



Standard Test Method for Determining Energy Consumption of MFDs with Copying Capability and Similar Office Imaging Equipment¹

This standard is issued under the fixed designation F 2495; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This procedure provides a test method by which multi-functional devices (MFDs) with electro-photographic copying capability and similar office imaging equipment may be rated for energy consumption.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 International Standards:

ISO/IEC 11159 Minimum Information to be Included in Specification Sheets—Copying Machines²

ISO 554 Standard Atmospheres for Conditioning and/or Testing Specifications²

2.2 Federal Energy Management Program (FEMP) website:

http://www.eere.energy.gov/femp/technologies/eep_standby_power.cfm#sleep

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *optional devices*—any device added to improve the functionality of the base unit. They include an automatic document feeder (ADF), sorter, finisher and expansion memory.

3.1.2 *copier speed, first copy (X)*—one of the convenient levels for which the machine's speed is measured. This is calculated based on the amount of time, a_1 (sec), counted in a normal operating mode from the beginning of pressing the print button of the machine to the end of ejecting the first copy, $X = 60/a_1$ (ipm). For MFDs with ADF, the amount of time, a_1 shall be used, counted from pressing the print button after

placing an original or originals on the ADF to the end of ejecting the first copy.

3.1.3 *copier speed, multi copy (Y)*—one of the convenient levels for which the machine's speed is measured. This is calculated based on the amount of time, a_2 (sec), counted in a normal operating mode from the end of ejecting the first copy after pressing the print button of the machine to the end of ejecting the remaining copies (b), $Y = (b) \times 60/a_2$ (ipm). Normally, the value declared in the machine's specifications shall be used.

3.1.4 *ready mode*—the condition that exists when the machine is ready for copying, but has not yet started copying, and has not entered an energy-saver mode, either.

3.1.5 *copying cycle*—the condition that exists from the beginning to the end of a nominal job cycle (1 h) to produce a copy or copies. According to the machine's multi copy speed (Y) declared in the specifications, the following are listed in Job Tables: nominal monthly volumes assumed, nominal volumes per day and combinations of the number of jobs as $\frac{1}{8}$ day (1 h) nominal jobs, the number of originals per job and the number of copies per original.

3.1.6 *copying energy*—the amount of energy needed in excess of ready mode energy during a copying cycle.

3.1.7 *copying time*—the amount of time that the nominal jobs are run when testing copying energy during a copying cycle.

3.1.8 *wake-up energy*—the amount of energy needed in excess of ready mode energy when the machine recovers from a standard work day's first sleep stand-by mode.

3.1.9 *energy-saver mode*—the condition that exists when the machine is not making copies and is consuming less power than when the machine is in a ready mode. The machine goes into this mode after it completes a job such as copying and no job is scheduled in a specified time period. Since the International Energy Star Program has been used widely in the world, this has caused MFDs to have this mode. This standard particularly designates this condition as an energy-saver mode in operating hours (9 h) of a standard work day.

3.1.9.1 *Discussion*—The International Energy Star Program stipulates that the machine shall be set to enter an energy-saver mode 15 minutes or less after the end of a job such as copying. However, on the assumption that the machine is used in a

¹ This test method is under the jurisdiction of ASTM Committee F05 on Business Imaging Products and is the direct responsibility of Subcommittee F05.04 on Electrostatic Imaging Products.

Current edition approved June 1, 2005. Published June 2005.

² Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

networked environment, considering the fact that shorter passing time has been set than before because a recovery trigger easily takes place and recovery time tends to be reduced, this test method stipulates that the machine shall stay in a ready mode for 10 minutes after the end of a job such as copying up until it starts passing to the energy-saver mode. The recovery time from the energy-saver mode to the ready mode shall be set to 30 seconds or less. Energy-saver mode design to fulfill this recovery time is left to the manufacturer's discretion. This test method provides energy calculations on the assumption that the passing time is 10 minutes. If setting of the time shorter than 10 minutes is accepted by users in the future, the procedure of this test method will be reviewed.

3.1.10 *sleep stand-by mode*—the condition with less energy consumption than the energy-saver mode in 3.1.9. The machine enters the energy-saver mode 10 minutes after the end of a job such as copying and then enters a sleep stand-by mode, if no additional job is scheduled in a specified time period. Normally, this sleep stand-by mode stays for a whole day of Saturday and Sunday weekends other than standard work days. As for standard work days, the machine stays in this mode at night as a night stand-by condition. It is calculated by subtracting the 9 hours of operation from the 24 hours in a day.

3.1.11 *energy-saver recovery time*—the amount of time that the machine takes to enter the ready mode after it comes out of the energy-saver mode in the 9-h operating condition of a standard work day.

3.1.12 *energy-saver mode time*—the amount of time that the machine is in an energy-saver mode in the 9-hour operating condition of a standard work day.

3.1.13 *lunch break*—one hour assigned to a lunch break that exists between 4-h morning and 4-h afternoon in the 9-h operating condition of a standard work day. The machine stays in an energy-saver mode during this time period.

3.1.14 *job*—making a copy or copies from one or more originals without interruption or delay between originals. Since target machines are MFDs with copying capability, copying shall be used for rating to represent all the jobs.

3.1.15 *machine energy*—the energy obtained by subtracting energy consumed for copying (3.1.6) from total energy consumed in a standard month where the machine is plugged-in 24 h/day including the 9-h operating condition.

3.1.16 *nominal copies per day*—the number of nominal copies produced on a single machine during a nominal standard work day.

3.1.17 *nominal monthly volume*—monthly volume nominally determined according to the copying speed band category.

3.1.18 *plug-in mode*—the condition that exists when the machine is connected to an appropriate electrical source and is not turned on. (This mode is also referred to as hard-off mode, manual-off mode or plug-in-off mode.) This corresponds to the one specified on the FEMP website.

3.1.19 *recovery energy*—the amount of energy needed in excess of energy-saver mode energy to pass from the energy-saver mode to the ready mode.

3.1.20 *standard copy*—a sheet imaged on one side that measures 210 by 297 mm (A4) or 8½ by 11 in. (letter size).

3.1.21 *standard month*—thirty 24-h days.

3.1.22 *standard work day*—a day having an operating condition (9-h) including a 1-h lunch break. A standard month (30 days) has 22 days.

3.1.23 *wake-up mode*—the condition that exists when the machine comes out of a sleep stand-by mode for the first time in the morning of a day of 22 standard work days, but has not yet entered into a ready mode.

3.1.24 *warm-up mode*—the condition that exists when the machine is turned on from a plug-in mode and prior to reaching the ready mode.

3.1.25 *operating condition*—nine hours starting from the day's first wake-up mode on condition that recovery from the sleep stand-by mode occurs each of 22 standard work days. This consists of 1 h of a lunch break and 8 hours of day's typical job cycles.

4. Summary of Test Method

4.1 The standard energy consumption rating is determined (using a watt-hour meter) for a MFD while the machine is in a simulated customer installation performing copying representing a typical day's jobs for one eighth (1 h) of the day. The typical day's jobs (the number of jobs, originals, and copies per original) are based on the standard monthly volume assumed according to its copy speed. In this test method, there is no difference in assumed nominal monthly volumes between monochrome MFDs and color ones. In other words, since a color MFD naturally has two copying speeds (speeds in color and monochrome modes), this test method gives the color MFD the nominal standard monthly volume of a monochrome MFD of which speed equals the color MFD's maximum speed (normally, in monochrome mode).

4.1.1 However, since the job conditions depend on whether or not a MFD has a color mode, separate job tables have been provided for color MFDs and monochrome MFDs.

4.1.2 Moreover, note should be taken that two types of job tables have been provided for color MFDs according to the structure (1 drum: serial type, and 4 drum: parallel type). (Refer to the Job Tables in Annex A1.)

4.2 The energy consumption may be calculated based on the following assumptions, that the MFD will typically:

4.2.1 Be connected to a live power line for thirty 24 h days (720 h) per month.

4.2.2 Be in the operating condition each of 22 work days per month and be in an operating condition for an average of 9 h each of the 22 days.

4.2.3 As a result of items 4.2.2 and 3.1.23, come out of the sleep stand-by mode to enter the wake-up mode each of 22 work days, since the MFD normally has the sleep stand-by mode where the machine automatically enters after a period of time of non-use or no job scheduled.

4.2.4 As a result of Discussion in item 3.1.9.1, not enter the energy-saver mode during a copy cycle, if the number of nominal jobs per hour (1/8 of a day's copying cycle) is 6 or more in the job table and this leads to job interval of 10 minutes or less; and as a result of 3.1.13, be in the energy-saver mode during the 1-h lunch break each of 22 work days. To facilitate the tests, the upper limit of the number of jobs shall be 6.

4.2.4.1 *Discussion*—In actual use, the higher the monthly copying volume is, the larger the number of jobs is. Besides, it is less likely for the machine to go into the energy-saver mode. Considering these, the numbers of jobs are provided according to the nominal monthly volume in the job table and the machine behavior as follows:

(1) The nominal monthly volume of 35 000 or less leads to the number of jobs of 5 or less per hour ($\frac{1}{8}$ day) and the machine enters the energy-saver mode during the copying cycle; and

(2) The nominal monthly volume of 42 000 or more leads to the number of jobs of 6 per hour ($\frac{1}{8}$ day) and the machine does not enter the energy-saver mode during the copying cycle.

4.2.5 Perform a typical day's copying jobs each of the 22 work days each month.

4.3 The rating of energy consumption per hour in a typical month (kWh/h) is determined using calculations based on the test data.

5. Significance and Use

5.1 This test method provides a procedure for measuring the energy consumption of the product and optional devices in various operating modes. It is intended to permit rating the energy requirements of products by a method that will permit accurate energy efficiency comparisons of each product with all other similar products.

6. Apparatus and Supplies

6.1 *Watt-Hour Meter*, shall be calibrated properly and have a crest factor of 3 or more.

6.2 *Timer*, a timing device accurate to 1 s.

6.3 *Test Target*, 210 by 297 mm (A4) or 8½ by 11 in. (letter) with 4 to 8 % coverage.

6.4 *Paper*, 210 by 297 mm (A4), 60 to 80 g/m², 8½ by 11 in. (letter), 20-lb bond or where not applicable, use machine manufacturer's recommended paper size and weight, depending on the machine sales area.

7. Sampling (Equipment Under Test: EUT)

7.1 The energy rating should be that for a device representative of the commercially available equipment. Any modification of the product or additional configurations that significantly alter energy consumption will require re-ratings or additional ratings.

7.2 Those MFDs configured with automatic duplex option should be rated twice for each job, once at 100 % single-sided copy and once at 100 % of two-sided copies (making two-sided copies from single-sided originals, each side counted as one copy).

7.3 The MFD(s) to be evaluated should be set to within the manufacturer's operating specifications.

8. Preparation of Apparatus

8.1 *Test Conditions*:

8.1.1 The room ambient shall be within a range of 23 ± 3°C; 50 ± 10 % relative humidity in compliance with **ISO 554**.

8.1.2 The working voltage shall be machine-rated voltage ± 2 %. Stabilized power supply shall be used.

8.1.3 The machine shall be at least 500 mm from any wall or obstacle.

8.1.4 All supplies used shall be those specified by the MFD manufacturer and preconditioned for a minimum of 12 h in the room ambient environment (see 8.1.1) prior to evaluating the MFD energy rating.

8.1.5 The power supply voltage shall be supplied as a true sine wave with no more than 3 % harmonic distortion.

8.1.6 The power frequency must be rated frequency ± 0.1 Hz.

8.1.7 The manufacturer will define the configuration (including optional devices) of the machine to be tested, the nominal monthly volume at which it will be rated (see Job Tables), and both the first copy speed and multi copy speed.

8.1.8 The test should be discontinued if an unusually high number of machine problems occur. Excess machine stoppages may distort the overall energy rating. A reasonable number of paper jams that can be readily cleared by the operator should not be considered reason to discontinue the test.

9. Procedure

9.1 Steps 9.1.1-9.1.10 of this procedure should be completed once for each test machine. The data from 9.1.5 will only apply to one configuration and, if the machine has configuration variations, the rating must be repeated for each configuration for which the machine is being rated. Prior to the start of this test, the machine should be plugged in to a live power line but turned off and stabilized at specified room ambient conditions (indoors) for at least 12 h. An appropriate watt-hour meter should be in line with the machine, ready to give an accurate indication of machine energy. This test should be run at the machine setting that, in the opinion of the evaluator, is the one yielding an appropriate copy.

9.1.1 *Copying Time*—Choose the appropriate formula from Job Tables (see **Annex A1**) that matches the monthly volume for which the machine is being rated, according to the machine type, monochrome or color (serial or parallel). In accordance with 3.1.2 and 3.1.3, using the manufacturer's values for copier speeds, where X is the first copy speed, and Y is the multi copy speed per minute, follow the appropriate formulas. Record the copying time in **Fig. 1** (in minutes).

9.1.2 *Plug-In Mode Energy*—Read the indication (W) of the watt-hour meter connected to the test machine. This mode corresponds to the one addressed in FEMP. If no change is observed in energy in the plug-in mode, record the indication (W) in **Fig. 1** for plug-in mode energy use (Wh).

9.1.3 *Warm-Up Plus Ready Mode Energy*—While the machine is in the stabilized plug-in mode, read and record the indication (Wh) of the watt-hour meter connected to the test machine and the time (or start the stopwatch or timer). Turn the machine on and allow the machine to warm up and stabilize in a ready mode until it is ready for copying. Record the warm-up time until the ready mode in minutes in **Fig. 1**. After 1 h, read and record the watt-hour indication (Wh) again. The difference between the two readings of the watt-hour meter is the observed data for warm-up plus ready mode energy use. Record the result in **Fig. 1**, Test Results Part A. Since the machine has an energy-saver mode, change the machine setting