APPENDIX C:

Data Sheets for New Products

Table of Contents

Standards Consideration

Product: Beverage Merchandisers

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	High-Efficiency Compressor + Brushless DC Fan Motors = 0.33[1]
Product / Technology Availability (Including Price/Cost information):	Technology — Payback Period[1] — Tech. Maturity[2] — Peak Load Impact High-Effcy Compressor — ~1 — New — High Brushless DC Fan Motors — 1.4 to 4.4 — New — High
Cumulative Burden	• The industry dealt with the phase out of chlorofluorocarbons (CFC's) in the mid-1990's. • If the Kyoto protocol were ratified, the industry would possibly have to convert to refrigerants with reduced global warming potential. • Some of the companies involved in manufacturing this equipment have parent companies which own divisions which have been subject to energy standards of other products.
Status of Test Procedures	Treated as a Glass-Door Reach-In by California. Applicable Test Procedure Standards are as follows: • American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) 117 • Canadian Standards Association (CSA) C827-98: Based on ASHRAE 117 • Coca Cola Test Procedures (includes CL-I-006ae for steady-state energy use)
Other Regulatory Actions	
Evidence of Market-Driven or Voluntary Efficiency Improvements	California: Treated as a Glass-Door Reach-In.
Issues	Importance of energy use during pulldown versus steady state.

[1] Based on "Energy Savings Potential for Commercial Refrigeration Equipment," Arthur D. Little (ADL) for DOE, June 1996. Table 5-17, Row 12. Payback period in years based on medium energy cost locations (7.82¢/kWh).

[2] Technology Maturity Description definitions – Current: Available but not widely used; New: Available, but not used in commercially available equipment; Advanced: Needs development prior to commercialization.

Background Material

Description	Value	Comments/Source
Total Energy Use (Quads, 1995)	0.052	ADL/DOE Refrigeration Study, 1996.
Unit Energy Consumption (kWh)	6,031	Divide energy use by installed base.
Annual Shipments (millions, 1995)	0.06 to 0.12	ADL/DOE Refrigeration Study, 1996, According to more recent communications with Copeland and Delfield representatives, these estimates are probably low.
Installed Base (millions, 1995)	0.8	ADL/DOE Refrigeration Study, 1996,
Product Lifetime (years)	7 to 10	ADL/DOE Refrigeration Study, 1996,
Minimum Efficiency Standard	N/A	
Stock Efficiency	10.75 kWh/day	Energy consumption for a typical 27 ft^3 merchandiser. ADL/DOE Refrigeration Study, 1996.
Typical New Efficiency	~10 kWh/day	Assumed similar to stock.
Best Available Efficiency	N/A	
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	10.42 kWh/day	ASHRAE 117 Test consumption for 27 ft^3 cabinet. Proposed California Tier 1 Regulation.

Test Procedure Summary

Product: Beverage Merchandisers

Factors	Assessment
Test Procedure Overview	• California treats Glass-Door Beverage Merchandisers as Glass-Door Reach-Ins, for which ASHRAE Standard 117 is the established test procedure (see discussion on Reach-Ins for Test procedure details). • Coca Cola has proprietary test procedures, which include evaluation of energy use.
Future/Potential Test Procedure(s)	A test procedure could be developed which is more suited than ASHRAE 117 to the operation of beverage merchandisers. In particular, the energy effect of loading of warm beverages is not addressed by the current procedure.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• The test procedure ambient temperature of 75^{o}F is appropriate for typical temperatures for beverage merchandisers in most applications. • The test procedure does not have a component, which evaluates the energy required to pull down the temperature of warm beverages loaded into the machine.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	The ASHRAE 117 test procedure's lack of a component addressing the loading of warm beverages into the machine, and its moderate ambient temperature would tend to make peak load predictions of the procedure low for beverage merchandisers.

Standards Consideration

Product: Ice Machines

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	Combination of Energy Savings Technologies: 0.18[3] Canadian Standards: 0[4] FEMP Recommended/ Best Available: 0.16 / 0.31[5]
Product / Technology Availability (Including Price/Cost information):	Technology / Payback Period[3] / Tech. Maturity / Peak Load Impact High-Effcy Compressor / 1.8 years / New / High Reduced Evap Therm Cyc / 1.2 years / New / High
Cumulative Burden	• The industry dealt with the phase out of CFC's in the mid-1990's. • If the Kyoto protocol were ratified, the industry would possibly have to convert to refrigerants with reduced global warming potential. • Some of the companies involved in manufacturing this equipment have parent companies, which own divisions which have been subject to energy standards of other products.
Status of Test Procedures	• ASHRAE 29 • ARI 810-2000: Based on ASHRAE 29 • CSA C742-98: Based on ASHRAE 29
Other Regulatory Actions	Canadian Regulations and availability of ARI Data.
Evidence of Market-Driven or Voluntary Efficiency Improvements	FEMP Recommendations
Issues	Significant product variety.

[3] Based on "Energy Savings Potential for Commercial Refrigeration Equipment," ADL for DOE, June 1996. Table 5-17, Row 12. Includes High-Efficiency Compressor and Brushless DC Evaporator Fan Motor. Payback period in years based on medium energy cost locations (7.82¢/kWh).

[4] See plot of Standards vs. Air-Conditioning and Refrigeration Institute (ARI) data. Nearly all units comply with the current standard.

[5] Based on ARI average consumption for air-cooled ice makers with 401 to 500 lb/day capacity (7.05 kWh/100lb) and water-cooled ice makers with 301 to 500lb/day capacity (5.62kWh/100lb) compared with Federal Energy Management Program (FEMP) recommended and "best available" data for these ranges.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1995)	0.10	ADL/DOE Refrigeration Study, 1996
Unit Energy Consumption (kWh)	7,900	Divide energy use by installed base.
Annual Shipments (millions, 1998)	0.296	Census data for 1998.
Installed Base (millions, 1995)	1.2	ADL/DOE Refrigeration Study, 1996.
Product Lifetime (years)	7 to 10	ADL/DOE Refrigeration Study, 1996.
Minimum Efficiency Standard	N/A	
Stock Efficiency	7 kWh/100 lb	Assumed same as typical new.
Typical New Efficiency	7 kWh/100 lb	Average of efficiencies for 500 lb/day air-cooled units – ARI data.
Best Available Efficiency	5.8 kWh/100 lb	Best available 500 lb/day air-cooled unit – ARI data.
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)	N/A	

Test Procedure Summary

Product: Ice Machines

Factors	Assessment
Test Procedure Overview	ASHRAE Standard 29 has been adopted for performance and energy evaluation for Ice Machines. Both ARI and Canadian test procedures are based on the ASHRAE standard. Although the ASHRAE standard does not specify temperatures, the ARI test is based on the following: • 90°F Ambient Temperature • 70°F Supply Water Temperature and/or Cooling Water Temperature for water-cooled Ice Machines • Ice Machine runs at full capacity during test.
Future/Potential Test Procedure(s)	It is unlikely any new test procedure will be developed. However, a test procedure with more typical ambient and supply water temperatures would be more representative of actual energy use.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• The ambient and water temperatures are higher than typical temperatures for ice machines in most applications. The test procedure uses higher temperatures because it was initially developed to test primarily ice machine capacity. • In addition, the testing of ice machines at full capacity overestimates duty cycle of machines used in many applications.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	The current test procedure involving high ambient and water temperatures and 100% duty cycle is an ideal indicator of peak load and peak load impact.

Standards Consideration

Product: Reach-In Freezers

<table>
<tr><th>Factors for Consideration</th><th>Assessment</th></tr>
<tr><td>Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030</td><td><table>
<tr><th>Combination of Energy Saving Options</th><th>California Regulations (Tier 1, Tier 2)</th><th>Energy Star</th></tr>
<tr><td>0.40[6]</td><td>0.09, 0.15[7]</td><td>0.23[7]</td></tr>
</table></td></tr>
<tr><td>Product / Technology Availability (Including Price/Cost information):</td><td><table>
<tr><th>Technology</th><th>Payback Period[8]</th><th>Tech. Maturity</th><th>Peak Load Impact</th></tr>
<tr><td>System Optimization</td><td>1 year</td><td>Current</td><td>High</td></tr>
<tr><td>Rifled Tubes</td><td colspan="3">No savings unless heat exchangers are space-constrained</td></tr>
<tr><td>Var-Speed Compressor</td><td>1.4 years</td><td>New</td><td>Medium</td></tr>
<tr><td>Dual Compressor</td><td>1.5 years</td><td>New</td><td>Low</td></tr>
<tr><td>Brushless DC Fan Mtr</td><td>0 to 3 years</td><td>New/Advanced</td><td>High</td></tr>
<tr><td>PSC Fan Motors</td><td>2 to 14 yrs</td><td>Current</td><td>High</td></tr>
<tr><td>Evap Fan Shutdown</td><td>1 year</td><td>New</td><td>High</td></tr>
<tr><td>Face Frame Impr</td><td>0 years</td><td>New</td><td>High</td></tr>
<tr><td>Condensate Trap</td><td>0.5 year</td><td>Current</td><td>High</td></tr>
<tr><td>Improved Insulation</td><td>2.4 years</td><td>Current</td><td>High</td></tr>
<tr><td>Thicker Walls</td><td>1 year</td><td>Current</td><td>High</td></tr>
</table></td></tr>
<tr><td>Cumulative Burden</td><td>• The industry dealt with the phase out of CFC’s in the mid-1990’s.
• If the Kyoto protocol were ratified, the industry would possibly have to convert to refrigerants with reduced global warming potential.
• Some of the companies involved in manufacturing this equipment have parent companies, which own divisions which have been subject to energy standards of other products.</td></tr>
<tr><td>Status of Test Procedures</td><td>• ASHRAE 117: Door-opening test with load and ambient humidity.
• Natural Sanitation Foundation (NSF) 7: Closed-door test without load for performance test.
• CSA C827-98: Based on ASHRAE 117.</td></tr>
<tr><td>Other Regulatory Actions</td><td>Regulation of Reach-Ins by California. Tier 1 takes effect July 1, 2002 and Tier 2 takes effect July 1, 2004.</td></tr>
<tr><td>Evidence of Market-Driven or Voluntary Efficiency Improvements</td><td>ENERGY STAR® Program launched in September 2001.</td></tr>
<tr><td>Issues</td><td>• Significant product variety.
• ASHRAE 117 test issues: Repeatability issues with door-opening tests. Expense of test means that not all products are tested, and limited spot checks are made by the manufacturer.</td></tr>
</table>

[6] “Energy Savings Potential for Commercial Refrigeration Equipment,” ADL for DOE, June 1996. Table 5-18, row 13. Includes Hot Gas Antisweat, High Efficiency Compressor, Brushless DC Evaporator and Condenser Fan Motors, 35% Energy Reduction.

[7] Based on the assumption that a baseline 20 ft^3solid-door Reach-In will have 8.65kWh/day energy consumption (Delfield 6125S).

[8] "Application of Best Industry Practice to the Design of Commercial Refrigerators,” ADL, Review Meeting with DOE, March 25, 2001. All payback periods are in years based on modification of a typical two-door solid-door refrigerator with top-mount condensing unit. Assumes current unit energy use of 12 kWh/day, $0.076/kWh.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1995)	0.067	ADL/DOE Refrigeration Study, 1996.
Unit Energy Consumption (kWh)	7,650	Divide energy use by installed base.
Annual Shipments (millions, 1995)	0.080	ADL/DOE Refrigeration Study, 1996.
Installed Base (millions, 1995)	0.80	ADL/DOE Refrigeration Study, 1996.
Product Lifetime (years)	8 to 10	ADL/DOE Refrigeration Study, 1996.
Minimum Efficiency Standard	N/A	
Stock Efficiency	~8 kWh/day	Assumed same as typical new.
Typical New Efficiency	~8 kWh/day	Average for 20 ft^3 freezer based on California Energy Commission (CEC) data (ASHRAE 117 Energy Test).
Best Available Efficiency	~5 kWh/day	Soon to be commercially available. Rough estimate of energy use of new Delfield freezers for 20 ft^3 volume.
ENERGY STAR® Efficiency	9.36 kWh/day	www.EnergyStar.gov for 20 ft^3 freezer
Maximum Efficiency (Future Technology)	N/A	

Standards Consideration

Product: Reach-In Refrigerators

<table>
<tr><th>Factors for Consideration</th><th>Assessment</th></tr>
<tr><td>Potential Energy Savings from Regulatory Action;
Cumulative (Quads) 2008-2030</td><td>
<table>
<tr><th>Combination of Energy Saving Options</th><th>California Regulations (Tier 1, Tier 2)</th><th>Energy Star</th></tr>
<tr><td>0.42[9], 0.64[10], 0.76[11]</td><td>0, 0.09[12]</td><td>0.28[12]</td></tr>
</table>
</td></tr>
<tr><td>Product / Technology Availability (Including Price/Cost information):</td><td>
<table>
<tr><th>Technology</th><th>Payback Period[13]</th><th>Tech. Maturity</th><th>Peak Load Impact</th></tr>
<tr><td>System Optimization</td><td>1 year</td><td>Current</td><td>High</td></tr>
<tr><td>Rifled Tubes</td><td colspan="3">No savings unless heat exchangers are space-constrained</td></tr>
<tr><td>Var-Speed Compressor</td><td>1.4 years</td><td>New</td><td>Medium</td></tr>
<tr><td>Dual Compressor</td><td>1.5 years</td><td>New</td><td>Low</td></tr>
<tr><td>Brushless DC Fan Mtr</td><td>0 to 3 years</td><td>New/Advanced</td><td>High</td></tr>
<tr><td>PSC Fan Motors</td><td>2 to 14 yrs</td><td>Current</td><td>High</td></tr>
<tr><td>Evap Fan Shutdown</td><td>1 year</td><td>New</td><td>High</td></tr>
<tr><td>Face Frame Impr</td><td>0 year</td><td>New</td><td>High</td></tr>
<tr><td>Condensate Trap</td><td>0.5 year</td><td>Current</td><td>High</td></tr>
<tr><td>Improved Insulation</td><td>2.4 years</td><td>Current</td><td>High</td></tr>
<tr><td>Thicker Walls</td><td>1 year</td><td>Current</td><td>High</td></tr>
</table>
</td></tr>
<tr><td>Cumulative Burden</td><td>• The industry dealt with the phase out of CFC's in the mid-1990's.
• If the Kyoto protocol were ratified, the industry would possibly have to convert to refrigerants with reduced global warming potential.
• Some of the companies involved in manufacturing this equipment have parent companies, which own divisions which have been subject to energy standards of other products.</td></tr>
<tr><td>Status of Test Procedures</td><td>• ASHRAE 117: Door-opening test with load and ambient humidity.
• NSF 7: Closed-door test without load for performance test.
• CSA C827-98: Based on ASHRAE 117.</td></tr>
<tr><td>Other Regulatory Actions</td><td>Regulation of Reach-Ins by California. Tier 1 takes effect 07/01/02 and Tier 2 takes effect 07/01/04.</td></tr>
<tr><td>Evidence of Market-Driven or Voluntary Efficiency Improvements</td><td>ENERGY STAR® Program launched in September, 2001.</td></tr>
<tr><td>Issues</td><td>• Significant product variety.
ASHRAE 117 test issues: Repeatability issues with door-opening tests. Expense of test means that not all products are tested, and limited spot checks are made by the manufacturer.</td></tr>
</table>

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[9] "Energy Savings Potential for Commercial Refrigeration Equipment," ADL for DOE, June 1996. Table 5-19, row 10. Includes Hot Gas Antisweat, High Efficiency Compressor, Brushless DC Evaporator and Condenser Fan Motors, 44% Energy Reduction

[10] "Application of Best Industry Practice to the Design of Commercial Refrigerators," ADL, Review Meeting with DOE, March 21, 2001, p. 16, fifth row. Includes Improved Face Frame Design, Improved Gasket, Reduced Antisweat Heater Wage, Condensate Line Trap, Brushless DC Evaporator Fan Motor, PSC Condenser Fan Motor, Evaporator Fan Shutdown, Refrigeration System Optimization, 67% Reduction.

[11] Ibid., Row 6. Includes Improved Face Frame Design, Improved Gasket, Reduced Antisweat Heat Input, Condensate Line Trap, Brushless DC Evaporator and Condenser Fan Motors, Variable-Speed Refrigeration System, Hot Gas Antisweat Heating, 80% Reduction.

[12] Based on the assumption that a baseline 43.5 ft^3 solid-door Reach-In will have 9kWh/day energy consumption (Delfield 6051S).

[13] "Application of Best Industry Practice to the Design of Commercial Refrigerators," ADL, Review Meeting with DOE, March 21, 2001. All payback periods are in years based on modification of a typical two-door solid-door refrigerator with top-mount condensing unit. Assumes current unit energy use of 12 kWh/day, $0.076/kWh.

Standards Consideration

Product: Reach-In Refrigerators

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1995)	0.054	ADL/DOE Refrigeration Study, 1996.
Unit Energy Consumption (kWh)	3,854	Divide energy use by installed base.
Annual Shipments (millions, 1995)	0.12	ADL/DOE Refrigeration Study, 1996.
Installed Base (millions, 1995)	1.3	ADL/DOE Refrigeration Study, 1996.
Product Lifetime (years)	8 to 10	ADL/DOE Refrigeration Study, 1996.
Minimum Efficiency Standard	N/A	
Stock Efficiency	9 kWh/day	Assumed same as typical new.
Typical New Efficiency	9 kWh/day	Measured by ADL (ASHRAE 117 Test) for “Typical” 43.5 ft^3 two-solid-door reach-in. Also consistent with CEC data.
Best Available Efficiency	~4 kWh/day	Soon to be commercially available. Energy measured for Delfield prototype jointly developed with ADL with DOE funding.
ENERGY STAR® Efficiency	6.39 kWh/day	www.EnergyStar.gov for 43.5 ft^3 freezer.
Maximum Efficiency (Future Technology)	~2 kWh/day	Estimates developed for variable-speed refrigerator . As part of DOE-funded project.

Test Procedure Summary

Product: Reach-In Freezers and Refrigerators

Factors	Assessment
Test Procedure Overview	Precedent has been set for use of ASHRAE Standard 117 for determination of Reach-In Energy Use. This standard has been adopted by Canada, California, and EPA ENERGY STAR®. • Ambient Conditions 75+/-2F Dry Bulb Temperature, 64 +/-2F Wet Bulb Temperature (55% Relative Humidity). • Internal Load consisting of containers of salt-water solution and wood filler. • Automatic door-opening for the first 8 hours of the test. Doors remain closed for remaining 16 hours. • The ASHRAE procedure does not specify an internal temperature (energy standards based on this procedure must make this specification). Typical temperatures specified by energy standards are 38F average internal temperature for refrigerators, 0F for freezers, and -5F for ice cream freezers. The complexity of the test procedure is a potential issue in spite of its acceptance among key manufacturers. • CEC has qualified only two test laboratories for energy testing of Reach-Ins • CEC requires energy testing only for representative cabinets and allows projections of energy use for similar cabinets. • The test's complexity make verification of compliance very difficult. ADL is aware of two examples in which reported energy test results are definitely low or likely to be low. • Experience with residential energy test procedures shows that repeatability is suspect with test procedures involving door-openings and/or internal loads.
Future/Potential Test Procedure(s)	Test procedures involving no internal load and no automatic door openings would be significantly easier to carry out and would have greater repeatability.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• The ambient temperature condition is somewhat low compared to temperatures often seen in commercial kitchens employing the equipment. • The automatic door-openings provide a reasonable representation of typical reach-in use. • Test does not take into account energy required to "pull down" warm food introduced into units.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Correlation of peak load impact with ASHRAE 117 test procedure would be low, since the test procedure ambient temperature is relatively low.

Standards Consideration

Product: Supermarket Refrigeration Systems

<table>
<tr><th>Factors for Consideration</th><th>Assessment</th></tr>
<tr><td>Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030</td><td><table><tr><th>Brushless DC Evaporator Fan Motors</th><th>Other Options with less than 5-year payback</th></tr><tr><td>0.44</td><td>0.39[14]</td></tr></table></td></tr>
<tr><td>Product / Technology Availability (Including Price/Cost information):</td><td>Most of the technologies and design options noted in the data sheet are currently available.<table><tr><th>Technology</th><th>Payback Period[14]</th><th>Tech. Maturity</th><th>Peak Load Impact</th></tr><tr><td>Brushless DC Fan Motors</td><td>1.6 years</td><td>New</td><td>High</td></tr><tr><td>Hot Gas Defrost</td><td>1.4 years</td><td>Current</td><td>High</td></tr><tr><td>Antisweat Heater Control</td><td>1.6 years</td><td>Current</td><td>High</td></tr><tr><td>Defrost Control</td><td>3 to 7 years</td><td>Advanced</td><td>High</td></tr><tr><td>Liq-Suct. Heat Exchangers</td><td>4 to 14 years</td><td>Current</td><td>High</td></tr><tr><td>Evaporative Condensers</td><td><1 year</td><td>Current</td><td>High</td></tr><tr><td>Floating Head Pressure</td><td>2.5 years</td><td>Current</td><td>Low</td></tr><tr><td>Heat Reclaim</td><td>2.5 years</td><td>Current</td><td>Low</td></tr><tr><td>Mechanical Subcooling</td><td>4.9 years</td><td>Current</td><td>High</td></tr></table></td></tr>
<tr><td>Cumulative Burden</td><td>• The industry dealt with the phaseout of CFC’s in the mid-1990’s. HFC and HFC blend replacements for traditional refrigerants R-502 and R-12 have been developed and are now generally established.
• There is continued concern regarding the level of potential emissions associated with leakage and service in supermarket refrigeration systems. Since most systems are now using non-ozone-depleting refrigerants, the environmental concern focuses on global warming. If the Kyoto protocol were ratified, this would be a significant issue for the supermarket refrigeration industry.
• Some of the companies involved in manufacturing this equipment have parent companies that own divisions that have been subject to energy standards of other products.</td></tr>
<tr><td>Status of Test Procedures</td><td>• Separate Test Procedures for display cases and compressors and/or condensing units.
• Display Cases: CRS-S1-96 (ARI CRMD), ASHRAE 72, CSA C657-95
Compressors and Condensing Units: Many different test standards depending on compressor and heat rejection type.</td></tr>
<tr><td>Other Regulatory Actions</td><td>None known.</td></tr>
<tr><td>Evidence of Market-Driven or Voluntary Efficiency Improvements</td><td>Market penetration of energy-saving technologies (ADL/DOE Study)
• Floating Head Pressure 62%
• Mechanical Subcooling 65%
• Liquid-Suction Heat Exchanger 25% (MT), 50% (LT)
Antisweat Heater controls 69%</td></tr>
<tr><td>Issues</td><td>• Many system types
• Systems are engineered and built on-site (not factory-completed)
Interaction between air-conditioning and refrigeration systems</td></tr>
</table>

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[14] “Energy Savings Potential for Commercial Refrigeration Equipment,” ADL for DOE, June 1996. Includes Hot Gas Defrost, Antisweat Heater Control, Defrost Control, Liquid-Suction Heat Exchangers for Low Temperature applications, Evaporative Condenser, Floating Head Pressure, Heat Reclaim, and Mechanical Subcooling. Payback period in years based on medium energy cost locations ($0.0782/kWh).

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1995)	0.329	ADL/DOE Refrigeration Study, 1996.
Unit Energy Consumption (kWh)	1,000,000	Divide energy use by installed base.
Annual Shipments (millions, 1995)	0.055	Compressor shipments for Supermarkets, ADL/DOE Refrigeration Study, 1996.
Installed Base (millions, 1995)	0.03	ADL/DOE Refrigeration Study, 1996, CBECS 1995.
Product Lifetime (years)	10	Compressors, Condensers: ADL/DOE Ref Study, 1996.
	5 to 15	Display Cases: ADL/DOE Refrigeration Study, 1996.
Minimum Efficiency Standard	N/A	No suitable efficiency definitions have been established for Supermarket Refrigeration systems, since they are complex systems composed of many components.
Stock Efficiency	N/A	
Typical New Efficiency	N/A	
Best Available Efficiency	N/A	
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)	N/A	

Test Procedure Summary

Product: Supermarket Refrigeration Systems

Factors	Assessment
Test Procedure Overview	• No applicable test procedures for complete supermarket refrigeration systems. • Test procedures for separate components of supermarket refrigeration systems (i.e., display cases, condensing units, condensers, compressors) generally focus on capacity at design conditions rather than energy use, although energy input may be measured during the test. • An example of a test standard for a refrigeration system component is ARI Standard 460-2000, “Remote Mechanical-Draft Air-Cooled Refrigerant Condensers”. Reporting for this standard includes reporting of condenser fan power. The standard’s focus is evaluation of capacity and power input during 100% run of an air-cooled condenser. The standard rating condition for this test procedure involves 95°F entering air temperature.
Future/Potential Test Procedure(s)	• Application of energy standards to supermarket refrigeration systems is extremely complicated due to the very wide range of system architecture utilized. • Energy test procedures might focus on individual components, such as display cases.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• Typical standard rating conditions apply to operating conditions which are more energy intensive than average typical conditions. For example, the 95°F entering air temperature for ARI Standard 460 mentioned above certainly exceeds a typical average condition. • Furthermore, the standard does not take into consideration that the system does not operate at 100% capacity at all times. A condenser fan would cycle to maintain a head pressure, thus resulting in less fan power. Or, the condenser fan would run continuously, thus allowing very low condensing conditions at low ambient temperatures. This latter scenario would result in significant reduction in compressor power.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Correlation of peak load impact with typical test procedures would be good, since test procedures generally do not address part load operation.

Standards Consideration

Product: Vending Machines

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	Combination of Energy Saving Options = 0.67[15] Royal Vending Machines Econo-Cool = 1.1
Product / Technology Availability (Including Price/Cost information):	Technology Payback Period[15] Tech. Maturity Peak Load Impact High-Effcy Compressor ~1 year New High Brushless DC Fan Motors ~2 years New High
Cumulative Burden	• The industry dealt with the phaseout of CFC's in the mid-1990's. • If the Kyoto protocol were ratified, the industry would possibly have to convert to refrigerants with reduced global warming potential. • Some of the companies involved in manufacturing this equipment have parent companies which own divisions which have been subject to energy standards of other products.
Status of Test Procedures	• ASHRAE 32.1 • CAN/CSA C804-96: Based on ASHRAE 32.1
Other Regulatory Actions	California: Registration required; design standard for use of T8 lamps.
Evidence of Market-Driven or Voluntary Efficiency Improvements	ENERGY STAR® in development.
Issues	Significant product variety.

[15] "Energy Savings Potential for Commercial Refrigeration Equipment," ADL for DOE, June 1996. Table 5-21, Row 11. Includes High-Efficiency Compressor and Brushless DC Evaporator Fan Motor, 28% energy use reduction. The 28% energy use reduction estimate is consistent with other estimates presented in "Commercial Packaged Refrigeration: An Untapped Lode for Energy Efficiency," Toru Kubo, et. al., presented at the 2000 ACEEE Summer Study. Payback period in years based on medium energy cost locations (7.82¢/kWh).

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1995)	0.135	ADL/DOE Refrigeration Study, 1996.
Unit Energy Consumption (kWh)	3,033	Divide energy use by installed base.
Annual Shipments (millions, 1995)	0.4	Inventory divided by ~10 year life.
Installed Base (millions, 1995)	4.1	ADL/DOE Refrigeration Study, 1996.
Product Lifetime (years)	7 to 10	ADL/DOE Refrigeration Study, 1996.
Minimum Efficiency Standard	N/A	
Stock Efficiency	10.8 kWh/day	Assumed same as typical new.
Typical New Efficiency	10.8 kWh/day	Average for 600-can beverage machine. Based on limited data received by EPA.
Best Available Efficiency	9 kWh/day	Average for 600-can beverage machine. Based on limited data received by EPA.
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	N/A	

Test Procedure Summary

Product: Vending Machines

Factors	Assessment
Test Procedure Overview	ASHRAE Standard 32.1 has been adopted for performance and energy evaluation for Refrigerated Vending Machines. • Three test procedures for (1) Steady State Energy Consumption, (2) Vend Test (recovery capability after loading half of the machine with warm beverages, and (3) Recovery Test (recovery capability after loading the entire machine with warm beverages. The second and third tests do not measure energy use associated with recovery. • Ambient Conditions 90+/-2^{o}FDry Bulb Temperature, 65 +/-5% Relative Humidity. • Beverage Temperature 36 +/- 1^{o}F for energy test. • Energy test duration is 6 hours after attainment of steady state. Attainment of steady state will take more than 24 hours according to the test procedure requirements. The proposed Canadian energy standard is based on the ASHRAE 32.1 Steady State test.
Future/Potential Test Procedure(s)	A test procedure based on ASHRAE 32.1 (but perhaps with more moderate ambient and product loading temperatures) should be developed which gives proper weighting of energy use associated with steady-state and temperature recovery.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• The ambient temperatures are higher than typical temperatures for refrigerated vending machines in most applications. • The energy test procedure does not provide weighting of energy use associated with steady state and recovery after loading of product. • The test procedure does not have a procedure for evaluation of energy used for keeping product from freezing for outdoor units during the winter.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	• The current test procedures involving high ambient and product loading temperatures are relatively good indicator of peak load. However, an appropriate weighting consistent with typical vending machine operation for the three test parts of ASHRAE 32.1 would improve correlation with peak load impact.

Standards Consideration

Product: Walk-In Coolers

<table>
<tr><th>•</th><th>•</th></tr>
<tr><td>Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030</td><td>Combination of Energy Saving Options = 0.37[16]</td></tr>
<tr><td>Product / Technology Availability (Including Price/Cost information):</td><td>
<table>
<tr><th>Technology</th><th>Payback Period[16]</th><th>Tech. Maturity</th><th>Peak Load Impact</th></tr>
<tr><td>Floating Head Pressure</td><td>0.3 year</td><td>New</td><td>Low</td></tr>
<tr><td>Ambient Subcooling</td><td>1.7 years</td><td>New</td><td>Medium</td></tr>
<tr><td>Evap Fan Shutdown</td><td>0.7 to 2 years</td><td>New</td><td>Medium</td></tr>
<tr><td>Brushless DC Fan Motors</td><td>~1 year</td><td>New</td><td>High</td></tr>
<tr><td>External Heat Rejection</td><td>7 years</td><td>New</td><td>High</td></tr>
<tr><td>Hot Gas Defrost</td><td>1.8 years</td><td>Current</td><td>High</td></tr>
</table>
</td></tr>
<tr><td>Cumulative Burden</td><td>• The industry dealt with the phaseout of CFC's in the mid-1990's.
• If the Kyoto protocol were ratified, the industry would possibly have to convert to refrigerants with reduced global warming potential.
• Some of the companies involved in manufacturing this equipment have parent companies which own divisions which have been subject to energy standards of other products.</td></tr>
<tr><td>Status of Test Procedures</td><td>Various Test Procedures for Compressors and Condensing Units, depending on compressor and heat rejection type.</td></tr>
<tr><td>Other Regulatory Actions</td><td>Not known.</td></tr>
<tr><td>Evidence of Market-Driven or Voluntary Efficiency Improvements</td><td>Not known.</td></tr>
<tr><td>Issues</td><td>• Significant product variety.
• Systems are often engineered and built on-site (not factory-completed).</td></tr>
</table>

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[16] "Energy Savings Potential for Commercial Refrigeration Equipment," ADL for DOE, June 1996. Table 5-23, row 13. Includes Floating Head Pressure, Ambient Subcooling, Evaporator Fan Shutdown, Brushless DC Evaporator and Condenser Fan Motors. Payback period in years based on medium energy cost locations (7.82¢/kWh).

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1995)	0.096	ADL/DOE Refrigeration Study, 1996
Unit Energy Consumption (kWh)	16,200	Divide energy use by installed base
Annual Shipments (millions, 1995)	0.02	30,000 Walk-In Sales [ADL/DOE Refrigeration Study, 1996] Distribution of sales by type proportional to installed base distributions. A larger number of Walk-In Refrigeration systems are sold for replacement.
Installed Base (millions, 1995)	0.54	ADL/DOE Refrigeration Study, 1996.
Product Lifetime (years)	12 to 25	Insulated Box: ADL/DOE Refrigeration Study, 1996.
	8 to 12	Refrigeration Systems: ADL/DOE Ref. Study, 1996.
Minimum Efficiency Standard	N/A	Appropriate Efficiency Definitions have not been defined for Walk-In Coolers.
Stock Efficiency	N/A	
Typical New Efficiency	N/A	
Best Available Efficiency	N/A	
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	N/A	

Standards Consideration

Product: Walk-In Freezers and Combination Cooler/Freezers

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	Combination of Energy Saving Options = 0.35[17]
Product / Technology Availability (Including Price/Cost information):	Technology / Payback Period[17] / Tech. Maturity / Peak Load Impact Floating Head Pressure / 0.3 year / New / Low Ambient Subcooling / 1.7 years / New / Medium Evap Fan Shutdown / 0.7 to 2 years / New / Medium Brushless DC Fan Motors / ~1 year / New / High External Heat Rejection / 7 years / New / High Hot Gas Defrost / 1.8 years / Current / High
Cumulative Burden	• The industry dealt with the phaseout of CFC's in the mid-1990's. • If the Kyoto protocol were ratified, the industry would possibly have to convert to refrigerants with reduced global warming potential. • Some of the companies involved in manufacturing this equipment have parent companies which own divisions which have been subject to energy standards of other products.
Status of Test Procedures	Various Test Procedures for Compressors and Condensing Units, depending on compressor and heat rejection type.
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	Not known.
Issues	1. Significant product variety. 2. Systems are often engineered and built on-site (not factory-completed).

[17] "Energy Savings Potential for Commercial Refrigeration Equipment," ADL for DOE, June 1996. Table 5-24, row 13. Includes External Heat Rejection, Hot Gas Defrost, Evaporator Fan Shutdown, Brushless DC Evaporator and Condenser Fan Motors. Payback period in years based on medium energy cost locations (7.82¢/kWh).

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1995)	0.086	ADL/DOE Refrigeration Study, 1996
Unit Energy Consumption (kWh)	21,400 Freezers 30,200 Combo	Divide energy use by installed base.
Annual Shipments (millions, 1995)	0.02	30,000 Walk-In Sales [ADL/DOE Refrigeration Study, 1996] Distribution of sales by type proportional to installed base distributions.
Installed Base (millions, 1995)	0.275 Freezers 0.065 Combo	ADL/DOE Refrigeration Study, 1996
Product Lifetime (years)	12 to 25	Insulated Box: ADL/DOE Refrigeration Study, 1996
	8 to 12	Refrigeration Systems: ADL/DOE Ref. Study, 1996
Minimum Efficiency Standard	N/A	Appropriate Efficiency Definitions have not been defined for Walk-In Freezers and Combination Freezer/Coolers.
Stock Efficiency	N/A	
Typical New Efficiency	N/A	
Best Available Efficiency	N/A	
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	N/A	

Test Procedure Summary

Product: Walk-In Coolers, Freezers, and Combination Cooler/Freezers

Factors	Assessment
Test Procedure Overview	• No applicable test procedures for complete walk-in refrigeration systems • Test procedures for condensing units which would serve walk-in refrigeration generally focus on capacity at design conditions rather than energy use. • An example of a test standard for a refrigeration system component is ARI Standard 460-2000, “Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.” Reporting for this standard includes reporting of condenser fan power. The standard’s focus is evaluation of capacity and power input during 100% run of an air-cooled condenser. The standard rating condition for this test procedure involves 95oF entering air temperature.
Future/Potential Test Procedure(s)	• Application of energy standards to walk-in refrigeration is complicated by (1) the range of combinations of insulated box and condensing unit actually used in the field and (2) the importance of field installation to overall energy use. • Energy test procedures should focus on individual components, such as the condensing units and/or the insulated boxes.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• Typical standard rating conditions apply to operating conditions more energy intensive than average typical conditions. For example, the 95oF entering air temperature for ARI Standard 460 mentioned above certainly exceeds a typical average. • Furthermore, the standard does not take into consideration the fact that the system is not operating at 100% capacity at all times. A condenser fan would cycle to maintain a head pressure, thus resulting in less fan power. Or, the condenser fan would run continuously, thus allowing very low condensing conditions during low ambient temperatures. This latter scenario would result in significant reduction in compressor power.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Correlation of peak load impact with typical test procedures would be good, since test procedures generally do not address part load operation.

Standards Consideration

Product: Water Coolers

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	Combination of Energy Saving Options = 0.26[18] ENERGY STAR® = 0.24
Product / Technology Availability (Including Price/Cost information):	Payback Period Ranges for High Insulation Value, Energy Efficient Compressors, Better Thermal Bond between coil and evaporator, and Storage Coil Redesign range from 2 to 10 years.[18]
Cumulative Burden	• The industry dealt with the phaseout of CFC's in the mid-1990's. • If the Kyoto protocol were ratified, the industry would possibly have to convert to refrigerants with reduced global warming potential.
Status of Test Procedures	• ASHRAE 18-1987 (R1997) CSA C815-99, based on ASHRAE 18, includes both pulldown and standby impacts.
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	ENERGY STAR® Program, Penetration for first year of program will be reported to EPA shortly.
Issues	

[18] "Characterization of Commercial Building Appliances," ADL, June 1993, Table 5-28 Includes High Insulation Value, Energy Efficient Compressors, Better Thermal Bond between coil and evaporator, Improved motor efficiencies, and Storage Coil Redesign. Payback period in years based on medium energy cost locations (7.82¢/kWh).

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1992)	0.043	ADL/DOE Commercial Appliance Study, 1993.
Unit Energy Consumption (kWh)	657	Divide energy use by installed base.
Annual Shipments (millions, 1998)	1.0	Census Data (1998).
Installed Base (millions, 1992)	6.03	ADL/DOE Commercial Appliance Study, 1993.
Product Lifetime (years)	10	
Minimum Efficiency Standard	N/A	
Stock Efficiency	2.19 kWh/day	Assume same as typical new.
Typical New Efficiency	2.19 kWh/day	Hot/Cold bottle units. Based on EPA data.
Best Available Efficiency	N/A	
ENERGY STAR® Efficiency	1.2 kWh/day	Hot/Cold bottle units. (www.EnergyStar.com)
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	N/A	

Test Procedure Summary

Product: Water Coolers

Factors	Assessment
Test Procedure Overview	•ASHRAE Standard 18-1987 (R1997) is the basis of water cooler test standards. However, this standard does not provide much detail regarding test conditions (ambient and water inlet and outlet temperatures are not specified), and is focused on capacity testing rather than energy testing. •The EPA ENERGY STAR® test is based on ASHRAE 18 with the following clarifications. • Only energy use to maintain water temperatures is measured. No draw of water during the •test. • Test period 24 hours. • Ambient temperature 75 +/- 2°F. • Cold Water Temperature not more than 50°F, Hot water not less than 165°F. • The proposed Canadian test standard, also based on ASHRAE 18, includes both energy associated with water cooling/heating and standby loss. This standard also uses different temperatures and specifies water inlet temperatures for water coolers connected to city water lines.
Future/Potential Test Procedure(s)	It is not very likely that alternative test procedures will be developed. In any case, all future test procedures will likely be based on the ASHRAE procedure.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• The EPA test procedure's emphasis on just standby energy use probably captures most of the energy use associated with water coolers. • The ambient temperature of 75°F used in the EPA test is appropriate for most applications.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	• Peak load impact of Energy Efficient Compressors, Better Thermal Bond Between Coil and Evaporator, and Storage Coil Redesign are high, while peak load impact of High Insulation Value is Low. • The EPA ENERGY STAR® test procedure is not a good indicator of peak load, because it includes only standby energy use. The test's ambient temperature of 75°F is only slightly lower than expected typical temperatures for water coolers for peak load conditions. • The ARI test procedure correlates better with peak power demand, as the 90°F ambient air temperature and the 90°F inlet water temperature both correspond to a hot, summer day.

Standards Consideration

Product: Commercial Clothes Dryers, Gas

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Humidity Sensor = 0.40 • Modulating = 0.81
Potential Economic Benefits/Burdens	Not available.
Potential Environmental or Energy Security Benefits	Specific estimates of emission reductions have not been developed however, estimated energy savings indicated above are indicative of the comparative emission benefits that are likely to be possible.
Status of Test Procedures	Energy Factor (EF) measure according to Code of Federal Regulations (CFR) Pt. 430, Subpt. B App D.
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• There is no ENERGY STAR® program for clothes dryers. • Due to lack of standards, market-driven efficiency gains occur when coincident with convenience and quality improvements (e.g., shorter cycle time resulting from modulation).
Issues	• CFR EF test does not accurately account for sensor systems (e.g., humidity). • Humidity sensors are rare in laundromats because coin-operated dryer operating times depend upon the amount of operating time purchased rather than dryness (humidity) of the clothing.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1990)	0.122	ADL/DOE Commercial Appliance Study, 1993.
Unit Energy Consumption (MMBtu)	72	ADL/DOE Commercial Appliance Study, 1993.
Annual Shipments (millions)	0.113	ADL/DOE Commercial Appliance Study, 1993.
Installed Base (millions)	1.7	ADL/DOE Commercial Appliance Study, 1993.
Product Lifetime (years)	15	ADL/DOE Commercial Appliance Study, 1993.
Minimum Efficiency Standard	N/A	No Federal minimum.
Stock Efficiency	Unknown	
Typical New Efficiency	1.0	Normalized to typical new, per Office of Building Technology, State and Community Programs (BTS) (2000).
Best Available Efficiency	Unknown	Small efficiency differences expected for commercial gas clothes dryers.
ENERGY STAR® Efficiency	N/A	No ENERGY STAR® program
Maximum Efficiency (Future Technology)	1.43	Modulation burner (ADL, 2001) with performance normalized to “typical new” per BTS (2000)
Other Notable Efficiency Level	N/A	

Test Procedure Summary

Product: Commercial Clothes Dryers, Gas

Factors	Assessment
Test Procedure Overview	• Clothes dryer efficiency is measured as Energy Consumed / load as follows: Energy Consumed (kWh) = [66 / moisture removed (lbs.)] x FU x **[** Electric Energy Supplied (kW-hr) + Gas Energy Consumed / 3412 (Btu/hr) + Total Annual Pilot Energy Consumed / (416 x 3412) (kWh) **]** • 66 is an experimentally established value for the percent reduction in the moisture content; FU is the Field Use factor, it equals 1.18 for Time Termination and 1.04 for Automatic Termination; 416 is the number of cycles per year; 3412 is the conversion from Btu/hr to kWh. • A standard load consists of 7 lbs. of test cloth; a compact size dryer uses 3 lbs. of test cloth. • Test cloth is moistened with 100°F water containing 0-17 ppm hardness water; is extracted until the moisture content is between 66.5 and 73.5 % of the bone-dry weight. • Bone dry is defined as the weight of the cloth after it has not changed weight more then 1% following a ten minute dry cycle. • The ambient test conditions must be 75°F and 50% relative humidity.
Future/Potential Test Procedure(s)	• A test procedure to compare automatic termination control is needed since most new products include such devices. • Pilot light energy consumption may not be accounted for correctly in current standard (for older machines; current machines cannot have a pilot).
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• The accuracy of the annual energy consumption is dependant on the accuracy of the estimate of 419 dryer loads per year and the assumptions made in the derivation of the constant 66 in the formula. • Test procedure requires the use of Time Termination if it is available. Clothes are dried until the moisture content is between 2.5-5% of the bone dry weight. It is unrealistic to measure actual energy consumption by drying clothes to a precise condition. • The Field Use factor is general and does not indicate variations in automatic cycle termination controls, i.e. not all moisture sensors work the same yet they all qualify for an FU of 1.04.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	• Test procedure does not identify design impact on peak demand. • Automatic cycle termination does not impact peak load of the device, but does reduce the amount of time spent at peak load by reducing over-drying. • Modulation increases the peak load; however it reduces the duration of the peak load as well as the overall drying time.

Standards Consideration

Product: Commercial Clothes Washers

Factors for	Assessment	
	Family Sized	**Industrial Sized**
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• ENERGY STAR® (MEF=1.26) = 0.27[19] • Horz. Axis, MEF=2.0 = 0.46[19] • Soil Sensor = Insufficient Data[19, 20]	• Soil Sensor = Insufficient Data[20] • Ozone = 0.26
Product / Technology Availability (Including Price/Cost information):	• Horizontal-axis family-sized washers have come to market. • Five (5) family-sized commercial washer models have an MEF >=2.0; more than 25 have a MEF>1.80.	• Many large-capacity commercial clothes washers are horizontal axis machines, as the high utilization makes the first-cost premium affordable.
Cumulative Burden	• No minimum energy efficiency standard exists for large capacity commercial clothes washers. • The residential clothes dryer has seen no regulations, however, residential clothes washers are on an efficiency improvement plan with milestones in `04 and `07. •Many commercial clothes washer manufacturers make other "white" goods that have minimum energy efficiency standard: Residential dishwashers in the process of starting a standards review (effective date of implementation ~2005); Residential refrigeration standards were set in 1990,1993, and in 2001 •In March 2001, a broad cross-section of consumer advocacy organizations petitioned DOE to reconsider its new energy conservation standards for clothes washers.	
Status of Test Procedures	Energy Factor (EF) test changed to the Modified Energy Factor (MEF) test to account for remaining moisture content at end of cycle. EF and MEF measured according to CFR Pt. 430, Subpt. B, App J & J1	
Other Regulatory Actions	Not known.	
Evidence of Market-Driven or Voluntary Efficiency Improvements	ENERGY STAR® minimum MEF=1.26 and is only for family sized units.	No ENERGY STAR® Program or Federal Minimum.
Issues	•No Federal standards exist. ENERGY STAR® program applied to family-sized commercial units only. •Accounting for remaining moisture content (RMC) has been resolved. •CFR Test does not account for energy savings resulting from soil sensors because CFR test uses clean cloth. •Few reliable sources of information on energy and water consumption of commercial washers since there are no DOE testing requirements. (CEE, 1988)	

[19] Data is based on commercial family sized units only. Savings based on baseline MEF = 1.0.

[20] Soil sensor effectiveness under all conditions is unclear (Meier, 1998).

Background Material

Description	Value		Comments/Source	
	Family	**Indust.**	**Family Sized**	**Industrial Sized**
Total Energy Use (quads, 1990)	0.035	0.019	ADL/DOE Commercial Appliance Study, 1993	
Unit Energy Consumption (kWh)	2451	Unknown	ADL/DOE 1993	
Annual Shipments (millions)	0.265	Unknown	CEE (1998)	
Installed Base (millions)	1.3	Unknown	ADL/DOE 1993	
Product Lifetime (years)	10	8	CEE (1998)	ADL/DOE 1993
Minimum Efficiency Standard	N/A	N/A	No Federal minimum.	
Stock Efficiency	Unknown	1		Assumed same as typical new.
Typical New Efficiency	MEF=1.04	1	Vertical Axis; FEMP (2000)	Horizontal Axis (performance normalized to “typical new”); BTS (2000)
Best Available Efficiency	MEF=2.0	Unknown	Horizontal Axis; FEMP (2000)	Little room for improvement over horz. axis machine expected
ENERGY STAR$^{\circledR}$ Efficiency	MEF=1.26	N/A	www.EnergyStar.gov	
Maximum Efficiency (Future Technology)	MEF=2.0	3.2	Horizontal Axis; FEMP (2000)	Ozone washers (performance normalized to “typical new”); ADL/DOE (1993)

Test Procedure Summary

Product: Commercial Clothes Washers

Factors	Assessment
Test Procedure Overview	Modified Energy Factor MEF = Capacity [ft³] / (Machine Electrical Energy Consumption (weighted per cycle) [kWh] + Water Energy Consumption (weighted per cycle) [kWh] + Energy Consumption for removal of Remaining Moisture Content RMC (per cycle) [kWh] • A test load is determined based on the capacity of the test unit • Modified Energy Factor accounts for remaining moisture content (RMC) Energy test cloth is used for no more than 25 cycles. • Measurements are made over full arrange of operation temperatures (extra hot, hot, warm, and cold) and fill levels (maximum, average, and minimum fill). • Temperature Use Factors (TUF) and Load Use Factors account for various water temperatures and fill levels as well as manual and adaptive fill control systems.
Future/Potential Test Procedure(s)	• CFR 10 Pt. 430, Subpt. B, App. J1 will be used for determining compliance with standards set beginning 1/1/2004. • For Family-Sized residential washers only, on July 27, 2000, all manufacturers of residential clothes washers sold in the United States joined several energy conservation advocacy organizations and utilities in submitting to DOE a Joint Stakeholders Comment (Joint Comment), endorsing new standards for clothes washers. These standards would require a 22 percent increase in efficiency by 2004 and a 35 percent increase by 2007 above the standards currently in effect.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• App. J1 is more realistic since it incorporates test procedures to include different water temperatures. • There are many factors in the calculations and derived results from test measurements that are estimated for means of product comparison. Estimates may effect annual usage figures. • For Family-Sized washers only, DOE accepts waivers for systems that cannot be tested appropriately under the J1 guidelines. The manufacturer must supply an acceptable test procedure for that clothes washer.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	• Test procedure does not identify design impact on peak demand, only total energy consumption; furthermore, water heating energy consumption often occurs off-peak and/or via non-electric water heating means (oil, gas) which do not impact peak electric demand. • The MEF metric of the test procedure takes into account additional moisture extracted by the washers that reduces the energy consumed by the dryer, also reducing the peak demand impact of electric dryers.

Standards Consideration

Product: Gas Duct Furnace

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Power Vent (E_t = 82%) = 0.13[21] • Pulse Combustion (E_t = 90%) = 0.16[21] • Condensing (E_t = 93%) = 0.30[21]
Product / Technology Availability (Including Price/Cost information):	• The installed cost of duct furnaces varies by the type of unit and by capacity. The smallest units (150MBtu) cost approximately four times more (USD per Btu) than the largest units (500MBtu). • On average, units in the best-selling size range (400-500MBtu) cost ~$8/MBtu, installed (GRI, 1997)
Cumulative Burden	Gas duct furnace manufacturers often make unit heater products, which fall under many building codes (e.g., via ASHRAE 90.1); some manufacturers make commercial roof-top air-conditioning products, which have minimum energy efficiency levels.
Status of Test Procedures	Efficiency is primarily stated as steady-state thermal efficiency (see ANSI Z83.9). Any references to seasonal efficiencies use annual fuel efficiency utilization (AFUE) (see ANSI/ASHRAE Standard 103).
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	Power vented units account for a significant fraction of unit sales.
Issues	Gas Duct Furnaces currently fall under ASHRAE 90.1-1999.

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[21] E_t is steady-state thermal efficiency as defined by ANSI Z83.9 test procedure. Savings based on baseline typical efficiency (E_t) of 80%.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1998)	0.10	GRI-97/0100
Unit Energy Consumption (MMBtu)	420	Divided total energy use by installed base.
Annual Shipments (millions, 1995)	0.016	GRI-97/0100 (Gas Research Institute).
Installed Base (millions, 1997)	0.24	Average based on shipments and lifetime.
Product Lifetime (years)	15 - 20	GRI-97/0100; estimated average accounting for geographical variations and capacity.
Minimum Efficiency Standard	74% / 78% *	Steady-state thermal efficiency at Min./Max. capacity (ASHRAE 90.1-1999).
Stock Efficiency	78%	AFUE; ADL, 2001 (Commercial HVAC vol.1), GRI (1995)
Typical New Efficiency	78%	AFUE; ADL, 2001 (Commercial HVAC vol.1)
Best Available Efficiency	93%	AFUE; Condensing, GRI (1997)
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	82%	AFUE; Power vented, improved heat transfer.

* As of October 29, 2001, ASHRAE 90.1-1999 indicate a minimum combustion efficiency (i.e., 100% minus flue losses) of 80%.

Test Procedure Summary

Product: Gas Duct Furnace

Factors	Assessment
Test Procedure Overview	•All measurements are taken during standardized, full-load, steady-state operation of the heater. • Measure inlet and outlet air temperatures. • Measure flue gas temperature, CO2 concentration, and condensate rate. • Based on the above measurements and the measured heating value in the fuel, calculate percent of energy lost (in the form of water vapor, unburned fuel, and warm air) through the flue to the outdoor air (called "%flue loss"). • Calculate the thermal efficiency of the duct furnace, equal to 100% - %flue loss. • Calculate jacket losses, the energy lost through the body of the heater, using measured temperatures of the outermost furnace surface and the temperature of the ambient air.
Future/Potential Test Procedure(s)	There are no known new test procedures being developed for gas duct furnaces.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	The test procedure accurately measures thermal (or combustion) efficiency for duct furnaces operating under full-load and steady-state conditions. However, thermal efficiency measured under these conditions does not fully indicate the actual annual energy consumption of duct furnaces. First, the test procedure only measures a duct furnace's full-load steady-state efficiency and does not indicate how well the heater performs during "warm-up" and "cool-down" operation nor during part-load operation (when the airflow through the furnace is reduced). Second, the jacket loss calculations are based on empirical correlations, not measured directly, and may be slightly inaccurate. Third, duct furnaces are primarily used to heat air in an occupied space to temperatures that are comfortable, but "thermal efficiency" does not indicate how effectively the heater distributes its warm air to keep the space comfortable.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Negligible (natural gas energy dominates gas duct furnace annual energy consumption, and the furnaces almost never operate during periods of peak electricity demand).

Standards Consideration

Product: Gas Unit Heaters

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Power Vent (E_t = 82%) = 0.59[22] • Pulse Combustion (E_t = 90%) = 0.72[22] • Condensing (E_t = 93%) = 1.3[22]
Product / Technology Availability (Including Price/Cost information):	• The installed cost of unit heaters varies by the type of unit and by capacity. The smallest units (25MBtu) cost approximately four times more (USD per MBtu) than the largest units (500MBtu). • Standard (Typical) units are widely available in sizes between 25MBtu and 500MBtu, with an installed cost of ~$8/MBtu for the best-selling size range (250-375MBtu). • Power-vented units are widely available in sizes between 25MBtu and 500MBtu, with an installed cost of ~$10/MBtu for the best-selling size range (250-375MBtu). • Pulse-combustion units are available in sizes between 25MBtu and 500MBtu, with and installed cost of ~$18/MBtu for the best-selling size range (250-375MBtu). Condensing units are manufactured by one major manufacturer and are available in three sizes (225 MBtu, 300MBtu, and 400 MBtu). While available in the U.S. since 1999, condensing units are primarily marketed in Europe. The list price of the 300MBtu unit is currently ~$5,500 ($18.25/MBtu). Estimating the installation cost as 25% of list price gives a total installed cost estimate of ~$23/MBtu.
Cumulative Burden	Gas unit heater manufacturers often make duct furnace products, which fall under many building codes (e.g., via ASHRAE 90.1); some manufacturers make commercial roof-top air-conditioning products, which have minimum energy efficiency levels.
Status of Test Procedures	Efficiency is primarily stated as steady-state thermal efficiency (see ANSI Z83.9). Any references to seasonal efficiencies use AFUE (see ANSI/ASHRAE Standard 103).
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• Power Vent: 15% market share (circa 1995) • Pulse Combustion: 0.6% market share (circa 1995) • Condensing Units only beginning commercial availability (circa 1999)
Issues	Gas unit heaters currently fall under ASHRAE 90.1-1999.

[22] E_t is steady-state thermal efficiency as defined by ANSI Z83.9 test procedure. Savings based on baseline typical efficiency (E_t) of 80%.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1998)	0.54	GRI-97/0100 and ADL (2001).
Unit Energy Consumption (MMBtu)	170	Divided total energy use by installed base.
Annual Shipments (millions, 1995)	0.14	GRI-97/0100.
Installed Base (millions, 1995)	3.3	GRI-97/0100.
Product Lifetime (years)	17 - 26	GRI-97/0100; estimated average accounting for geographical variations and capacity.
Minimum Efficiency Standard	75% / 78% *	Steady-state thermal efficiency at Min./Max. capacity (ASHRAE 90.1-1999).
Stock Efficiency	70%	AFUE; ADL, 2001 (Commercial HVAC vol.1), GRI (1995).
Typical New Efficiency	78%	AFUE; ADL, 2001 (Commercial HVAC vol.1).
Best Available Efficiency	93%	AFUE; Condensing, GRI (1997) .
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	82%	AFUE; Power vented, improved heat transfer.

* As of October 29, 2001, ASHRAE 90.1-1999 indicates a minimum combustion efficiency (i.e., 100%minus flue losses) of 80%.

Test Procedure Summary

Product: Gas Unit Heaters

Factors	Assessment
Test Procedure Overview	All measurements are taken during standardized, full-load, steady-state operation of the heater. • Measure inlet and outlet air temperatures. • Measure flue gas temperature, carbon dioxide concentration, and condensate rate. • Based on the above measurements and the measured heating value in the fuel, calculate percent of energy lost (in the form of water vapor, unburned fuel, and warm air) through the flue to the outdoor air (called "%flue loss"). • Calculate the thermal efficiency of the duct furnace, equal to 100% - %flue loss. • For unit heaters installed indoors, jacket losses are not considered since the energy "lost" by the jacket goes into the space being heated.
Future/Potential Test Procedure(s)	There are no known new test procedures being developed for oil unit heaters.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	The test procedure accurately measures thermal (or combustion) efficiency for unit heaters operating under full-load and steady-state conditions. However, thermal efficiency measured under these conditions does not fully indicate the actual annual energy consumption of unit heaters. First, unit heaters have fans (or some other type of air-mover) built in to the unit that consume electricity but are not covered under the current testing procedure. Second, the test procedure only measures a unit heater's full-load steady-state efficiency and does not indicate how well the heater performs during "warm-up" and "cool-down" operation nor during part-load operation (when the dampers are partially closed or if the fan operates at partial speeds). Lastly, unit heaters are primarily used to heat air in an occupied space to temperatures that are comfortable, but "thermal efficiency" does not indicate how effectively the heater distributes its warm air to keep the space comfortable.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Negligible (natural gas energy dominates gas unit heater annual energy consumption, and the heaters almost never operate during periods of peak electricity demand).

Standards Consideration

Product: Oil Unit Heaters

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; **Cumulative (Quads) 2008-2030**	• Power Vent (E_t = 84%) = 0.006[23, 24] • Pulse Combustion (E_t = 90%) = 0.008[23, 24] • Condensing (E_t = 93%) = 0.015[23, 24]
Product / Technology Availability (Including Price/Cost information):	• Oil unit heaters cost between 8-10$US/MBtu depending on capacity (GRI, 1997) • Currently, only standard gravity vented ("low-tech") models are available for oil-fired unit heaters. No manufacturer was found that markets a "higher-efficiency" model.
Cumulative Burden	Oil unit heater manufacturers often make other products (gas duct furnace, gas unit heaters), that fall under many building codes (e.g., via ASHRAE 90.1); some manufacturers also make commercial roof-top air-conditioning products, which have minimum energy efficiency levels.
Status of Test Procedures	Efficiency is primarily stated as steady-state thermal efficiency (see underwriters Labor Law (UL) Standard 731). Any references to seasonal efficiencies use AFUE (see ANSI/ASHRAE Standard 103).
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• Market share of power vented, pulse combustion, and condensing units approaches 0%.
Issues	Oil Unit heaters currently fall under ASHRAE 90.1-1999.

[23] E_t is steady-state thermal efficiency. Savings based on baseline typical efficiency (E_t) of 82%.

[24] Without existing oil-fired unit heaters in these categories, the thermal efficiency values for potential improvements are estimated to be the same as for gas-fired unit heaters.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1998)	0.006	GRI-97/0100 and ADL (2001).
Unit Energy Consumption (MMBtu)	215	Divided total energy use by installed base.
Annual Shipments (millions, 1995)	0.001	GRI-97/0100.
Installed Base (millions, 1995)	0.03	GRI-97/0100.
Product Lifetime (years)	13.7	GRI-97/0100; estimated average accounting for capacity variations.
Minimum Efficiency Standard	81% / 81% *	Steady-state thermal efficiency at Min./Max. capacity (ASHRAE 90.1-1999).
Stock Efficiency	82%	Steady-state thermal efficiency; Same as typical new efficiency.
Typical New Efficiency	82%	Steady-state thermal efficiency; Average of six available models (Modine and Reznor).
Best Available Efficiency	84%	Steady-state thermal efficiency; Modine model POR-100.
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	N/A	

* As of October 29, 2001, ASHRAE 90.1-1999 indicates a minimum combustion efficiency (i.e., 100%minus flue losses) of 80%.

Test Procedure Summary

Product: Oil Unit Heaters

Factors	Assessment
Test Procedure Overview	All measurements are taken during standardized, full-load, steady-state operation of the heater. • Measure inlet and outlet air temperatures. • Measure flue gas temperature, carbon dioxide concentration, and condensate rate. • Based on the above measurements and the measured heating value in the fuel, calculate percent of energy lost (in the form of water vapor, unburned fuel, and warm air) through the flue to the outdoor air (called "%flue loss"). • Calculate the thermal efficiency of the duct furnace, equal to 100% - %flue loss. • For unit heaters installed indoors, jacket losses are not considered since the energy "lost" by the jacket goes into the space being heated.
Future/Potential Test Procedure(s)	There are no known new test procedures being developed for oil unit heaters.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	The test procedure accurately measures thermal (or combustion) efficiency for unit heaters operating under full-load and steady-state conditions. However, thermal efficiency measured under these conditions does not fully indicate the actual annual energy consumption of unit heaters. First, unit heaters have fans (or some other type of air-mover) built in to the unit that consume electricity but are not covered under the current testing procedure. Second, the test procedure only measures a unit heater's full-load steady-state efficiency and does not indicate how well the heater performs during "warm-up" and "cool-down" operation nor during part-load operation (when the dampers are partially closed or if the fan operates at partial speeds). Last, unit heaters are primarily used to heat air in an occupied space to temperatures that are comfortable, but "thermal efficiency" does not indicate how effectively the heater distributes its warm air to keep the space comfortable.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Negligible (oil energy dominates gas unit heater annual energy consumption, and the heaters almost never operate during periods of peak electricity demand).

Standards Consideration

Product: Exit Signs

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	•14 W Maximum = 0.06[25] • 1 W Maximum = 0.4125 • 5 W Maximum (ENERGY STAR®) = 0.31[25] • 3.5 W Maximum = 0.35[25]
Product / Technology Availability (Including Price/Cost information):	• Light emitting diode (LED) exit signs are readily available - ENERGY STAR® has more than twenty certified manufacturers. • 10-year total ownership costs for LED signs are $65 compared to $380 for incandescent sign. • Price for plastic LED sign without battery backup is $40 compared to $25 for comparable incandescent sign. • FEMP provides a table of exit sign lighting options, these include: • LED signs: $22 initial purchase, $5 annual operating Incandescent: $6 initial purchase, $42 annual operating
Cumulative Burden	• California may implement a standard that specifies a 5 W per face maximum. • The proposed efficiency standards will be reissued on November 6, 2001. • The adoption hearing will take place in January 2002. • Some states banned incandescent lamps from exit signs in the 1990's. Although not energy related, exit sign manufacturers must comply with strict performance and safety standards for this product contained in building codes administered from the state to the local level.
Status of Test Procedures	• Other specifications for Exit Signs include visibility (letter size and spacing, luminance contrast, luminance) and reliability (warranty, backup power source). • The EPA has ENERGY STAR® Program Requirements for Exit Signs. Other standards bodies include NFPA, UL, US OSHA, BOCA, and the Uniform Building Code published by the International Conference of Building Officials.
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• The ENERGY STAR® program has 22 certified manufacturers. • FEMP recommends the ENERGY STAR® guideline. Exit signs are identified as one of the top three highest potential energy efficiency technologies for market transformation, including energy savings potential, cost savings, and likelihood of successful market transformation (American Council for Energy Efficient Economy) (ACEEE) report, 1998).
Issues	Codes from all types of jurisdictions require regular exit sign inspection, despite predicted lamp life.

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[25] Savings based on a baseline consumption of 15 W where 75% of installed based are 15 W exit signs.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1998)	0.05	ADL Draft US Lighting Report - Phase I Inventory, 2001.
Unit Energy Consumption (kWh)	143.5	Based on stock efficiency.
Annual Shipments (millions)	1.35	ACEEE, 2001. Calculated for 2000 using 1994 data, assuming 2% growth.
Installed Base (millions)	29.5	ADL Draft US Lighting Report - Phase I Inventory, 2001.
Product Lifetime (years)	25	Incandescents: 2-20 years. Fluorescents: 1-2 years. LEDs: 25 years Various product specifications sheets.
Minimum Efficiency Standard	5 W per face in CA	CEC, 2001 (effective July 2002).
Stock Efficiency	16.4 W	Weighted average of installed base. ADL Draft US Lighting Report - Phase I Inventory, 2001.
Typical New Efficiency	9 - 40 W	Incandescent and compact fluorescent light (CFL) from Hubbell, Lithonia, Noralighting, and Chloride product specification sheets.
Best Available Efficiency	0.9 - 3.5 W	LED exit signs from Hubbell and Chloride Specification sheets.
ENERGY STAR® Efficiency	5 W or less per face	EPA, 2001.
Maximum Efficiency (Future Technology)	< 1 W	Electroluminescent and some LED panels already use 1 W or less. Photoluminescent materials require zero electrical energy input.

Test Procedure Summary

Product: Exit Signs

Factors	Assessment
Test Procedure Overview	• ENERGY STAR® and the proposed California Energy Commission *Amendments to Title 20 Energy Efficiency Standards* give the same testing method guidelines for exit signs. • Prior to measurement, the exit sign shall be operated at the rated input voltage for 100 hours. • • Input power shall be measured with an appropriate True RMS W Meter. • Each of the photometric characteristics of the sign shall be measured at three voltages: • Rated input voltage which represents normal operation, • Voltage corresponding to the minimum voltage provided either by the internal battery or a remote emergency power source, and • Voltage corresponding to the minimum voltage provided by the internal batter after the marked rated operating time or at 87.5% of the rated emergency input voltage. • Luminance measurement positions • "Measurement of Exit Sign Luminance," NFPA 101, *Life Safety Code.* • "Directional Indicator Luminance Measurement Points," ANSI/UL 924, *Standard for Safety: Emergency Lighting and Power Equipment*, May 9, 1995.
Future/Potential Test Procedure(s)	No issues to mention at this time.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• An exit sign must be operated for 100 hours before testing, enabling the power system to stabilize. Lumen output may be higher at testing time than at the average life of the light source, which will occur after at least 3000 hours of operation. • Exit signs operate 24 hours per day; so duty cycle and the per-fixture installed savings potential can be accurately determined. There is some uncertainty around the installed base in the U.S., which affects the Quad savings calculation.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Because exit signs operate 24 hours per day, the peak load impact is proportional to the power draw measured under the test standard.

Standards Consideration

Product: Torchieres

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Wage Limit set at 190 W = 0.83[26] • Wage Limit set at 70 W = 1.7[26]
Product / Technology Availability (Including Price/Cost information):	• Product is primarily directed toward the residential sector. • Readily available at retail outlets for homewares. • Utilities have sponsored turn-in and rebate programs for halogen torchieres. • Most halogen or incandescent torchieres retail for less than $20, while non-subsidized CFL torchieres typically cost in the range of $30 to $50 (CWEB, 2000).
Cumulative Burden	• California will implement state-wide maximum Wage of 190 W on fixtures, approved in February 2002. • Although not mandated, many manufacturers are responding to the combination of safety concerns and high energy consumption, by installing safety measures such as lower Wage bulbs and protective cages to avoid materials coming into contact with the bulb.
Status of Test Procedures	• No test procedure for efficiency, although applicable measurement standards on efficacy, lamp life, color rendering, etc. do exist (EPA, 2001). These testing standards are promulgated by the Illuminating Engineering Society of North America (IESNA), American National Standards Institute (ANSI) and Institute of Electrical and Electronics Engineers (IEEE). • EPA has developed ENERGY STAR® Program Requirements for Residential Light Fixtures.
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• 190 W incandescent torchieres ~31% of market, CFL just under 5% of market. • DOE worked with Lawrence Berkeley National Laboratory (LBNL) to develop a CFL-based torchiere lamp (BTS, 2000). • Many universities (e.g., Brown, Harvard, Stanford, Yale) have banned halogen torchieres from dormitories for safety reasons (LBNL, 1999). • FEMP and several utilities around the country have sponsored “Torchiere Trade-in” schemes, where consumers swap their old halogen torchiere for a new CFL one (FEMP 1998; HE, 1999).
Issues	• Regulations should be considered across all sectors (e.g., not excluding residential) as this is primarily a residential sector product. • While not an energy efficiency regulation issue, regulations could lead to lower Wage lamps and may reduce fire risk.

[26] Savings based on a baseline consumption of 300 W. Savings estimates based on installed base remaining constant (i.e., no growth in sales). Greater savings will be realized if sales increase.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1997)	0.19	Assumes all installed units are 300 W halogen lamps (C. Calwell, 1998; BTS, 2000) and 3.9 hr. operation per day (ADL, 1998).
Unit Energy Consumption (kWh)	427	Based on halogen installed base. ACEEE, 1999; BTS, 2000; LBNL, 1999. Based on stock efficiency.
Annual Shipments (millions)	14	Halogen, 9; Incandescent: 4.5; CFL: 0.65. Calwell and Granda, 1999.
Installed Base (millions)	40	BTS, 2000.
Product Lifetime (years)	Fixture: 20	EPA assumption. CEC uses 12 years; ACEEE uses 10 years.
Minimum Efficiency Standard	CEC: 190 W	CEC has set a maximum Wage of 190W, effective July, 2002. UL (1996) set a maximum of 500W for UL listing.
Stock Efficiency	300 W	Installed base assumes all halogen.
Typical New Efficiency	Halogen: 300 W CFL: 65 W	Sales of halogen torchieres have been decreasing following fires. Move to lower Wage incandescent (< 190 W) or CFL (< 70 W).
Best Available Efficiency	50 W	BTS, 2000. One of seven CFL substitute lamps developed due to DOE initiative.
ENERGY STAR® Efficiency	~ 67 W	EPA 2001. Calculated using 60 lumen per W (lm/W) ENERGY STAR® specification (for fixture 24 inches and 30 W) and 4,000 lumen output (typical 300W Halogen).
Maximum Efficiency (Future Technology)	~40 W	Assume efficacy will improve to highest linear florescent tube (100 lm/W) and 4000 lumen demand.

Test Procedure Summary

Product: Torchieres

Factors	Assessment
Test Procedure Overview	• ENERGY STAR® requires testing using the methods in Table 1 for performance characteristics including input power and light output. • CEC proposed standards do not specify a test method for torchiere fixtures.
Future/Potential Test Procedure(s)	ENERGY STAR® states that there will potentially be revisions for durability testing that may include on-off cycling, voltage variations and current variations among other factors.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	The test procedures cover the two key energy efficiency metrics that represent energy consumption and the potential savings - input power and light output.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Test procedure and metric of energy input correlate highly with the peak load impact.

Table 1: Residential Indoor and Outdoor Lights: ENERGY STAR®

Performance Characteristic	**Reference standard for method of measurement**
Efficacy	
Light output	IESNA LM-9; LM-66
Input power	IESNA LM-9; LM-66; ANSI C82.2
Power factor	ANSI C82.11-3.3.1
Lamp current crest factor	ANSI C82.11-3.3.3
Lamp start time	ANSI C82.11-5.2
Lamp Life	IESNA LM-40; LM-65
Lamp Color Rendering	IESNA LM-58; LM-16
Lamp Correlated Color Temperature	IESNA LM-58; LM-16
Dimming	Use manufacturer protocol
Warranty	Use manufacturer protocol
Safety – Portable Fixtures	ANSI/UL 153
Safety – Hardwired Fixtures	UL 1598
Safety – Ballasts and “Fluorescent Adapters”	ANSI/UL 935; UL 1993
Ballast Frequency	IESNA LM-28
Transient Protection	IEEE C 62.41

Standards Consideration

Product: Traffic Signals

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; **Cumulative (Quads) 2008-2030**	• All Red Signals to LED = 0.3027 • All traffic signals to LED = 0.6027 • Red and Green Signals to LED = 0.4927 • Red and Green pedestrian to LED = 0.5927
Product / Technology Availability (Including Price/Cost information):	• Prices vary, but the first cost of a 12-inch red LED signal is approximately $125. Amber LED signals cost about $170 and green signals are about $250. Payback periods of 1 to 1.5 yrs (Delean, 1996), 1.5 to 3 yrs (Lundberg, 1997b), 4.5 yrs (Haussler, 1997), and 6 to 7 yrs (Vargas, 1994) have all been reported. The actual period will depend on electricity prices, unit costs, and possible financial incentives offered by utility or government organizations (Bullough et al., 2000). • Since LED signals first hit the market, prices have declined considerably and manufacturers believe this trend will continue. • ENERGY STAR® currently has 4 certified manufacturers.
Cumulative Burden	• California may implement a standard of 8-22 W, corresponding to signal type (e.g., red ball, green arrow, etc.). • The proposed efficiency standards will be reissued on November 6, 2001. • The adoption hearing will take place in January of 2002. • California, Minnesota, Texas, Ohio, and Oregon have standards pertinent to performance, visibility and use requirements of LED traffic signals (Bullough et al., 2000). • Although not related to energy consumption, traffic signals are subject to performance, visibility, electrical, and quality assurance requirements set forth by the Institute of Transportation Engineers (ITE).
Status of Test Procedures	• ITE has specifications for LED traffic signals which include chromaticity, luminous intensity, compatibility with load switches, QA, etc.. • EPA has ENERGY STAR® Program Requirements for Traffic Signals. • EPA is working with the ITE to develop the visibility requirements for LED yellow signals.
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• ENERGY STAR® program is less than one year old and has 4 certified manufacturers. • Consortium for Energy Efficiency (CEE) launched a similar program in January 2000 with 22 partner utilities around the U.S. Philadelphia was an early adopter, investing $2.33 million program to replace all 28,000 signals in the city. • LED Traffic signals may reach saturation soon simply because installation makes clear economic sense, especially in cases where utilities sponsor rebate programs.
Issues	

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[27] Savings based on a baseline of 99% incandescent and 1% LED.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1997)	0.04	ADL Draft US Lighting Report - Phase I Inventory, 2001.
Unit Energy Consumption (kWh)	11110	Per intersection, using installed base data.
Annual Shipments (millions)	1.15	Suozzo (ACEEE), 1998. Assumed annual replacements of 1/lifetime plus 2% growth.
Installed Base (millions)	9.6	ADL Draft US Lighting Report - Phase I Inventory, 2001.
Product Lifetime (years)	Incand.: 0.7 LED: 5 - 7	CEE, EPA ENERGY STAR®, and Dialight product spec sheets.
Minimum Efficiency Standard	N/A	There are specifications regarding safety (luminous intensity), power factor, voltage and circuitry, but not efficiency.
Stock Efficiency	150 W	Contrary to this 1997 value, it is very likely that lower Wage LEDs, especially red, are already at a much higher penetration.
Typical New Efficiency	Incand: 125,150 W LED: 10-22 W	ITE, 2001; ADL Draft Phase I, 2001; Dialight Corp., 2001.
Best Available Efficiency	6 - 13 W	Best available LED signals today are 7 W red, 9 W yellow and 11 W green (LedTronics, 2001).
ENERGY STAR® Efficiency	11 - 15 W	When the ITE approves yellow LED’s, EPA ENERGY STAR® will develop a criteria for yellow signals (EPA, 2001).
Maximum Efficiency (Future Technology)	3 - 7 W	LED efficacy expected to double over the next five years (Petrow, 2001).

Test Procedure Summary

Product: Traffic Signals

Factors	Assessment
Test Procedure Overview	• There is currently no test procedure that evaluates energy consumption of traffic signals; focus of test procedures has been product performance and safety. • The Institute of Transportation Engineers (ITE) is one of the authorities working directly with the US Department of Transportation in the regulation of transport-related technologies. • The ITE has established a test procedure to regulate safety and performance standards for traffic signals. This same test procedure can be applied to more efficient devices, as the new products must comply with the same minimum standards. • The ITE has a specification and test procedure outlined in their Vehicle Traffic Control Signal Heads (VTCSH) document. Section 2 and 2a are an interim draft for LED signal modules. • ENERGY STAR® products must meet the minimum performance requirements of the relevant ITE specification and be tested under the conditions presented in Section 6.4.2 of the VTCSH Part 2.
Future/Potential Test Procedure(s)	• Although yellow balls and arrows fall under the ITE specifications, compliant products have not yet been developed (ENERGY STAR® Program Requirements, 2001). ENERGY STAR® is working with ITE to revise the specifications. • ITE will add specifications for pedestrian and arrow signal modules.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• The test procedures do not cover power input, only power factor and other electrical characteristics. • Installed base and duty cycle for traffic signals is fairly well known, so the corresponding energy savings potential is reasonably accurate.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	• The peak power draw of traffic signals correlates directly with their impact upon peak. • The test procedures do not cover energy input; therefore, they do not correlate with the metric that indicates peak load impact.

Standards Consideration

Product: Ceiling Fans

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• ENERGY STAR® compliant (75 CFM/W) = 0.47 • Best Available Aerodynamic (131 CFM/W) = 1.1 • Aerodynamic and High-Efficiency Motor (260 CFM/W) = 1.6 • ENERGY STAR® compliant lighting (pin-based CFL) = 3.7
Product / Technology Availability (Including Price/Cost information):	According to preliminary data supplied by ENERGY STAR® in which 26 fan models from 9 different manufacturers were tested by the Hunter Method, 8 of the models (31%) met ENERGY STAR® guidelines for airflow efficiency. Currently Home Depot stores sell the highest efficiency fan on the market, the Hampton Bay “Gossamer Wind” series.
Cumulative Burden	Most manufacturers of ceiling fans do not make other products that have faced energy efficiency regulation; insufficient data for other regulation.
Status of Test Procedures	“Solid State Test Method” described in “ENERGY STAR® Program Requirements for Residential Ceiling Fans.”
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• “In Development” for ENERGY STAR®; expected “launch” in 2002. • Upgraded “Tier 2” ENERGY STAR® in 2003 will include a maximum 1W standby (www.energystar.gov). • Home Depot selling “Best Available” Technology.
Issues	• Different capacity fans. • Lighting is often integral with ceiling fans and warrants consideration for inclusion.

Background Material

Description	Value		Comments/Source	
	Fan	Lighting	Fan	Lighting
Total Energy Use (quads)	0.14	0.36	Calwell and Horowitz. 2001.	Calwell and Horowitz. 2001.
Unit Energy Consumption (kWh)	78	217	Average based on total energy and installed base.	Calwell, Chris and Noah Horowitz. 2001. Home Energy, January/February 2001, pp 24-29.
Annual Shipments (millions)	16.5 (~75% with lighting)		Appliance Magazine, May 2001.	
Installed Base (millions)	159	151	Calwell and Horowitz. 2001.	
Product Lifetime (years)	13		Appliance Magazine, September, 2000.	
Minimum Efficiency Standard	N/A			
Stock Efficiency	N/A			
Typical New Efficiency	62 CFM/W	180 W	Low-speed efficiency. (Based on Parker, 1999.)	60 W incandescent three light fixture.
Best Available Efficiency	131 CFM/W	60 W	Low-speed efficiency. (Aerodynamic blades - Parker, 1999).	60 W incandescent three light fixture.
ENERGY STAR® Efficiency	75 CFM/W	60 W	Low-speed efficiency. (www.EnergyStar.gov).	Pin-based CFL. (www.EnergStar.gov).
Maximum Efficiency (Future Technology)	260 CFM/W	-	Low-speed efficiency. (Aerodynamic blades and high-efficiency motor).	-

Test Procedure Summary

Product: Ceiling Fans

Factors	Assessment
Test Procedure Overview	ENERGY STAR® recently adopted the Hunter Method for testing ceiling fans. • Fan is hung in a temperature and humidity controlled room above a tunnel or large diameter tube, that is slightly larger than the outer diameter of the fan blades. • Air directed from fan during operation is made to pass through the tunnel, with airflow measurements taken at various points simultaneously and instantaneously. The average of the recorded velocities is used in airflow calculations. • Throughout operation, power consumption is monitored. • Fans are rated for efficiency on a CFM/W basis.
Future/Potential Test Procedure(s)	As the Hunter Method was proposed very recently (December 15, 2000) there are currently no details on future modification of testing procedures.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• The Hunter Method will provide an effective analysis of air flow efficiency. Tier I ENERGY STAR® requirements, set to take effect on January 1, 2002, also govern controls, lighting, warranty, and provided consumer information. Tier II levels take effect on October 1, 2003, and include amendments for most of the above categories and additional noise regulations. Controls can also increase energy savings, e.g., the Gossamer Wind fan includes motion sensing controls to insure that the fan does not operate with no one in the room.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	The amount of air moved per W, as quantified by the Hunter Method test, correlates well with the impact of ceiling fans on peak energy loads because the majority of ceiling fans will operate during peak load times.

Standards Consideration

Product: Compact Audio

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Current ENERGY STAR® (2 W standby) = 0.49[29] • ENERGY STAR® Year 2003 (1 W standby) = 0.55[29] • Best Available (0.25 W standby) = 0.60[29]
Product / Technology Availability (Including Price/Cost information):	Presently, about 50 compact audio models draw 1W or less in standby mode.
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.
Status of Test Procedures	"ENERGY STAR® Program Requirements for Consumer Audio and DVD Products."
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• 54% ENERGY STAR® Market Penetration Target (2000). • ~50 Different Models Consume 1W or Less Standby
Issues	

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[29] Savings based on a baseline consumption of 10 W standby.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1998)	0.057	Average based on UEC and installed base.
Unit Energy Consumption (kWh)	110	Rosen and Meier, 1999.
Annual Shipments (millions, 2000)	11.8	Appliance Magazine, May 2001.
Installed Base (millions, 1998)	47	Rosen and Meier, 1999.
Product Lifetime (years)	7	Appliance Magazine, September 2000.
Minimum Efficiency Standard	N/A	
Stock Efficiency	9.8 W Standby	Rosen and Meier, 1999.
Typical New Efficiency	9.8 W Standby	Rosen and Meier, 1999.
Best Available Efficiency	0.25 W Standby	www.EnergyStar.gov.
ENERGY STAR® Efficiency	2 W Standby	Phase I (2002) – www.EnergyStar.gov.
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	1 W Standby	Phase II (2003) - www.EnergyStar.gov.

Standards Consideration

Product: Component Stereo and Rack Audio

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Current ENERGY STAR® (2 W standby) = 0.10 • ENERGY STAR® Year 2003 (1 W standby) = 0.203 • Best Available (0.26 W standby) = 0.273
Product / Technology Availability (Including Price/Cost information):	Presently, more than 25 Rack/Component audio models draw 1W or less in standby mode.
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.
Status of Test Procedures	"ENERGY STAR® Program Requirements for Consumer Audio and DVD Products"
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• 54% ENERGY STAR® Market Penetration Target (2000) Numerous (>25) Receiver Models Meet or Falls Below 1W standby
Issues	

30 Savings based on a baseline consumption of 6 W standby.

31 Only for receiver; 1.1W was the lowest standby Rack system power draw measured by Rosen and Meier (LBNL, 1999).

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1998)	0.105	Average based on unit energy consumption (UEC) and installed base.
Unit Energy Consumption (kWh)	129	Rosen and Meier (LBNL, 1999)
Annual Shipments (millions)	10.6	Average based on installed base and lifetime. (Rosen and Meier (LBNL, 1999) estimate shipments of ~5 million in 1998.)
Installed Base (millions, 1998)	74	Rosen and Meier (LBNL, 1999).
Product Lifetime (years)	7	Appliance Magazine, September 2000.
Minimum Efficiency Standard	N/A	
Stock Efficiency	3 W Standby	Rosen and Meier (LBNL, 1999).
Typical New Efficiency	3 W Standby	Rosen and Meier (LBNL, 1999)
Best Available Efficiency	0.26 W Standby	www.EnergyStar.gov.
ENERGY STAR® Efficiency	2 W Standby	Phase I (2002) - www.EnergyStar.gov.
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	1 W Standby	Phase II (2003) - www.EnergyStar.gov.

Test Procedure Summary

Product: Compact Audio, Component Stereo, and Rack Audio

Factors	Assessment
Test Procedure Overview	• In accordance with ENERGY STAR® guidelines, units are tested under the following conditions: Total Harmonic Distortion (Voltage) <3% THD, Ambient Temperature of 22°C, and within Market-Specific Ranges for Voltage and Frequency. • Test equipment is set up and the test unit connected properly. The unit is brought to standby mode, then allowed to reach operating temperature and stabilize (approximately 90 minutes). • Test conditions and test data, defined as the true standby power requirements of the product (in W), are recorded within a time measurement that is long enough to measure the correct average value within a +10% - 0% error range.
Future/Potential Test Procedure(s)	The testing procedure will not change with the implementation of ENERGY STAR® Phase II requirements on January 1, 2003.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	The test procedure correlates mildly with the energy consumption of compact audio devices, as standby energy consumption currently accounts for about 50% of compact audio energy consumption. On the other hand, standby power is a poor proxy for Rack/Component audio energy consumption; only about 10% of Rack/Component audio energy consumption occurs in the standby mode.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	The current test procedure likely fails to evaluate peak load conditions, as the test procedure only considers standby power draw but many units operate during peak load times.

Standards Consideration

Product: Dehumidifiers

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• EnergyStar Level (1.5 L/kWh) = 0.1932 • Best Available (1.85 L/kWh) = 0.5332
Product / Technology Availability (Including Price/Cost information):	As of August 30, 2001, 2 high-capacity dehumidifiers (36<L/day<57) and 10 standard capacity dehumidifiers (up to 35 L/day) meet ENERGY STAR® requirements.
Cumulative Burden	The major manufacturers of dehumidifiers also make other household appliances which have been regulated for energy efficiency, such as room AC units (Fedders, Frigidaire, Whirlpool) and other major white goods (Frigidaire, Whirlpool make dryers, washers, dishwashers, etc., all of which have been regulated in the past). Insufficient data for other regulation.
Status of Test Procedures	• "ENERGY STAR® Program Requirements for Dehumidifiers." • ANSI/AHAM DH-, for Test Methodology. CAN/CSA-C749-94 (Section 4.2), for Energy Factor Calculation.
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	12 Models Meet or Exceed ENERGY STAR® Performance Levels.
Issues	Different sized dehumidifiers

[32] Savings based on a baseline consumption of 1.35 L/kWh. ENERGY STAR® level and best available efficiencies vary with size. Values given are for mid-sized units, 25 - 35 L/day.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1997)	0.118	Average based on UEC and installed base.
Unit Energy Consumption (kWh)	970	Zogg and Alberino, 1998.
Annual Shipments (millions, 2000)	1	Appliance Magazine, May 2001.
Installed Base (millions)	11	Average based on shipments and lifetime.
Product Lifetime (years)	11	Appliance Magazine, September 2000.
Minimum Efficiency Standard	N/A	
Stock Efficiency	N/A	
Typical New Efficiency	1.35 L/kWh	For mid-sized units (25-35 L/day) www.EnergyStar.gov.
Best Available Efficiency	1.85 L/kWh	For mid-sized units (25-35 L/day) www.EnergyStar.gov.
ENERGY STAR® Efficiency	1.50 L/kWh	For mid-sized units (25-35 L/day) www.EnergyStar.gov.
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	N/A	

Test Procedure Summary

Product: Dehumidifiers

Factors	Assessment
Test Procedure Overview	• Tests are conducted in accordance with ANSI/AHAM Standard DH-1 and Canadian standard CSA-C749-94. • Air entering the dehumidifier must be at 80°F dry bulb/70°F wet bulb (standard conditions). • Energy Factor is calculated according to section 4.2 of CAN/CSA-C749-94, by dividing the mass of the condensate collected by the energy consumption. That result is divided by the density of water at the test temperature (1 kg/litre at standard conditions) and expressed in terms of L/kWh.
Future/Potential Test Procedure(s)	There are no indications of imminent changes in the test procedure.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	The testing procedure closely models the UEC, as dehumidifiers typically operate at steady-state conditions approaching similar dry-to-wet bulb temperature ratios.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	The test procedure correlates well with performance during peak demand periods, as a dehumidifier typically run around the clock and under similar dry-to-wet bulb conditions.

Standards Consideration

Product: Set-Top Boxes

Factors for Consideration	Assessment	
	Analog/Digital	**Wireless**
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Current ENERGY STAR® (15W standby) = 0.4533 • ENERGY STAR® 2004 (7 W standby) = 0.9533 • Best Available (1 W standby) = 1.333	3. Current ENERGY STAR® (15 W standby) = 0.02[34] 4. ENERGY STAR® 2004 (7 W standby) = 0.15[34] 5. Best Available (1 W standby) = 0.25[34]
Product / Technology Availability (Including Price/Cost information):	As of February 2002, only two set-top box models meet ENERGY STAR® requirements; both digital boxes made by Pace Micro Technology. These two units became available in June 2001. Once Tier 2 limits take effect on January 1, 2004, analog boxes will have an easier time fulfilling ENERGY STAR® requirements, as allowable power draw levels will rise from 3 W to 7 W for all categories.	
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.	
Status of Test Procedures	• "ENERGY STAR® Program Requirements for Set-Top Boxes." • "Testing Guidelines for ENERGY STAR® Qualified Set-Top Boxes."	
Other Regulatory Actions	Not known.	
Evidence of Market-Driven or Voluntary Efficiency Improvements	No products meet ENERGY STAR® levels for Analog Cable TV	Only two products, both for Digital Cable TV, satisfy ENERGY STAR® Criterion (Category 2); they came to market in June 2001.
Issues	• Wide range of products covered under ENERGY STAR® Program including: Cable TV (analog and digital), digital TV, satellite TV, wireless TV, personal VCF, video game console, internet access devices, videophone, multifunction devices. • 1W Standby feasibility unclear. • Market moving away from Analog towards Digital cable boxes (no analog boxes expected by 2008).	

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[33] Savings based on a baseline consumption of 197 kWh/yr, i.e. all analog units become digital by 2008.

[34] Savings based on a baseline consumption of 16.2 W standby.

Background Material

Description	Value			Comments/Source	
	Digital	**Analog**	**Wireless**	**Digital**	**Wireless**
Total Energy Use (quads, 1999)	0.08	.047	0.02	Average based on UEC and installed base.	
Unit Energy Consumption (kWh)	197	---	143	Rosen, Meier, and Zandelin. (LBNL, 2001).	
Annual Shipments (millions)	0.4	4.5	1.3	Average based on installed base and lifetime.	
Installed Base (millions, 1999)	3.8	45	13	Rosen, Meier, and Zandelin. (LBNL, 2001).	
Product Lifetime (years)	10	10	10	Rosen, Meier, and Zandelin. (LBNL, 2001).	
Minimum Efficiency Standard	N/A	N/A	N/A		
Stock UEC (kWh/yr)	197	---	140	Rosen, Meier, and Zandelin. (LBNL, 2001).	
Typical New UEC (kWh) or Efficiency	197	---	140	Rosen, Meier, and Zandelin. (LBNL, 2001).	
Best Available UEC (kWh) or Efficiency	140	---	78	www.EnergyStar.gov and Rosen, Meier, and Zandelin. (LBNL, 2001).	
ENERGY STAR® Efficiency	15 W standby	---	15 W standby	www.EnergyStar.gov.	
Maximum Efficiency (Future Technology)	N/A	---	N/A		
Other Notable Efficiency Level	7 W standby	---	7 W standby	Proposed for 2003 EnergyStar. (www.EnergyStar.gov)	

Test Procedure Summary

Product: Set-Top Boxes

Factors	Assessment
Test Procedure Overview	Refer to "Testing Guidelines for ENERGY STAR® Qualified Set-top Boxes" • In accordance with ENERGY STAR® guidelines, units are tested under the following conditions: Total Harmonic Distortion (Voltage) <3% THD, Ambient Temperature of 22°C, and within Market-Specific Ranges for Voltage and Frequency. • Test equipment is set up and the test unit connected properly. The unit is brought to standby mode, then allowed to reach operating temperature and stabilize (approximately 90 minutes). • Test conditions and test data, defined as the true standby power requirements of the product (in W), are recorded within a time measurement that is long enough to measure the correct average value within a +10% - 0% error range.
Future/Potential Test Procedure(s)	There are currently no indications of an imminent change in the testing procedure.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	The lack of active mode testing does not make a significant difference in evaluating set-top box energy consumption, as analog and digital boxes consume more than three times more energy annually in standby mode than in active mode. In addition, the boxes consume little additional energy in active mode (relative to standby): analog boxes require an average of 1.4W (13%) more to operate in the active mode, digital boxes 0.7W (3%). If the difference between active and standby mode power draw increased in the future, then the test procedure would not correlate as strongly with device annual energy consumption.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	The test procedure closely models the impact on peak load, since the standby power draw measured during testing is does not vary significantly from the active power draw. The correlation between peak power draw and the test method will decrease if standby power draw decreases, as many set-top boxes operate in the active mode during the peak demand periods.

Standards Consideration

Product: Televisions

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Current ENERGY STAR® (3 W standby) = 0.8035 • Future ENERGY STAR® (1 W standby) = 1.435 • Best Available (0.1 W standby) = 1.735 • LCD = 1.135
Potential Economic Benefits/Burdens	Not available.
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.
Potential Environmental or Energy Security Benefits	Specific estimates of emission reductions have not been developed however, estimated energy savings indicated above are indicative of the comparative emission benefits that are likely to be possible.
Status of Test Procedures	"ENERGY STAR® Program Requirements for TVs, VCRs, TV/VCRs, TV/DVDs, and TV/VCR/DVDs;" currently under revision (www.EnergyStar.gov).
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• 40% ENERGY STAR® Market Penetration Target (2000; Webber et al., 2000). • Numerous (>50) Models Consume 1W or Less Standby (www.energystar.gov). • LCD Televisions Commercialized; 2.7% market share in 2000 based on distributor unit sales. (Appliance Magazine, May 2001). • Impact of Electronic Programming Guides and high definition TV (HDTV) can significantly change standby and active power consumption
Issues	

[35] Savings based on a baseline consumption of 5 W standby. Used 25-inch and 27-inch TVs for savings estimates.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1998)	0.35	Average based on UEC and installed base.
Unit Energy Consumption (kWh)	150	Rosen and Meier (LBNL, 1999).
Annual Shipments (millions, 2000)	31.4	Appliance Magazine, May, 2001.
Installed Base (millions, 1998)	212	Rosen and Meier (LBNL, 1999).
Product Lifetime (years)	9	Appliance Magazine, September 2000.
Minimum Efficiency Standard	N/A	
Stock Efficiency	4.9 W Standby	Rosen and Meier (LBNL, 1999) – 27" screens.
Typical New Efficiency	5.7 W Standby	Rosen and Meier (LBNL, 1999).
Best Available Efficiency	0.1 W Standby	www.EnergyStar.gov.
ENERGY STAR® Efficiency	1 W Standby	Future ENERGY STAR® level. (www.EnergyStar.gov).
Maximum Efficiency (Future Technology)	Same minimum standby, with significantly lower active draw.	Rosen and Meier (LBNL, 1999); ADL 2001. LCD technology

Test Procedure Summary

Product: Televisions

Factors	Assessment
Test Procedure Overview	DOE Test Procedure: It calls for the measurement of standby and active power draw levels; see Technical Support Document for additional details (Appendix B). ENERGY STAR® Test Procedure (for MOU Version 1.0, current through April, 2001): • Details: Standby mode is when the TV is connected to a power source but is not communicating sound nor picture. In this mode the device can be switched to active with a remote control (some power is being drawn). Off mode is when the device is plugged in but drawing no power. Typically the TV is unable to turn on with the use of a remote control. Current draw is blocked with a hard on/off switch. • Plug the unit in and allow it to come to temperature and stabilize (~90 minutes). • Using a calibrated (performed yearly) power meter, measure the power draw of the TV in the standby mode - turned off with remote. Measurement should account for inconstancy in current draw, i.e., perform a time averaged measurement. • Test must be performed under the following conditions: 1) <3% total harmonic distortion (voltage) 2) Ambient Temperature = 22 deg C +/- 4 deg C 3) 115 V RMS (+/- 3 V), 60 Hz. (+/- 3 Hz.)
Future/Potential Test Procedure(s)	Version 2.0 of the ENERGY STAR® memorandum of understanding (MOU) for Televisions and video cassette recorder (VCRs),
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	The DOE test procedure measures active and standby power draw, giving it the potential for high correlation with actual energy consumption and savings; however, the specification for making the measurements appears to be out of date and in need of revision. Neither the original nor the revised ENERGY STAR® test procedures effectively model the majority of TV energy consumption or potential energy savings. The ENERGY STAR® test procedure measures only standby power, while active power dominates (89%) TV energy consumption. Consequently, the test procedures will not account for potential energy savings from approaches that decrease the active power draw of TVs (such as liquid crystal display (LCD)).
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	1) If updated, the DOE test procedure would correlate well with TV peak demand impact (assuming a representative model for TV usage patterns). 2) The ENERGY STAR® test procedure correlates minimally with the peak load impact of TVs because the procedure measures standby power draw but many TVs are active during peak demand periods. 3) LCD technology would realize significant peak load reductions because LCD TVs operate at substantially lower active power levels than conventional cathode reg. tube (CRT) devices.

Standards Consideration

Product: Video Cassette Recorders

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• New ENERGY STAR® Compliant Level (2 W standby) = 0.25[36] • 1 W standby = 0.38[36]
Product / Technology Availability (Including Price/Cost information):	Many VCRs in the market meet ENERGY STAR® standards, i.e., the ENERGY STAR® website lists 45 models by 8 different manufacturers, available as of September 2001, that satisfy the Phase I requirements.
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.
Status of Test Procedures	"ENERGY STAR® Program Requirements for TVs, VCRs, TV/VCRs, TV/DVDs, and TV/VCR/DVDs;" currently under revision (www.EnergyStar.gov).
Other Regulatory Actions	Not known.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• 55% ENERGY STAR® Market Penetration Target (2000; Webber et al., 2000). • ~5 Different Models Consume 1W or Less Standby (www.energystar.gov).
Issues	1-W Standby power proposed for 2003 ENERGY STAR® criterion (www.energystar.gov).

[36] Savings based on a baseline consumption (typical new) of 4 W standby. Baseline consumption extrapolated for year 2000 from Rosen and Meier (LBNL, 1999).

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 1998)	0.1	Rosen and Meier (LBNL, 1999)
Unit Energy Consumption (kWh)	71	Rosen and Meier (LBNL, 1999)
Annual Shipments (millions, 2000)	24	Appliance Magazine, May, 2001
Installed Base (millions, 1998)	129	Rosen and Meier (LBNL, 1999)
Product Lifetime (years)	7	Rosen and Meier (LBNL, 1999)
Minimum Efficiency Standard	N/A	
Stock Efficiency	5.9 W Standby	Rosen and Meier (LBNL, 1999)
Typical New Efficiency	4 W Standby	Rosen and Meier (LBNL, 1999)
Best Available Efficiency	0.85 W Standby	www.EnergyStar.gov
ENERGY STAR® Efficiency	2 W Standby	www.EnergyStar.gov
Maximum Efficiency (Future Technology)	N/A	
Other Notable Efficiency Level	1 W Standby	Proposed for 2003 ENERGY STAR® (www.EnergyStar.gov)

Test Procedure Summary

Product: Video Cassette Recorders

Factors	Assessment
Test Procedure Overview	No testing procedures exist for VCRs as of June 19, 2001; the ENERGY STAR® program expects to develop a test procedure in the near future.
Future/Potential Test Procedure(s)	Future revisions of "ENERGY STAR® Program Requirements for TVs, VCRs, TV/VCRs, TV/DVDs, and TV/VCR/DVDs" will include test procedures. While the details of the test procedure are not known, it will call for using a power meter to measure VCR power draw while the VCR is in standby mode.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	Assuming that the future test procedure is similar to that used to evaluate Rack and Compact Audio equipment, i.e., to measure standby power draw, the ENERGY STAR® program would have a low correlation with VCR energy consumption; standby mode accounts for ~35% of VCR energy consumption.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	The degree of correlation between stand-by power and VCR peak power impact depends upon the (unknown) distribution of VCR operational mode during peak power demand periods and cannot be readily determined.

Standards Consideration

Product: Copy Machines

Factors for Consideration	Assessment	
	Commercial	**Residential**
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Copier of the future, 100% Power management = 0.1[37] • Conversion to Inkjet Technology = 0.7[37]	• Copier of the future = 0.0838 • Conversion to Inkjet Technology = 0.1138
Product / Technology Availability (Including Price/Cost information):	• Copier of the Future (CotF): Two companies, Canon and Ricoh, offer mid-speed range machines that fulfill the CotF criteria. The CotF cost premium is most likely minimal because the CotF devices have replaced previously existing product models (based on speed performance). A cost premium is unlikely due to effort of keeping products competitive. • Inkjet printer substitution: Inkjet copiers are not available commercially.	
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.	
Status of Test Procedures	• ENERGY STAR® test procedure document. • Copier of the Future.	
Evidence of Market-Driven or Voluntary Efficiency Improvements	• 90% of Copy machine stock 2000 is ENERGY STAR® Compliant • 34% of Copiers in stock are Power management enabled. • 52.3% of the Copy machine Stock is ENERGY STAR® Compliant. (Webber et al., 1999). • Federal government must purchase E*-compliant Copy Machines. • Best in class Copiers with low power capability, Panasonic 60 cpm (FP-D605), 15 W in sleep, Canon imageRUNNER 3300 (33 cpm) - less than 10 W in sleep (CotF award).	• 52% ENERGY STAR® Market Penetration target for Y2000 (Webber et al., 2000) • 34% of Copiers in stock are Power management enabled • Best in class Copiers with low power capability, Panasonic 60 cpm (FP-D605), 15 W in sleep, Canon imageRUNNER 3300 (33 copies per minute (cpm)) - less than 10 W in sleep (Copier of the Future award).
Issues	• Energy savings depend on the technical abilities to lower sleep power. • Power Management enablement is the key to limiting electricity use. • Power management, although prevalent in new copier sales, is not at enabled in the majority of machines. • Longer-term feasibility of 1 W sleep unclear; however lower requirement than that defined by CotF may be possible.	

[37] Savings based on a baseline consumption that corresponds to typical new technology.

[38] Savings based on a baseline consumption that corresponds to typical new technology, 100% power management-enabled.

Background Material

Description	Value		Comments/Source	
	Comm	**Resid**	**Commercial**	**Residential**
Total Energy Use (quads, 2000)	0.10	0.01	ADL, 2002	Kawamoto et al., 2001.
Annual Shipments (millions, 2000)	2.0		ADL, 2002	ADL, 2002
Stock (millions, 2000)	9	3.8	ADL, 2002	ADL, 2002
Product Lifetime (years)	6	6	ADL, 2002	Kawamoto et al., 2001.
Current UEC (kWh/year)	1000	315	34% Power management enabled (ADL, 2002).	Current low level machine (ADL, 2002; Kawamoto et al., 2001).
Typical New UEC (kWh/year)	602	165	100% Power management enabled (ADL, 2002).	100% Power management enabled , (ADL, 2002; Kawamoto et al., 2001).
Best Available UEC (kWh/year)	546	190	Copier of the future, 100% power management enabled (ADL, 2002).	Copier of the future requirements , (ADL, 2002; Kawamoto et al., 2001; Nordman et al., 1998).
ENERGY STAR® UEC (kWh/year)	602	165	100% Power management enabled , (ADL, 2002).	100% Power management enabled (ADL, 2002; Kawamoto et al., 2001).
Minimum UEC (kWh/year) Future Technology	216	27	Conversion to Inkjet processes (ADL, 2002).	Conversion to Inkjet processes (ADL, 2002; Kawamoto et al., 2001).

Test Procedure Summary

Product: Copy Machines

Factors	Assessment	
	Commercial	**Residential**
Test Procedure Overview	From the ENERGY STAR® Copier MOU - Version 2.0 1) The test conditions for all copiers are: • Line Impedance <0.25 ohm • Total Harmonic Distortion (Voltage) <3% • Ambient Temperature = 21 deg C +/- 3 C • Relative Humidity = 40-60% • Minimum distance of 2 feet from a wall • Voltage/Frequency = 115 VRMS +/- 5V, 60 Hz. +/-3Hz. 2) Prior to Off-mode and Low-power testing the devices must be plugged in, then turned off, and allowed to stabilize for at least 12 hours. 3) All copier speed bands are subjected to Off-mode testing • Turn on copier and let it warm up. • Wait exactly the amount of time specified (based on copier speed) for the copier to switch into Off mode. Begin recording energy consumption. • Continue for one hour and compute the time average power draw. 4) For the mid and high copier speed range, the copier is subjected to sleep-mode testing • Turn on the copier and make on copy. • Let the machine sit for exactly 15 minutes. • Record energy consumption for one hour. • Compute the time-average power draw. 5) Testing details: All W meters must be calibrated,at least every year and have a resolution of 0.1 W. The measurements recorded must be accurate within +/-0.5 W.	
Future/Potential Test Procedure(s)	No future/potential test procedures identified. CotF procedure is more strict.	
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	The testing metrics do not correlate closely with the UEC and potential energy savings because the "standby" mode, not the "sleep" mode measured by the test procedure, accounts for the majority of device UEC. Improvements in the Power management enabled rate will increase the amount of time in and percentage of device UEC accounted for by the "sleep" and "off" modes, increasing the relevance of test procedure to copier energy consumption.	The test procedure does not capture a significant portion of the possible energy savings. A 100% Power management enabled rate would realize about a 60% reduction in energy consumption. The current Power management enabled rate (68%) limits the magnitude of the potential gains.

Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	• Copiers can have a substantial peak load impact, as higher-end devices can draw up to a few kiloW while copying. In addition, most commercial copiers spend most of the peak demand period in "standby" mode. As a result, copiers infrequently enter the "sleep" mode power draw measured by the test procedure, resulting in a low correlation between the test method and copier peak load impact. • The Copier of the Future criteria would decrease peak loads somewhat by decreasing the "standby" power draw and the amount of time spent in "standby" mode during peak demand periods. • Conversion to inkjet copiers would certainly reduce the peak loads in both the sleep (regulated by test procedure) and active modes.	• Presumably, most residential copiers reside in home offices. The "standby" mode power draw has the greatest impact upon peak period power draw; thus a weak correlation exists between actual operating patterns and the "sleep" mode considered in the current test procedure. • The CotF criteria would reduce the "standby" energy consumption duration and limit any peak load impact. • Conversion to inkjet technology will reduce the peak loads in both the Off (covered by test procedure) and active modes.

Standards Consideration

Product: Desktop Computers

Factors for Consideration	Assessment	
	Commercial	**Residential**
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• 50% Power Management Enabled = .8939 • 100% Power management enabled, Pentium III = 1.939 • 1 W Sleep (Current Power management enabled rate) with a Pentium III = 0.1639 • Laptop Computer = 3.839 Low-Power Design = 3.639	• 100% Power management enabled, Pentium III = 0.0839 • 1 W Sleep (Current Power management enabled rate) with a Pentium III = 0.1139 • Laptop Computer = 0.3539 • Low-Power Design = 0.4839 • 50% Power Management enabled = 0.03
Product / Technology Availability (Including Price/Cost information):	• Desktop personal computer (PCs) with a 1 W sleep levels are not yet available; the lowest power desktop PC listed on the ENERGY STAR® website draws ~1.5 W. • Many of the low-power strategies used in commercially-available laptop computers technology (low-power microprocessors, spinning the hard drive down, sleep modes, etc.) often command a price premium.	
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.	
Status of Test Procedures	ENERGY STAR® test procedure document.	
Evidence of Market-Driven or Voluntary Efficiency Improvements	• 90% of Desktop Computers sold in 2000 were ENERGY STAR® Compliant (Webber et al., 2000). • 25% of Desktops in stock are Power management enabled (Nordman et al., 2000). • 85% ENERGY STAR® Market Penetration target for Y2000 (Webber et al., 2000). • 17% of the Personal Computer (i.e., desktop + laptop) stock are computers of laptop design. • Federal government must purchase E*-compliant computers. • Executive order mandates that the Federal Government purchase of devices with <1 W/sleep power draw where available and cost-effective (July 31, 2001).	• 25% of Desktop Computers in stock are Power management enabled (Nordman et al., 2000). • 85% ENERGY STAR® Market Penetration target for Y2000 (Webber et al., 2000). • ~17% of the personal computer stock (i.e., desktop + laptop) in 2000 is of Laptop design. • Current best market performer: SCENIC L.i815, draws 2.3 W in sleep.
Issues	• Energy savings depend in large part upon increasing Power management enabled rate, a software option. • E*, although prevalent in new computer sales, is often disabled by user; increasing Power management enabled rate may require software modification, e.g., permanent enabling of power-down features. • 1 W sleep may not be technically feasible. • Low-power designs may encounter resistance in non-portable machines due to the necessity of manufacturer re-design and demand for faster central processing units (CPUs).	

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[39] Savings based on a baseline consumption that corresponds to typical new Pentium III technology (25% Power management enabled).

Standards Consideration

Product: Desktop Computers

Background Material

Description	Value		Comments/Source	
	Comm	Resid	Commercial	Residential
Total Energy Use (quads, 2000)	0.19	0.03	ADL, 2002	Kawamoto et al., 2001.
Annual Shipments (millions, 2000)	44		ADL, 2002	ADL, 2002.
Stock (millions, 2000)	59	51	ADL, 2002	ADL, 2002.
Product Lifetime (years)	3	3	ADL, 2002	ADL, 2002.
Current UEC (kWh/year)	297	52	ADL, 2002	Pentium II, 25% power enabled (Kawamoto et al., 2001; ADL, 2002).
Typical New UEC (kWh/year)	325	56	25% Power management enabled, using Pentium III (ADL, 2002; Intel, 2001).	Pentium III, 25% power enabled (Kawamoto et al., 2001; ADL, 2002; Intel , 2001).
Best Available UEC (kWh/year)	35	27	Laptop Computer (ADL, 2002).	Laptop Technology (Kawamoto et al., 2001; ADL, 2002)
ENERGY STAR® UEC (kWh/year)	178	50	100% Power management enabled, Pentium III (ADL, 2002; Intel, 2001).	100% Power management enabled (Kawamoto et al., 2001; ADL, 2002).
Minimum UEC (kWh/year) Future Technology	35	27	Laptop Computer (ADL, 2002).	Laptop Computer (ADL, 2002).
Other Notable UEC (kWh/year)	56	15	Low-power design, Current power management enabled rate (ADL, 2002).	Low-power design, urrent power management enabled rate (ADL, 2002).
Additional Notable UEC (kWh/year)	313	47	1 W Sleep Pentium III, Current power management enabled rate (ADL, 2002).	1 W Sleep Pentium III, Current power management enabled rate (ADL, 2002).

Test Procedure Summary

Product: Desktop Computers

Factors	Assessment	
	Commercial	**Residential**
Test Procedure Overview	• For Tier II Models (manufactured after July 1, 2000) - only considering guideline A • System must adhere to ENERGY STAR® sleep mode levels which are measured in the following manner: • The system must go into sleep mode after a period of inactivity, default time set to less than 30 minutes. • Any system that consumes less than 15 W in the active mode is not required to have a sleep mode. • Detailed ENERGY STAR® Test Conditions (from the Computer MOU Version 3.0, EPA - Attachment C) • Power source must be 115 VAC RMS (+/- 5 V RMS) • Measure the True power consumption using a traceably calibrated NBS true RMS W-meter with resolution to 0.1 W. • Test conditions: line impedance <0.25 ohm, Total harmonic distortion <5%, Input AC frequency = 60 Hz • (+/- 3 Hz.), and an ambient temperature of 25 degrees C. • Under the above conditions the power level in the sleep mode is then measured. • Product meets ENERGY STAR® criteria if 95% or more of the products sold are able to meet the criteria.	
Future/Potential Test Procedure(s)	No future/potential test procedures identified.	
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	The ENERGY STAR® test procedure does not correlate closely with actual energy consumption and potential savings because it only measures sleep-mode power draw and, due to the low Power management enabled rate (25%) of actual computers, the "active" mode energy consumption dominates the UEC. If the Power management enabled rate increases appreciably (to 100%), the sleep mode energy consumption would account for a majority of the UEC and strengthen the correlation between the ENERGY STAR® test procedure and UEC.	The ENERGY STAR® test procedure is not capturing the majority of energy savings because of the low Power management enabled rate and the measurement of only the sleep power draw. In the current PC model (25% Power management enabled) the active energy consumption dominates the total energy consumption. Even if the Power management enabled rate is raised to 100% the active mode will dominate the UEC.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	• The computer active mode dominates the peak power impact of desktop computers, because many computers are active during the work day. The ENERGY STAR® test procedure does not address active power draw. However, increasing the Power management enabled rate, which the test procedure directly addresses, would reduce the aggregate peak demand of desktop PCs by increasing the number of PCs that power down during peak demand periods • A PC of laptop or low-power design directly reduces peak power draw by about 80%. • Reducing the sleep mode ENERGY STAR® power level will achieve a small reduction in peak electrical power draw.	Most likely, desktop PCs do not have a substantial peak power impact, as residential computer use is more common at night than during the day. Research shows that the majority PCs and monitors not "active" are in the "off" mode instead of "sleep." Thus during the peak-load sensitive times of the day, PC's and monitors draw minimal power, in modes not measured under the test procedure.

Standards Consideration

Product: Fax Machines

Factors for Consideration	Assessment	
	Commercial	**Residential**
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Enhanced Laser Technology = 0.1240 • Inkjet 1 W Sleep (Current Power management enabled rate) = 0.24[40]	$ Inkjet 1 W Sleep = 0.07[40] $ Enhanced Laser Technology = 0.04[40]
Product / Technology Availability (Including Price/Cost information):	• Inkjet facsimile machines account for a plurality (but not a majority) of new product sales. • An existing laserjet device consumes 2 W in the standby mode.	
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.	
Status of Test Procedures	ENERGY STAR® test procedure document.	
Evidence of Market-Driven or Voluntary Efficiency Improvements	• 95% ENERGY STAR® Market Penetration Target for 2000 (Webber et al., 2000). • 38% of Faxes sold in 2000 are of Inkjet technology (30% are laser; ADL, 2001). • Federal government must purchase E*-compliant fax machines. • 2W sleep power is lowest for device currently on the market (FAX 5000L, a laser jet); inkjet fax machines attain similar levels (e.g., the Savin F3615 draws 2W in sleep mode; see: www.energystar.gov). Executive order mandates that the Federal Government purchase of devices with <1 W/sleep power draw where available and cost-effective (July 31, 2001).	
Issues	• Design changes to achieve 1 W sleep levels. • A significant amount of faxes are laser technology.	• Energy savings are largest with implementation of 1 W sleep mode with an inkjet facsimile machine; 1 W sleep devices currently do not exist.

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[40] Savings based on a baseline consumption that corresponds to typical new inkjet technology.

Background Material

Description	Value		Comments/Source	
	Comm	Resid	Commercial	Residential
Total Energy Use (quads, 2000)	0.03	0.01	ADL, 2002.	Kawamoto et al (LBNL, 2001).
Annual Shipments (millions, 2000)	7.4		ADL, 2002.	ADL, 2002.
Stock (millions, 2000)	23.2	11.6	ADL, 2002.	ADL, 2002.
Product Lifetime (years)	5	5	ADL, 2002.	ADL, 2002.
Current UEC (kWh/year)	132	77.5	Laser, 100% power management enabled rate (ADL, 2002).	Laser Technology (ADL, 2002; Kawamoto et al., 2001).
Typical New UEC (kWh/year)	57	33.6	Inkjet, 100% power management enabled rate (ADL, 2002).	Inkjet Technology (ADL, 2002; Kawamoto et al., 2001).
Best Available UEC (kWh/year)	57	33.6	Inkjet, 100% power management enabled rate (ADL, 2002).	Inkjet Technology (ADL, 2002; Kawamoto et al., 2001).
ENERGY STAR® UEC (kWh/year)	57	N/A	Inkjet, 100% power management enabled rate (ADL, 2002).	All new equipment satisfy ENERGY STAR® criteria, (Webber et al., 2000).
Minimum UEC (kWh/year) Future Technology	9	5.4	Inkjet, with 1 W Sleep (ADL, 2002).	Inkjet, with 1 W Sleep.
Other Notable UEC (kWh/year)	33	19.4	Enhanced Laser Technology (Canon, 2001).	Enhanced Laser Technology (Canon, 2001).

Test Procedure Summary

Product: Fax Machines

Factors	Assessment	
	Commercial	Residential
Test Procedure Overview	*From the Printer, Fax, Printer/Fax, and mailing machine MOU, version 3.0* • Power measurement of devices in the sleep mode. • Test conditions: • Power source must be 115 VAC RMS (+/- 5 V RMS) • Measure the true power consumption using a traceably calibrated NBS true RMS W-meter. • Line impedance <0.25 ohm, Total harmonic distortion <5%, Input AC frequency = 60 Hz (+/- 3 Hz.), and an ambient temperature of 25 degrees C. • Test procedure: • Measure the average power drawn by the fax machine in the sleep mode. • Record the energy consumed for one hour and divide by one. • This ensures that variations in current draw are accounted for. • This method is recommended in order to gain accurate results but is not essential for equipment that draws constant power.	
Future/Potential Test Procedure(s)	No future/potential test procedures identified.	
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	Testing procedures and metrics accurately capture the essence of energy consumption and savings tactics for this device, because standby energy consumption represents the vast majority of the UEC.	
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Because facsimile machines operate in active mode infrequently, the standby power draw measured by the test procedure correlates closely to the peak impact (and reduction potential) of facsimile machines.	

Standards Consideration

Product: Laser Printers

Factors for Consideration	Assessment	
	Commercial	**Residential**
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Copier of the Future Criterea = 0.2[42, 43] • Conversion to Inkjet Technology = 0.5[42]	Inkjet Printer = 0.0[42]
Product / Technology Availability (Including Price/Cost information):	• For Commercial only, Copier of the Future (CofF) criteria exist and could be applied to laser printers. Meeting power draw levels of the sleep-mode for higher-speed laser printers (e.g., Large Office band) may be difficult. However, commercially-available laser printers that fulfill the C of F criteria do not exist. • Laser printer manufacturers continue to investigate high-throughput inkjet technology heavily. In general, inkjet printers could more readily displace low-end laser printers, at a lower first cost (assuming print quality concerns can be overcome).	
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.	
Status of Test Procedures	• ENERGY STAR® test procedure document.	
Evidence of Market-Driven or Voluntary Efficiency Improvements	• 99% of the Laser Printer stock in 2000 are ENERGY STAR® Compliant (CCAP_office2.xls) • 54% of Lasers in stock are Power management enabled • 99% of Printer stock is ENERGY STAR® compliant (Webber 1999) • Federal government must purchase E*-compliant laser printers. • 1 W sleep implementation is unclear. Best marketed product currently draws 3.5 W in low power mode. Xerox Laserjet Docucolor 2060 (60 ppm). • Executive order mandates that the Federal Government purchase of devices with <1 W/sleep power draw where available and cost-effective (July 31, 2001)	
Issues	• Energy savings depend in large part upon increasing Power management enabled rate. Power management enabled rate is less than 99% for 2000 stock. • Change to inkjet technology might not be consumer acceptable due to beliefs of laser technology superiority.	Energy savings are largest with a transition to inkjet printers. Because of the small size (slower printing rate) these devices, inkjet technology is a sensible alternative. However, improvement of inkjet performance equality is necessary.

[42] Savings based on a baseline consumption that corresponds to typical new technology, 100% Power management enabled.

[43] Copier of the Future technology scenario is defined as requirement of printers to meet the Target 1 copier requirements. It specifies a maximum of 10 W in sleep mode.

Background Material

Description	Value		Comments/Source	
	Comm	Resid	Commercial	Residential
Total Energy Use (quads, 2000)	0.05	0.003	ADL (2002).	Kawamoto et al., 2001.
Annual Shipments (millions, 2000)	4.4		ADL (2002).	ADL (2002).
Stock (millions, 2000)	6.8		ADL (2002).	ADL (2002).
Product Lifetime (years)	4	4	ADL (2002).	ADL (2002).
Current UEC (kWh/year)	670	33	Average of all Equipment, 54% Power management enabled Rate (ADL, 2002).	ADL, 2002; Kawamoto et al., 2001.
Typical New UEC (kWh/year)	483	30	100% Power management enabled Rate (ADL, 2002).	100% Power management enabled (ADL, 2002; Kawamoto et al., 2001).
Best Available UEC (kWh/year)	483	28	100% Power management enabled Rate, (ADL, 2002).	Conversion to inkjet printer (ADL, 2002; Kawamoto et al., 2001).
ENERGY STAR® UEC (kWh/year)	483	30	100% Power management enabled Rate (ADL, 2002).	100% Power management enabled (ADL, 2002; Kawamoto et al., 2001).
Minimum UEC (kWh/year) Future Technology	163	28	Conversion to Inkjet Technology (ADL, 2002).	Conversion to inkjet printer (ADL, 2002; Kawamoto et al., 2001).
Other Notable UEC (kWh/year)	372		Copier of the Future Requirements, Current power management enabled rate, (Nordman et al., 1998; ADL, 2001).	

Test Procedure Summary

Product: Laser Printers

Factors	Assessment	
	Commercial	**Residential**
Test Procedure Overview	*From the Printer, Fax, Printer/Fax, and Mailing Machine MOU, version 3.0* • Power measurement of devices in the sleep mode. • Test conditions: • Power source must be 115 VAC RMS (+/- 5 V RMS) • Measure the true power consumption using a traceably calibrated NBS true RMS W-meter. • Line impedance <0.25 ohm, Total harmonic distortion <5%, Input AC frequency = 60 Hz (+/- 3 Hz.), and an ambient temperature of 25 degrees C. • Test procedure: • Measure the average power drawn by the fax machine in the sleep mode. • Record the energy consumed for one hour and divide by one. • This ensures that variations in current draw are accounted for. • This method is recommended in order to gain accurate results but is not essential for equipment that draws constant power.	
Future/Potential Test Procedure(s)	No future/potential test procedures identified.	
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	Test procedures do not correlate well with energy consumption and savings potential, because the ENERGY STAR® program only measures the low power level (it also defines the maximum time period to before entering "sleep" mode). Laser printers have a 60% Power management enabled rate, and the "active" and "standby" modes account for most (~80%) energy consumption. A higher Power management enabled rate would increase the relevance of the test procedure to the UEC and energy savings potential by decreasing the amount of time and energy consumed in the "standby" mode.	The ENERGY STAR® test procedures correlate weakly with actual energy consumption energy savings, as it measures only the low (or sleep) power draw. The standby (ready-to-print) mode accounts for a majority of energy consumption.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	• The test procedures do not correspond closely with the peak load impact of laser printers, as laser printers operate in "active" and "standby" modes during much of the peak period portion of the day. The test procedure only measures "sleep" mode power draw. • CotF criteria would reduce the peak load impact by decreasing the standby draw and increasing the amount of time in "sleep" mode (i.e., by reducing the "warm-up" period for the printer). • Displacing laser printers with inkjet printers would dramatically reduce peak loads due to much lower "active" and "standby" power draw levels.	Peak load is not an important issue for these devices because residential laser printers are estimated to spend >95% of their time in the Off mode.

Standards Consideration

Product: Low-End Servers, Commercial

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• ENERGY STAR® / Power Management (PM) = 0.194 • Low-power Server (15 W on, 7 W sleep), No PM = 0.884 • Low-power Server with 1 W sleep and PM scheme = 0.924
Product / Technology Availability (Including Price/Cost information):	• Low-power and power-management capable servers came to market in 2001; unknown cost premium.
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.
Status of Test Procedures	• No test standards known. • Gubler & Peters have data upon which PM time schemes can be based.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• Low-power/PM servers have just entered the market (0% market share). • Implementation of power management schemes is possible (Gubler & Peters; RLX) • RLX Technologies and Amphus products are examples of energy efficient low-end server computer design.
Issues	Integration of PM schemes could impact server performance.

[44] Savings based on a baseline consumption that corresponds to typical new technology, 0% Power management enabled.

[45] Based on the low power level similarity of Desktop computers and server usage from Gubler & Peters (2000).

[46] RLX Technologies uses a transmetta chip and a PM scheme.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 2000)	0.049	ADL (2002).
Annual Shipments (millions, 2000)	1.6	ADL (2002).
Stock (millions, 2000)	4.1	ADL (2002).
Product Lifetime (years)	3	Same as a PC (ADL, 2002).
Current UEC (kWh/year)	1095	Typical Server (ADL, 2002).
Typical New UEC (kWh/year)	1095	Typical Server (ADL, 2002).
Best Available UEC (kWh/year)	107	Low-power server (w/ power management, e.g., RLX (Hipp, 2001).
ENERGY STAR® UEC (kWh/year)	N/A	No ENERGY STAR® program.
Minimum UEC (kWh/year) Future Technology	87	Low-power server, 1 W sleep and Power Management (ADL, 2002).
Other Notable UEC (kWh/year)	131	Low-power server without Power Management (ADL, 2002).
Additional Notable UEC (kWh/year)	869	Current design with Power Management.

Test Procedure Summary

Product: Low-End Servers, Commercial

Factors	Assessment
Test Procedure Overview	No test procedure exists.
Future/Potential Test Procedure(s)	None are available.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	Not applicable.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Not applicable.

Standards Consideration

Product: Monitors

Factors for Consideration	**Assessment**	
	• Commercial	**Residential**
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• 100% Power management enabled, 17-inch CRT = 2.547 • 1 W sleep, Current Power management enabled rate, 17-inch CRT = 0.4447 • 17-inch LCD, Current Power management enabled rate = 3.647	• 100% Power management enabled = 0.1[48] • 1 W sleep, Current Power management enabled rate = 0.32[48] • LCD, Current Power management enabled rate = 0.84[48]
Product / Technology Availability (Including Price/Cost information):	• LCD - commercially available, costs are decreasing. In late 2001, an LCD monitor had a cost premium of 85% (relative to CRT), down from up to 300% in preceding years. The payback period for a 15-inch LCD with commercial and residential patterns is ~11 and ~33 years, respectively, as compared to a 17-inch CRT monitor (assuming $0.08/kWh; in practice, a 15-inch LCD effectively replaces a 17-inch CRT due to the LCD's more efficient use of screen space for viewing and higher display resolution.) • Organic LED technology is under development but not commercially available in monitors. • As of January 1, 2002, 90 17-inch or larger monitors listed on the ENERGY STAR® website consume 1W or less in their lowest power sleep mode.	
Cumulative Burden	This and related products have not been regulated for energy efficiency; insufficient data for other regulation.	
Status of Test Procedures	ENERGY STAR® test procedure document; no DOE test procedure.	
Evidence of Market-Driven or Voluntary Efficiency Improvements	• 95% ENERGY STAR® Market Penetration target for 2000 (Webber et al.). • 60% of monitors in stock are Power management enabled (Nordman et al., 2000). • 3% of monitors sold in 2000 were LCD (ADL, 2002). • Executive order mandates that the Federal Government purchase of devices with <1 W/sleep power draw where available and cost-effective (July 31, 2001). • Federal government must purchase of E*-compliant monitors.	• 59% of monitors in stock are Power management enabled (ADL, 2002). • 95% ENERGY STAR® Market Penetration target for 2000 (Webber et al., 2000). • 3% of residential monitors sold in 2000 were LCD (ADL, 2002).
Issues	• Energy savings depend in large part upon increasing Power management enabled rate, a software option. • E*, although prevalent in new monitor sales, is often disabled by user; increasing Power management enabled rate may require software modification, e.g., permanent enabling of power-down features. • LCD technology is expensive (ADL, 2002).	• High LCD cost premium impedes LCD market penetration, with higher barriers expected in the residential market than the commercial market. • Strict enforcement of ENERGY STAR® configuration will save energy. • Electronics efficiency optimization (for sleep) can save much energy at little additional cost to consumer and no interruption of performance.

[47] Savings based on a baseline consumption that corresponds to typical new 17-inch CRT technology, 60% Power management enabled.

[48] Savings based on a baseline consumption that corresponds to typical new technology, 60% Power management enabled. ENERGY STAR® category is defined as having a low power level of 8 W.

Standards Consideration

Product: Monitors

Background Material

Description	Value		Comments/Source	
	Comm	**Resid**	**Commercial**	**Residential**
Total Energy Use (quads, 2000)	0.20	0.05	ADL, 2002.	Kawamoto et al., 2001.
Annual Shipments (millions, 2000)	38		ADL, 2002.	ADL, 2002.
Stock (millions, 2000)	63	51	ADL, 2002.	ADL, 2002.
Product Lifetime (years)	3	3	ADL, 2002.	ADL, 2002.
Current UEC (kWh/year)	333	92	17-inch CRT, 60% Power management enabled Rate, (ADL, 2002).	17-inch CRT, 60% Power management enabled Rate (ADL, 2002; Kawamoto et al., 2001).
Typical New UEC (kWh/year)	333	92	17-inch CRT, 60% Power management enabled Rate, (ADL, 2002).	17-inch CRT, 60% Power management enabled Rate (ADL, 2002; Kawamoto et al., 2001).
Best Available UEC (kWh/year)	51	17	Liquid Crystal Display, 15-inch, Current power management enabled rate (ADL, 2002).	Liquid Crystal Display, 15-inch, Current power management enabled rate (Kawamoto et al., 2001; ADL, 2002).
ENERGY STAR® UEC (kWh/year)	149	84	17-inch CRT, 100% Power management enabled (ADL, 2002).	17-inch CRT, 100% power management enabled (Kawamoto et al., 2001; ADL, 2002).
Minimum UEC (kWh/year) Future Technology	4.5	2	Cholesteric LCD, 15-inch panel, Current power management enabled rate Technology (Kent State, 200; ADL, 2002).	Cholesteric LCD, 15-inch panel, Current power management enabled rate, (Kent State, 2001; Kawamoto et al., 2001).
Other Notable UEC (kWh/year)	17	11	OLED at 100% Power management enabled rate (ADL, 2002).	OLED at 100% Power management enabled rate (ADL, 2002; Kawamoto et al., 2001).
Additional Notable UEC (kWh/year)	301	64	17-inch CRT with 1 W sleep, Current Power management enabled rate (ADL, 2002).	17-inch CRT with 1 W sleep and Current power management enabled rate (Kawamoto et al., 2001; ADL, 2002).

Test Procedure Summary

Product: Monitors

Factors	Assessment	
	Commercial	**Residential**
Test Procedure Overview	*For Tier II models - (test standard for equipment shipped after July 1, 2000)* • Monitor into 1st sleep mode within 30 min. of inactivity, deep sleep after 60 min - controlled by computer •Testing procedure is the same for that of the computer except power is measured at the two mentioned stages instead of only one sleep level. System must adhere to ENERGY STAR® sleep mode levels which are measured in the following manner: • The system must go into sleep mode after a period of inactivity. • Detailed ENERGY STAR® Test Conditions (from the Computer MOU Version 3.0, EPA - Attachment C) • Power source must be 115 VAC RMS (+/- 5 V RMS). • Measure the True power consumption using a traceably calibrated NBS true RMS W-meter with resolution to 0.1 W. • Test conditions: line impedance <0.25 ohm, Total harmonic distortion <5%, Input AC frequency = 60 Hz (+/- 3 Hz.), and an ambient temperature of 25 degrees C. • Under the above conditions the power level in the sleep mode is then measured. • Product meets ENERGY STAR® criteria if 95% or more of the products sold are able to meet the criteria.	
Future/Potential Test Procedure(s)	No future/potential test procedures identified.	
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	• The ENERGY STAR® test procedure does not capture much of the energy savings because of the actual (field-measured) Power management enabled rate. • Depending on the Power management enabled rate, the influence of the active and standby energy consumption, relative to total UEC, changes. Currently, CRT monitors realize a 60% Power management enabled rate and active energy consumption dominates energy consumption. This suggests that effort into active power draw reduction (which is not measured by the test procedure) would realize higher energy savings than decreasing the sleep power draw. As the Power management enabled rate approaches 100%, the sleep mode energy consumption becomes more significant but the active energy use still accounts for a majority of energy consumption.	
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	The “active” power draw and Power management enabled rate dominate the peak load impact of commercial monitors. The test procedure effectively captures the ability of monitors to power down during peak periods, but does not capture the peak power draw of “active” monitors during peak periods.	Residential monitors probably do no impact peak loads because residential computers and monitors operate more frequently at night than during the day. In addition, the majority PCs and monitors not “active” are in the “off” mode rather than “standby” mode. Thus, during the peak-load sensitive times of the day, PC’s and monitors likely draw power in modes that do not fall under the test procedure.

Standards Consideration

Product: Pool Pumps

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Best available (best pump and best motor) = 0.09 • Optimum technology (best pump and best motor technology) = 0.21
Product / Technology Availability (Including Price/Cost information):	• Brushless DC motors available.
Cumulative Burden	Manufacturers of motors of >1HP have been regulated for energy efficiency (EPACT). The same manufacturers make lower horsepower motors for use in pool pumps.
Status of Test Procedures	• No pool pump specific test procedure is available. • Motor Test Procedure: Rotating Electrical Machines - Methods for Determining Losses and Efficiency of Rotating Electrical Machinery from Tests. This is a general procedure - not solely aimed at pump motors.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• Southern California Edison lists efficient pool pumps and gives rebates for purchasing such equipment. The efficiency of this equipment was not included in the analysis due to inconsistencies in the data. • Some equipment is marketed for its energy efficiency (e.g., Pentair, Speck, and Sta-rite). • GE ECM motors are available.
Issues	

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 2000)	0.04	(ADL, 1998)
Annual Shipments (millions, 2000)	N/A	
Stock (millions, 2000)	5.5	(ADL, 1998)
Product Lifetime (years)	10	(ADL, 2001)
Current UEC (kWh/year)	725	(ADL, 1998)
Typical New UEC (kWh/year)	725	(ADL, 1998)
Best Available UEC (kWh/year)	635	(ADL, 2001)
ENERGY STAR® UEC (kWh/year)	N/A	
Minimum UEC (kWh/year) Future Technology	517	(ADL, 2001)
Other Notable UEC (kWh/year)	N/A	
Additional Notable UEC (kWh/year)	N/A	

Test Procedure Summary

Product: Pool Pumps

Factors	Assessment
Test Procedure Overview	No product specific test procedures.
Future/Potential Test Procedure(s)	National Pool and Spa Institute may be trying to implement a test procedure for pool pump manufacturers, says David Nibbler of Waterpik Technologies/Jandy Pool Products. Detailed information was not known.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	Not applicable.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	These devices operate several hours per day. This period may or may not coincide with peak load sensitive times. Pool pumps can operate at any time as long as the National Sanitation Foundation requirement of one water change every 8 hours is met.

Standards Consideration

Product: Well Pumps

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	• Best available (best pump and best motor) = 0.17 $ Optimum technology (best pump and best motor technology) = 0.24
Product / Technology Availability (Including Price/Cost information):	• Brushless DC motors are available.
Cumulative Burden	Manufacturers of motors >1HP have been regulated for energy efficiency (EPACT). It is unknown if pump industry has ever been regulated for other applications and also unknown if companies who manufacture pumps have been subject to regulations for other equipment they manufacture.
Status of Test Procedures	• No specific water well pump test procedure. • Motor Test Procedure: Rotating Electrical Machines - Methods for Determining Losses and Efficiency of Rotating Electrical Machinery from Tests.
Evidence of Market-Driven or Voluntary Efficiency Improvements	• High efficiency pumps are commercially available; however, they do not appear to be marketed as such (inferred from viewing product literature). • Brushless DC motors are available (e.g., from GE) but are not marketed as motors for well pumps.
Issues	• Lifetime and durability are important factors for this equipment. • Submersible pump motors have unique geometry - narrow design and must fit into a well hole. Technical challenges may exist in applying energy efficient motor designs to this application.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads, 2000)	0.03	(ADL, 1998) and (ADL, 2001).
Annual Shipments (millions, 2000)	N/A	
Stock (millions, 2000)	14.3	(ADL, 1998) and (RECS, 1997).
Product Lifetime (years)	17.5	GWP (2001, personal communication).
Current UEC (kWh/year)	173	(ADL, 2001) and (ADL, 1998).
Typical New UEC (kWh/year)	173	(ADL, 2001) and (ADL, 1998).
Best Available UEC (kWh/year)	90.9	(ADL, 2001) and (ADL, 1998).
ENERGY STAR® UEC (kWh/year)	N/A	
Minimum UEC (kWh/year) Future Technology	60.2	(ADL, 2001) and (ADL, 1998).
Other Notable UEC (kWh/year)	N/A	
Additional Notable UEC (kWh/year)	N/A	

Test Procedure Summary

Product: Well Pumps

Factors	Assessment
Test Procedure Overview	No product specific test procedures.
Future/Potential Test Procedure(s)	Nothing under development. A submersible pump test (not specifically for well water pumps) will be available at the end of 2001, says the Hydraulic Institute.
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	Not applicable.
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	This product most likely has a limited affect on peak load. Equipment is most heavily used in the morning and operates for a minimal amount of time each day (19 minutes/household-day).

Standards Consideration

Product: Broilers

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	0.044[50]
Product / Technology Availability (Including Price/Cost information):	
Cumulative Burden	Most commercial cooking equipment manufacturers do not make other equipment that has seen prior energy efficiency regulation; insufficient data for other regulation.
Status of Test Procedures	All equipment types have ASTM Test Standards.
Evidence of Market-Driven or Voluntary Efficiency Improvements	
Issues	

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[50] All calculations based upon difference between “Best Available” and “Typical New” **gas** equipment. This will tend to overstate savings of electric devices, which typically have significantly higher efficiencies than gas devices.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads)	0.033	“Characterization of Commercial Building Appliances” (ADL, 1993).
Unit Energy Consumption (MMBtu)	282	“Characterization of Commercial Building Appliances” (ADL, 1993).
Annual Shipments (millions, 1997)	6,500 gas 2,250 elec	FE&S (1997).
Installed Base (million, 1995)	0.157	NAFEM (ADL, 1995).
Product Lifetime (years)	15 - 20	ADL Estimate (2001).
Minimum Efficiency Standard	N/A	
Stock Efficiency	20 - 40% gas 40 - 60% elec	“Characterization of Commercial Building Appliances” (ADL, 1993).
Typical New Efficiency	30% gas 60% elec	Year 2000 estimates based on “Characterization of Commercial Building Appliances” (ADL, 1993).
Best Available Efficiency		
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)		
Comments		Installed Base is 91% gas / 9% electric (NAFEM & Food Management; c. 1990).

Standards Consideration

Product: Fryers

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	0.27[51]
Product / Technology Availability (Including Price/Cost information):	
Cumulative Burden	Most commercial cooking equipment manufacturers do not make other equipment that has seen prior energy efficiency regulation; insufficient data for other regulation.
Status of Test Procedures	All equipment types have ASTM Test Standards.
Evidence of Market-Driven or Voluntary Efficiency Improvements	
Issues	

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[51] All calculations based upon difference between "Best Available" and "Typical New" **gas** equipment. This will tend to overstate savings of electric devices, which typically have significantly higher efficiencies than gas devices.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads)	0.060	"Characterization of Commercial Building Appliances" (ADL, 1993).
Unit Energy Consumption (MMBtu)	62	"Opportunities and Competition in the Food Service Equipment Industry" (ADL, 1995).
Annual Shipments (millions, 1997)	117,000	Appliance (May 2000) About 70% gas/30% elec. FE&S (1997).
Installed Base (million, 1995)	0.97	NAFEM & Food Management (c. 1990).
Product Lifetime (years)	7 - 10	ADL Estimate (2001).
Minimum Efficiency Standard	N/A	
Stock Efficiency	40 - 50% gas 55 - 65% elec	"Characterization of Commercial Building Appliances" (ADL, 1993).
Typical New Efficiency	50 - 60% gas 95% elec	Year 2000 estimates based on "Characterization of Commercial Building Appliances" (ADL, 1993).
Best Available Efficiency	80% gas 98% elec	Large increase in fryer-liquid heat exchange surface area (ADL, 2001).
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)		
Comments		Installed Base is 58% gas / 42% electric (NAFEM & Food Management; c. 1990).

Standards Consideration

Product: Griddles

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	0.14[52]
Product / Technology Availability (Including Price/Cost information):	
Cumulative Burden	Most commercial cooking equipment manufacturers do not make other equipment that has seen prior energy efficiency regulation; insufficient data for other regulation.
Status of Test Procedures	All equipment types have ASTM Test Standards.
Evidence of Market-Driven or Voluntary Efficiency Improvements	
Issues	

[52] All calculations based upon difference between "Best Available" and "Typical New" **gas** equipment. This will tend to overstate savings of electric devices, which typically have significantly higher efficiencies than gas devices.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads)	0.039	"Characterization of Commercial Building Appliances" (ADL, 1993).
Unit Energy Consumption (MMBtu)	125	"Characterization of Commercial Building Appliances" (ADL, 1993).
Annual Shipments (millions, 1997)	34,455	FE&S (1997).
Installed Base (million, 1995)	0.312	NAFEM (ADL, 1995).
Product Lifetime (years)	10 - 15	ADL Estimate (2001).
Minimum Efficiency Standard	N/A	
Stock Efficiency	35 - 45% gas 50 - 65% elec	"Characterization of Commercial Building Appliances" (ADL, 1993).
Typical New Efficiency		
Best Available Efficiency	55% gas 65% elec	Year 2000 estimates based on "Characterization of Commercial Building Appliances" (ADL, 1993).
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)		
Comments		Installed Base is 50% gas / 50% electric (NAFEM & Food Management; c. 1990).

Standards Consideration

Product: Ovens

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	0.28[53]
Product / Technology Availability (Including Price/Cost information):	
Cumulative Burden	Most commercial cooking equipment manufacturers do not make other equipment that has seen prior energy efficiency regulation; insufficient data for other regulation.
Status of Test Procedures	All equipment types have ASTM Test Standards.
Evidence of Market-Driven or Voluntary Efficiency Improvements	
Issues	

[53] All calculations based upon difference between "Best Available" and "Typical New" **gas** equipment. This will tend to overstate savings of electric devices, which typically have significantly higher efficiencies than gas devices.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads)	0.24	"Characterization of Commercial Building Appliances" (ADL, 1993).
Unit Energy Consumption (MMBtu)	282	"Characterization of Commercial Building Appliances" (ADL, 1993).
Annual Shipments (millions, 1997)	89,000 gas 67,000 elec	Appliance May, 2000.
Installed Base (million, 1995)	0.85	NAFEM (ADL, 1995).
Product Lifetime (years)	15 - 20	ADL Estimate.
Minimum Efficiency Standard	N/A	
Stock Efficiency	35 - 45% gas 65% elec	"Characterization of Commercial Building Appliances" (ADL, 1993).
Typical New Efficiency	45% gas 65% elec	ADL Estimate (2001).
Best Available Efficiency		
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)		
Comments		Installed Base is 55% gas / 45% electric (NAFEM & Food Management; c. 1990).

Standards Consideration

Product: Ranges

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	0.18[54]
Product / Technology Availability (Including Price/Cost information):	
Cumulative Burden	Most commercial cooking equipment manufacturers do not make other equipment that has seen prior energy efficiency regulation; insufficient data for other regulation.
Status of Test Procedures	All equipment types have ASTM Test Standards.
Evidence of Market-Driven or Voluntary Efficiency Improvements	
Issues	

[54] All calculations based upon difference between “Best Available” and “Typical New” **gas** equipment. This will tend to overstate savings of electric devices, which typically have significantly higher efficiencies than gas devices.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads)	0.090	“Characterization of Commercial Building Appliances” (ADL, 1993).
Unit Energy Consumption (MMBtu)	138	“Characterization of Commercial Building Appliances” (ADL, 1993).
Annual Shipments (millions, 1997)	81,300	FE&S (1997).
Installed Base (million, 1995)	0.65	NAFEM (ADL, 1995).
Product Lifetime (years)	15 - 20	ADL Estimate.
Minimum Efficiency Standard	N/A	
Stock Efficiency	40 - 50% gas 65 - 75% elec	“Characterization of Commercial Building Appliances” (ADL, 1993).
Typical New Efficiency		
Best Available Efficiency	60% gas 80% elec	Year 2000 estimates based on “Characterization of Commercial Building Appliances” (ADL, 1993).
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)		
Comments		Installed Base is 91% gas / 9% electric (NAFEM & Food Management; c. 1990).

Standards Consideration

Product: Steamers

Factors for Consideration	Assessment
Potential Energy Savings from Regulatory Action; Cumulative (Quads) 2008-2030	0.11[55]
Product / Technology Availability (Including Price/Cost information):	
Cumulative Burden	Most commercial cooking equipment manufacturers do not make other equipment that has seen prior energy efficiency regulation; insufficient data for other regulation.
Status of Test Procedures	All equipment types have ASTM Test Standards.
Evidence of Market-Driven or Voluntary Efficiency Improvements	
Issues	

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[55] All calculations based upon difference between "Best Available" and "Typical New" **gas** equipment. This will tend to overstate savings of electric devices, which typically have significantly higher efficiencies than gas devices.

Background Material

Description	Value	Comments/Source
Total Energy Use (quads)	0.056	"Characterization of Commercial Building Appliances" (ADL, 1993).
Unit Energy Consumption (MMBtu)	329	"Characterization of Commercial Building Appliances" (ADL, 1993).
Annual Shipments (millions, 1997)	9,800	FE&S (1997).
Installed Base (million, 1995)	0.17	NAFEM (ADL, 1995).
Product Lifetime (years)	10 - 15	ADL Estimate (2001).
Minimum Efficiency Standard	N/A	
Stock Efficiency	40 - 60% gas 60 - 70% elec	"Characterization of Commercial Building Appliances" (ADL, 1993).
Typical New Efficiency		
Best Available Efficiency	70% gas 90% elec	Year 2000 estimates based on "Characterization of Commercial Building Appliances" (ADL, 1993).
ENERGY STAR® Efficiency	N/A	
Maximum Efficiency (Future Technology)		
Comments		Installed Base is 33% gas / 67% electric (NAFEM & Food Management; c. 1990).

Test Procedure Summary

Product: All Commercial Cooking

Factors	Assessment
Test Procedure Overview	All equipment types have ASTM Test Standards.
Future/Potential Test Procedure(s)	
How effectively do test procedure(s) and metric(s) represent actual annual energy consumption and potential savings?	
Product Peak Load Impact and Correlation with Test Procedure and Metric, by Technology	Unknown; only electric appliances contribute to peak loads, and they account for only ~19% of all site cooking energy consumption (ADL, 1993).