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Standard Test Method for Determining Energy Consumption of MFDs with Copying Capability and Similar Office Imaging Equipment[1]

This standard is issued under the fixed designation F2495; 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 Machines[2]

ISO 554 Standard Atmospheres for Conditioning and/or Testing Specifications[2]

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 ⅛ 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

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

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 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 (⅛ 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 (⅛ 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 (⅛ 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/m^2, 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

EUT	Single-sided Copy	Duplex Copy
Monthly volume, *N*	_____	
Number of copies, *n*, in test (from Table)	_____	
Copying time, C_t (from Table)	_____ min	
Wake-up time, T_{wk} (= Warm-up time, T_{wm})	_____ min	
Number of Jobs, *j*, in test (from Table)	_____	
Plug in mode energy	_____ Wh	
Test Results (1-h test):		
A. Warm-up plus ready mode energy	_____ Wh	
B. Ready mode energy	_____ Wh	
C. Copying energy plus ready mode energy	_____ Wh	_____ Wh
D Energy-saver mode energy	_____ Wh	
E. Energy-saver recovery time	_____ sec	
F. Recovery energy plus energy-saver mode energy	_____ Wh	
G. Sleep standby mode energy	_____ Wh	
Calculations, All MFDs:		
(1) Wake-up energy, E_r [A — B]	_____ Wh	
(2) Copying energy, E_c [C — B]	_____ Wh	_____ Wh
(3) Copying energy per copy, *Ec*/*n*	_____ Wh	_____ Wh
(4) Recovery energy, E_{rc} [F — D]	_____ Wh	
(5) Recovery energy, E_{rc} [F — D] per month	_____ Wh	
No. of jobs ≤ 5: (F — D) × {22 + (*j*) × 176}		
No. of jobs ≥ 6: (F — D) × 22		
(6) Ready mode energy time per month	_____ h	
No. of jobs ≤ 5: [{(T_w) × 22 + (C_t/*n*) × *N* + 10 × (*j*) × 176} ÷ 60]		
No. of job ≥ 6: [176 h]		
(7) Energy-saver time per month [198 – (6)]	_____	
(8) Sleep standby mode energy per standard month [G × 522]	_____ Wh	
(9) Wake-up energy per standard month [(A — B) × 22]	_____ Wh	
(10) Ready mode energy per standard month [B × (6)]	_____ Wh	
No. of jobs (*j*) ≤ 5: [B × {(T_w) × 22 + (C_t/*n*) × *N* + 10 × (*j*) × 176} ÷ 60]		
No. of jobs (j) ≥ 6: [B × 176]		
(11) Energy-saver mode energy per standard month (D × (7))	_____ Wh	
No. of jobs (j) ≤ 5: D × [198 – {(T_w) × 22 + (C_t/ *n*) × *N* + 10 × (*j*) × 176} ÷ 60]		
No. of jobs (*j*) ≥ 6: [D × 22]		
(12) Machine energy per standard month	_____ Wh	
E_m = [(8) + (9) + (10) + (11) + (5)]		
(13) Total energy per month $E_t = E_m + (E_c/ n) \times N$	_____ Wh	_____ Wh
(14) Average total energy per hour	_____ Wh/h	_____ Wh/h
$E_{tave} = \{E_m + (E_c/n) \times N\} \div 720$		

FIG. 1 Sample Data Sheet

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 in advance to prevent the machine from entering the energy-saver mode from the ready mode.

9.1.3.1 *Discussion*—Although wake-up time shall be measured actually, warm-up time is substituted for the wake-up time, since the wake-up time is regarded to be equal to the warm-up time.

9.1.4 *Ready Mode Energy*—During the previous step (9.1.3), read and record the watt-hour meter indication (Wh) and the time after the test machine has warmed up and entered the ready mode showing that it is ready for copying. The test machine must have been left in the ready mode after the end of the previous step (9.1.3). 1 h after the watt-hour meter indication (Wh) and the time are recorded as stated above in this step, read and record the watt-hour indication (Wh) again. The difference between the watt-hour reading at the start and finish of the hour is the observed data for ready mode energy use. Record the result in Fig. 1, Test Results Part B.

9.1.5 *Copying Energy Plus Ready Mode Energy*—After the measurement has been completed in the previous step (9.1.4), read and record the indication (Wh) of the watt-hour meter connected to the test machine in the ready mode and the time (or start the stopwatch or timer). Using a nominal original or originals (see 6.3) refer to Job Table for the nominal standard monthly volume for which the machine is being rated and perform the nominal jobs. Equally space the jobs throughout the 1 h allocated for this part of the test (see Job Table for the job time interval). For machines without ADF, the operator should change the original or originals in such a manner as to have a minimal impact on job time and energy use (see 8.1.8 for exceptions). For color machines, refer to the job table according to the type (serial or parallel) and repeat the jobs starting from the color mode and then the monochrome mode, in turn. The number of jobs can vary between color and monochrome modes. In this case, repeat the monochrome mode at the end. 1 h after all the jobs have been performed, read and record the watt-hour meter indication again. The difference between the two readings of the watt-hour meter is

the observed data for copying energy plus ready mode energy use. Record the result in Fig. 1, Test Results Part C.

9.1.6 *Energy-Saver Mode Energy*—Change the machine setting so that the machine can enter the energy-saver mode. When the machine has automatically entered the energy-saver mode, read and record the watt-hour meter indication (Wh) 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 observed data for energy-saver mode energy. Record the result in Fig. 1, Test Results Part D. If the machine reaches a sleep stand-by mode within 1 h after the start point of the energy-saver mode measurement, change the setting of the time to pass to the sleep stand-by mode to prevent the sleep stand-by mode function from working during the measurement.

9.1.7 *Energy-Saver Recovery Time*—Using the stopwatch, record the amount of time (in seconds) it takes the machine to come out of the energy-saver mode when the appropriate button (copy, or energy saver) is pressed. Record this in Fig. 1, Part E.

9.1.8 *Recovery Energy Plus Energy-Saver Mode Energy*—Repeat the steps in 9.1.6, when the machine enters the energy-saver mode, read and record the watt-hour meter indication (Wh) and the time (or start the stopwatch or timer). At one hour minus the time needed for the machine to come out of the energy-saver mode (9.1.7), bring the machine out of the energy-saver mode. When the machine reaches the ready mode, the time should show one hour. Record the watt-hour meter reading (Wh). The difference between these two readings is the observed data for recovery energy plus energy-saver mode energy. Record this in Fig. 1, Part F.

9.1.9 *Sleep Standby Mode Energy*—Change the machine setting so that the machine can enter the sleep stand-by mode. When the machine has automatically entered the sleep stand-by mode, read and record the watt-hour meter indication (Wh) and the time. After 1 h, record the watt-hour reading (Wh) again. The difference between the watt-hour reading at the start and finish of the hour is the observed data for sleep stand-by mode energy. Record the result in Fig. 1, Test Results Part G.

9.1.10 For machines configured with automatic duplex option, repeat the steps in 9.1.5 in a mode where two-sided copies are made from single-sided originals. Record the result in the appropriate section in Fig. 1. The copying time in the duplex mode is obtained in a different manner from the calculation in 9.1.1. Actual copying time of at least one job should be measured separately within a copy cycle of 1 h allocated for this part of the test. For efficiency measurements in the duplex mode in step 9.1.10 should be made after step 9.1.5, because the machine has been set not to enter the energy-saver mode in 9.1.5. However, since copies are made 100 % in the duplex mode in 9.1.5 without considering a single-to-duplex copying ratio, the value obtained should be used as reference only.

10. Calculation

10.1 Refer to the appropriate Job Table according to the machine type, color MFD (1 drum – serial type or 4 drum – parallel type) or monochrome MFD. Enter the following into Fig. 1: the nominal monthly copying volume (N) assumed based on the machine speed, the nominal number of jobs per hour of the machine (j), the number of copies (n), copying time (C_t) obtained in 9.1.1 and plug in mode energy obtained in 9.1.2.

10.2 Calculate the data for 100 % single sided copies obtained from steps 9.1.3 – 9.1.9 and list in the appropriately designated sections in Fig. 1.

10.2.1 Enter the data obtained from steps 9.1.3 – 9.1.9 under Test Results, Parts A, B, C, D, E, F and G, respectively.

10.2.2 Calculate wake-up energy (A – B) and record under (1).

10.2.2.1 This can be regarded as the difference between the warm-up plus ready mode energy and ready mode energy.

10.2.3 Calculate copying energy (E_c) using (C – B) and record under (2). Calculate copying energy per copy (E_c/n) and record under (3).

10.2.4 Calculate recovery energy from the energy-saver mode (E_{rc}) from (F – D) and record under (4). Calculate recovery energy per standard month.

10.2.4.1 If the number of jobs (j) is 6 or more, the job interval will be 10 minutes or less and the machine does not go into the energy-saver mode during the copying cycle (see 3.1.9.1, Discussion). This means the energy-saver mode time per month is only the time of 22 lunch breaks per month. The recovery energy per standard month is obtained from:

$$(F - D) \times 22. \tag{1}$$

10.2.4.2 If the number of jobs (j) is 5 or less, the machine goes into the energy-saver mode and recovers "the number of jobs" times, that is, "the number of jobs (j) × 8 h" times in the copying cycle of each day or "the number of jobs (j) × 176 h" times per standard month, in addition to times of the lunch break energy-saver mode. In this case, the recovery energy per standard month is obtained from:

$$(F - D) \times \{(j) \times 176 + 22\} \tag{2}$$

10.2.4.3 Record this result in Fig. 1, (5).

10.2.5 Calculate ready mode energy time per standard month.

10.2.5.1 If the number of jobs (j) is 5 or less, the ready mode energy exists in *(i)* warm-up time (T_{wk}), *(ii)* copying time (C_t) and *(iii)* {10 × (j)}, multiplying 10 minutes designated as passing time to the energy-saver mode by the number of jobs (j). The ready mode energy time per standard month (in hours) is obtained from:

$$\{(T_w \times 22 + (C_t/n) \times N + 10 \times (j) \times 176)\} \div 60 \tag{3}$$

10.2.5.2 If the number of jobs (j) is 6 or more, the machine does not go into the energy-saver mode during the copying cycle. Eight hours of the copying cycle of each of 22 work days per month is regarded as ready mode energy time. The ready mode energy time per standard month is obtained from:

$$8 \times 22 = 176 \tag{4}$$

10.2.5.3 Record the result in Fig. 1, (6).

10.2.6 Calculate energy-saver mode energy time per standard month.

10.2.6.1 Operating hours per standard month is 198 hours as a result of calculation, 9 h × 22 days.

10.2.6.2 Energy-saver mode time per standard month is obtained by subtracting the ready mode energy time per standard month calculated in 10.2.5 from 198 hours; that is, 198 – (6).

10.2.6.3 If the number of jobs (j) is 5 or less, the energy-saver mode time per standard month is obtained from:

$$198 - \{(T_{wk}) \times 22 + (C_t/n) \times N + 10 \times (j) \times 176\} \div 60 \quad (5)$$

10.2.6.4 If the number of jobs (j) is 6 or more, the energy-saver mode energy time is 22 hours as a result of calculation, 198 – 176, since the ready mode energy time per standard month is 176 hours.

10.2.6.5 This corresponds to 22 hours of lunch breaks per standard month (1 h × 22 days).

10.2.6.6 Record the result (in hours) in Fig. 1, (7).

10.2.7 Calculate sleep stand-by mode energy per standard month.

10.2.7.1 Sleep stand-by mode time per standard month is 522 hours, which is obtained by subtracting operating hours (9 × 22 = 198 hours) from total hours in a standard month (24 × 30 = 720 hours). The energy is obtained from:

$$G \times 522 \quad (6)$$

10.2.7.2 Record the result in Fig. 1, (8).

10.2.8 Calculate wake-up energy per standard month from:

$$(A - B) \times 22 \quad (7)$$

10.2.8.1 Record the result in Fig. 1, (9).

10.2.9 Calculate ready mode energy per standard month (B × (6)).

10.2.9.1 If the number of jobs is 5 or less:

$$B \times \{(T_{wk}) \times 22 + (C_t/n) \times N + 10 \times (j) \times 176\} \div 60 \quad (8)$$

10.2.9.2 If the number of jobs is 6 or more:

$$B \times 176 \quad (9)$$

10.2.9.3 Record the result in Fig. 1, (10).

10.2.10 Calculate energy-saver mode energy per standard month (D × (7)).

10.2.10.1 If the number of jobs is 5 or less:

$$D \times [198 - \{(T_{wk}) \times 22 + (C_t/n) \times N + 10 \times (j) \times 176\} \div 60] \quad (10)$$

10.2.10.2 If the number of jobs is 6 or more:

$$D \times 22 \quad (11)$$

10.2.10.3 Record the result in Fig. 1, (11).

10.2.11 Calculate machine energy per standard month from:

$$E_m = [(8) + (9) + (10) + (11) + (5)] \quad (12)$$

10.2.11.1 Record the result in Fig. 1, (12).

10.2.12 Calculate the total energy per standard month (E_t).

10.2.12.1 Total energy equals machine energy plus copying energy, as follows:

$$E_t = (E_m) + (E_c/n)N \quad (13)$$

10.2.12.2 Record the result in Fig. 1, (13).

10.2.13 Calculate the average total energy per hour, as follows:

$$\{E_m + (E_c/n)N\} \div 720 \quad (14)$$

10.2.13.1 Record the result in Fig. 1, (14).

10.3 Obtain data from 9.1.5 for 100 % duplex copies (making two-sided copies from single sided originals) and calculate the data from 10.2.1 – 10.2.13. List in the appropriately designated sections in Fig. 1.

11. Report

11.1 If several identical machines of the same model are rated, the average energy rating should be reported. If the results for each machine differ by more than 10 %, the test should be repeated.

11.2 All data recorded should be reported to a minimum of three significant figures.

12. Keywords

12.1 copier-duplicating equipment; copy materials; copy products; electrostatic copier; energy-consumption; MFD; multi-function device; office equipment

ANNEX

(Mandatory Information)

A1. JOB TABLES

TABLE A1.1 Mono MFD Table (1)

Speed	Nominal Monthly Volume, *N*	Nominal Copies/Day	Nominal Jobs (⅛ day)					Copying Time C_t (min)
			Number of Jobs	Number of Originals	Number of Copies/ Originals	*n*	Job Interval	
0 < ipm ≤ 5	150	8	1	1	1	1	60 min	1/X
5 < ipm ≤ 10	1000	40	1	1	5	5	60 min	1/X + 4/Y
10 < ipm ≤ 15	2500	128	2	2	4	16	30 min	2/X + 14/Y
15 < ipm ≤ 20	5000	224	2	2	7	28	30 min	2/X + 26/Y
20 < ipm ≤ 25	8000	360	3	3	5	45	20 min	3/X + 42/Y
25 < ipm ≤ 30	12000	576	3	3	8	72	20 min	3/X + 69/Y
30 < ipm ≤ 35	16000	768	4	3	8	96	15 min	4/X + 92/Y
35 < ipm ≤ 40	22000	960	4	3	10	120	15 min	4/X + 116/Y
40 < ipm ≤ 45	28000	1280	5	4	8	160	12 min	5/X + 155/Y
45 < ipm ≤ 50	35000	1600	5	4	10	200	12 min	5/X + 195/Y
50 < ipm ≤ 55	42000	1920	6	4	10	240	10 min	6/X + 234/Y
55 < ipm ≤ 60	50000	2304	6	4	12	288	10 min	6/X + 282/Y
60 < ipm ≤ 65	60000	2688	6	4	14	336	10 min	6/X + 330/Y
65 < ipm ≤ 70	70000	3168	6	6	11	396	10 min	6/X + 390/Y
70 < ipm ≤ 75	80000	3744	6	6	13	468	10 min	6/X + 462/Y
75 < ipm ≤ 80	90000	4224	6	8	11	528	10 min	6/X + 522/Y
80 < ipm ≤ 85	100000	4608	6	8	12	576	10 min	6/X + 570/Y
85 < ipm ≤ 90	115000	5280	6	10	11	660	10 min	6/X + 654/Y
90 < ipm ≤ 95	130000	5760	6	10	12	720	10 min	6/X + 714/Y
95 < ipm ≤ 100	145000	6720	6	10	14	840	10 min	6/X + 834/Y
100 < ipm	160000	7200	6	10	15	900	10 min	6/X + 894/Y

TABLE A1.2 Color MFD Table (2) (Serial: 1 Drum)

Speed (B/W Mode)	Nominal Monthly Volume, *N*	Upper: Color Lower: B/W	Nominal Copies/Day	Nominal Jobs (⅛ Day)						Copying Time C_t, (min)
				Number of Jobs	Number of Originals	Number of Copies/ Originals	*n*	Total Number of Jobs	Job Interval	
0 < ipm ≤ 5	150	150	8	1	1	1	1	1	60 min	1/X
		n/a	n/a	n/a			n/a			
5 < ipm ≤ 10	1000	200	8	1	1	1	1	2	30 min	1/X
		800	32	1	2	2	4			1/X + 3/Y
10 < ipm ≤ 15	2500	500	24	1	1	3	3	2	30 min	1/X + 2/Y
		2000	96	1	3	4	12			1/X + 11/Y
15 < ipm ≤ 20	5000	1000	48	1	2	3	6	2	30 min	1/X + 5/Y
		4000	192	1	4	6	24			1/X + 23/Y
20 < ipm ≤ 25	8000	1600	72	1	3	3	9	3	20 min	1/X + 8/Y
		6400	288	2	3	6	36			2/X + 34/Y
25 < ipm ≤ 30	12000	2400	120	1	3	5	15	3	20 min	1/X + 14/Y
		9600	432	2	3	9	54			2/X + 52/Y
30 < ipm ≤ 35	16000	3200	144	1	3	6	18	4	15 min	1/X + 17/Y
		12800	576	3	4	6	72			3/X + 69/Y
35 < ipm ≤ 40	22000	4400	200	1	5	5	25	4	15 min	1/X + 24/Y
		17600	840	3	5	7	105			3/X + 102/Y
40 < ipm ≤ 45	28000	5600	256	2	4	4	32	5	12 min	2/X + 30/Y
		22400	1008	3	6	7	126			3/X + 123/Y
45 < ipm ≤ 50	35000	7000	320	2	4	5	40	5	12 min	2/X + 38/Y
		28000	1296	3	6	9	162			3/X + 159/Y
50 < ipm ≤ 55	42000	8400	384	2	4	6	48	6	10 min	2/X + 46/Y
		33600	1536	4	6	8	192			4/X + 188/Y
55 < ipm ≤ 60	50000	10000	448	2	4	7	56	6	10 min	2/X + 54/Y
		40000	1792	4	7	8	224			4/X + 220/Y
60 < ipm ≤ 65	60000	12000	560	2	5	7	70	6	10 min	2/X + 68/Y
		48000	2304	4	8	9	288			4/X + 284/Y
65 < ipm ≤ 70	70000	14000	640	2	5	8	80	6	10 min	2/X + 78/Y
		56000	2560	4	8	10	320			4/X + 316/Y
70 < ipm ≤ 75	80000	16000	720	2	5	9	90	6	10 min	2/X + 88/Y
		64000	3072	4	8	12	384			4/X + 380/Y
75 < ipm ≤ 80	90000	18000	800	2	5	10	100	6	10 min	2/X + 98/Y
		72000	3328	4	8	13	416			4/X + 412/Y
80 < ipm ≤ 85	100000	20000	960	2	6	10	120	6	10 min	2/X + /118Y
		80000	3584	4	8	14	448			4/X + 444/Y
85 < ipm ≤ 90	115000	23000	1056	2	6	11	132	6	10 min	2/X + 130/Y
		92000	4160	4	10	13	520			4/X + 516/Y
90 < ipm ≤ 95	130000	26000	1152	2	6	12	144	6	10 min	2/X + 142/Y
		104000	4800	4	10	15	600			4/X + 596/Y
95 < ipm ≤ 100	145000	29000	1344	2	6	14	168	6	10 min	2/X + 166/Y
		116000	5120	4	10	16	640			4/X + 636/Y
100 < ipm	160000	32000	1440	2	6	15	180	6	10 min	2/X + 178/Y
		128000	5760	4	10	18	720			4/X + 716/Y

TABLE A1.3 Color MFD Table (3) (Parallel: 4 Drums)

Speed (B/W Mode)	Nominal Monthly Volume, *N*	Upper: Color Lower: B/W	Nominal Copies/Day	Nominal Jobs (⅛ Day)						Copying Time C_t, (min)
				Number of Jobs	Number of Originals	Number of Copies/ Originals	*n*	Total Number of Jobs	Job Interval	
0 < ipm ≤ 5	150	150	8	1	1	1	1	1	60 min	1/X
		n/a	n/a		n/a		n/a			
5 < ipm ≤ 10	1000	500	24	1	1	3	3	2	30 min	1/X + 2/Y
		↑	↑	1	1	3	3			1/X + 2/Y
10 < ipm ≤ 15	2500	1250	56	1	1	7	7	2	30 min	1/X + 6/Y
		↑	↑	1	1	7	7			1/X + 6/Y
15 < ipm ≤ 20	5000	2500	112	1	2	7	14	2	30 min	1/X + 13/Y
		↑	↑	1	2	7	14			1/X + 13/Y
20 < ipm ≤ 25	8000	4000	192	2	2	6	24	3	20 min	2/X + 22/Y
		↑	↑	1	3	8	24			1/X + 23/Y
25 < ipm ≤ 30	12000	6000	288	2	3	6	36	3	20 min	2/X + 34/Y
		↑	↑	1	4	9	36			1/X + 35/Y
30 < ipm ≤ 35	16000	8000	384	2	4	6	48	4	15 min	2/X + 46/Y
		↑	↑	2	4	6	48			2/X + 46/Y
35 < ipm ≤ 40	22000	11000	480	2	5	6	60	4	15 min	2/X + 58/Y
		↑	↑	2	5	6	60			2/X + 58/Y
40 < ipm ≤ 45	28000	14000	648	3	3	9	81	5	12 min	3/X + 78/Y
		↑	640	2	5	8	80			2/X + 78/Y
45 < ipm ≤ 50	35000	17500	768	3	4	8	96	5	12 min	3/X + 93/Y
		↑	800	2	5	10	100			2/X + 98/Y
50 < ipm ≤ 55	42000	21000	960	3	5	8	120	6	10 min	3/X + 117/Y
		↑	↑	3	5	8	120			3/X + 117/Y
55 < ipm ≤ 60	50000	25000	1152	3	6	8	144	6	10 min	3/X + 141/Y
		↑	↑	3	6	8	144			3/X + 141/Y
60 < ipm ≤ 65	60000	30000	1344	3	7	8	168	6	10 min	3/X + 165/Y
		↑	↑	3	7	8	168			3/X + 165/Y
65 < ipm ≤ 70	70000	35000	1536	3	8	8	192	6	10 min	3/X + 189/Y
		↑	↑	3	8	8	192			3/X + 189/Y
70 < ipm ≤ 75	80000	40000	1728	3	8	9	216	6	10 min	3/X + 213/Y
		↑	↑	3	8	9	216			3/X + 213/Y
75 < ipm ≤ 80	90000	45000	1944	3	9	9	243	6	10 min	3/X + 240/Y
		↑	↑	3	9	9	243			3/X + 240/Y
80 < ipm ≤ 85	100000	50000	2160	3	9	10	270	6	10 min	3/X + 267/Y
		↑	↑	3	9	10	270			3/X + 267/Y
85 < ipm ≤ 90	115000	57500	2640	3	10	11	330	6	10 min	3/X + 327/Y
		↑	↑	3	10	11	330			3/X + 327/Y
90 < ipm ≤ 95	130000	65000	2880	3	10	12	360	6	10 min	3/X + 357/Y
		↑	↑	3	10	12	360			3/X + 357/Y
95 < ipm ≤ 100	145000	72500	3360	3	10	14	420	6	10 min	3/X + 417/Y
		↑	↑	3	10	14	420			3/X + 417/Y
100 < ipm	160000	80000	3600	3	10	15	450	6	10 min	3/X + 447/Y
		↑	↑	3	10	15	450			3/X + 447/Y