



# ENERGY STAR® Program Requirements Product Specification for Imaging Equipment

## Test Method for Determining Imaging Equipment Energy Use Draft 1 Rev. Aug-2017

### 1 OVERVIEW

The following test method shall be used for determining product compliance with requirements in the ENERGY STAR Eligibility Criteria for Imaging Equipment.

### 2 APPLICABILITY

ENERGY STAR test requirements are dependent upon the feature set of the products under evaluation. Table 1 shall be used to determine the applicability of each section of this document.

**Table 1: Test Procedure Applicability**

Product Type	Media Format	Marking Technology	ENERGY STAR Evaluation Method
Copier	Standard	Direct Thermal (DT), Dye Sublimation (DS), Electro-photographic (EP), Solid Ink (SI), Thermal Transfer (TT)	Typical Energy Consumption (TEC)
	Large	DT, DS, EP, SI, TT	Operational Mode (OM)
Digital Duplicator	Standard	Stencil	TEC
Fax Machine	Standard	DT, DS, EP, SI, TT	TEC
		Ink Jet (IJ)	OM
Mailing Machine	All	DT, EP, IJ, TT	OM
Multifunction Device (MFD)	Standard	High Performance IJ, DT, DS, EP, SI, TT	TEC
		IJ, Impact	OM
	Large	High Performance IJ, DT, DS, EP, IJ, SI, TT	OM
Printer	Standard	High Performance IJ, DT, DS, EP, SI, TT	TEC
		IJ, Impact	OM
	Large or Small	DT, DS, EP, Impact, IJ, SI, TT	OM
	Large	High Performance IJ	OM
	Small	High Performance IJ	TEC
Scanner	All	N/A	OM

8 **3 DEFINITIONS**

9 Unless otherwise specified, all terms used in this document are consistent with the definitions in the  
10 ENERGY STAR Eligibility Criteria for Imaging Equipment.

11 **4 TEST SETUP**

12 **4.1 General Test Setup**

- 13 A) Test Setup and Instrumentation: Test setup and instrumentation for all portions of this procedure shall  
14 be in accordance with the requirements of International Electrotechnical Commission (IEC) Standard  
15 62301, Ed. 2.0, "Measurement of Household Appliance Standby Power", Section 4, "General  
16 Conditions for Measurements." In the event of conflicting requirements, the ENERGY STAR test  
17 method shall take precedence.
- 18 B) Ac Input Power: Products intended to be powered from an ac mains power source shall be connected  
19 to a voltage source appropriate for the intended market, as specified in Table 2 or Table 3.
- 20 1) Products shipped with external power supplies (EPSs) shall first be connected to the EPS and  
21 then to the voltage source specified in Table 2 or Table 3.
- 22 2) If a product is rated to operate at a voltage/frequency combination in a specific market that is  
23 different from the voltage/frequency combination for that market (e.g., 230 volts (V), 60 hertz (Hz)  
24 in North America), the unit shall be tested at the manufacturer rated voltage/frequency  
25 combination for that unit. The voltage/frequency used shall be reported.

26 **Table 2: Input Power Requirements for Products with**  
27 **Nameplate Rated Power Less Than or Equal to 1500 W**

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 V ac	+/- 1.0 %	2.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 V ac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 1.0 %	2.0 %	50 Hz or 60 Hz	+/- 1.0 %

28 **Table 3: Input Power Requirements for Products with**  
29 **Nameplate Rated Power Greater than 1500 W**

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 V ac	+/- 4.0 %	5.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 V ac	+/- 4.0 %	5.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 4.0 %	5.0 %	50 Hz or 60 Hz	+/- 1.0 %

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- 32 C) Low-voltage Dc Input Power:
- 33 1) Products may be powered with a low-voltage dc source (e.g., via network or data connection)
- 34 only if the dc source is the only acceptable source of power for the product (i.e., no ac plug or
- 35 EPS is available).
- 36 2) Products powered by low-voltage dc shall be configured with an ac source of the dc power for
- 37 testing (e.g., an ac-powered universal serial bus (USB) hub).
- 38 a) The ac source of the dc power used for testing shall be recorded and reported for all tests.
- 39 3) Power for the unit under test (UUT) shall include the following, as measured per Section 5 of this
- 40 method:
- 41 a) Ac power consumption of the low-voltage dc source with the UUT as the load ( $P_L$ ); and
- 42 b) Ac power consumption of the low-voltage dc source with no load ( $P_S$ ).
- 43 D) Ambient Temperature: Ambient temperature shall be  $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ .
- 44 E) Relative Humidity: Relative humidity shall be between 10% and 80%.
- 45 F) Power Meter: Power meters shall possess the following attributes:
- 46 1) Minimum Frequency Response: 3.0 kHz
- 47 2) Minimum Resolution:
- 48 a) 0.01 W for measurement values less than 10 W;
- 49 b) 0.1 W for measurement values from 10 W to 100 W;
- 50 c) 1 W for measurement values from 100 W to 1.5 kW; and
- 51 d) 10 W for measurement values greater than 1.5 kW.
- 52 e) Measurements of accumulated energy should have resolutions which are generally
- 53 consistent with these values when converted to average power. For accumulated energy
- 54 measurements, the figure of merit for determining required accuracy is the maximum power
- 55 value during the measurement period, not the average, since it is the maximum that
- 56 determines the metering equipment and setup.
- 57 G) Measurement Uncertainty<sup>1</sup>:
- 58 1) Measurements of greater than or equal to 0.5 W shall have an uncertainty of 2% or better at the
- 59 95% confidence level.
- 60 2) Measurements of less than 0.5 W shall have an uncertainty of 0.02 W or better at the 95%
- 61 confidence level.
- 62 H) Time Measurement: Time measurements may be performed with a standard stopwatch or other time
- 63 keeping device with a resolution of at least 1 second.
- 64 I) Paper Specifications:
- 65 1) Standard Format Products shall be tested in accordance with Table 4.
- 66 2) Large, Small, and Continuous Format products shall be tested using any compatible paper size.
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<sup>1</sup> Measurement uncertainty calculations should be performed according IEC 62301 Ed. 2.0 Appendix D. Only the uncertainty due to the measurement instrument shall be calculated.

**Table 4: Paper Size and Weight Requirements**

Market	Paper Size	Basis Weight (g/m <sup>2</sup> )
North America / Taiwan	8.5" × 11"	75
Europe / Australia / New Zealand	A4	80
Japan	A4	64

## 72 5 LOW-VOLTAGE DC SOURCE MEASUREMENT FOR ALL 73 PRODUCTS

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- 75 1) Connect the dc source to the power meter and relevant ac supply as specified in Table 2.
- 76 2) Verify that the dc source is unloaded.
- 77 3) Allow the dc source to stabilize for a minimum of 30 minutes.
- 78 4) Measure and record the unloaded dc source power (P<sub>s</sub>) according to section 9.1.A.1 of this test
- 79 method.
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## 83 6 PRE-TEST UUT CONFIGURATION FOR ALL PRODUCTS

### 84 6.1 General Configuration

85 A) As-shipped Condition: All products shall be tested in their "as-shipped" configuration unless otherwise  
86 specified by this test method.

87 B) Product Speed for Calculations and Reporting: The product speed for all calculations and reporting  
88 shall be the highest speed as claimed by the manufacturer per the following criteria, expressed in  
89 images per minute (ipm) and rounded to the nearest integer:

90 1) In general, for Standard-size products, a single A4 or 8.5" × 11" sheet printed/copied/scanned on  
91 one side in one minute is equal to 1 (ipm).

92 a) When operating in duplex mode a single A4 or 8.5" × 11" sheet printed/copied/scanned on  
93 both sides in one minute is equal to 2 (ipm).

94 2) For all products, the product speed shall be based on:

95 a) The manufacturer-claimed monochrome print speed based on International Organization for  
96 Standardization/International Electrotechnical Commission (ISO/IEC) Standard 24734  
97 Estimated Saturated Throughput (ESAT), unless the product cannot print, in which case,

98 b) The manufacturer-claimed monochrome copy speed based on ISO/IEC Standard 24735  
99 Estimated Saturated Throughput (ESAT), unless the product does not have an automatic  
100 document feeder, in which case,

101 c) The manufacturer-claimed monochrome copy speed based on ISO/IEC Standard 29183  
102 Estimated Saturated Throughput (ESAT), unless the product cannot print or copy, in which  
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**Note:** One stakeholder requested that EPA require testing print speed in accordance with international standards, similar to the Blue Angel specification. After comparing the print speeds reported by manufacturers in test reports and specifications available online with the ENERGY STAR dataset, EPA believes there is an opportunity to promote further consistency by referencing the above ISO/IEC standards. By using the same method of measurement, ISO/IEC print speeds allow consumers to gauge the true performance of printers and compare all printers from different manufacturers. EPA expects that manufacturers are already performing tests according to these international standards, and therefore does not expect this requirement to impose any further burden, while promoting consistency. EPA welcomes feedback on this proposal.

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- d) The manufacturer-claimed scan speed.
- e) When a manufacturer intends to qualify a product in a certain market by making use of test results that qualified the product in another market using other sizes of paper (e.g., A4 versus 8.5" x 11"), and if its maximum claimed speeds differ when producing images on different sizes of paper, the highest speed shall be used.

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**Table 5: Calculation of Product Speed for Standard, Small, and Large Format Products with the Exception of Mailing Machines**

Media Format	Media Size	Product Speed, <i>s</i> (ipm)
		<i>Where:</i> <ul style="list-style-type: none"> <li>• <i>s<sub>P</sub></i> is the maximum claimed monochrome speed in images per minute when processing the given media,</li> <li>• <i>w</i> is the width of the media, in meters (<i>m</i>),</li> <li>• <i>ℓ</i> is the length of the media, in meters (<i>m</i>).</li> </ul>
Standard	8.5" x 11"	<i>s<sub>P</sub></i>
	A4	<i>s<sub>P</sub></i>
Small	4" x 6"	0.25 x <i>s<sub>P</sub></i>
	A6	0.25 x <i>s<sub>P</sub></i>
	Smaller than A6 or 4" x 6"	16 x <i>w</i> x <i>ℓ</i> x <i>s<sub>P</sub></i>
Large	A2	4 x <i>s<sub>P</sub></i>
	A0	16 x <i>s<sub>P</sub></i>

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- 3) For Continuous Form products, product speed shall be calculated per Equation 1

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**Equation 1: Calculation of Product Speed**

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$$s = 16 \times w \times s_L$$

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*Where:*

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- *s* is the product speed, in ipm,

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- *w* is the width of the media, in meters (*m*),

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- *s<sub>L</sub>* is the maximum claimed monochrome speed, in meters per minute.

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- 4) For Mailing Machines, product speed shall be reported in units of mail pieces per minute (mppm).

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- 5) The product speed used for all calculations and qualification, as calculated above, may not be the same as the product speed used for testing.

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- C) Color: Color-capable products shall be tested making monochrome (black) images.

- 132 1) For those products without black ink, a composite black shall be used.
- 133 D) Network Connections: Products that are capable of being network-connected as-shipped shall be
- 134 connected to a network.
- 135 1) Products shall be connected to only one network or data connection for the duration of the test.
- 136 a) Only one computer may be connected to the UUT, either directly or via a network.
- 137 2) The type of network connection depends on the characteristics of the UUT and shall be the
- 138 topmost connection listed in Table 6 available on the unit as-shipped.

139 **Table 6: Network or Data Connections for Use in Test**

Order of Preference for Use in Test (if Provided by UUT)	Connections for all Products
1	Ethernet – 1 Gb/s
2	Ethernet – 100/10 Mb/s
3	Wi-Fi
4	USB 3.x
5	USB 2.x
6	USB 1.x
7	RS232
8	IEEE 1284 <sup>2</sup>
9	Other Wired – in order of preference from highest to lowest speed
10	Other Wireless – in order of preference from highest to lowest speed
11	If none of the above, test with whatever connection is provided by the device (or none)

140 **Note:** EPA has re-prioritized the list of network connections, such that Wi-Fi now takes priority over

141 USB, to reflect the protocol's popularity among consumer imaging equipment.

- 142 3) Products connected to Ethernet, per paragraph 6.1.D)2) above, and capable of supporting
- 143 Energy Efficient Ethernet (IEEE Standard 802.3az)<sup>3</sup>, shall be connected to a network switch or
- 144 router that also supports Energy Efficient Ethernet for the duration of the test.
- 145 4) In all cases the type of connection used during the test shall be reported.
- 146 E) Service/Maintenance Modes: UUTs shall never be in service/maintenance modes, including color
- 147 calibration, during testing.
- 148 1) Service/Maintenance modes shall be disabled prior to testing.

<sup>2</sup> Also referred to as a Parallel or Centronics interface.

<sup>3</sup> Institute of Electrical and Electronics Engineers (IEEE) Standard 802.3az-2010. "IEEE Standard for Information Technology—Telecommunications and Information Exchange Between Systems—Local and Metropolitan Area Networks—Specific Requirements—Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications." 2010.

- 149 2) Manufacturers shall provide instructions detailing how to disable service/maintenance modes if  
150 this information is not included in the product documentation packaged with the UUT or is not  
151 readily available online.
- 152 3) If service/maintenance modes cannot be disabled and a service/maintenance mode occurs  
153 during a job other than the first job, the results from the job with the service/maintenance mode  
154 shall be replaced with results from a substitute job. In this case, the substitute job shall be  
155 inserted into the test procedure immediately following Job 4 and the inclusion of the substitute job  
156 shall be reported. Each job period shall be 15 minutes.

## 157 **6.2 Configuration for Fax Machines**

- 158 A) All fax machines and MFDs with fax capability that connect to a telephone line shall be connected to  
159 a telephone line during the test, in addition to the network connection specified by Table 6 if the UUT  
160 is network capable.
- 161 1) In the case that a working phone line is not available, a line simulator may be used as a  
162 replacement.
- 163 2) Only fax machines shall be tested using the fax capability.
- 164 B) Fax machines shall be tested with one image per job.

## 165 **6.3 Configuration for Digital Duplicators**

- 166 A) Except as noted below, digital duplicators shall be configured and tested as printers, copiers, or  
167 MFDs, depending on their capabilities as-shipped.
- 168 1) Digital duplicators shall be tested at maximum claimed speed, which is also the speed that should  
169 be used to determine the job size for performing the test, not at the default as-shipped speed, if  
170 different.
- 171 2) For digital duplicators, there shall be only one original image.

# 172 **7 PRE-TEST UUT INITIALIZATION FOR ALL PRODUCTS**

## 173 **7.1 General Initialization**

- 174 A) Prior to the start of testing, the UUT shall be initialized as follows:
- 175 1) Set up the UUT per the instructions in the Manufacturer's Instructions or documentation.
- 176 a) Accessories, such as paper source, that are shipped with the base product and are intended  
177 to be installed or attached by the end-user shall be installed as intended for the product  
178 model. Paper shall be placed in all paper sources designated to hold the paper specified for  
179 testing, and the UUT shall pull from the default paper source, using the as-shipped paper  
180 source settings.
- 181 b) If the product is connected to a computer, either directly or via a network, during the test, the  
182 computer shall be running the newest version of the manufacturer's default driver available at  
183 the time of testing using settings corresponding to the default settings upon shipment, unless  
184 otherwise specified in this test method. The print driver version used for testing shall be  
185 recorded.
- 186 i) In the event that a setting does not have a default and is not defined in this test method,  
187 the setting shall be set according to the tester's discretion and shall be recorded.
- 188 ii) When connecting via a network and multiple computers are connected to the network,  
189 print driver settings apply only to the computer sending the print jobs to the UUT.

- 190 c) For products designed to operate on battery power when not connected to the mains power  
191 source, the battery shall be removed for all tests. For UUTs where operation without a battery  
192 pack is not a supported configuration, the test shall be performed with fully charged battery  
193 pack(s) installed, making sure to report this configuration in the test results. To ensure the  
194 battery is fully charged, perform the following steps:
- 195 i) For UUTs that have an indicator to show that the battery is fully charged, continue  
196 charging for an additional 5 hours after the indication is present.
- 197 ii) If there is no charge indicator, but the manufacturer's instructions provide a time estimate  
198 for when charging this battery or this capacity of battery should be complete, continue  
199 charging for an additional 5 hours after the manufacturer's indication.
- 200 iii) If there is no indicator and no time estimate in the instructions, the duration shall be 24  
201 hours.
- 202 2) Connect the UUT to its power source.
- 203 3) Power on the UUT and perform initial system configuration, as applicable. Verify that default  
204 delay times are configured according to product specifications and/or manufacturer  
205 recommendations.
- 206 a) Product Speed for Testing: The product shall be tested with speed settings in their default as-  
207 shipped configuration.
- 208 b) Auto-off for TEC Products: If a printer, digital duplicator, fax machine, or MFD with print-  
209 capability has Auto-off capability and it is enabled as-shipped, it shall be disabled prior to  
210 testing.
- 211 c) Auto-off for OM Products: If a product has an Auto-off Mode enabled as-shipped, it shall  
212 remain enabled for the duration of testing.
- 213 4) User-controllable anti-humidity features shall be turned off or disabled for the duration of testing.
- 214 5) Pre-conditioning: Place the UUT in Off Mode, then let the UUT sit idle for 15 minutes.
- 215 a) For EP-TEC products, let the UUT sit in Off Mode for an additional 105 minutes, for a total of  
216 at least 120 minutes (2 hours).
- 217 b) Pre-conditioning is only required prior to beginning the first test on each UUT.

## 218 **8 TYPICAL ENERGY CONSUMPTION (TEC) TEST PROCEDURE**

### 219 **8.1 Job Structure**

- 220 A) Jobs per Day: The number of jobs per day ( $N_{\text{JOBS}}$ ) is specified in Table 7.



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**Table 7: Number of Jobs per Day (N<sub>JOBS</sub>)**

Monochrome Product Speed, s (ipm)	Jobs per Day (N <sub>JOBS</sub> )
s ≤ 8	8
8 < s < 32	s
s ≥ 32	32

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- B) Images per Job: Except for fax machines, the number of images shall be computed according to Equation 2, below. For convenience, Table 11 at the end of this document provides the resultant images per job computation for each integer product speed up through 100 ipm.

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**Equation 2: Calculation of Number of Images per Job**

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$$N_{IMAGES} = \begin{cases} 1 & s < 4 \\ \mathit{int} \left[ \frac{(0.5 \times s^2)}{N_{JOBS}} \right] & s \geq 4 \end{cases}$$

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Where:

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- *N<sub>IMAGES</sub>* is the number of images per job, rounded down (truncated) to the nearest integer,
- *s* is the product speed in images per minute (ipm), calculated in section 6.1.B), of this test procedure, and
- *N<sub>JOBS</sub>* is the number of jobs per day, as calculated per Table 7.

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- C) Test Image: Test Pattern A from ISO/IEC Standard 10561:1999 shall be used as the original image for all testing.

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- 1) Test images shall be rendered in 10 point size in a fixed-width Courier font (or nearest equivalent).

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- 2) German-specific characters need not be reproduced if the product is incapable of German character reproduction.

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- D) Print Jobs: Print jobs for the test shall be sent over the network connection designated in Table 6 immediately before printing each job.

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- 1) Each image in a print job shall be sent separately, (i.e., all images may be part of the same document), but shall not be specified in the document as multiple copies of a single original image (unless the product is a digital duplicator).

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- 2) For printers and MFDs that can interpret a page description language (PDL) (e.g., Printer Command Language PCL, Postscript), images shall be sent to the product in a PDL.

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- E) Copy Jobs:

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- 1) For copiers with speed less than or equal to 20 ipm, there shall be one original per required image.

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- 2) For copiers with speed greater than 20 ipm, it may not be possible to match the number of required original images (i.e., due to limits on document feeder capacity). In this case, it is permissible to make multiple copies of each original, and the number of originals shall be greater than or equal to ten.

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**Example:** For a 50 ipm unit that requires 39 images per job, the test may be performed with four copies of 10 originals or three copies of 13 originals.

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3) Originals may be placed in the document feeder before the test begins.

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a) Products without a document feeder may make all images from a single original placed on the platen.

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F) Fax Jobs: Fax jobs shall be sent via the connected phone line or line simulator immediately before performing each job.

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## 8.2 Measurement Procedures

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A) Measurement of TEC shall be conducted according to Table 8 for printers, fax machines, digital duplicators with print capability, and MFDs with print capability, and Table 9 for copiers, digital duplicators without print capability, and MFDs without print capability, subject to the following provisions:

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1) Paper: There shall be sufficient paper in the UUT to perform the specified print or copy jobs.

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2) Duplexing: Products shall be tested in simplex mode, unless the speed of duplex mode output is greater than the speed of simplex mode output, in which case they shall be tested in duplex mode. In all cases, the mode in which the unit was tested and the print speed used must be documented. Originals for copying shall be simplex images.

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3) Energy Measurement Method: All measurements shall be recorded as accumulated energy over time, in Wh; all time shall be recorded in minutes.

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a) "Zero meter" references may be accomplished by recording the accumulated energy consumption at that time rather than physically zeroing the meter.

**Table 8: TEC Test Procedure for Printers, Fax Machines, Digital Duplicators with Print Capability, and MFDs with Print Capability**

Step	Initial State	Action	Record (at end of step)	Unit of Measure	Possible States Measured
1	Off	Connect the UUT to the meter. Ensure the unit is powered and in Off Mode. Zero the meter; measure energy over 5 minutes or more. Record both energy and time.	Off energy	Watt-hours (Wh)	Off
			Testing Interval time	Minutes (min)	
2	Off	Turn on unit. Wait until unit indicates it is in Ready Mode.	–	–	–
3	Ready	Print a job of at least one output image but no more than a single job per Table 11. Measure and record time to first sheet exiting unit.	Active0 time	Minutes (min)	–
4	Ready (or other)	Wait until the meter shows that the unit has entered its final Sleep Mode or the time specified by the manufacturer.	–	–	–
5	Sleep	Zero meter; measure energy and time over 1 hour. Record the energy and time.	Sleep energy, $E_{SLEEP}$	Watt-hours (Wh)	Sleep
			Sleep time, $t_{SLEEP}$ ( $\leq 1$ hour)	Minutes (min)	
6	Sleep	Zero meter and timer. Print one job (calculated above). Measure energy and time. Record time to first sheet exiting unit. Measure energy over 15 minutes from job initiation. The job must finish within the 15 minutes.	Job1 energy, $E_{JOB1}$	Watt-hours (Wh)	Recovery, Active, Ready, Sleep
			Active1 time	Minutes (min)	
7	Ready (or other)	Repeat Step 6.	Job2 energy, $E_{JOB2}$	Watt-hours (Wh)	Same as above
			Active2 time	Minutes (min)	
8	Ready (or other)	Repeat Step 6 (without Active time measurement).	Job3 energy, $E_{JOB3}$	Watt-hours (Wh)	Same as above
9	Ready (or other)	Repeat Step 6 (without Active time measurement).	Job4 energy, $E_{JOB4}$	Watt-hours (Wh)	Same as above
10	Ready (or other)	Zero meter and timer. Measure energy and time until meter and/or unit shows that unit has entered Sleep Mode or the final Sleep Mode for units with multiple Sleep modes, or the time specified by the manufacturer, if provided. Record energy and time.	Final energy, $E_{FINAL}$	Watt-hours (Wh)	Ready, Sleep
			Final time, $t_{FINAL}$	Minutes (min)	

278 Notes:

- 279 • Steps 4 and 10: For those units that do not indicate when they have entered the Final Sleep Mode, manufacturers shall specify the time to Final Sleep Mode for testing purposes.
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**Table 9: TEC Test Procedure for Copiers, Digital Duplicators without Print Capability, and MFDs without Print Capability**

Step	Initial State	Action	Record	Unit of Measure	Possible States Measured
1	Off	Connect the UUT to the meter. Ensure the unit is powered and in Off Mode. Zero the meter; measure energy over 5 minutes or more. Record both energy and time.	Off energy	Watt-hours (Wh)	Off
			Testing Interval time	Minutes (min)	
2	Off	Turn on unit. Wait until unit has entered Ready Mode.	–	–	–
3	Ready	Copy a job of at least one image but no more than a single job per Table 11. Measure and record time to first sheet exiting unit	Active0 time	Minutes (min)	–
4	Ready (or other)	Wait until the meter shows that the unit has entered its final Sleep Mode or the time specified by the manufacturer and measure the default time to sleep	Sleep default-delay time, $t_{SLEEP}$	Minutes (min)	–
5	Sleep	Zero meter; measure energy and time over 1 hour or until unit enters Auto-off Mode. Record the energy and time.	Sleep energy	Watt-hours (Wh)	Sleep
			Sleep time ( $\leq 1$ hour)	Minutes (min)	
6	Sleep	Zero meter and timer. Copy one job (calculated above). Measure and record energy and time to first sheet exiting unit. Measure energy over 15 minutes from job initiation. The job must finish within the 15 minutes.	Job1 energy, $E_{JOB1}$	Watt-hours (Wh)	Recovery, Active, Ready, Sleep, Auto-off
			Active1 time	Minutes (min)	
7	Ready (or other)	Repeat Step 6.	Job2 energy, $E_{JOB2}$	Watt-hours (Wh)	Same as above
			Active2 time	Minutes (min)	
8	Ready (or other)	Repeat Step 6 (without Active time measurement).	Job3 energy, $E_{JOB3}$	Watt-hours (Wh)	Same as above
9	Ready (or other)	Repeat Step 6 (without Active time measurement).	Job4 energy, $E_{JOB4}$	Watt-hours (Wh)	Same as above
10	Ready (or other)	Zero meter and timer. Measure energy and time until meter and/or unit shows that unit has entered its Auto-off Mode or the time specified by the manufacturer. Record energy and time; if unit began this step while in Auto-off Mode, report both energy and time values as zero.	Final energy, $E_{FINAL}$	Watt-hours (Wh)	Ready, Sleep
			Final time, $t_{FINAL}$	Minutes (min)	
11	Auto-off	Zero the meter; measure energy and time over 5 minutes or more. Record both energy and time.	Auto-off energy, $E_{AUTO}$	Watt-hours (Wh)	Auto-off
			Auto-off time, $t_{AUTO}$	Minutes (min)	

283 Notes:

- *Steps 4 and 10: For those units that do not indicate when they have entered the Final Sleep Mode, manufacturers shall specify the time to Final Sleep Mode for testing purposes.*

### 8.3 Network Activity Test

The following network-connected sleep test step will be included in the TEC Test Procedure for Printers, Fax Machines, Digital Duplicators with Print Capability, and MFDs with Print Capability, placed after Step 10, after the unit has entered Sleep Mode.

- A) Ensure that SNMP Service is enabled on the computer connected to the UUT<sup>4</sup>. For a Windows computer, follow these steps to enable SNMP Service (administrator must be logged in):
  - 1) From the computer's Control Panel, click on "Programs and Features."
  - 2) Within Programs and Features, click on "Turn Windows features on or off." Check the box for "Simple Network Management Protocol (SNMP)" if it is not checked already. Click "OK" which will install the feature.
  - 3) Restart the computer.
  - 4) Search and open "Services" or "services.msc" from the Taskbar.
  - 5) Right click on "SNMP Service" and open Properties.
  - 6) In the General tab, ensure that Automatic is selected for Startup Type.
  - 7) In the Security tab, add an accepted community name (i.e. community string) called "public" which has at least "Read Only" rights, if this community string is not already present.
  - 8) Still in the Security tab, select "Accept SNMP packets from these hosts" and input the UUT's IP address, or select "Accept SNMP packets from any host" if compatible with the computer's security needs.
  - 9) In the Agent tab, fill out the Contact and Location fields and check all boxes, to ensure that all SNMP values will be made available to the computer.
  - 10) Select "OK" and restart the server. SNMP Service is now enabled.
- B) From the computer, download, install, start, and configure any Acceptable Software Program<sup>5</sup> necessary to communicate with the UUT using each of the following protocols:
  - 1) Simple Network Management Protocol (SNMP)
  - 2) NetBIOS Name Service (NBNS)

The remaining test language assumes the use of OiDVIEW SNMP MIB Walker and Nbtstat, but use the equivalent when using other Acceptable Software Programs.

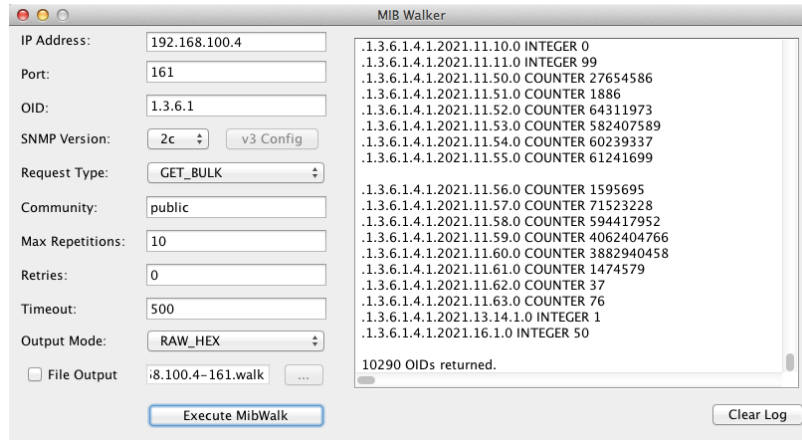
<sup>4</sup> There are currently three versions of SNMP: 1, 2c, and 3, with the key difference being that Version 3 requires encryption and authentication, with a specific username and password, while the older versions simply require a "community string" which is usually set to "public" for easy access. Most devices support Version 2c, which is the default for most SNMP software programs, therefore, please attempt to use Version 2c. In the event that Version 2c is not available, please enable Version 3 and perform required steps to use it (e.g., set up username and password).

<sup>5</sup> Acceptable software programs are any which can successfully demonstrate communication to the imaging equipment via one of the listed protocols. A sample of such programs are shown below.

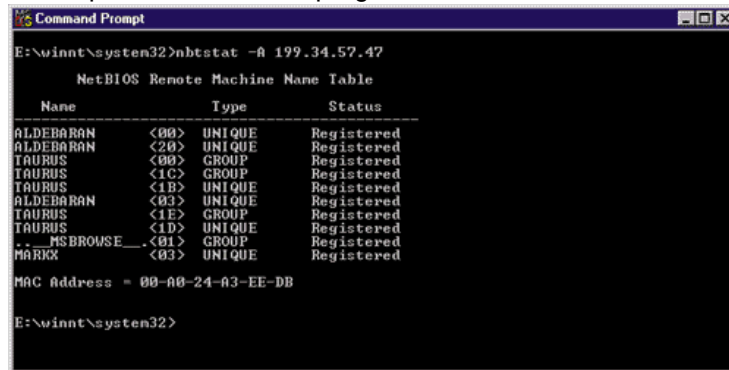
**Table A: Sample Software Programs**

Software Program Name	Protocols Covered	Website
OiDVIEW SNMP MIB Walker	SNMP	<a href="http://www.oidview.com/snmp-mibwalker.html">http://www.oidview.com/snmp-mibwalker.html</a>
Nbtstat Windows command	NBNS	<a href="https://technet.microsoft.com/en-us/library/cc940106.aspx">https://technet.microsoft.com/en-us/library/cc940106.aspx</a>

- 318
- 319 C) Obtain the UUT's IP address from its user interface or via a packet analysis tool like
- 320 Wireshark.
- 321 D) Open the OidVIEW SNMP MIB Walker's mibwalker\_gui application, in preparation of the
- 322 upcoming SNMP communication.
- 323 E) Run the Windows command line, in preparation of the upcoming NBNS communication.
- 324 F) Zero meter and timer.
- 325 G) Measure energy and time over 1 hour.
- 326 H) Within the first minute of the hour, use the Acceptable Software Programs to communicate as
- 327 follows:
- 328 1) SNMP:
- 329 a) In the mibwalker\_gui application, keep the default values for Port (161), SNMP
- 330 Version (2c), OID (1.3.6.1) as well as all other default values.
- 331 b) Enter the UUT's IP address and click "Execute MibWalk."
- 332 c) Typical output of the software program:
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- 336 2) NBNS:
- 337 a) In the Windows command line, type "nbtstat -A XX", where XX is the IP address of
- 338 the UUT. Hit Enter.
- 339 b) Typical output of the software program:



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- 342 l) Record whether the UUT returned a well-formed and complete response for each protocol,
- 343 using Wireshark to capture packets as well as comparing with the above "typical output" of
- 344 the software program.
- 345 J) Record the energy and time.

346 K) Report the results.

347 **Note:** This section of the test method is to test the behavior of imaging equipment in sleep mode, when  
 348 subjected to packets typical of an office network. EPA, with assistance from partners, determined that the  
 349 packets under consideration are typically sent by network equipment and programs running on servers,  
 350 and are used for network and device management.

351  
 352 Of 27 packet types reviewed, EPA chose Simple Network Management Protocol (SNMP) and NetBIOS  
 353 Name Service (NBNS) packets, as these are common types to which imaging equipment should respond  
 354 to without waking up. ARP was not chosen because it is a simpler protocol to respond to and should not  
 355 cause wake-ups. Protocols which cause unavoidable wake-ups as well as protocols which require no  
 356 device response were excluded, so that the test can measure any avoidable changes in sleep mode  
 357 power.

358  
 359 By testing for these transitions, the TEC test method will be more representative of a variety of real-life  
 360 conditions. EPA welcomes stakeholder feedback on this addition, and whether a similar test should be  
 361 added to the OM test (EPA has proposed this for TEC products but is aware that some OM products are  
 362 used in office settings where they may also be affected by network traffic).

363 **Note:** EPA envisions the following reporting elements as part of the proposed network test to be included  
 364 in a forthcoming data reporting template:

Test Requirement	Units/ Data Type	Data
Manufacturer		
Model Number		
Average Sleep Mode Power for comparison		
Average sleep mode power without any network activity (if possible) or without intentional network activity (Step 5 of TEC Test in	watts	
SNMP packets captured bi-directionally via Wireshark?	Y/N	
SNMP program output	Text or Screen-shot	
SNMP Software Program output well-formed and complete?	Y/N	
NBNS packets captured bi-directionally via Wireshark?	Y/N	
NBNS program output	Text or Screen-shot	
NBNS Software Program output well-formed and complete?	Y/N	
Average sleep mode power over the hour including and following network tests	watts	

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## 368 9 OPERATIONAL MODE (OM) TEST PROCEDURE

### 369 9.1 Measurement Procedures

370 A) Measurement of OM power and delay times shall be conducted according to Table 10, subject to the  
371 following provisions:

372 1) Power Measurements: All power measurements shall be made using either the average power or  
373 accumulated energy approaches as described below:

374 a) Average Power Method: The true average power shall be measured over the course of a  
375 user selected period, which shall be no less than 5 minutes.

376 i) For those modes that do not last 5 minutes, the true average power shall be measured  
377 over the mode's entire duration.

378 b) Accumulated Energy Approach: If the test instrument is incapable of measuring the true  
379 average power, the accumulated energy consumption over the course of a user selected  
380 period shall be measured. The test period shall be no less than 5 minutes. The average  
381 power shall be determined by dividing the accumulated energy consumption (in watt-hours)  
382 by the time of the test period (in hours).

383 i) For those modes that do not last 5 minutes, the accumulated energy consumption shall  
384 be measured over the mode's entire duration.

385 c) If the power consumption of the tested mode is periodic, then the test duration shall contain  
386 one or more complete periods.



**Table 10: Operational Mode (OM) Test Procedure**

Step	Initial State	Action(s)	Record	Unit of Measure
1	Off	Plug the UUT into meter. Turn on unit. Wait until unit indicates it is in Ready Mode.	–	
2	Ready	Print, copy, or scan a single image.	–	
3	Ready	Measure Ready power.	Ready power, $P_{READY}$	Watts (W)
4	Ready	Wait and measure default delay-time to Sleep.	Sleep default-delay time, $t_{SLEEP}$	Minutes (min)
5	Sleep	Measure Sleep power.	Sleep power, $P_{SLEEP}$	Watts (W)
6	Sleep	Wait and measure default delay time to Auto-off. (Disregard if no Auto-off Mode).	Auto-off default-delay time	Minutes (min)
7	Auto-off	Measure Auto-off power. (Disregard if no Auto-off Mode).	Auto-off power $P_{AUTO-OFF}$	Watts (W)
8	Auto-off	Manually turn device off and wait until unit is off. (If no manual on-off switch, note and wait for lowest-power Sleep state).	–	–
9	Off	Measure Off power. (If no manual on-off switch, note and measure Sleep Mode power).	Off power $P_{OFF}$	Watts (W)

388 Notes:

- 389 • Step 1 – If the unit has no Ready indicator, use the time at which the power consumption level
- 390 stabilizes to the Ready level, and note this detail when reporting the product test data.
- 391 • Step 4 – The Default Delay Time shall be measured starting from the completion of the job until
- 392 the unit enters Sleep Mode.
- 393 • Steps 4 and 5 – For products with more than one Sleep level, repeat these steps as many times
- 394 as necessary to capture all successive Sleep levels and report these data. Two Sleep levels are
- 395 typically used in large-format copiers and MFDs that use high-heat marking technologies. For
- 396 products lacking this Mode, disregard Steps 4 and 5.
- 397 • Steps 4 and 5 – For products without a Sleep Mode, perform and record measurements from
- 398 Ready Mode.
- 399 • Steps 4 and 6 – Default-delay time measurements are to be measured in parallel fashion,
- 400 cumulative from the start of Step 4. For example, a product set to enter a Sleep level in 15
- 401 minutes and enter a second Sleep level 30 minutes after entering the first Sleep level will have a
- 402 15-minute default-delay time to the first level and a 45 minute default-delay time to the second
- 403 level.

404 **10 TEST PROCEDURES FOR PRODUCTS WITH A DIGITAL FRONT**  
405 **END (DFE)**

406 This step applies only to products that have a DFE as defined in Section 1 of the ENERGY STAR  
407 Program Requirements for Imaging Equipment.

408 **10.1 Ready Mode DFE Test**

- 409 A) Products that are network-capable as-shipped shall be connected during testing. The network  
410 connection used shall be determined using Table 6.
- 411 B) If the DFE has a separate main power cord, regardless of whether the cord and controller are internal  
412 or external to the imaging product, a 10 minute power measurement of the DFE alone shall be made,  
413 and the average power recorded while the main product is in Ready Mode.
- 414 C) If the DFE does not have a separate main power cord, the tester shall measure the dc power required  
415 for the DFE when the unit as a whole is in Ready Mode. A 10 minute power measurement of the dc  
416 input to the DFE shall be made, and the average power recorded while the main product is in Ready  
417 Mode. This will most commonly be accomplished by taking an instantaneous power measurement of  
418 the dc input to the DFE.

419 **10.2 Sleep Mode DFE Test**

420 This testing shall be performed to obtain the Sleep Mode power of a DFE device over a 1 hour period.  
421 The resulting value will be used to qualify Imaging Equipment products that incorporate DFEs with  
422 network-capable Sleep Modes.

- 423 A) Products that are network-capable as-shipped shall be connected during testing. The network  
424 connection used shall be determined using Table 6.
- 425 B) If the DFE has a separate main power cord, regardless of whether the cord and controller are internal  
426 or external to the imaging product, a 1 hour power measurement of the DFE alone shall be made,  
427 and the average power recorded while the main product is in Sleep Mode. At the end of the 1 hour  
428 power measurement, a print job shall be sent to the main product to ensure the DFE is responsive.
- 429 C) If the DFE does not have a separate main power cord, the tester shall measure the dc power required  
430 for the DFE when the unit as a whole is in Sleep Mode. A 1 hour power measurement of the dc input  
431 to the DFE shall be made, and the average power recorded while the main product is in Sleep Mode.  
432 At the end of the 1 hour power measurement, a print job shall be sent to the main product to ensure  
433 the DFE is responsive.
- 434 D) In cases B) and C), the following requirements apply:
- 435 1) Manufacturers shall provide information on:
- 436 a) Whether DFE Sleep Mode is enabled as-shipped; and
- 437 b) The expected time to sleep of the DFE.
- 438 2) If the DFE does not respond to the print request at the end of 1 hour, the Ready Mode power  
439 level measured in the test method shall be reported as the Sleep Mode power.
- 440

441 *Note: All information specified or provided by manufacturers for product testing shall be publicly available.*

442 **11 REFERENCES**

- 443 A) ISO/IEC 10561:1999. Information technology — Office equipment — Printing devices — Method  
444 for measuring throughput — Class 1 and Class 2 printers.
- 445 B) IEC 62301:2011 . Household Electrical Appliances – Measurement of Standby Power. Ed. 2.0.

Table 11: Number of Images per Day Calculated for Product Speeds, s, from 1 to 100 ipm

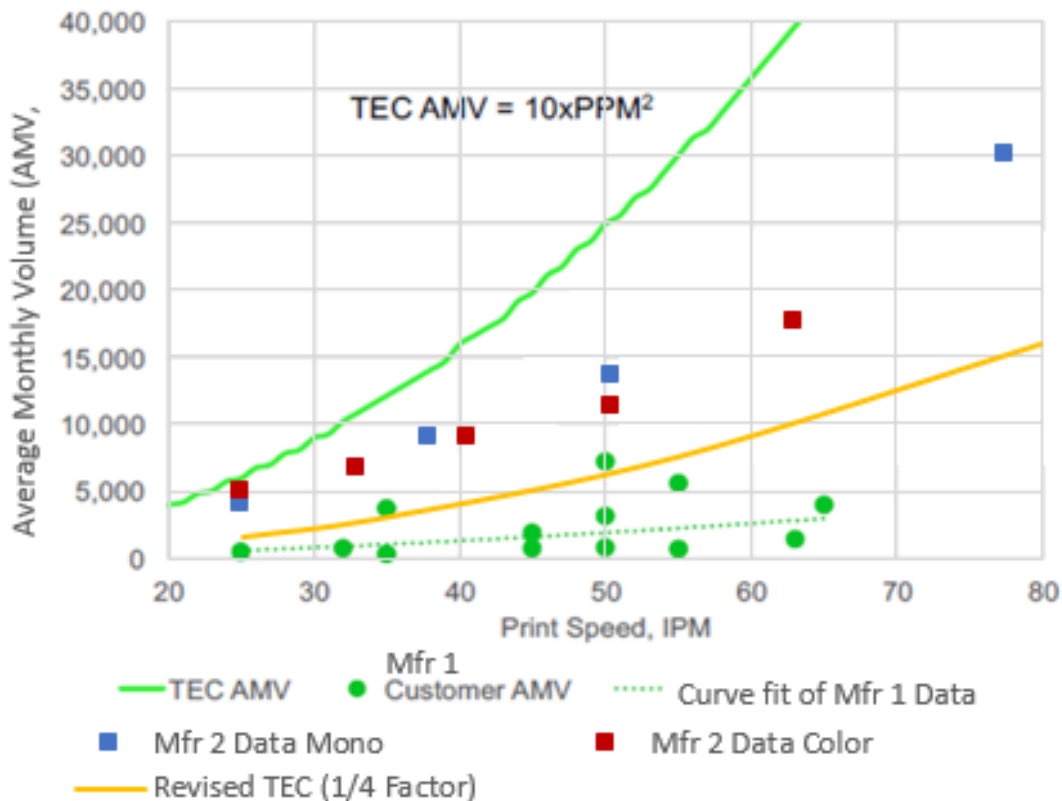
Speed (ipm)	Jobs/Day (from Table 7, used only to calculate Images/Job)	Unrounded Images/ Job	Images/ Job	Images/ Day (after adjustment in TEC spec)	Speed (ipm)	Jobs/Day (from Table 7, used only to calculate Images/Job)	Unrounded Images/ Job	Images / Job	Images/ Day (after adjustment in TEC spec)
1	8	0.06	1	2	51	32	40.64	40	320
2	8	0.25	1	2	52	32	42.25	42	336
3	8	0.56	1	2	53	32	43.89	43	344
4	8	1.00	1	2	54	32	45.56	45	360
5	8	1.56	1	2	55	32	47.27	47	376
6	8	2.25	2	4	56	32	49.00	49	392
7	8	3.06	3	6	57	32	50.77	50	400
8	8	4.00	4	8	58	32	52.56	52	416
9	9	4.50	4	9	59	32	54.39	54	432
10	10	5.00	5	13	60	32	56.25	56	448
11	11	5.50	5	14	61	32	58.14	58	464
12	12	6.00	6	18	62	32	60.06	60	480
13	13	6.50	6	20	63	32	62.02	62	496
14	14	7.00	7	25	64	32	64.00	64	512
15	15	7.50	7	26	65	32	66.02	66	528
16	16	8.00	8	32	66	32	68.06	68	544
17	17	8.50	8	34	67	32	70.14	70	560
18	18	9.00	9	41	68	32	72.25	72	576
19	19	9.50	9	43	69	32	74.39	74	592
20	20	10.00	10	50	70	32	76.56	76	608
21	21	10.50	10	53	71	32	78.77	78	624
22	22	11.00	11	61	72	32	81.00	81	648
23	23	11.50	11	63	73	32	83.27	83	664
24	24	12.00	12	72	74	32	85.56	85	680
25	25	12.50	12	75	75	32	87.89	87	696
26	26	13.00	13	85	76	32	90.25	90	720
27	27	13.50	13	88	77	32	92.64	92	736
28	28	14.00	14	98	78	32	95.06	95	760
29	29	14.50	14	102	79	32	97.52	97	776
30	30	15.00	15	113	80	32	100.00	100	800
31	31	15.50	15	116	81	32	102.52	102	816
32	32	16.00	16	128	82	32	105.06	105	840
33	32	17.02	17	136	83	32	107.64	107	856
34	32	18.06	18	144	84	32	110.25	110	880
35	32	19.14	19	152	85	32	112.89	112	896
36	32	20.25	20	160	86	32	115.56	115	920
37	32	21.39	21	168	87	32	118.27	118	944
38	32	22.56	22	176	88	32	121.00	121	968
39	32	23.77	23	184	89	32	123.77	123	984
40	32	25.00	25	200	90	32	126.56	126	1008
41	32	26.27	26	208	91	32	129.39	129	1032
42	32	27.56	27	216	92	32	132.25	132	1056
43	32	28.89	28	224	93	32	135.14	135	1080
44	32	30.25	30	240	94	32	138.06	138	1104
45	32	31.64	31	248	95	32	141.02	141	1128
46	32	33.06	33	264	96	32	144.00	144	1152
47	32	34.52	34	272	97	32	147.02	147	1176
48	32	36.00	36	288	98	32	150.06	150	1200
49	32	37.52	37	296	99	32	153.14	153	1224
50	32	39.06	39	312	100	32	156.25	156	1248

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**Note:** EPA has revised this table above to reflect the proposed change to the use assumptions in the TEC section of the specification to better align the test with typical usage, as reported to EPA by manufacturers in stakeholder comments. While no changes are proposed to the testing (i.e., the same 8–32 number of jobs per day and resultant images per job), the final TEC would be based on the per-job results multiplied by a new factor of  $\frac{1}{4}$  in addition to the previously calculated number of jobs per day. This factor is based on stakeholder data, described below, and is reflected in the final images/per day column, which has been revised above.

Based on aggregated use data provided across a range of product speeds by two manufacturers, it appears that reducing the total number of paper by a factor of 4 would be a more representative assumption, than the current combination of images per job and jobs per day, which for imaging equipment with speed equal to or greater than 32 ipm works out to an average monthly volume (AMV) of  $10s^2$ , where  $s$  is the speed and AMV is the number of images per day multiplied by 20 workdays per month. The below graph compares the AMV of several models of imaging equipment monitored remotely by manufacturers as well as two sets of TEC assumptions. The solid green line shows the current TEC assumption of  $AMV = 10s^2$ , while the points are tested data received by EPA. This data shows how the average monthly volume is far less than what has been assumed. The yellow line indicates the Draft 1 test method proposal of  $2.5s^2$ .

## Manufacturer-provided Customer Information compared to TEC Usage



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468 As mentioned above, rather than modifying the jobs-per day or images-per-job assumptions in  
469 Section 8.1, EPA proposes to instead adjust the Daily Job Energy equation in the TEC section of the  
470 Eligibility Criteria (specification) by  $\frac{1}{4}$ . This will allow TEC to simply be re-calculated without the need for  
471 new testing. EPA welcomes feedback on typical use data, the TEC assumptions, and the proposed path  
472 forward.