAC_Air_Filters_Dimming_Fluorescent_Ballasts.pdf.

CHAPTER 16: Proposed Regulatory Language

Proposed new language appears as underline (example) and proposed deletions appear as strikeout (~~example~~). Existing language appears as plain text. Three dots or "…" represents the substance of the regulations that exists between the proposed language and current language.

§ 1601. Scope.

…

(c) Central air conditioners, which are electrically-powered unitary air conditioners and electrically-powered unitary heat pumps, except those designed to operate without a fan; and gas-fired air conditioners and gas-fired heat pumps, air filters ~~for residential buildings for use in forced-air heating or forced-air cooling equipment~~, and heat pump water-chilling packages.

…

§ 1602. Definitions.

…

(c) Air Conditioners, Air Filters, and Heat Pump Water-Chilling Packages.

…

"Air filter" means an air-cleaning device ~~installed in forced-air heating or cooling equipment and~~ used for removing particulate matter from the air and designed for installation in residential ducted forced-air heating or cooling systems. "Air filter" does not include models that allow the consumer to adjust the dimensions of the end-use device.

"Air filter media" means the part of the air filter that conducts the actual removal of particulates.

"Air filter depth" means air filter thickness dimension measured perpendicular to the face area plane, expressed in inches.

"Airflow rate" means the actual volume of air passing through the device per unit of time, expressed in cubic~~-~~ feet~~-~~ per~~-~~ minute, to three significant figures.

…

"Basic model" of an air filter means all units of a given type of air filter with the same depth and the same construction, including type and grade of air filter media, pleat spacing, pleat height, pleat support, and filter frame pattern. The "basic model" of an air filter includes air filters with different filter face areas.

…

"Dust holding capacity" means the total weight of the synthetic loading dust captured by the filter device over all of the incremental dust loading steps of the test.

…

"Face area" means the gross area of the air filter exposed to airflow, as measured in a plane perpendicular to the direction of the airflow approaching the air filter (air filter length multiplied by air filter width), expressed in square~~-~~ feet.

"Face velocity" means the rate of air movement at the face of the air filter (airflow rate divided by face area) expressed in feet~~-~~ per~~-~~ minute.

"Final resistance" means the resistance to airflow of the air filter operating at the point where the test is terminated and results determined.

…

"Initial resistance" means the resistance of the air filter operating at its rated airflow rate, as published by the manufacturer, with no dust load.

…

"Maximum rated airflow rate" means the highest airflow rate at which the air filter is operated, as published by the manufacturer.

"Minimum efficiency reporting value (MERV)" means the composite particle efficiency metric defined in ASHRAE 52.2-~~2012~~2017.

…

"Particle size" means the polystyrene latex (PSL) light-scattering equivalent size of particulate matter as expressed as a diameter in micrometers (μm).

"Particle size efficiency" also known as "particle size removal efficiency" means the fraction (percentage) of particles that are captured on the air filter. Particle size efficiency is measured in three particle size ranges: 0.3-1.0, 1.0-3.0, 3.0-10 micrometers (μm). Particle size efficiency abbreviated as "PSE" in the required ~~labels~~marking for air filters.

…

"Pressure drop" means the drop in static pressure versus air flow rate across air filter media in the forced-air heating or cooling ~~equipment~~system.

…

§ 1604. Test Methods for Specific Appliances.

…

(c) Central Air Conditioners, Air Filters, and Heat Pump Water-Chilling Packages.

…

(4) The test methods for air filters are shown in Table C-2.

Table C-2
Air Filter Test Methods

Appliance Performance Criteria	Test Method
Air Filter Pressure Drop	~~AHRI 680-2009~~ ANSI/AHRI Standard 680 (I-P)-2015 or ASHRAE 52.2-~~2012~~2017
Minimum Efficiency Reporting Value (MERV)	ASHRAE 52.2-~~2012~~2017
Air Filter Particle Size Efficiency	~~AHRI 680-2009~~ ANSI/AHRI Standard 680 (I-P)-2015 or ASHRAE 52.2-~~2012~~2017
Dust Holding Capacity	~~AHRI 680-2009~~ ANSI/AHRI Standard 680 (I-P)-2015 or ASHRAE 52.2-~~2012~~2017

Manufacturers shall test each basic model of air filter. The tested air filter shall be the filter with dimensions closest to 24 inches wide x 24 inches long. Manufacturers may test additional air filters at other dimensions.~~small, medium, and large size filters for each grade.~~

…

The following documents are incorporated by reference in Section 1604.

…

~~AIR-CONDITIONING, HEATING, AND REFRIGERATION INSTITUTE (AHRI)~~

~~AHRI 680-2009 2009 Standard for Performance Rating of Residential Air Filter Equipment~~

~~Copies available from: Air-Conditioning, Heating, and Refrigeration Institute (AHRI)~~

~~2111 Wilson Blvd, Suite 500~~

~~Arlington, VA 22201~~

~~Phone: (703) 524-8800~~

~~FAX: (703) 562-1942~~

~~http://www.ahrinet.org/~~

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

…

ANSI/AHRI Standard 680 (I-P)-2015 2015 Standard for Performance Rating of Residential Air Filter Equipment

…

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2-~~2012~~2017 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

…

§ 1606. Filing by Manufacturers; Listing of Appliances in Database.

(a) Filing of Statements.

…

(1) General Rules.

…

(H) Air Filters. The statement for air filters shall be for each basic model of air filter, consistent with Section 1604(c)(4).

Table X

Data Submittal Requirements

	Appliance	**Required Information**	**Permissible Answers**
C	Air Filters manufactured on or after April 1, 2019	~~Air filter sizes tested~~	~~Small, medium, and large~~
		Model number of tested air filter	
		Minimum Efficiency Reporting Value (MERV)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, ~~17, 18, 19, 20~~ N/A
		Particle Size Efficiency for 0.3 to 1.0 µm particle size	
		Particle Size Efficiency for 1.0 to 3.0 µm particle size	
		Particle Size Efficiency for 3.0 to 10.0 µm particle size	
		Test Procedure used to determine air filter efficiency performance	~~AHRI 680-2009~~ ANSI/AHRI Standard 680 (I-P)-2015, or ASHRAE 52.2-~~2012~~2017
		~~Air Filter~~ Length of tested air filter	
		~~Air Filter~~ Width of tested air filter	
		~~Air Filter~~ Depth of tested air filter	
		~~Air Filter~~ Face Area of tested air filter	
		Face Velocity Utilized for the test procedure	Value in feet per minute or N/A
		Airflow Rate value 1	
		Airflow Rate value 2	
		Airflow Rate value 3	
		Airflow Rate value 4	
		Airflow Rate value 5-Maximum Rated Airflow Rate	
		Initial Resistance at air flow rate value 1	Test results to one-hundredths of an Inch of Water Column

		Initial Resistance at airflow rate value 2	Test results to one-hundredths of an Inch of Water Column
		Initial Resistance at airflow rate value 3	Test results to one-hundredths of an Inch of Water Column
		Initial Resistance at airflow rate value 4	Test results to one-hundredths of an Inch of Water Column
		Initial Resistance at airflow rate value 5	Test results to one-hundredths of an Inch of Water Column
		Final Resistance at the point where test is terminated and results determined	Test results to one-hundredths of an Inch of Water Column
		Dust Holding Capacity at the maximum rated airflow rate as published by the manufacturer	Test results in multiples of one gram~~.~~
		Airflow Rate value determined at an Initial Resistance of 0.1 Inch of Water Column	

…

§ 1607. Marking of Appliances.

…

(d) Energy Performance Information.

…

(12) Air Filters. Each unit of air filters manufactured on or after April 1, 2019, shall be marked, permanently and legibly, on an accessible and conspicuous place on the edge of the filter itself or on the pleats, in characters of font size 12, with the information specified in either section (A), ~~or~~ (B), or (C) below as applicable to the air filter ~~model~~ unit:

(A) Air filters that have been tested and for which the reported information is determined in accordance with the ~~AHRI standard 680-2009~~ ANSI/AHRI Standard 680 (I-P)-2015 shall be marked with the following information:

1. Particle size efficiency (PSE) of the unit in three particle size ranges: 0.3-1.0, 1.0-3.0, 3.0-10 micrometers (μm).
2. Initial resistance for the range of airflow rates as published by the manufacturer, including the maximum rated airflow rate. The selected airflow rates shall be in multiples of 400 cfm. If the maximum rated airflow rate is not a multiple of 400 cfm, then report initial resistance at multiples of 400 cfm, and any fraction thereof, to include the maximum rated airflow rate as described in subsections a, b, c, d, e below.

    a. Airflow Rate Value 1 (val 1) = 400 ~~cubic-feet-per-minute (~~cfm~~)~~. If 400 cfm is not within the manufacturer's published range of airflow rates for the filter, value = N/A.

b. Airflow Rate Value 2 (val 2) = 800 ~~cubic-feet-per-minute (~~cfm~~)~~. If 800 cfm is not within the manufacturer's published range of airflow rates for the filter, value = N/A.

c. Airflow Rate Value 3 (val 3) = 1200 ~~cubic-feet-per-minute (~~cfm~~)~~. If 1200 cfm is not within the manufacturer's published range of airflow rates for the filter, value = N/A.

d. Airflow Rate Value 4 (val 4) = 1600 ~~cubic-feet-per-minute (~~cfm~~)~~. If 1600 cfm is not within the manufacturer's published range of airflow rates for the filter, value = N/A.

e. Airflow Rate Value 5 (val 5) = Maximum Rated Airflow Rate ~~(~~in cfm~~)~~.

3. Mark the non-reported MERV information field as "N/A~~.~~".

(B) Air filters that have been tested and for which the reported information is determined in accordance with ASHRAE Standard 52.2-~~2012~~2017 shall be marked with the following information:

1. Particle size efficiency (PSE) of the unit in three particle size ranges: 0.3-1.0, 1.0-3.0, 3.0-10 micrometers (μm).

2. Initial resistance for the range of airflow rates as published by the manufacturer, including the maximum rated airflow rate. The airflow rate values shall be the maximum rated airflow rate, and the values for 50%, 75%, 100% and 125% of the test airflow rate value determined in accordance with ASHRAE 52.2-~~2012.~~2017 as described in subsections a, b, c, d, e below.

a. Airflow Rate Value 1 (val 1) = 50% of the test airflow rate in ~~cubic-feet-per-minute~~cfm (50% of airflow rate value 3).

b. Airflow Rate Value 2 (val 2) = 75% of the test airflow rate in ~~cubic-feet-per-minute~~cfm (75% of airflow rate value 3).

c. Airflow Rate Value 3 (val 3) = 100% of the test airflow rate in ~~cubic-feet-per-minute~~cfm; determined as equal to selected test face velocity (feet per minute) multiplied by the air filter face area (square feet).

d. Airflow Rate Value 4 (val 4) = 125% of the test airflow rate in ~~cubic-feet-per-minute~~cfm (125% of airflow rate value 3).

e. Airflow Rate Value 5 (val 5) = Maximum Rated Airflow Rate ~~(~~in cfm~~)~~.

3. Minimum Efficiency Reporting Value (MERV).

(C) All air filters that have not been tested shall be marked with information that is based on the information for an air filter of the same basic model which has been tested per section 1604(c)(4) and certified to the Energy Commission per section 1606(a)(1)(H). Information for an air filter that has not been tested shall be determined assuming a face velocity that is identical to the face velocity from the tested air filter of the same basic model. All air filters that have not been tested shall be marked with the following information:

1. Particle size efficiency (PSE) of the unit in three particle size ranges: 0.3-1.0, 1.0-3.0, 3.0-10 micrometers (μm). The PSE values for an air filter that has not been tested shall be identical to the PSE values determined for a tested air filter of the same basic model.
2. Initial resistance values for the range of airflow rate values 1 through 5. The initial resistance values for an air filter that has not been tested shall be identical to the initial resistance values 1 through 5 determined for a tested air filter of the same basic model. Some fields may be marked as "N/A".
3. Airflow rate values 1 through 5. Airflow rate values 1 through 5 for an air filter that has not been tested shall each be equal to the corresponding airflow rate values 1 through 5 from a tested air filter of the same basic model multiplied by the face area of the filter that has not been tested and divided by the face area of the tested air filter of the same basic model. Some fields may be marked as "N/A".
4. Minimum Efficiency Reporting Value (MERV). The MERV for an air filter that has not been tested shall be identical to the value determined for a tested air filter of the same basic model. The value shall be either a whole number between 1 and 16 or "N/A".

The information shall be disclosed in the format in Table Z.

Table Z
Sample Air Filter Marking

<table>
<tr><td>MERV</td><td rowspan="2">(μm)
PSE
(%)</td><td>0.30-1.0</td><td>1.0-3.0</td><td>3.0-10</td><td>Airflow Rate (CFM)</td><td>[val 1]</td><td>[val 2]</td><td>[val 3]</td><td>[val 4]</td><td>[val 5]*</td><td rowspan="2">*Max Rated Airflow</td></tr>
<tr><td>[value]</td><td>[value]</td><td>[value]</td><td>[value]</td><td>Initial Resistance (IWC)</td><td>[value]</td><td>[value]</td><td>[value]</td><td>[value]</td><td>[value]</td></tr>
</table>

If the marking on the air filter is not legible through its retail packaging, then the packaging shall also be labeled with the same information and in the same format as Table Z. The requirements of this section shall not preclude manufacturers from providing additional information.