Designation: F1318 – 90 (Reapproved 2009)

Standard Test Method for Determination of Productivity Using Electrostatic Copy Machines with Various Configurations[1]

This standard is issued under the fixed designation F1318; 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 test method covers the determination of productivity using electrostatic copy machines with various combinations of accessories and in different operating modes.

1.2 The results from this test method will enable copy machine users to compare the productivity of similarly equipped copiers to each other or the productivity of a copy machine can be compared with itself in its various configurations.

1.3 *This standard does not purport to address all of the safety problems, 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:*[2]

F335 Terminology Relating to Electrostatic Imaging

F995 Practice for Estimating Toner Usage in Copiers Utilizing Dry Two-Component Developer

3. Terminology

3.1 *Definitions:*

3.1.1 *copy rate*—the average number of copies per minute that an electrostatic copy machine produces when a given number of copies are made of a given input load.

3.1.2 *productivity factor*—the number of copies per minute that an electrostatic copy machine produces on the average when allowances are made for the effects of work load, accessories, feed time, warm-up, operating mode and other factors which affect the output of the copier.

3.1.3 For other definitions see Terminology F335.

4. Summary of Test Method

4.1 The test method consists of two procedures for determining the productivity of an electrostatic copy machine when using any combination of accessories or attachments.

4.1.1 Procedure A, Test Method For Measuring Machine Productivity, is a series of direct measurements of the time required to do specific numbers of copies under given circumstances with selected accessories. It is intended to be quick and machine dependent.

4.1.2 Procedure B, Test Method For Measuring Job Productivity, is a series of measurements of the various tasks and operations on a copy machine. It uses standard jobs, and arrives at overall productivity ratings which are both machine and operator dependent.

5. Significance and Use

5.1 This test method is used to determine the copy per minute rating (productivity) of electrostatic copiers under standard conditions. It measures the time required to copy a specific standard load on a copy machine. This productivity value is to be compared to the repeat copy rate for the same machine to see if there is a change in the efficiency of the machine when various accessories or combinations of accessories are added to or used on the machine, or when the work load changes. It can also be used to compare the efficiencies of different but similarly equipped copy machines. It is suitable for productivity evaluation by the user, and in research and development.

6. Interferences

6.1 The productivity of a copier can be affected by the attachment of an accessory whether it is operating or not. Thus, for a full comparison of the efficiency of a machine, it should be tested with a given accessory removed, with it attached but not operating, and with it attached and operating. If two or more copiers are being tested and compared, it is important to maintain as equitable a situation as possible, with attachments on all machines being used in the same state.

6.2 Productivity can be affected by the paper input source selection and similar nuances in operation. The default conditions are not always the most efficient operating mode. Nor are

[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 Feb. 1, 2009. Published February 2009. Originally approved in 1990. Last previous edition approved in 2003 as F1318 – 90(2003). DOI: 10.1520/F1318-90R09.

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

automatic selections necessarily faster than manual selections. Therefore it may be necessary to perform several trial operations to optimize conditions.

6.3 Some of the activities being timed in this test can be affected by the ability of the operator. Therefore it is important that the test operator be as familiar with the test machine as the average operator in the field would be. For this test, the operator should have read the operator's manual thoroughly, and have operated the test machine several times before the actual test. If operator proficiency cannot be satisfactorily achieved, the time extensions induced by operator activities may be excluded from the calculations. However this should be noted in the report.

6.4 This test method addresses only the measurement of the time needed for the copy machine to operate. If office productivity is to be measured, several other factors such as service time, supply availability, queuing time, etc., must be considered. They are beyond the scope of this test method.

6.5 In both test methods the number of copies to be made, the number of originals to be used and the number of runs to be made were selected to fit as typical a set of cases as possible. However for a given situation restricting the measurement to these values may not be adequate. Therefore the user of this method is advised to use values for number of copies, number of originals, number of runs and other parameters so that the situation is adequately covered and a fair equitable comparison can be made.

7. Apparatus

7.1 *Copy Machine* to be tested with instruction manuals and specification sheets.

7.2 *Standard Test Load, Test Originals,* a set of 8.5 by 11 in. originals. The number of sheets depends on the test being performed. The sheets should be reasonably flat, free from curl, unwrinkled, and neither crushed nor torn. A20 lb basis weight (17 in. by 22 in. 500 sheet ream) is preferred.

7.3 *Stopwatch or Timer,* accurate to 0.1 s.

7.4 *Clock or Second Timer* with a second hand.

7.5 *Supplies* for the copy machine which meet the copy machine manufacturer's specifications.

8. Conditioning

8.1 The test area shall be the normal office environment, within the temperature and humidity range recommended by the copier manufacturer for normal use.

8.2 All supplies and the standard test loads shall be in the same room as the test machine for at least 24 h prior to the test so that the temperature and moisture content of the supplies will have stabilized. Supplies should be kept in their normal wrappers or storage containers until needed.

9. Procedure A—Method For Measuring Machine Productivity

9.1 Prepare the test machine for operation in accordance with the manufacturer's instructions. Run the machine to see that it is operating properly. Determine the proper settings for the test so that the images will be of proper quality and all accessories are functioning properly. If necessary, have the copier serviced to avoid any problems.

9.2 *Preparing the Originals*—Any typing typical of the office work environment may be used as an original for these tests, however the 4 % "k" chart in Fig. 1 of Test Method F995 is recommended. Two sets of originals are needed. One set will consist of ten copies of the 4 %" k" chart or other original. These are to be on one side of the sheet of paper, and will be used for most of the tests. Make a second set of originals with the pattern on both sides of the sheet of paper. This second set should consist of five sheets of paper with the pattern on both sides of the paper so that there are ten patterns on five sheets of paper. The second set is for some of the duplexing tests. Number the individual "k" charts so that the copies can be uniquely identified. If extensive testing is to be done, several sets of originals may be needed so that good, clean, flat, unwrinkled, and uncreased originals are always used.

9.3 *Machine Repeat Copy Rate:*

9.3.1 Measure the machine repeat copy rate. This is the number of 8.5 by 11 in. copies the machine can produce in 1 min from the same original after the first copy has been made. All accessories are off, and all paper is fed from the default source and is in the default orientation. If the default tray allows for feeding of the paper in either the short or long direction, load the paper or set the machine so that in default it feeds in the short direction. Note the feed direction.

9.3.2 Place a copy of the "k" chart on the platen of the copier. Check to see that the copier is turned on and ready to operate. Run one copy. Set the copier to produce eleven copies. Press the start button. When the trailing edge of the first copy exits the machine, start the stopwatch. When the trailing edge of the eleventh copy exits the machine stop the stopwatch.

9.4 *First Copy Time:*

9.4.1 Measure the first copy time. This is the time the copier uses to produce one copy from one original.

9.4.2 Set the copier paper feed as described in 9.3.1. Place one original on the platen. Set the selector to make one copy of the original.

9.4.3 Simultaneously start the stopwatch and press the start button on the copier. Stop the stopwatch when the trailing edge of the copy exits the machine. Check the printed copy to see that the copy is properly made and is of good quality. If there has been a discrepancy, a blank sheet is found, or a jam occurred, make note of this and then redo the test. The latter result will be considered valid.

9.5 *Copy Rate in the Simplex Mode:*

NOTE 1—To measure the copy rate in the simplex mode the copier must be equipped with a feeder. If the test copier is not so equipped, go to 9.6.

9.5.1 Measure the copy rate in the simplex mode. This is the number of copies per minute that the copier can make for a given number of originals with a given number of copies from each original. Because the rate will depend on the load, a set of three values will be calculated. The series will consist of making one copy each of ten originals, three copies each of ten originals, and five copies each of ten originals.

9.5.2 Set the copier paper feed as described in 9.3.1. Place the first set of originals (the single-sided ones) in the feeder. Set the selector to make one copy per original.

9.5.3 Simultaneously start the stopwatch and press the start button on the copier. Stop the stopwatch when the "ready for copying" prompt or indicator comes on. (If there is no ready indicator per se, stop the watch when the last copy drops into the out tray, when the last original is ejected from the feeder, or other appropriate time.) Check the printed copies to see that all copies were properly made and are of good quality. If there has been a discrepancy, a blank sheet is found or a jam occurred, make note of this and then redo the test. The latter result will be considered valid.

9.5.4 Set the copier paper feed as described in 9.3.1. Place the first set of originals (the single-sided ones) in the feeder. Set the selector to make three copies per original. Set the sorter to sort and collate the three sets of copies. Repeat steps 9.5.3 to 9.5.4. Report this result as the simplex rate with three copies. (To make this measurement the copier must be equipped with a feeder and sorter, with a feeder and offset stacking tray, or with a recycling stack feeder. If the test copier is not so equipped, go to 9.6 below.)

9.5.5 Set the copier paper feed as described in 9.3.1. Place the first set of originals (the single-sided ones) in the feeder. Set the selector to make five copies per original. Set the sorter to sort and collate the five sets of copies. Repeat steps 9.5.3 and 9.5.4. Report this result as the simplex rate with five copies.

9.6 *Machine Copy Rate with Duplexing:*

9.6.1 Measure the copy rate with duplexing. This is the number of copies per minute that the copier can make for a given number of originals with text on one or both sides of the originals and the copying being done to one or both sides of the copies. There are three types of duplexing: 1 to 2, 2 to 1 and 2 to 2. Because the copy rate will depend on the load and the duplexing mode, each duplexing mode will be tested with outputs of one, three and five sets from ten originals.

9.6.1.1 One to two duplexing is the copying of material from originals with information on one side of the original to copies with information on both sides of the copies. There should be a one to one correspondence between originals and copies in pages but there should be fewer sheets of copied paper.

9.6.1.2 Two to one duplexing is the copying of material from originals with information on both sides of the original to copies with information on one side of the copies. There should be a one to one correspondence between originals and copies in pages but there should be more sheets of copied paper than original sheets of paper.

9.6.1.3 Two to two duplexing is the copying of material from originals with information on both sides of the original to copies with information on both sides of the copies. There should be a one to one correspondence between originals and copies on both sheets of paper and pages.

9.6.2 To measure the 1 to 2 duplexing copy rate set the copier paper feed as described in 9.3.1. Place the one-sided set of originals in the feeder. Set the selectors to make one copy of the originals in the 1 to 2 duplexing mode. (To make this measurement the copier must be configured to do 1 to 2 duplexing. If the test copier is not so designed, go to 9.6.6 below.)

9.6.3 Simultaneously start the stopwatch and press the start button on the copier. Stop the stopwatch when the "ready for copying" prompt or indicator comes on. (If there is no ready indicator per se, stop the watch when the last copy drops into the out tray, when the last original is ejected from the feeder, or other appropriate time.) Check the printed copies to see that all copies were properly made, are properly sorted and are of good quality. If there is a discrepancy, a blank side is found, or a jam occurs, make note of this and then redo the test. The latter result will be considered valid.

9.6.4 To measure the 1 to 2 duplexing copy rate for three sets, set the copier paper feed as described in 9.3.1. Place the one-sided set of originals in the feeder. Set the selectors to make three copies of the originals in the 1 to 2 duplexing mode. Repeat steps 9.6.3 and 9.6.4. Report this result as the copy rate with 1 to 2 duplexing and three copies.

9.6.5 To measure the 1 to 2 duplexing copy rate for five sets, set the copier paper feed as described in 9.3.1. Place the one-sided set of originals in the feeder. Set the selectors to make five copies of the originals in the 1 to 2 duplexing mode. Repeat steps 9.6.3 and 9.6.4. Report this result as the copy rate with 1 to 2 duplexing and five copies.

9.6.6 To measure the 2 to 1 duplexing copy rate for one set, set the copier paper feed as described in 9.3.1. Place the two-sided set of originals in the feeder. Set the selectors to make one copy of the originals in the 2 to 1 duplexing mode. Repeat steps 9.6.3 and 9.6.4. Report this result as the copy rate with 2 to 1 duplexing. (To make this measurement the copier must be configured to do 2 to 1 duplexing. If the test copier is not so designed, go to 9.6.9 below.)

9.6.7 To measure the 2 to 1 duplexing copy rate for three sets, set the copier paper feed as described in 9.3.1. Place the two-sided set of originals in the feeder. Set the selectors to make three copies of the originals in the 2 to 1 duplexing mode. Repeat steps 9.6.3 and 9.6.4. Report this result as the copy rate with 2 to 1 duplexing and three copies.

9.6.8 To measure the 2 to 1 duplexing copy rate for five sets, set the copier paper feed as described in 9.3.1. Place the two-sided set of originals in the feeder. Set the selectors to make five copies of the originals in the 2 to 1 duplexing mode. Repeat steps 9.6.3 and 9.6.4. Report this result as the copy rate with 2 to 1 duplexing and five copies.

9.6.9 To measure the 2 to 2 duplexing copy rate for one set, set the copier paper feed as described in 9.3.1. Place the two-sided set of originals in the feeder. Set the selectors to make one copy of the originals in the 2 to 2 duplexing mode. Repeat steps 9.6.3 and 9.6.4. Report this result as the copy rate with 2 to 2 duplexing. (To make this measurement the copier must be configured to do 2 to 2 duplexing. If the test copier is not so designed the test is completed.)

9.6.10 To measure the 2 to 2 duplexing copy rate for three sets, set the copier paper feed as described in 9.3.1. Place the two-sided set of originals in the feeder. Set the selectors to make three copies of the originals in the 2 to 2 duplexing mode.

Repeat steps 9.6.3 and 9.6.4. Report this result as the copy rate with 2 to 2 duplexing and three copies.

9.6.11 To measure the 2 to 2 duplexing copy rate for five sets, set the copier paper feed as described in 9.3.1. Place the two-sided set of originals in the feeder. Set the selectors to make five copies of the originals in the 2 to 2 duplexing mode. Repeat steps 9.6.3 and 9.6.4. Report this result as the copy rate with 2 to 2 duplexing and five copies.

10. Procedure B—Method for Measuring Job Productivity

10.1 Prepare the test machine. At least one day before the actual test run, try the machine to see that it is operating properly. Make a simulated test run. Determine the proper settings for the test so that the images will be of proper quality and all accessories are functioning properly. If necessary, have the copier serviced to avoid any problems.

10.2 Prepare the standard test load. From Table 1 determine the standard monthly volume, copies per month for which the test is to be run. Locate the number of originals which correspond to that standard monthly volume. (The values given in Table 1 are suggested parameters. Other values indicative of the user's special circumstances may be substituted. However, any deviations should be included in the report.) Prepare that number of pages to be used as the originals in the test. Any typing typical of the office work environment will do, however the 4 % "k" Chart in Fig. 1 of Test Method F995 is recommended. If extensive testing is to be done, several sets of originals may be needed so that good, clean, flat, unwrinkled, and uncreased originals are always used.

10.3 Measure the machine initial warm-up time. This is the time it takes for the machine to warm up when first turned on at the start of the work day.

10.3.1 This measurement can be made only after the test copier has been off, over night status, for at least 8 h.

10.3.2 Turn the main power switch on. At the same time, start the stopwatch or timer. When the copier signals that it is ready to start copying, stop the watch or timer. Record this as the initial warm-up time.

TABLE 1 Standard Parameters for Each Standard Volume

Standard Monthly Volume (Copies per Month)	Standard Day's Copies	Standard Jobs (⅛ day)			
		Number of Jobs	Number of Originals	Number of Copies/ Original	Job Interval, minutes
200	8	1	1	1	60.0
500	24	3	1	1	20.0
1000	48	3	1	2	20.0
2500	112	7	1	2	8.6
5000	224	7	2	2	8.6
10000	432	9	2	3	6.6
25000	1152	16	3	3	3.7
40000	1824	19	3	4	3.1
80000	3600	18	5	5	3.3
100000	4800	3	10	20	20.0
280000	13200	2	15	55	30.0
500000	22800	2	15	95	30.0
1000000	45600	2	15	190	30.0

10.4 Determine the job interval from Table 1. Set the copy machine in its between-jobs state as per the manufacturer's instructions. On copiers where the time before rest or standby is adjustable, set it to maximum or, if possible, set it to off so the rest or standby state is not entered. Wait the specified time before continuing.

10.5 Measure the job time. This consists of the machine setup time, first copy time, repeat time, feed time, and sort time or however many of these apply to the copier being tested.

10.5.1 Start the stopwatch or timer. Also record the starting time, either from a normally running clock or with another stopwatch or timer. This second timing is for the observation of the job interval time as given in Table 1. It will be used to determine when to start the second run.

10.5.2 Set all the copier selections necessary to complete the job. These selections should be determined beforehand. They should be indicative of the intended use of the copier and data. Several tests may be necessary to cover all applicable combinations. If the copier is job programmable, program it to perform the operations required in the test. This selection can consist of some or all of the following:

10.5.2.1 Darkness.

10.5.2.2 Number of copies (see Table 1).

10.5.2.3 Paper supply.

10.5.2.4 Duplexing.

10.5.2.5 Feeder settings.

10.5.2.6 Sorter settings.

10.5.2.7 Reduction/enlargement settings.

10.5.3 Insert the job load in the feeder, or place the first page on the platen, whichever applies.

10.5.4 Start the copier.

10.5.5 Repeat copies.

10.5.5.1 If the copier is operating in an automatic feed mode, or there is only one copy of one page called for in Table 1, go to step 10.5.6.

10.5.5.2 If the copier document feed device is semiautomatic or is operating in a semiautomatic feed mode, press the feed button or take the appropriate action to feed the second page. Repeat this until all the pages in the job load have been copied the required number of times. Then continue with step 10.5.6.

10.5.5.3 If the copier is not equipped with a document feed device, or is being operated in a manual feed mode, when the first page is copied the required number of times, remove it from the platen, and replace it with the second page. Operate the necessary switches if any to start copying. Repeat this step until all the pages in the job load have been copied the required number of times. The operator should make every effort possible to replace the originals at an efficient and constant rate.

10.5.6 When all the required copies have been made, remove the originals and the copies from the copier. If the copier does not have an automatic shut off, set it in its between-jobs state as per the manufacturer's instructions. On copiers where the time before rest is adjustable, set it to maximum or, if possible, set it to off so the rest state is not entered.

10.5.7 Stop the stopwatch or timer. Record this as the job time.

10.5.8 After waiting for the job interval time as given in Table 1 to elapse, repeat steps 10.5.1 through 10.5.7. The job interval time is the time from the start of the first run to the start of the second run as measured on the second clock noted in 10.5.1.

10.5.9 Repeat step 10.5.8 at least two more times, so that four or more job times are measured. The exact number of job time measurements to be made is dependent on the accuracy desired.

10.5.10 Calculate the average and the standard deviation of the job times measured in 10.5.7 to 10.5.9 above. Reject all values which are outside of the 90 % confidence interval. Average the remaining job times. This is now the average job time.

10.6 Measure the paper loading time. This is the time it takes for the operator to load paper into the paper source, considering only those tasks which cannot be performed while the copier is operating.

10.6.1 Determine the time required to make ten copies as described in 9.3.1 to 9.3.2. The stopwatch reading mentioned at the end of 9.3.2 will be used here as the uninterrupted base time.

10.6.2 Repeat the operations of 9.3.1 to 9.3.2 with the following changes.

10.6.2.1 Before the run starts, prepare to reload the paper source. Any preparation can be made beforehand which would normally be made while the machine is operating. That is, the paper can be unwrapped and fanned. If the copier has automatic or manual source change, and it is normally used, the second source may be loaded. The change-over may be programmed. If a second tray is normally kept ready to exchange with the empty tray, it may be readied, etc.

10.6.2.2 When the run starts, have only five sheets of paper in the paper feed source from which the copier is feeding.

10.6.2.3 When the run is interrupted because the paper source is empty, take the necessary action, if any, to load or change over the paper supply. The change-over may be automatic.

10.6.3 Repeat steps 10.6.2 to 10.6.3 at least three more times, so that four or more paper loading times are measured. The exact number of paper loading time measurements to be made is dependent on the accuracy desired.

10.6.4 Calculate the average and the standard deviation of the paper loading times measured in 10.6.3 to 10.6.4 above. Reject all values which are outside of the 90% confidence interval. Average the remaining paper loading times. This is now the average paper loading time.

11. Calculation

11.1 *Calculations for Procedure A:*

11.1.1 To calculate the repeat copy rate, C_B, for Procedure A, divide the stopwatch reading from 9.3.2 by 60 to convert the stopwatch reading to minutes. Then divide this value into ten to arrive at the repeat copy rate in copies per minute:

$$C_B = \frac{60 \times 10}{S_s} \quad (1)$$

where S_s is the stopwatch reading in seconds.

11.1.2 To calculate the simplex copy rate, S_s, for Procedure A, divide the number of seconds registered on the stopwatch in 9.5.3 by 60 to convert it to minutes. Then divide this quotient into the number of copies produced to arrive at the number of copies per minute produced for this mode of operation:

$$S = \frac{60 \times C}{S_s} \quad (2)$$

where:

C = number of copies and
S_s = stopwatch reading in seconds.

11.1.3 To calculate the copy rate with duplexing, S_D, for Procedure A, divide the number of seconds registered on the stopwatch in 9.6.3 by 60 to convert it to minutes. Then divide this quotient into the number of copies produced (remember to count copies of pages, not output sheets), to arrive at the number of copies per minute produced for this mode of operation:

$$S_D = \frac{60 \times C}{S} \quad (3)$$

where:

C = number of copies and
S = stopwatch reading in seconds.

11.2 *Calculations for Procedure B:*

11.2.1 The stopwatch reading for the run in 10.6 through 10.6.2.3 is the base time plus the paper loading time. The paper loading time is the difference between the base time plus the paper loading time and the uninterrupted base time:

$$P = (B+P) - B_u \quad (4)$$

where:

P = paper loading time,
B = base time, and
B_u = uninterrupted base time.

11.2.2 A sample calculation sheet is provided in Fig. 1. Enter the designated values in the appropriate space and make calculations as directed below.

11.2.3 Enter the standard day's copies and number of jobs on lines A and B, respectively. They were determined as specified in 10.2 from Table 1.

Test I.D. _____ Date____
Copier Configuration _____

A. Standard Day's Copies . . . . . _____
B. Number of Jobs . . . . . _____
C. Number of Jobs per Day . . . . . _____
D. Average Job Time . . . . . _____ Minutes
E. Total Day's Job Time . . . . . _____ Minutes
F. Initial Warm-up Time . . . . . _____ Minutes
G. Paper Loading Time . . . . . _____ Minutes
H. Prorated Paper Loading Time . . . . . _____ Minutes
I. Total Operation Time . . . . . _____ Minutes
J. Productivity Factor . . . . . _____ Copies per Minute

FIG. 1 Sample Calculation Sheet Procedure B

11.2.4 The number of jobs per day is eight times the number of jobs in line B. Calculate the number of jobs per day, and enter it on line C.

11.2.5 Enter the average job time as calculated in 10.5.10 on line D. This should be given in minutes and fractions of minutes.

11.2.6 Calculate the total days job time. It is the number of jobs per day multiplied by the average job time, that is, line C times line D. Enter this product on line E.

11.2.7 Enter the initial warm-up time as measured in 10.3.2 on line F. This should be given in minutes.

11.2.8 Enter the average paper loading time calculated in 10.6.4 on line G. If the copier being tested has automatic tray change-over when both trays are loaded with the same size paper so that paper loading is done while the machine is running, and you have used the copier in this mode, enter zero on line G.

11.2.9 To find the prorated paper loading time, divide the standard day's copies from line A by the tray capacity, then multiply this quotient by the paper loading time from line G. Enter this product on line H.

11.2.10 The total operation time is the total day's job time plus the initial warm-up time plus the prorated paper loading time (line E plus line F plus line H). Enter this sum on line I.

11.2.11 The productivity factor is the standard day's copies divided by the total operation time. That is, line A divided by line I. Enter the value on line J.

12. Report

12.1 *Procedure A:*

12.1.1 Report the following information:

12.1.1.1 The brand name and model name or number.

12.1.1.2 Identification of the accessories attached to the copier.

12.1.1.3 The paper feed direction. (If the paper feed direction is the same for all tests, indicate that this is so and report that direction. If it is different for different tests, report the paper feed direction with each test.)

12.1.1.4 The repeat copy rate.

12.1.1.5 The first copy time.

12.1.1.6 The simplex copy rate, if measured.

12.1.1.7 The simplex copy rate with three copies, if measured.

12.1.1.8 The simplex copy rate with five copies, if measured.

12.1.1.9 The copy rate with 1 to 2 duplexing, if measured.

12.1.1.10 The copy rate with 1 to 2 duplexing with three copies, if measured.

12.1.1.11 The copy rate with 1 to 2 duplexing with five copies, if measured.

12.1.1.12 The copy rate with 2 to 1 duplexing, if measured.

12.1.1.13 The copy rate with 2 to 1 duplexing with three copies, if measured.

12.1.1.14 The copy rate with 2 to 1 duplexing with five copies, if measured.

12.1.1.15 The copy rate with 2 to 2 duplexing, if measured.

12.1.1.16 The copy rate with 2 to 2 duplexing with three copies, if measured.

12.1.1.17 The copy rate with 2 to 2 duplexing with five copies, if measured.

12.2 *Procedure B:*

12.2.1 Report the following information:

12.2.1.1 The brand name and model name or number.

12.2.1.2 Identification of the accessories used in the test, with their status.

(1) Possible accessories are feeder, sorter, book copier, forms feeder, etc.

(2) The accessories' status can be attached and operating, attached and not operating, removed, etc.

12.2.1.3 The operating configuration. The operating configuration can include such things as reduction, enlargement, automatic document feed, semiautomatic document feed, manual feed, duplexing, automatic paper tray change over, programmed operations, paper feed direction, etc.

12.2.1.4 The manufacturer's given repeat copy rate for the basic copier.

12.2.1.5 The productivity factor.

13. Precision and Bias

13.1 When Procedure A of this practice is used within a laboratory, the results are repeatable to within 3 %. Interlaboratory compatibility has not been determined.

13.2 For Procedure B of this practice intralaboratory and interlaboratory compatibility has not been determined.

14. Keywords

14.1 copier; copier efficiency; copier productivity; copier throughput; electrostatic copiers; xerography

APPENDIX

(Nonmandatory Information)

X1. CALCULATION OF COPY TIMES

X1.1 This appendix defines and gives instructions for the calculation of the times involved in the various productivity rates measured in Procedure A. The following times and variables are calculated:

X1.1.1 T_1 = Time for first copy from one original.

X1.1.2 T_2 = Time for first copy from second or subsequent original.

X1.1.3 T_3 = Time for second or subsequent copy from same original.

X1.1.4 T_4 = Additional time per sorter bin being used.

X1.1.5 n = Copies per original.

X1.1.6 N = Number of originals.

X1.1.7 t = Copying time; total time to produce nN copies.

X1.1.8 B = Total number of sorter bins available.

X1.1.9 X = Time to make 2B copies using all available sorter bins.

X1.2 *Calculations for Simplex Operations*:

X1.2.1 Time for first copy from one original, T_1, is the first copy time measuired in 9.4. It is the stopwatch reading in seconds taken in paragraph 9.4.3.

X1.2.2 Time for second or subsequent copy from same original, T_3, is the reciprocal of the Repeat Copy Rate calculated in 9.3. To calculate T_3 in seconds, divide the stopwatch reading taken in 9.3.2 by the number of copies made minus one:

$$T_3 = \frac{(S_s)}{(n-1)} \tag{X1.1}$$

where:

n = 11 (from 9.3.2) and
S_s = stopwatch reading, s.

X1.2.3 Time for first copy from second or subsequent original, T_2, can be calculated from T_1, T_3, t and the load used. The relation between the variables is:

$$T_2 = \frac{t - T_1 - T_3\,(n-1)\,N}{(N-1)} \tag{X1.2}$$

Several combinations of t, n and N are available. The value of t can be the stopwatch reading in seconds from paragraph 9.5.4, 9.5.5 or 11.1.2. In the calculation the corresponding values for n and N should be used.

X1.3 *Calculations for Duplex Operations*:

X1.3.1 Each of the three types of duplexing will have its own set of T values. For a given copy machine some of them may be the same, or they can all be different.

X1.3.2 Time for first copy from one original in duplexing, T_1, can be measured by setting the copier for the type of duplexing to be measured, and then proceeding as in 9.4 and then applying the instructions in X1.2.1.

X1.3.3 Time for second or subsequent copy from same original, T_3, in duplexing can be measured by setting the copier for the type of duplexing to be measured, and then proceeding as in 9.3 and then applying the instructions in X1.2.1.

X1.3.4 Time for first copy from second or subsequent original, T_2, in duplexing can be calculated from T_1, T_3, t and the load used. The equation and instructions from X1.2.3 apply except that the stopwatch readings and corresponding n and N values from 9.6.3, or 9.6.5 through 9.6.11 should be used.

X1.4 Additional time per sorter bin being used, T_4, can be calculated from any of the above data sets and a measurement of X, the time to make 2 B copies using all available sorter bins.

X1.4.1 To measure X , set up the copier as appropriate for simplex or duplex operation, and place two originals in the input hopper. Set the machine to make a number of copies equal to the number of available sorter bins. For example, if the copy machine has a 20 bin sorter, set the copier to make 20 copies and put one in each bin. Simultaneously start the stopwatch and press the start button on the copier. Stop the stopwatch when the "ready for copying" prompt or indicator comes on. (If there is no ready indicator per se stop the watch when the last copy drops into the last bin, when the last original is ejected from the feeder, or other appropriate time.) Check the printed copies to see that all copies were properly made, are properly sorted and are of good quality. If there is a discrepancy, a blank side is found or a jam occurs, make note of this and then redo the test. The latter result will be considered valid. This stopwatch reading is X.

X1.4.2 Additional time per sorter bin being used, T_4, can be calculated with this formula:

$$T_4 = \frac{X - T_1 - T_2(N-1) - T_3(n-1)N}{B} \tag{X1.3}$$

X1.5 The above equation can be rearranged to calculate the copying time, t, or total time to produce nNcopies. The relation is:

$$t = T_1 + T_2(N-1) + T_3(n-1)N + nT_4 \tag{X1.4}$$