



## Standard Practice for Determining Energy Consumption of Facsimile Machines<sup>1</sup>

This standard is issued under the fixed designation F 1707; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

<sup>ε1</sup> NOTE—Keywords were added editorially in January 2008.

### 1. Scope

1.1 This procedure provides a method by which electrophotographic, direct-thermal, thermal transfer, or ink-jet facsimile machines can be tested 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 *ASTM Standards:*<sup>2</sup>

F 335 Terminology Relating to Electrostatic Imaging

F 757 Test Method for Determining Energy Consumption of Copier and Copier-Duplicating Equipment<sup>3</sup>

2.2 *ANSI Standard:*

C 12.10 Electromechanical Watthour Meters<sup>4</sup>

### 3. Terminology

3.1 For definitions of terms used in this practice, see Terminology F 335 and Test Method F 757.

3.2 *cycle out*—the condition that exists when the machine has finished sending or receiving a page, and has returned to a stand-by mode.

3.3 *idle time*—the amount of time that the machine is not sending or receiving when testing sending or receiving energy.

3.4 *job*—receiving or sending one or more pages without interruption or delay between pages.

3.5 *machine energy*—the energy consumed by a facsimile machine that is plugged in 24 h/day and turned on 10.5 h (see Note 1), but is not sending, receiving, or making copies.

NOTE 1—Some users may want to adjust this time if they do not turn off their facsimile machines. Therefore, the test should be performed for the plug-in and warm-up modes, but won't be included in the calculations. If the user wants to include these modes in the calculations, the tester should recalculate the numbers used in Section 10.

3.6 *nominal facsimiles received per day*—the number of standard facsimiles received on a single machine during a standard work day.

3.7 *nominal facsimiles sent per day*—the number of standard facsimiles sent on a single machine during a standard work day.

3.8 *receiving*—the machine condition that exists from the beginning to the end of the cycle that receives a page from an outside source and prints that page while receiving.

3.9 *receiving energy*—the energy consumed during a designated receiving mode exclusive of stand-by and plug-in energy.

3.10 *sending*—the machine condition that exists from the beginning to the end of the cycle that sends a page to an outside source.

3.11 *sending energy*—the energy consumed during a designated sending mode exclusive of stand-by and plug-in energy.

3.12 *sending receiving time*—the amount of time that the nominal jobs are run when testing sending and receiving energy.

3.13 *stand-by*—the condition that exists when the machine is not sending, receiving, or copying, has reached operating conditions, but has not yet entered into energy-saver mode.

3.14 *warm-up mode*—the condition that exists when the machine is turned on from a plug-in mode and prior to sending, receiving, or copying.

### 4. Summary of Test Method

4.1 The standard energy consumption rating is determined for a facsimile machine while the machine is in a simulated customer installation performing one eighth of a typical day's jobs (using a watt-hour meter). The typical day's jobs (size and number of pages) are based on a standard volume (see Table 1). The simulated customer installation can be calculated with actual usage data, or can be based on the following assumptions, that the printer will typically:

<sup>1</sup> This practice 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.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Withdrawn.

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

**TABLE 1 Nominal Parameters for Each Standard Volume**

Nominal Monthly Volume, Pages per Month	Nominal Day's Pages	Nominal Jobs (1/8 day) $n^A$		
		Number of Jobs	Number of Pages per Job	Job Interval
200	8	1	1	60 min
500	24	3	1	20 min
1 000	48	3	2	20 min
2 500	112	7	2	8.6 min
5 000	224	14	2	8.6 min
10 000	432	18	3	3.3 min
25 000	1152	36	4	1.6 min
40 000	1824	57	4	62 s

<sup>A</sup> $n$  = number of jobs × number of originals × number of pages per original.

4.1.1 Be plugged in to a live power line for thirty 24-h days (720 h)/month.

4.1.2 Never be turned on and off (see **Note 1**).

4.1.3 Be left on 24 h/day for 30 days of each standard work month.

4.1.4 Be in an energy-saver mode some amount of time depending on the nominal volume and use from **Table 1**, the sending receiving time from **Table 2**, and the energy-saver delay time.

4.1.5 Perform a typical day's jobs for each of the 30 workdays each month.

4.2 The energy consumption per page or the typical month's energy consumption rating (kilowatt hour (kWh) per month) are determined using calculations based on the test data.

## 5. Significance and Use

5.1 This practice provides a procedure for measuring the energy consumption of the product and associated accessories in various operating modes. It does not reflect the total energy required to produce a page. It does not, for example, include the energy required to manufacture the paper or the machine. It is intended to permit rating the energy requirements of products by a method that will permit accurate energy efficiency comparisons with similar products.

## 6. Apparatus and Supplies

6.1 *Watt-Hour Meter*, one per phase, accurate to three figures and compliant with ANSI **C 12.10**, performance tables 5.1.8.<sup>5</sup>

6.2 *Timer*—A timing device accurate to 1 s and  $\pm 0.5\%$ .

6.3 *Test Target*—A ten-pitch pica; 45 lines of lower case "k" character; 65 characters per line (2925 total characters) with a 1-in. (25-mm) clear border around the typed area on white

<sup>5</sup> The sole source of supply of the series 1000 Kilowatt Hour Meter apparatus known to the committee at this time is National Meter Industries, Inc., P.O. Box 462, Stamford, CT 06907. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,<sup>1</sup> which you may attend.

**TABLE 2 Calculation for Sending/Receiving Time**

Nominal Monthly Volume, Pages per Month	Number of Jobs, $j$	Number of Pages per Job	Printing Time, min/h (S/R) <sub>i</sub>
200	1	1	1/X
500	3	1	3/X
1 000	3	2	3/X + 3/Y
2 500	7	2	7/X + 14/Y
5 000	14	2	14/X + 14/Y
10 000	18	3	18/X + 36/Y
25 000	36	4	36/X + 108/Y
40 000	57	4	57/X + 171/Y

paper. This target is prepared by the user. Alternatively the ITU-TS Target #1<sup>6</sup> or equivalent with 4 % coverage may be used.

6.4 *Paper for Plain Paper Machines*, 8½ by 11 in. (216 by 280 mm), 20-lb bond or machine manufacturer's recommended midpoint range of paper weight.

6.4.1 *Paper for Other Than Plain Paper Machines*—The paper should be the manufacturer's recommended midpoint range of paper weight.

6.5 *Facsimile Machines*—Two identical facsimile machines are to be used, one as the test sample and a second sample to act as the transmitter or receiver as required.

6.6 *PBX Line Simulator*—A two-way telephone line simulator.<sup>7</sup>

6.7 *Telephone Wire*—Two lengths of exactly 6 ft should be used.

## 7. Sampling

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

7.2 The facsimile machine(s) to be evaluated should be setup within the manufacturers operating specifications.

7.3 If the facsimile machine has more than one rate of transmission, it should be tested for each transmission rate.

7.4 The facsimile machines equipped with more than one resolution setting should be tested at the standard resolution setting and optionally at other resolution settings.

<sup>6</sup> The sole source of supply of the International Telecommunications Union-Telecommunications Standardization Sector (ITU-TS) apparatus known to the committee at this time is Omnicom Institute, 115 Park Street SE, Vienna, VA 22180. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,<sup>1</sup> which you may attend.

<sup>7</sup> The sole source of supply of the Phantom Central Office Simulator apparatus known to the committee at this time is Command Communications, 14510 E. Fremont Ave., Centennial, CO 80112, and is available in California from Fleetmasters, Inc., 1505 S. 93rd St., Unit BP, Seattle, WA 98108. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,<sup>1</sup> which you may attend.

7.5 *Optional*—The facsimile machines equipped with the machine proprietary transmission protocols should be tested twice, once with the proprietary transmission protocol active, and once with the proprietary transmission protocol inactive. Both image quality and energy consumption should be compared at each protocol setting so optimal settings may be determined.

## 8. Preparation of Apparatus

### 8.1 Test Conditions:

8.1.1 The room ambient temperature shall be within a range of  $21 \pm 3^{\circ}\text{C}$ ; from 40 to 60 % relative humidity.

8.1.2 The working voltage shall be machine-rated voltage  $\pm 2\%$ .

8.1.3 The machine shall be at least 2 ft (610 mm) from any wall, obstacle, or air vent.

8.1.4 All supplies used shall be those specified by the facsimile machine manufacturer and preconditioned for a minimum of 24 h at room ambient temperature and humidity prior to evaluating the facsimile machine energy consumption.

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

8.1.6 The power frequency must be rated at  $\pm 0.1$  Hz.

8.1.7 The manufacturer will define the configuration (including accessories) of the machine to be tested and the volume at which it will be tested (Table 1). Normally, each facsimile machine will be tested for the standard volumes for which the manufacture intends to market the product.

NOTE 2—During the test cycle, the machine should be allowed to cycle out after the required number of pages have been sent or received. This aspect does not apply to machines with automatic document feeders or other features that allow for continuous operation without cycling out.

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 consumption. A reasonable number of paper misfeeds (such as >1 misfeed per 1000 images) that can readily be cleared by the operator should not be considered reason to discontinue the test.

## 9. Procedure

9.1 Steps 9.1.1 through 9.1.4 of this procedure should be completed once for each machine. The data from 9.1.1 through 9.1.4 applies to all standard volumes for which the machine is being tested. The data from 9.1.5 will only apply to one configuration, one resolution, and one combination of rates of transmission, and must be repeated for all other configurations. Prior to the start of this test, the machine should be plugged in to a live power line, turned on, and stabilized at ambient conditions for at least 12 h. Using the PBX line simulator and telephone wire, interconnect the test machine and its duplicate in such a way that they can send and receive facsimile messages between them. This should be done at least 12 h prior to the test. An appropriate watt-hour meter should be in line with the machine ready to give an accurate indication of machine energy consumption without disruption of the energy source.

9.1.1 *Sending/Receiving Time*—Choose the appropriate formula in Table 2 that matches the monthly volume for the

machine under test. Using the manufacturer's values for facsimile transmission speeds where  $X$  is the number of pages sent or received per minute, follow appropriate formulas. Do the calculations twice, once for each sending time and once for the receiving time. Add the two values together, then divide by two and record the sending/receiving time in Fig. 1.

9.1.2 *Plug-In Energy*—Read and record the watt-hour meter indication and the time (or start the stopwatch or timer). After 1 h, read and record the watt-hour meter indication again. The difference between the two readings of the watt-hour meter is the tested data for plug-in mode energy use. Record the result in Fig. 1, Test Results, Part A. If it is known that the test machine consumes no energy during the plug-in mode, or that the machine is never turned off, enter a zero for the tested data for plug-in energy use and omit this step (see Note 1).

9.1.3 *Warm-Up Plus Stand-By Energy*—With the machine in a stabilized plug-in condition, read and record the watt-hour meter indication and the time (or start the stopwatch or timer). Turn on the machine and allow it to warm up and stabilize in the ready mode. After 1 h, read and record the watt-hour indication again. The difference between the two readings of the watt-hour meter is tested data for warm-up mode plus stand-by mode energy use. Record the result in Fig. 1, Test Results, Part B. If it is known that the machine uses no energy in the warm-up mode (as defined by this procedure) or that the machine is never turned off, omit this step and proceed to 9.1.4 (see Note 1).

9.1.4 *Stand-by Energy*—For facsimile machines with an energy-saver mode, disable the feature. At the conclusion of the previous 1-h measurement (9.1.2) leave the machine turned on. After 1 h, record the watt-hour reading. The difference between the watt-hour reading at the start and finish of the hour is the tested data for the stand-by mode energy. Record the result in Fig. 1, Test Results, Part C.

9.1.5 *Energy-Saver Energy*—For facsimile machines with an energy-saver mode, enable the feature. If the energy-saver mode is automatic, let the machine enter the energy-saver mode. When it has entered the energy-saver mode, read and record the watt-hour meter and the time. After 1 h, record the watt-hour reading again. The difference between the watt-hour reading at the start and finish of the hour is the tested data for energy-saver mode energy. Record the result in Fig. 1, Test Results, Part D. If it is known that the machine does not have an energy-saver mode (as defined by this procedure) record the stand-by energy (results from Part C) in Fig. 1, Test Results, Part D.

9.1.6 *Energy-Saver Delay Time*—For facsimile machines with an energy-saver mode, if the time to enter the energy-saver mode is adjustable, set the feature to one minute. Send a page. Using the timer, record the amount of time it takes the machine to enter an energy-saver mode. If the machine is one which is manually placed in the energy-saver mode, activate the feature when the machine has cycled out, and then record the time it takes to reach the energy-saver mode. The printer should stay in the energy-saver mode for 1 h. Using the timer, record the amount of time it takes the machine to come out of the energy-saver mode. Add this time to the amount of time it

Machine Tested	Transmission/ Receptions
Monthly volume $N$ [ $n \times 176$ ]	_____
Number of pages $n$ in test (from Table 1)	_____
Sending Receiving Time $S R_i$ (from Table 2)	_____ min
Idle Time, $I_i$ [60 minutes - $SP_i$ ]	_____ min
Number of Jobs $j$ in test (from Table 1)	_____
<i>Test Results (1 - h Test)</i>	
A. Plug-in energy	_____ Wh
B. Warm-up plus stand-by energy	_____ Wh
C. Stand-by energy	_____ Wh
D. Energy-saver energy	_____ Wh
E. Energy-saver delay time	_____ Wh
F. Sending energy plus stand-by energy	_____ min
G. Receiving energy plus Stand-by energy	_____ Wh
H. Recovery Energy plus Energy-Saver	_____ Wh
<i>Calculations, All Facsimile machines</i>	
I. Warm-up energy, [B-C]	_____ Wh
J. Sending Energy, $E_s$ [F-C]	_____ Wh
K. Receiving Energy $E_r$ [G-C]	_____ Wh
L. Sending energy per page, $E_s/n$	_____ Wh
M. Receiving energy per page $E_r/n$	_____ Wh
N. Recovery Energy, $E_H$ [H-D]	_____ Wh
O. Energy saver time per hour [ $I_i - j \times E$ ]	_____ min/hr
P. Fraction energy-saver time [0/60]	_____ min
<i>Calculations, Facsimile Machine Without Auto Shut-off</i>	
Q. Plug-in energy per standard month [A X 489]	_____ Wh
R. Warm-up plus Stand-by energy per standard month [B X 20]	_____ Wh
S. Energy-saver time per month [(P X 176) + 35-(5 X E/60)]	_____ min
T. Stand-by energy per standard month [C X (211 - S)]	_____ Wh
U. Energy-saver energy per standard month [D X S]	_____ Wh
<i>Calculations, Facsimile machines, With Auto Shut off</i>	
V. Plug-in energy per standard month [A X 519]	_____ Wh
W. Warm-up plus stand-by energy standard per month [B X 22]	_____ Wh
X. Energy-saver time per month [(P X 176)+3-(3 X E/60)]	_____ min
Y. Stand -by energy per standard month [C X (179-X)]	_____ Wh
Z. Energy-saver energy per standard month [D X X]	_____ Wh
<i>Calculations, All Facsimile machines</i>	
AA. Machine energy per standard month -- Independent at Volume = [L+T+U] or [L+Y+Z]	_____ Wh
BB. Sending energy per standard month $LN$	_____ Wh
CC. Receiving energy per standard month $MN$	_____ Wh
DD. Recovery energy per standard month $(Ln)N$	_____ Wh
EE. Total energy per month $E_t = AA+BB+CC+DD$	_____ Wh
FF. Average total energy per page $E_{ave} = \frac{(AA+BB+CC+DD)}{N}$	_____ Wh

FIG. 1 Sample Data Sheet

took the printer to go into an energy-saver mode and record the result in Fig. 1, Test Results, Part E.

9.1.7 *Sending Energy Plus Stand-by Energy*—With the machine in a stand-by mode, read and record the watt-hour indication and the time (or start the stopwatch or timer). Using a standard original (6.3), send the standard jobs to the identical facsimile machine (Table 1) for the standard volume and configuration resolution or rate of transmission for which the machine is being tested. Equally space the jobs throughout the 1 h allocated for this part if the test (Table 1 for job time interval). The operator should send the original image so that it has minimal impact on job time and energy use. After the jobs have been performed and 1 h has elapsed, read and record the watt-hour meter indication again. The difference between the

two readings of the watt-hour meter is the tested data for printing energy use. Record the result in Fig. 1, Test Results, Part F.

9.1.8 *Receiving Energy Plus Stand-by Energy*—With the machine in a stand-by mode, read and record the watt-hour indication and the time (or start the stopwatch or timer). Using a standard original (6.3) have the identical facsimile machine send the standard jobs (Table 1) for the standard volume and configuration, resolution or rate of transmission for which the machine is being tested. Equally space the jobs throughout the 1 h allocated for this part in the test (Table 1 for job time interval). The operator should send the original image in such a manner so that it has a minimal impact on job time and energy use. After the jobs have been performed and 1 h has

elapsed, read and record the watt-hour meter indication again. The difference between the two readings of the watt-hour meter is the tested data for receiving energy use. Record the result in Fig. 1, Test Results, Part G.

9.1.9 *Recovery Energy Plus Energy-Saver Energy*—Repeat 9.1.5. When the machine enters the energy-saver mode, read and record the watt-hour indication and the time (or start the stopwatch or timer). At 1 h minus the time needed for the machine to come out of energy-saver mode, bring the machine out of the energy-saver mode. Record the watt-hour meter reading. The difference between these two readings is the test data for recovery energy plus energy-saver energy. Record this in Fig. 1, Test Results, Part H.

## 10. Calculation

10.1 Enter the number of pages  $n$  (Table 1) and the monthly volume  $N$  [ $n \times 176$ ] into Fig. 1.

10.2 Calculate the data from the following sections and list in the appropriately designated section in Fig. 1.

10.2.1 Enter the data obtained from 9.1.1 (Table 2) under Sending Receiving Time  $S R_r$  in Fig. 1.

10.2.2 Enter the data obtained from 9.1.2-9.1.9 under Test Results, Part A through H.

10.2.3 Calculate warm-up energy  $[B - C]$  and record under Part I.

10.2.4 Calculate sending energy  $E_s$  [ $F - C$ ] and record under Part J.

10.2.5 Calculate receiving energy  $E_r$  [ $G - C$ ] and record under Part K.

10.2.6 Calculate sending energy per page ( $E_s/n$ ). Record under Part L.

10.2.7 Calculate receiving energy per page ( $E_r/n$ ). Record under Part M.

10.2.8 Calculate recovery energy  $E_{rf}$  [ $H - D$ ]. Record under Part N.

10.2.9 For facsimile machines with an energy-saver mode, calculate the energy-saver time per hour. Multiply the number of jobs  $j$  by the energy-saver delay time, and subtract the total from the ideal time  $I_i(I_i - j \times E)$ . If this value is less than zero, enter zero. Record under Part O.

10.2.10 For facsimile machines with an energy-saver mode, calculate the fraction of energy-saver time. Divide the energy-saver time/hour by 60 min/h ( $O/60$ ). Record under Part P.

10.2.11 For facsimile machines without auto shutoff, calculate the plug-in energy per standard month ( $A \times 489$ ). Record under Part Q.

10.2.12 For facsimile machines without auto shutoff, calculate the warm-up plus stand-by energy per standard month ( $B \times 20$ ) Record under Part R.

10.2.13 For facsimile machines without auto shutoff, calculate the amount of time the facsimile machine is in an energy-saver mode per month ( $(P \times 176) + 35 - (5 \times 60)$ ). Record this result under Part S.

10.2.14 For facsimile machines without auto shutoff, calculate stand-by energy per standard month ( $C \times (211 - S)$  h/month) and record under Part T.

10.2.15 For facsimile machines without auto shutoff and with an energy-save mode calculate the energy-saver energy per standard month ( $D \times S$  h/month). Record under Part U.

10.2.16 For facsimile machines with auto shutoff, calculate plug-in energy per standard month ( $A \times 519$  h/month). Record under Part V.

10.2.17 For facsimile machines with auto shutoff, calculate warm-up plus stand-by energy per standard month ( $B \times 22$  h/month). Record this result under Part W.

10.2.18 For facsimile machines with auto shutoff and an energy-saver mode calculate the amount of time a facsimile machine is in an energy-saver mode per month ( $(P \times 176) + 35 - (3 \times E 60)$ ). Record this result under Part X.

10.2.19 For facsimile machines with auto shutoff, calculate stand-by energy per standard month ( $C \times (211 - X)$  h/month) and record under Part Y.

10.2.20 For facsimile machines with auto shutoff and an energy-saver mode calculate energy-saver energy per month ( $D \times X$  h/month). Record under Part Z.

10.2.21 Calculate machine energy per standard month  $E_m = [L + T + U]$  or  $[L + Y + Z]$ . This is the energy consumed by the machine independent of volume. Record under Part AA.

10.2.22 Calculate the sending energy per standard month  $LN$ . Record under Part BB.

10.2.23 Calculate the receiving energy per standard month  $MN$ . Record under Part CC.

10.2.24 Calculate the recovery energy per standard month  $E_{rf}$  [ $(On) N$ ]. Record this result under Part DD.

10.2.25 Calculate the total energy per month  $E_t$ . Total energy equals machine energy plus sending energy plus receiving energy.

$$E_t = AA + BB + CC + DD \quad (1)$$

Record under Part EE.

10.2.26 Calculate the average total energy per page as follows:

$$E_{tave} = \frac{(AA + BB + CC + DD)}{N} \quad (2)$$

Record under Part FF.

## 11. Report

11.1 If several identical machines are tested, report the average energy rating. If the results for each machine differ by more than 10 %, repeat the test.

11.2 Report all data recorded to a minimum of three significant figures.

## 12. Keywords

12.1 energy usage; facsimile machine; printer

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