

CAROT 2
OPTIMAL TRUNK TEST SCHEDULING
CENTRALIZED AUTOMATIC REPORTING ON TRUNKS (CAROT)

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2. OPTIMAL TESTING PHILOSOPHY

2.01 The objective of optimal testing is to make better use of CAROT trunk fault detection resources in order to reduce the effects of faulty trunks on network service. The CAROT optimal trunk testing philosophy takes into account CAROT inherent capabilities to detect operational trunk faults. Faulty trunks have various effects on service, ranging from causing a trunk to be inaccessible, to impairing transmission quality, to causing ineffective attempts via short holding time (killer) trunks. Of these, killer trunks have the greatest impact on service since they cause a significant volume of ineffective calls. A killer trunk in a group may produce unacceptable service as seen by customers. This is particularly true for smaller-size groups since an arriving call has a greater chance of selecting the killer than in a larger group.

2.02 The CAROT System can test a very large network and has the ability to detect various classes of killer trunks. Furthermore, the rates at which CAROT tests trunks can be specified in such a way that they take into account the individual characteristics of the network. Optimal selection of CAROT test rates should result in a reduction of the volume of ineffective calls due to killer trunks, and should provide adequate protection for trunk groups which give unacceptable service when a killer is present.

2.03 Currently, CAROT test rates are prescribed only on the basis of facility type without regard to ineffective calls due to killer trunks. For a given network, the effects of killer trunks depend on the characteristics of the trunk groups (such as group size, high usage, or final), the hunt discipline, and the trunk fault detection systems at the near-end machines. The procedure takes these characteristics into account and enables the

1. GENERAL

1.01 This section describes a procedure which can be used to optimize trunk testing on the CAROT network. The information in this section applies to CAROT Systems which incorporate generic 2 or later software.

1.02 Whenever this section is reissued, the reason for reissue will be given in this paragraph.

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tailoring of CAROT test rates to the network in order to accomplish the following:

- Minimize the volume of ineffective calls over the network due to killers
- Provide an adequate amount of testing for all trunks (at least one test per month for each trunk)
- Provide service protection to trunk groups which give unacceptable service when a killer occurs.

2.04 When a network is optimized, some CAROT testing is removed from machines having a great deal of built-in, automatic trunk fault detection capability (such as ESS), and reallocated to machines having little or no automatic fault detection capability (such as step-by-step). This reduces the overall ineffective rate of the overall network serviced by CAROT. It also tends to equalize the ineffective rates of the different near-end switching machines in the CAROT tested.

2.05 To implement optimal testing, a number of forms with various information are completed and a few simple calculations are made. The end result is three candidate solutions:

- The nominal solution which provides no specified service protection
- The small service protection solution which provides service protection to a small number of trunk groups that are most sensitive to killer trunks
- The large service protection solution which provides service protection to a larger number of trunk groups sensitive to killer trunks.

2.06 Each of these solutions provides an increasing amount of service protection by specifying various test schedules for various types of trunks. CAROT can presently handle up to four test codes, and each solution provides the interval for these codes. Associated engineering and management personnel must weigh several factors in order to select a solution to implement.

3. DATA COLLECTION

3.01 Various information should be collected and organized for use in completing the forms. A description of the information to be collected follows:

(1) Identify each switching machine associated with the CAROT network, and classify each in one of the following categories:

- (a) Step-by-step (SXS) with no automatic testing
- (b) Crossbar (XB) with small amount of automatic testing
- (c) Crossbar with moderate amount of automatic testing
- (d) Electronic Switching System (ESS) or crossbar with large amount of automatic testing
- (e) Step-by-step with the following surveillance:

- One week processing time
- Two days processing time
- Less than 1 day processing time.

(f) Crossbar with the following surveillance:

- Low-stuck sender tracing, 1 week processing time
- Low-stuck sender tracing, 2 days processing time
- Low-stuck sender tracing, less than 1 day processing time
- High-stuck sender tracing, 1 week processing time
- High-stuck sender tracing, 2 days processing time
- High-stuck sender tracing, less than 1 day processing time.

(2) For each machine type, determine the number of trunk groups, number of trunks

in each trunk group, and whether the trunk group is high usage or final.

- (3) From office records, determine the maximum number of trunks that CAROT can test per month.
- (4) Make copies of forms contained in Part 7 of this section.

4. PROCEDURES FOR COMPLETING FORMS

4.01 Five forms are provided to enter the necessary information and to enter the results of the required calculations. Information is entered on these forms by machine type (SXS, ESS, 5XB, 1XB, crossbar tandem [XBT]) taking into account associated automatic testing systems. Forms 1a and 1b are each four pages in length; a separate form should be completed for each near-end machine type on the CAROT network. Data associated with SXS, ESS, and 5XB machines should be entered on Form 1a while data associated with 1XB and XBT should be entered on Form 1b. The reason for having separate forms is due to the hunt discipline used by various machines. The remaining forms (2 through 5) can be used to collectively enter data for all machine types.

4.02 Examples of completed forms are presented in Fig. 1 through 9. Blank forms are discussed in Part 7 of this section.

4.03 For each form, enter data collected as described in Part 2, or transfer data from one form to another. Also, some calculations must be performed and then entered on the forms.

4.04 The following paragraphs describe how to complete each form. These descriptions are divided into two parts: (1) Information to be entered, and (2) calculations to be performed.

A. Form 1

Information To Be Entered

4.05 From the data collected in Part 3, enter on appropriate Form 1a or 1b for each machine type information described as follows:

MACHINE TYPE

Enter the near-end machine type associated with trunk information to be entered. Designate any

associated automatic testing systems. Insure that the proper form (1a or 1b) is being used.

NO. OF GROUPS (column b)

For each group size (column a), enter the total number of high-usage trunk groups in column b.

NO. OF GROUPS (column b')

For each group size (column a), enter the total number of final trunk groups in column b'.

Calculations To Be Performed

4.06 From the entered data, perform the following calculations and enter them on the form:

NO. OF TRUNKS (column c)

Multiply column a by b and enter result in column c. This is the number of high-usage trunks.

NO. OF TRUNKS (column c')

Multiply column a by b' and enter result in column c'. This is the number of final trunks.

TRUNK GROUP WEIGHT (column e)

Multiply column b by d and enter result in column e. This is the weight factor assigned to all high-usage groups of a given size.

TRUNK GROUP WEIGHT (column e')

Multiply column b' by d' and enter result in column e'. This is the weight factor assigned to all final groups of a given size.

4.07 On Page 4 of Forms 1a and 1b, enter a summation of the information contained on the form as follows:

For All Groups:

MACHINE TYPE

Enter the machine type as entered on Page 1 of the form.

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N_{ALL}

Sum all entries in columns c and c' and enter on form. This is the total number of trunks associated with this machine type.

W_{ALL}

Sum all entries in columns e and e' and enter on form. This is the total weight factor for trunks associated with this machine type.

Small Service Protection:

N_{SP}

Sum all entries in columns c and c' from top, down to the SMALL SERVICE PROTECTION line. This is the total number of trunks which can be provided protection from ineffective attempts via the small service protection solution.

W_{SP}

Sum columns e and e' from top of columns down to the SMALL SERVICE PROTECTION line. This is the total weight factor of the trunks protected via the small service protection solution.

N_{NET}

Subtract N_{SP} from N_{ALL} and enter on form. This N_{NET} is the number of trunks which will not be provided service protection via the small service protection solution.

W_{NET}

Subtract W_{SP} from W_{ALL} and enter on form. This W_{NET} is the weight factor of the trunks not protected via the small service solution.

Large Service Protection:

N_{SP}

Sum all entries in columns c and c' from top, down to the LARGE SERVICE PROTECTION line. This is the total number of trunks which can be provided protection from ineffective attempts via the large service protection solution.

W_{SP}

Sum columns e and e' from top of columns down to the LARGE SERVICE PROTECTION line. This is the total weight factor of the trunk protected via the large service protection solution.

N_{NET}

Subtract N_{SP} from N_{ALL} and enter on form. This N_{NET} is the number of trunks which will not be provided service protection via the large service protection solution.

W_{NET}

Subtract W_{SP} from W_{ALL} and enter on form. This is the weight factor of the trunks not protected via the large service protection solution.

4.08 After the summations have been completed, transfer the information to the table at the bottom of the page (Form 1, Page 4). Next, transfer this information by machine type as specified on the form to Form 2.

B. Form 2

Information To Be Entered

4.09 After columns A through E, H, and I have been entered with information from each Form 1, refer to Table A and enter information described as follows:

TEST RATE (column F)

For small service protection, enter the test rate for each machine type.

PROB KILLER (column G)

For small service protection, enter the probability of a killer occurring for each machine type.

TEST RATE (column J)

For large service protection, enter the test rate for each machine type.

PROB KILLER (column K)

For large service protection, enter the probability of a killer occurring for each machine type.

Y* FOR OPTIMIZATION (column L)

Enter the optimization factor for each machine type.

Calculations To Be Performed

- 4.10** From the entered data, perform the following calculations and enter on Form 2:

TOTAL TRUNKS (bottom of form)

Sum all entries in column B and enter on form. This is the total number of trunks associated with the CAROT network.

TOTAL OFFERED LOAD

Multiply the total number of trunks by 0.8 and enter on form. This is an approximation of the total network offered load.

C. Form 3**Information To Be Entered**

- 4.11** After Form 2 has been completed, respectively transfer the information in columns A, B, and C of Form 2 to columns A, B, and C of Form 3. Next, transfer the information in column L of Form 2 to column E of Form 3; and finally, enter at the top of the form the overall CAROT capacity (CC) in trunk-tests/month.

Calculations To Be Performed

- 4.12** From the entered data, perform the following calculations and enter them on the form:

N/W (column D)

Divide each N_{ALL} (column B) by its corresponding W_{ALL} (column C).

$$S^* = Y^* / (N/W) \text{ (column F)}$$

Divide each Y^* (column E) by its corresponding N/W (column D).

- 4.13** Columns G, H, I, etc, are used to optimize the monthly test rates. Column G illustrates the calculations to be performed for each S_n parameter. Calculations are entered in columns H through O, and individually summed to obtain a test capacity for S_n [Cap (S_n)] until Cap (S_n) approaches within

2 percent of the CAROT controller capacity that was entered at the top of the form.

- 4.14** To perform these calculations, start by entering information for column H as follows:

$$S_0 = \text{LARGEST } S^*$$

Enter for S_0 the largest quantity in column F.

$$R \times N_{ALL}$$

For each machine type, respectively copy the contents of column B to column headed by $R \times N_{ALL}$. No multiplication is required since $R = 1$.

Cap (S_0)

Sum the contents of column headed by $R \times N_{ALL}$ and enter at bottom of form at Cap (S_0).

- 4.15** Observe Cap (S_0). One of the following three cases will occur:

Case 1: Cap (S_0) is within 5 percent of CAROT capacity (CC). If this occurs, computations are finished and the test rate (R) is one test per month for all trunks. (This case is very unlikely to occur.)

Case 2: Cap (S_0) is greater than CC. If this occurs, computations are finished, but test trunks less than once per month. The test rate for all trunks should then be calculated from the following:

$$R = CC / (\text{sum of } N_{ALL}).$$

(This case is also very unlikely to occur.)

Case 3: Cap (S_0) is less than CC. This is the most likely case. Now, go on to generate next estimate of S.

- 4.16** Enter and perform the following calculations in column I for each machine type:

$$S_1 = \text{SMALLEST } S^*$$

Enter for S_1 the smallest quantity in column F.

$$Y = N/W S_1$$

For each machine type, respectively multiply column D (N/W) by S_1 and enter in column headed by $Y = (N/W) S_1$.

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R

For each machine type, refer to Fig. 10 to find the value of R and enter in column headed by R.

R x N_{ALL}

For each machine type, multiply its associated R parameter by N_{ALL} (column B) and enter in column headed by R x N_{ALL}.

Cap (S₁)

Sum the contents of column headed by R x N_{ALL} and enter at bottom of form at Cap (S₁).

4.17 Observe Cap (S₁). One of the following three cases will occur:

Case 1: Cap (S₁) is within 5 percent of CAROT capacity (CC). If this occurs, computations are finished. Take the values from the test rates given by the R column and enter them to the right part of the form in the column headed by NOMINAL TEST RATES R. Next, proceed to Form 4.

Case 2: Cap S₁ is less than CC. If this occurs, calculate S₂ and each successive S_n via the following formula:

$$S_n = \left(\frac{\text{Cap}(S_{n-1})}{CC} \right)^2 \times S_{n-1}$$

Next, calculate Cap (S_n) similarly as described for S₁ until Cap (S_n) approaches within 5 percent of CC. When Cap (S_n) approaches within 5 percent of CC, transfer the associated values of R to the right part of the form under the column designated NOMINAL TEST RATES R.

Case 3: Cap (S₁) is greater than CC. If this occurs, calculate S₂ via the following formula:

$$S_2 = \frac{CC - \text{Cap}(S_1)}{\text{Cap}(S_o) - \text{Cap}(S_1)} \times (S_o - S_1) + S_1$$

and each succeeding S_n via the following formula:

$$S_n = \frac{CC - \text{Cap}(S_b)}{\text{Cap}(S_a) - \text{Cap}(S_b)} \times (S_a - S_b) + S_b$$

Where:

Cap (S_a) is obtained by taking all previous values of Cap (S) which were smaller than CC and then assigning the largest of these to Cap (S_a).

Cap (S_b) is obtained by taking all previous values of Cap (S) which were larger than CC and then assigning the smallest of these to Cap (S_b).

S_a and S_b correspond to the S parameters associated with Cap (S_a) and Cap (S_b).

Calculate Cap (S_n) until it approaches within 5 percent of CC. When Cap (S_n) approaches within 5 percent of CC, transfer the associated values of R to the right part of the form in the column headed by NOMINAL TEST RATES R.

D. Form 4

4.18 Form 4 is used to apply service protection to small-size trunk groups. To do this, test these small-size trunks at a service protection rate (R_{SP}) which is somewhat higher than the nominal test rate (R). In order to maintain a constant CAROT capacity, the groups without service protection would thus be tested at rates lower than the nominal test rate R. Therefore, the purpose of Form 4 is to scale down the nominal test rates so that service protection can be applied. Two copies of Form 4 will have to be filled in, ie, one for the large service protection solution and one for the small service protection solution.

Information To Be Entered

4.19 After Form 3 has been completed, enter the following information:

SERVICE PROTECTION

On the top of the page enter LARGE or SMALL in the blank area preceding the words SERVICE

PROTECTION to denote which case is being calculated.

CC

On the next line, enter the CAROT test capacity from top of Form 3.

MACHINE TYPE (column A)

Enter each machine type from column A of Form 2.

R, N_{NET}, N_{SP} (column B)

For each machine type, enter the test rate (R) from the right column of Form 3. For the small service protection case, enter N_{NET} and N_{SP} from column D of Form 2. For the large service protection case, enter N_{NET} and N_{SP} from column H of Form 2.

R_{SP} = (column E)

For the small service protection case, enter from column F of Form 2. For the large service protection case, enter from column J of Form 2.

Calculations To Be Performed

4.20 From the entered data, perform the following calculations and enter them on the form:

R x N_{NET}, R x N_{SP} (column C)

For each machine type, multiply R times N_{NET}, and R times N_{SP}. R, N_{NET}, and N_{SP} are contained in column B. Enter the two results in the indicated spaces of column C.

I x N_{NET}, R_{SP} x N_{SP} (column D)

For each machine type, enter N_{NET} and the product of R_{SP} times N_{SP} in the indicated spaces of column D.

SUM OF COL D

Sum the entries in column D and enter result at bottom of form.

4.21 Compare the sum of column D with CC. One of the following conditions will occur:

Case 1: The sum of column D is greater than CC. If this occurs, the CAROT does not have

enough test capacity to apply this service protection. No further calculations can be performed on this form.

Case 2: The sum of column D is within 5 percent of CC. In this case, we can test all groups requiring service protection at their R_{SP}'s and all other groups once a month. No further calculations can be performed on this form. At the right part of the form, place a check mark (✓) in each blank in the column headed by TEST AT R_{SP} ? and transfer the contents of column E to the column headed by TEST RATE.

Case 3: The sum of column D is less than CC. In this case, we perform scaling calculations as described in the following paragraphs.

Scaling Calculations

4.22 If case 3 in paragraph 4.21 applies, scaling calculations need to be performed. The result of the scaling calculations will be a single-scale factor (Z) which can be used to reduce the test rates for all groups without service protection. In other words, test at the rate Z x R instead of R. To arrive at Z, make a few successive estimates of Z until an appropriate value of Z is obtained. Each column under the heading SCALING contains the calculations corresponding to a particular estimate of Z. For each scaling column, perform the following functions:

- (1) Enter the estimate of Z at the top of the column. If this is the initial entry into this procedure, start with Z = 1.
- (2) For each machine type, multiply R (column B) by Z and enter for ZR=.
- (3) For each machine type, compare associated ZR with those entries in column E.
 - If ZR is less than or equal to 1, place a check mark (✓) in the space below ZR directly across from the 1 in column E. If ZR is greater than 1, make no entry in this location.
 - If ZR is less than or equal to R_{SP}, place a check mark in the next space in the column directly across from R_{SP} in column E.

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- If ZR is greater than R_{SP}, make no entry in this location.

- (4) Observe the check marks. Sum all elements in column D for which a corresponding check mark appears in the scaling column. Enter this sum for S₁ at the bottom of the form.
- (5) Observe the blanks. Sum all elements in column C for which a corresponding check mark appears in the scaling column. Enter this sum for S₂ at the bottom of the form.
- (6) Form a new estimate of Z via the following equation:

$$\text{New } Z = \frac{(CC - S_1)}{S_2}$$

and enter in the next scaling column.

- (7) Examine the check marks and blanks. If two successive columns have check marks and blanks in identical positions, stop the process of estimating Z. If this has not yet occurred, return to Step 2.

4.23 For each machine type, fill in the right FINAL TEST RATES columns as follows:

- (1) On the line labeled N_{NET}, if a check mark appears on the same line in the last completed scaling column, enter a 1 on this line under the TEST RATE column. Otherwise, enter ZR from the last completed scaling column.
- (2) On the line labeled N_{SP}, if a check mark appears on the same line in the last completed scaling column, enter a check mark in the TEST AT R_{SP} ? column and enter the R_{SP} parameter (column E) in the TEST RATE column. If no check mark appears on the same line in the last completed scaling column, leave the TEST AT R_{SP} ? column blank, and enter the ZR parameter from the last completed scaling column in the TEST RATE column.

E. Form 5

4.24 The purpose of Form 5 is to evaluate the erlangs lost and the network ineffective rate for each of the three possible solutions.

Information To Be Entered

4.25 After Form 4 has been completed, enter the following information:

MACHINE TYPE (column A)

Transfer this information from Form 2, column A.

W_{ALL} (column B)

Transfer this from Form 2, column C.

W_{NET}, W_{SP} (column F)

Transfer both quantities from Form 2, column E.

W_{NET}, W_{SP} (column K)

Transfer both quantities from Form 2, column I.

TOTAL OFFERED LOAD (bottom left)

Transfer from bottom of Form 2

TEST RATE (column C)

From the right column of Form 3, transfer the nominal test rates R to appropriate position in column C.

PROB KILLER (column D)

For each machine type, refer to the appropriate part of Fig. 11 to determine the probability of killer occurring and enter on form. To obtain this probability, select the test rate (R) from column C, enter the horizontal axis in the appropriate part of Fig. 11 curve, and then obtain the probability on the vertical axis.

SERVICE PROTECTION/TEST RATE (columns G and H)

From Form 4 for the small service protection case, transfer the contents of the two right columns (TEST AT R_{SP} ?, and TEST RATE) to appropriate columns G and H of Form 5.

PROB KILLER (column I)

To complete column I, note that each machine type has two entries in column I which correspond to its two test rate entries in column H. Using the appropriate part of Fig. 11, obtain the probability of killer which corresponds to each of the two test rates (R) for each machine type.

Note: If a check mark appears in column G, select the second entry in column I (on the same line as the check mark) from the value given in column G of Form 2 for the corresponding machine type.

SERVICE PROTECTION/TEST RATE (columns L and M)

From Form 4 for the large service protection case, transfer the contents of the two right columns (TEST AT R_{SP} ? and TEST RATE) to columns L and M of Form 5.

PROB KILLER (column N)

To complete column N, note that each machine type has two entries in column N which correspond to its own test rate entries in column M. Using the appropriate part of Fig. 11, obtain the probability of killer which corresponds to each of the two test rates (R) for each machine type.

Note: If a check mark appears in column L, select the second entry in column N (on the same line as the check mark) from the value given in column K of Form 2 for the corresponding machine type.

Calculations To Be Performed

4.26 From the entered data, perform the following calculations and enter them on the form:

ERLANGS LOST (column E)

Product of W_{ALL} (column B) and PROB KILLER (column D).

ERLANGS LOST (column J)

Two calculations required for each machine type are (1) product of W_{NET} and associated PROB KILLER, and (2) W_{SP} and associated PROB KILLER. W_{NET} and W_{SP} are obtained from column F, and PROB KILLER from column I.

ERLANGS LOST (column O)

Two calculations required for each machine type are (1) product of W_{NET} and associated PROB KILLER, and (2) W_{SP} and associated PROB KILLER. W_{NET} and W_{SP} are obtained from column K, and PROB KILLER from column N.

TOTAL ERLANGS LOST (bottom of columns E, J, and O)

Individually sum each of columns E, J, and O, and enter each result in their respective positions.

NETWORK INEFFECTIVE RATE (bottom of columns E, J, and O)

Individually divide each TOTAL ERLANGS LOST by the TOTAL OFFERED LOAD (bottom left on Form 5) and multiply by 100 to obtain the NETWORK INEFFECTIVE RATE.

5. DETERMINE THE OPTIMAL SOLUTION

5.01 The three solutions have the following qualitative characteristics:

SOLUTION	SERVICE PROTECTION	NETWORK INEFFECTIVE RATE
Nominal	None. Only guarantees one test per month per trunk	Lowest possible value
Small service protection	Service protection for small trunk groups	Somewhat higher than nominal solution
Large service protection	Largest amount of service protection	Highest value

5.02 From the three solutions, notice that as the amount of service protection increases (desirable), the network ineffective rate also tends to increase (undesirable). For a network with a relatively few small trunk groups, the ineffective rate for the large service protection solution case will most likely approach that of normal solution. Thus, the large service protection case would be the optimal solution. Conversely, for a network consisting of mostly small trunk groups (such as a local metropolitan network), the ineffective rate for the large service protection solution may be unacceptably high. Also, there could exist a strong possibility that the CAROT controller will not have the test capacity to apply this solution.

5.03 In summation, the optimal solution is the one which provides as much service protection as possible and at the same time provides an ineffective rate which does not depart within 20 percent from that of the nominal solution.

6. MODIFY CAROT TEST SCHEDULES

6.01 CAROT 2 currently has a maximum of four distinct test rates. The new test rates are associated with the CAROT schedule category codes 00, 10, 20, and 30. Originally these codes corresponded to daily, weekly, biweekly, and monthly testing, respectively. Under optimal testing, these codes can be reassigned to four or fewer test rates. Form 5 contains the calculated test rates which must be achieved in order to implement the chosen solution. These test rates must be converted to schedule intervals to conform to the CAROT generic 2 format. This is accomplished using Form 6.

A. Form 6

6.02 The purpose of Form 6 is to gather on one form all information necessary to determine the schedule code which should be assigned to each trunk. The schedule code is based on the originating machine type, group size, and knowledge as to whether the group is high usage or final.

Information To Be Entered

6.03 If the normal solution has been chosen, Form 6a (Fig. 7) should be filled out. If either the small or large service protection solution has been chosen, Form 6b should be used. Circle small or large in the header of Form 6b (Fig. 8 and 9), as appropriate.

6.04 From Form 5, transfer all machine types and test rates to the appropriate columns on Form 6a or 6b.

6.05 If using Form 6b for each machine type, enter the choices of high usage and final in the traffic class column. Now, for each machine type and each traffic class, enter in the trunk group size column the trunk group size range for which service protection will be offered. This information is obtained from either Form 1a or 1b, depending on machine type.

Calculations To Be Performed

6.06 To convert the test rates to schedule intervals, divide each test rate into 30.4. Round off the results, and enter it into the test interval column. These results will be the minimum number of days between CAROT scheduled routine tests for trunks in this schedule category.

6.07 CAROT allows at most four test intervals. If more than four intervals exist on Form 6, close intervals should be combined to yield at most four intervals. The selected schedule codes should then be entered on Form 6. The four schedule codes for CAROT are 00, 10, 20, and 30; where 00 corresponds with the shortest test interval, 10 with the next shortest test interval, etc.

6.08 In order to verify that the solution chosen is still optimal (due to combining intervals in paragraph 6.07), the data base administrator may wish to convert the combined test intervals by dividing the interval into 30.4. Reinsert the revised test rates onto Form 5 and recompute the erlangs lost with the revised rates.

6.09 Once the administrator is satisfied that four or fewer test intervals have been determined, the actual CAROT schedule intervals can be modified to correspond to them. This is accomplished using the **SCINxx=** command, where xx = 00, 10, 20, or 30. A detailed procedure for setting the routine testing interval for optimal trunk testing is contained in Section 190-102-301.

6.10 If it is necessary to change the assigned test code associated with particular trunk

groups, the CAROT select program and text editor (Section 190-102-206) should be used to access control office and trunk group records, edit the test code data, and submit the changed data for update. If both the test rates and test codes assigned to trunk groups are to be changed, they should be performed concurrently during the same update cycle.

7. BLANK FORMS

7.01 Blank forms are provided (see Fig. 12, 13, 14, 15, 16, 17, 18, and 19) which may be reproduced as needed.

8. REFERENCES

SECTION	DESCRIPTION
190-102-203	CAROT Data Base Description and Input File Preparation
190-102-206	CAROT Select Program and Text Editor
190-102-301	CAROT Controller Operating Procedures, Generic 2

FORM 1a, PAGE 1
 FOR SXS, ESS, AND 5XB ONLY
 MACHINE TYPE: ESS

a GROUP SIZE	HIGH USAGE				FINALS			
	b NO. OF GROUPS	c NO. OF TRUNKS a X b	d TRUNK GROUP WEIGHT	e WEIGHT X NO. OF GROUPS b X d	b' NO. OF GROUPS	c' NO. OF TRUNKS a X b'	d' TRUNK GROUP WEIGHT	e' WEIGHT X NO. OF GROUPS b' X d'
1			1.2				.01	
2			2.9				.16	
3	4	12	5.1	20.4			.52	
4	7	28	7.6	53.2			1.1	
5	10	50	10	100			1.8	
6	9	54	13	117			2.7	
7	9	63	17	153			3.7	
8	6	48	20	120			4.8	
9	4	36	24	96			6.1	
10	13	130	28	364	1	10	7.5	7.5
11	1	11	31	31			9.0	
12	3	36	36	108			11	
13			40		1	13	12	12
14	8	112	44	352			14	
15	3	45	48	144			16	
16	2	32	53	106			18	
17	2	34	58	116	1	17	20	20
18			62				22	
19	4	76	67	268			25	
20	7	140	72	504	1	20	27	27
21			77		3	63	29	87
22	5	110	82	410	1	22	32	32
23	1	23	87	87	1	23	34	34
24	1	24	93	93	2	48	37	74
25			98				40	
26	1	26	103	103	2	52	42	84
27			109		1	27	45	45
28	2	56	114	228			48	
29	3	87	120	360			51	
30			126				54	
31			131		2	62	57	114
32			137		1	32	60	60
33	1	33	143	143			63	
34			149				67	
35	1	35	155	155	2	70	70	140
36			161				73	
37			167		2	74	77	154
38	1	38	173	173			80	
39	2	78	179	358	1	39	83	83
40			185		5	200	87	435

↑ SMALL SERVICE PROTECTION

↑ LARGE SERVICE PROTECTION

↑ SMALL SERVICE PROTECTION

↑ LARGE SERVICE PROTECTION

Fig. 1—Example of a Completed Form 1a (Sheet 1 of 4)

FORM 1a, PAGE 2

a GROUP SIZE	HIGH USAGE				FINALS			
	b NO. OF GROUPS	c NO. OF TRUNKS a X b	d TRUNK GROUP WEIGHT	e WEIGHT X NO. OF GROUPS b X d	b' NO. OF GROUPS	c' NO. OF TRUNKS a X b'	d' TRUNK GROUP WEIGHT	e' WEIGHT X NO. OF GROUPS b' X d'
* 41 TO 42			195		1	42	92	92
43 TO 44			207		1	44	100	100
45 TO 46	1	46	220	220	3	138	108	324
47 TO 48	2	96	233	446			115	
49 TO 50			247		5	250	123	615
** 51 TO 55	1	53	267	267	7	371	136	952
56 TO 60			301		9	522	157	1413
61 TO 65			336		4	252	179	716
66 TO 70			372		3	204	202	606
71 TO 75			409		3	219	226	678
76 TO 80			446		4	312	251	1004
81 TO 85			484		1	83	277	277
86 TO 90			523		2	76	304	608
91 TO 95			562		2	186	331	662
96 TO 100			601				359	
101 TO 110			662		1	105	402	402
111 TO 120			744		1	115	461	461
121 TO 130			828				523	
131 TO 140			914				587	
141 TO 150			1001		1	145	654	654

* USE THE "LARGER" NUMBER OF TRUNKS FOR GROUP SIZE
 ** USE THE "MIDDLE" NUMBER OF TRUNKS FOR GROUP SIZE

Fig. 1—Example of a Completed Form 1a (Sheet 2
of 4)

FORM 1a, PAGE 3

a GROUP SIZE	HIGH USAGE				FINALS			
	b NO. OF GROUPS	c NO. OF TRUNKS a X b	d TRUNK GROUP WEIGHT	e WEIGHT X NO. OF GROUPS b X d	b' NO. OF GROUPS	c' NO. OF TRUNKS a X b'	d' TRUNK GROUP WEIGHT	e' WEIGHT X NO. OF GROUPS b' X d'
151 TO 160			1089				722	
161 TO 170			1178				792	
171 TO 180			1270				863	
181 TO 190			1362				936	
191 TO 200			1454				1011	
201 TO 225			1621				1147	
226 TO 250	1	238	1861	1861			1346	
251 TO 275			2106				1552	
276 TO 300			2355				1765	
301 TO 325			2608				1985	
326 TO 350			2864				2210	
351 TO 375			3123				2441	
376 TO 400			3637				2676	
401 TO 425			3653				2916	
426 TO 450			3922				3159	
451 TO 475			4192				3407	
476 TO 500			4464				3658	

Fig. 1—Example of a Completed Form 1a (Sheet 3 of 4)

FORM 1a, PAGE 4

SUMMATIONS:

MACHINE TYPE: ESS

FOR ALL GROUPS FROM THIS MACHINE TYPE:

$N_{ALL} = 5786$ SUM ALL OF COLUMNS c AND c'

$W_{ALL} = 18,549.1$ SUM ALL COLUMNS e AND e'

SMALL SERVICE PROTECTION:

$N_{SP} = 291$ SUM COLUMNS c AND c' DOWN TO "SMALL SERVICE PROTECTION" LINES.

$W_{SP} = 659.6$ SUM COLUMNS e AND e' DOWN TO "SMALL SERVICE PROTECTION" LINES.

$N_{NET} = N_{ALL} - N_{SP} = 5495$

$W_{NET} = W_{ALL} - W_{SP} = 17,889.5$

LARGE SERVICE PROTECTION:

$N_{SP} = 691$ SUM COLUMNS c AND c' DOWN TO "LARGE SERVICE PROTECTION" LINES.

$W_{SP} = 1880.6$ SUM COLUMNS e AND e' DOWN TO "LARGE SERVICE PROTECTION" LINES.

$N_{NET} = N_{ALL} - N_{SP} = 5095$

$W_{NET} = W_{ALL} - W_{SP} = 16,668.5$

ENTER THE ABOVE VALUES INTO THE FOLLOWING TABLE:

ALL GROUPS		SMALL SERVICE PROTECTION		LARGE SERVICE PROTECTION	
N_{ALL} 5786	W_{ALL} 18,549.1	N_{NET} 5495	W_{NET} 17,889.5	N_{NET} 5095	W_{NET} 16,668.5
		N_{SP} 291	W_{SP} 659.6	N_{SP} 691	W_{SP} 1880.6

TRANSFER TO FORM 2:

COL B	COL C	COL D	COL E	COL H	COL I
-------	-------	-------	-------	-------	-------

Fig. 1—Example of a Completed Form 1a (Sheet 4 of 4)

FORM 2 PARAMETERS FOR MACHINE TYPES

SOURCE:

A MACHINE TYPE	NOMINAL SOLUTION		SMALL SERVICE PROTECTION				LARGE SERVICE PROTECTION				L Y* FOR OPTIMIZATION
	B N _{ALL}	C W _{ALL}	N _{NET} D	W _{NET} E	F TEST RATE R _{SP}	G PROB KILLER	N _{NET} H	W _{NET} I	J TEST RATE R _{SP}	K PROB KILLER	
			N _{SP}	W _{SP}			N _{SP}	W _{SP}			
SXS	12,004	39,928.16	11,988 16	39,923.3 4.86	7	.000780	11,958 46	39,846.5 81.66	14	.000390	.240
ESS	5,786	18,549.1	5,495 291	17,889.5 659.6	2	.000543	5,095 691	16,668.5 1,880.6	4	.000292	.0249
SXB MODERATE	7,925	27,546.62	7,228 697	25,895.1 1,651.52	2	.000675	5,738 2,187	21,294.1 6,252.52	4	.000393	.0258

SUM COLUMN B
 TOTAL TRUNKS = $\frac{25,715}{x.8}$
 TOTAL OFFERED LOAD = $\frac{20,572}{x.8}$

Fig. 2—Example of a Completed Form 2

FORM 3 OPTIMIZATION-NOMINAL SOLUTION
CAROT CAPACITY CC=11,321 TESTS/MONTH

A						G			H			I			J			K			L			M			N			O			NOMINAL TEST RATES R					
MACHINE TYPE	NALL	WALL	N/W	Y*(FORM 2 COL L)	S* = Y*/(N/W)	ESTIMATE OF S			S ₀ =LARGEST S ₀ * (COL F) S ₀ * = .797			S ₁ =SMALLEST S ₀ * (COL F) S ₁ * = .0798			S ₂ = .0415			S ₃ = .0461			S ₄ =			S ₅ =			S ₆ =			S ₇ =								
						Y = N/W S	R	R x NALL	Y = N/W S ₀	R	R x NALL	Y = N/W S ₁	R	R x NALL	Y = N/W S ₂	R	R x NALL	Y = N/W S ₃	R	R x NALL	Y = N/W S ₄	R	R x NALL	Y = N/W S ₅	R	R x NALL	Y = N/W S ₆	R	R x NALL	Y = N/W S ₇	R	R x NALL						
SXS	12,004	39,928.16	.301	.240	.797	Y = N/W S	R	R x NALL	/	I	12,004	.0240	3.2	38412.8	.0125	4.6	55,219.4	.0139	4.4	52,817.6													4.4					
ESS	5,786	18,549.1	.312	.0249	.0798	Y = N/W S	R	R x NALL	/	I	5,786	.0249	1	5,786	.0129	1.5	8,697	.0144	1.5	8,679													1.5					
5XB Moderate	7,925	27,546.62	.288	.0258	.0896	Y = N/W S	R	R x NALL	/	I	7,925	.0230	1.1	8,717.5	.0120	1.7	13,472.5	.0133	1.6	12,680													1.6					
						Y = N/W S	R	R x NALL	/	I																												
						Y = N/W S	R	R x NALL	/	I																												
						Y = N/W S	R	R x NALL	/	I																												
						Y = N/W S	R	R x NALL	/	I																												
						SUM OF THIS COLUMN				COP (S ₀) = 25,715				COP (S ₁) = 52,916.3				COP (S ₂) = 77,387.9				COP (S ₃) = 74,176.6 WITHIN 2% OF CC				COP (S ₄) =				COP (S ₅) =				COP (S ₆) =				COP (S ₇) =

Fig. 3—Example of a Completed Form 3

FORM 4 SCALING AND SERVICE PROTECTION
 SERVICE PROTECTION
 CAROT CAPACITY: CC = 73,391 TESTS/MONTH

MACHINE TYPE	A B C D E				SCALING								FINAL TEST RATES		
	R	FROM COL B	COL E X COL B	MINIMUM TESTING	Z = 1	Z =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	TEST AT R _{SP} ?	TEST RATE
	N NET	R X N NET	1 X N NET	1										N NET	
	N SP	R X N SP	R SP X N SP	R SP =										N SP	
SXS	R = 4.4				ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N NET = 11,988	52,747.2	11,988	1										N NET	4.33
	N SP = 16	70.4	112	R SP = 7	✓	✓								N SP	7
ESS	R = 1.5				ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N NET = 5,495	8,242.5	5,495	1										N NET	1.47
	N SP = 291	436.5	582	R SP = 2	✓	✓								N SP	2
5XB MODERATE	R = 1.6				ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N NET = 7,228	11,564.8	7,228	1										N NET	1.57
	N SP = 697	1,115.2	1,394	R SP = 2	✓	✓								N SP	2
	R =				ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N NET =			1										N NET	
	N SP =			R SP =										N SP	
	R =				ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N NET =			1										N NET	
	N SP =			R SP =										N SP	
	R =				ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N NET =			1										N NET	
	N SP =			R SP =										N SP	
	R =				ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N NET =			1										N NET	
	N SP =			R SP =										N SP	
	R =				ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N NET =			1										N NET	
	N SP =			R SP =										N SP	
	R =				ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N NET =			1										N NET	
	N SP =			R SP =										N SP	

SUM OF COL D 26,799
 (COMPARE AGAINST CC)

SUM OF ENTRIES IN COL D FOR WHICH "✓" APPEARS $S_1 = 2088$

SUM OF ENTRIES IN COL C IF NOT CHECKED $S_2 = 72,554.5$

CALCULATE $(CC - S_1) / S_2 = \text{NEW } Z = .983$ AND WRITE IN NEXT COLUMN

Fig. 4—Example of a Completed Form 4 for Small Service Protection

FORM 4 SCALING AND SERVICE PROTECTION

LARGE SERVICE PROTECTION
 CAROT CAPACITY: CC = 73,381 TESTS/MONTH

MACHINE TYPE	R		FROM COL B		COL E X COL B		MINIMUM TESTING		SCALING								FINAL TEST RATES			
	N NET	N SP	R X N NET	R X N SP	1 X N NET	R SP X N SP	R SP =	ZR =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	TEST AT R _{SP} ?	TEST RATE
SXS	R = 4.4							ZR = 4.4	Z = .8817	ZR =										
	N NET = 11,958		52,615.2		11,958		1												N NET	3.88
	N SP = 46		202.4		644		R SP = 14	✓	✓										N SP	✓ 14
ESS	R = 1.5							ZR = 1.5	Z = .8817	ZR =										
	N NET = 5,095		7,642.5		5,095		1												N NET	1.38
	N SP = 691		1,036.5		2,764		R SP = 4	✓	✓										N SP	✓ 4
5XB MODERATE	R = 1.6							ZR = 1.6	Z = .8817	ZR =										
	N NET = 5,738		9,180.8		5,738		1												N NET	1.41
	N SP = 2,187		3,499.2		8,748		R SP = 4	✓	✓										N SP	✓ 4
	R =							ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =			
	N NET =						1												N NET	
	N SP =						R SP =												N SP	
	R =							ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =			
	N NET =						1												N NET	
	N SP =						R SP =												N SP	
	R =							ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =			
	N NET =						1												N NET	
	N SP =						R SP =												N SP	
	R =							ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =			
	N NET =						1												N NET	
	N SP =						R SP =												N SP	
	R =							ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =			
	N NET =						1												N NET	
	N SP =						R SP =												N SP	

SUM OF COL D 34,947
 (COMPARE AGAINST CC)

SUM OF ENTRIES IN COL D FOR WHICH "v" APPEARS $S_1 = 12,156$

SUM OF ENTRIES IN COL C IF NOT CHECKED $S_2 = 61,438.5$

CALCULATE $(CC - S_1) / S_2 = \text{NEW } Z = .8817$ AND WRITE IN NEXT COLUMN

Fig. 5—Example of a Completed Form 4 for Large Service Protection

FORM 5 EVALUATE ERLANGS LOST

A MACHINE TYPE	B NOMINAL SOLUTION				F SMALL SERVICE PROTECTION					K LARGE SERVICE PROTECTION				
	B WALL	C TEST RATE	D PROB KILLER	E ERLANGS LOST	F WNET WSP	G SERVICE PROTECTION ?	H TEST RATE	I PROB KILLER	J ERLANGS LOST	K WNET WSP	L SERVICE PROTECTION ?	M TEST RATE	N PROB KILLER	O ERLANGS LOST
SXS	39,928.16	4.4	.00125	49.910	39,923.3	/	4.33	.00130	51.900	39,846.5	/	3.88	.00145	57.777
					4.86	✓	7	.000780	.004	81.66	✓	14	.00039	.032
ESS	18,549.1	1.5	.00069	12.799	17,889.5	/	1.47	.0007	12.523	16,668.5	/	1.38	.00075	12.501
					659.6	✓	2	.000543	.358	1,880.6	✓	4	.000292	.549
5XB MODERATE	27,546.62	1.6	.00082	22.588	25,895.1	/	1.57	.00085	22.011	21,294.1	/	1.41	.0009	19.165
					1,651.52	✓	2	.000675	1.115	6,252.52	✓	4	.000393	2.457
						/					/			
						/					/			
						/					/			
						/					/			
						/					/			
						/					/			
						/					/			

	<u>NOMINAL SOLUTION</u>	<u>SMALL SERVICE PROTECTION</u>	<u>LARGE SERVICE PROTECTION</u>
TOTAL OFFERED LOAD = 20,572	TOTAL ERLANGS LOST 85.297	TOTAL ERLANGS LOST 87.911	TOTAL ERLANGS LOST 92.481
	NETWORK INEFFECTIVE RATE .415%	NETWORK INEFFECTIVE RATE .427%	NETWORK INEFFECTIVE RATE .450%

Fig. 6—Example of a Completed Form 5

TABLE A
PARAMETERS FOR MACHINE TYPES

MACHINE TYPE	PARAMETERS FOR SERVICE PROTECTION				Y* FOR OPTIMIZATION
	SMALL SERVICE PROTECTION		LARGE SERVICE PROTECTION		
	TEST RATE R _{SP} TESTS/MONTH	PROBABLE KILLER	TEST RATE R _{SP} TESTS/MONTH	PROBABLE KILLER	
SXS No Automatic Testing	7	0.000780	14	0.000390	0.240
XB Small Automatic Testing	4	0.000705	10	0.000379	0.0278
XB Moderate Automatic Testing	2	0.000675	4	0.000393	0.0258
ESS & XB With High Automatic Testing	2	0.000543	4	0.000292	0.0249
SXS With Surveillance					
1 Week Processing Time	5	0.000795	12	0.000394	0.0292
2 Days Processing Time	2	0.000819	9	0.000400	0.00748
Less Than 1 day Processing Time	1	0.0	1	0.0	0.0
XB With Surveillance					
Low-Stuck Sender Tracing—1 Week Processing Time	2	0.000720	8	0.000383	0.00512
Low-Stuck Sender Tracing—2 Days Processing Time	1	0.000466	3	0.000389	0.00135
Low-Stuck Sender Tracing—Less Than 1 Day Processing Time	1	0.0	1	0.0	0.0

TABLE A (Contd)

PARAMETERS FOR MACHINE TYPES

MACHINE TYPE	PARAMETERS FOR SERVICE PROTECTION				Y* FOR OPTIMI- ZATION
	SMALL SERVICE PROTECTION		LARGE SERVICE PROTECTION		
	TEST RATE R _{SP} TESTS/MONTH	PROBABLE KILLER	TEST RATE R _{SP} TESTS/MONTH	PROBABLE KILLER	
High-Stuck Sender Tracing—1 Week Processing Time	1	0.000510	2	0.000403	0.00389
High-Stuck Sender Tracing—2 Days Processing Time	1	0.000266	1	0.000266	0.000889
High-Stuck Sender Tracing—Less Than 1 Day Processing Time	1	0.0	1	0.0	0.0

FORM 6a	NOMINAL SOLUTION		
MACHINE TYPE	TEST RATE	TEST INTERVAL	SCHEDULE CODE
SXS	4.4	7	∅∅
ESS	1.5	2∅	2∅
5XB-MODERATE	1.6	19	1∅

Fig. 7—Example of a Completed Form 6a

FORM 6b		SMALL <u>LARGE</u> SERVICE PROTECTION			
MACHINE TYPE	TRAFFIC CLASS	TRUNK GROUP SIZE	TEST RATE	TEST INTERVAL	SCHEDULE CODE
SXS	HIGH USAGE	≤ 18	14	2	$\emptyset\emptyset$
		> 18	3.88	8	1 \emptyset
	FINAL	≤ 7	14	2	$\emptyset\emptyset$
		> 7	3.88	8	1 \emptyset
ESS	HIGH USAGE	≤ 18	4	8	1 \emptyset
		> 18	1.38	22	2 \emptyset
	FINAL	≤ 7	4	8	1 \emptyset
		> 7	1.38	22	2 \emptyset
5XB-MODERATE	HIGH USAGE	≤ 18	4	8	1 \emptyset
		> 18	1.41	22	2 \emptyset
	FINAL	≤ 7	4	8	1 \emptyset
		> 7	1.41	22	2 \emptyset

Fig. 8—Example of a Completed Form 6b for Large Service Protection

FORM 6b		SMALL LARGE SERVICE PROTECTION			
MACHINE TYPE	TRAFFIC CLASS	TRUNK GROUP SIZE	TEST RATE	TEST INTERVAL	SCHEDULE CODE
SXS	HIGH USAGE	≤ 9	7	4	00
		> 9	4.33	7	10
	FINAL	≤ 4	7	4	00
		> 4	4.33	7	10
ESS	HIGH USAGE	≤ 9	2	15	20
		> 9	1.47	21	30
	FINAL	≤ 4	2	15	20
		> 4	1.47	21	30
5XB-MODERATE	HIGH USAGE	≤ 9	2	15	20
		> 9	1.57	19	30
	FINAL	≤ 4	2	15	20
		> 4	1.57	19	30

Fig. 9—Example of a Completed Form 6b for Small Service Protection

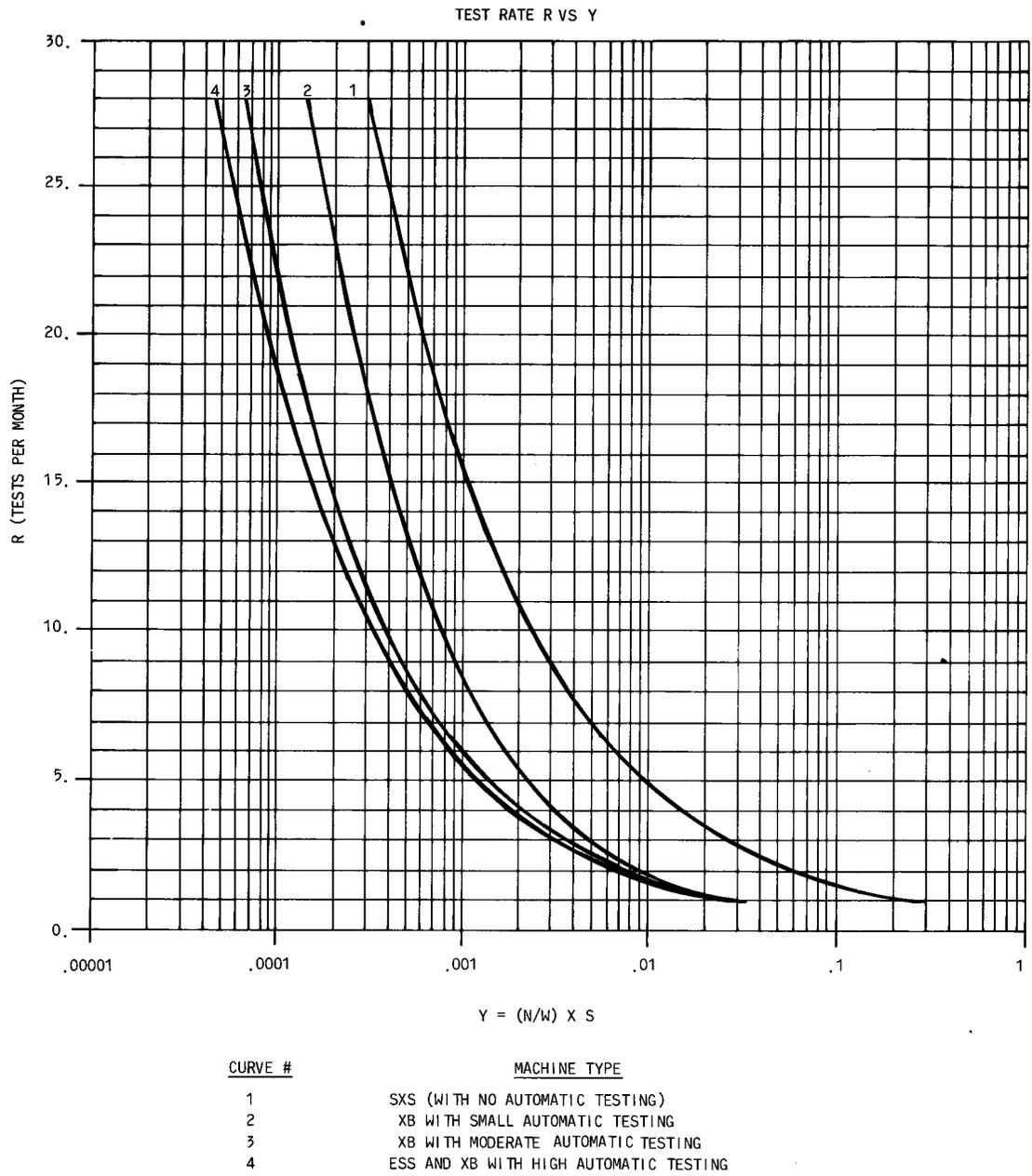


Fig. 10—Graphs Depicting Tests Per Month (R) Versus Y for Various Machine Types (Sheet 1 of 4)

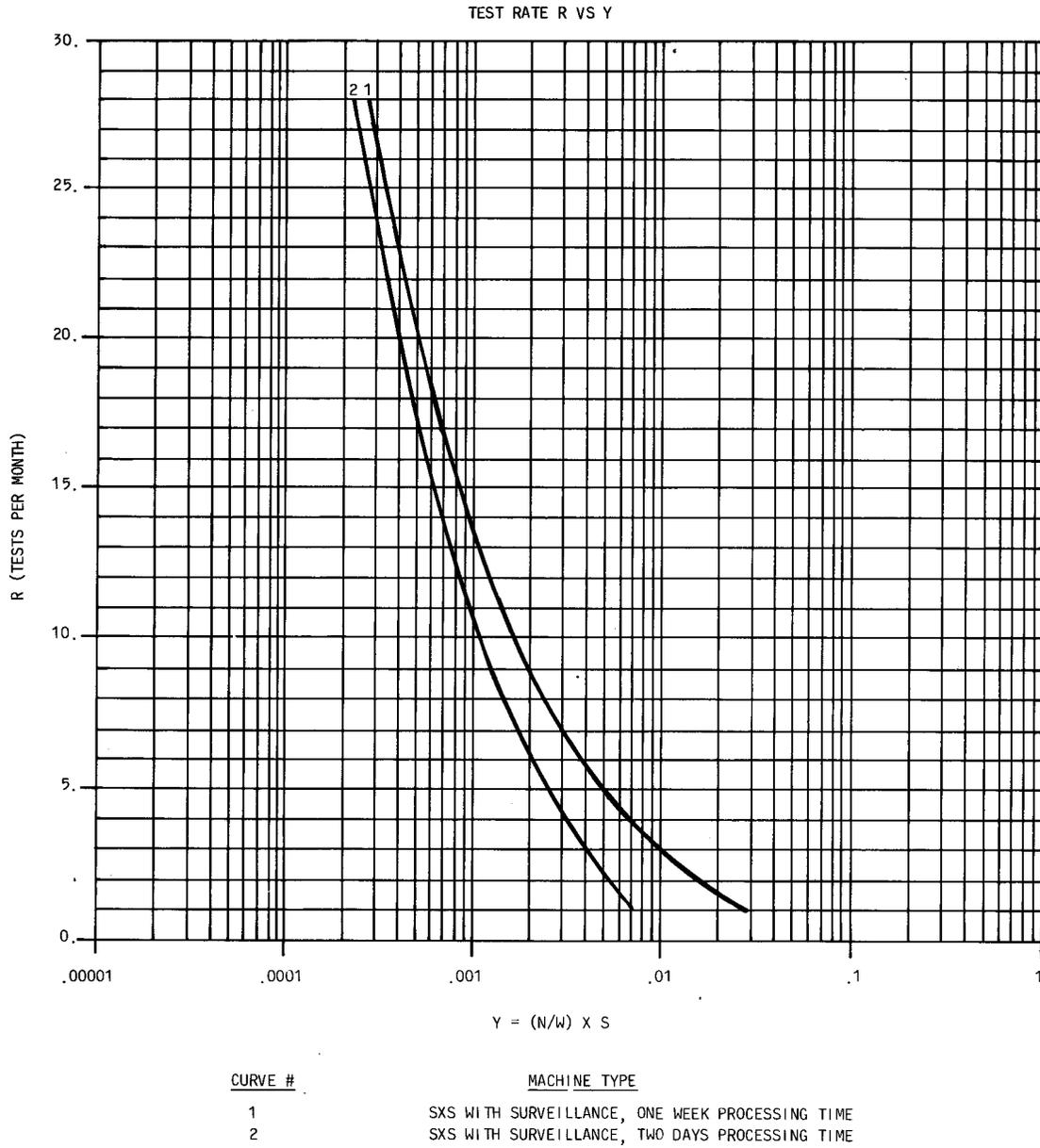
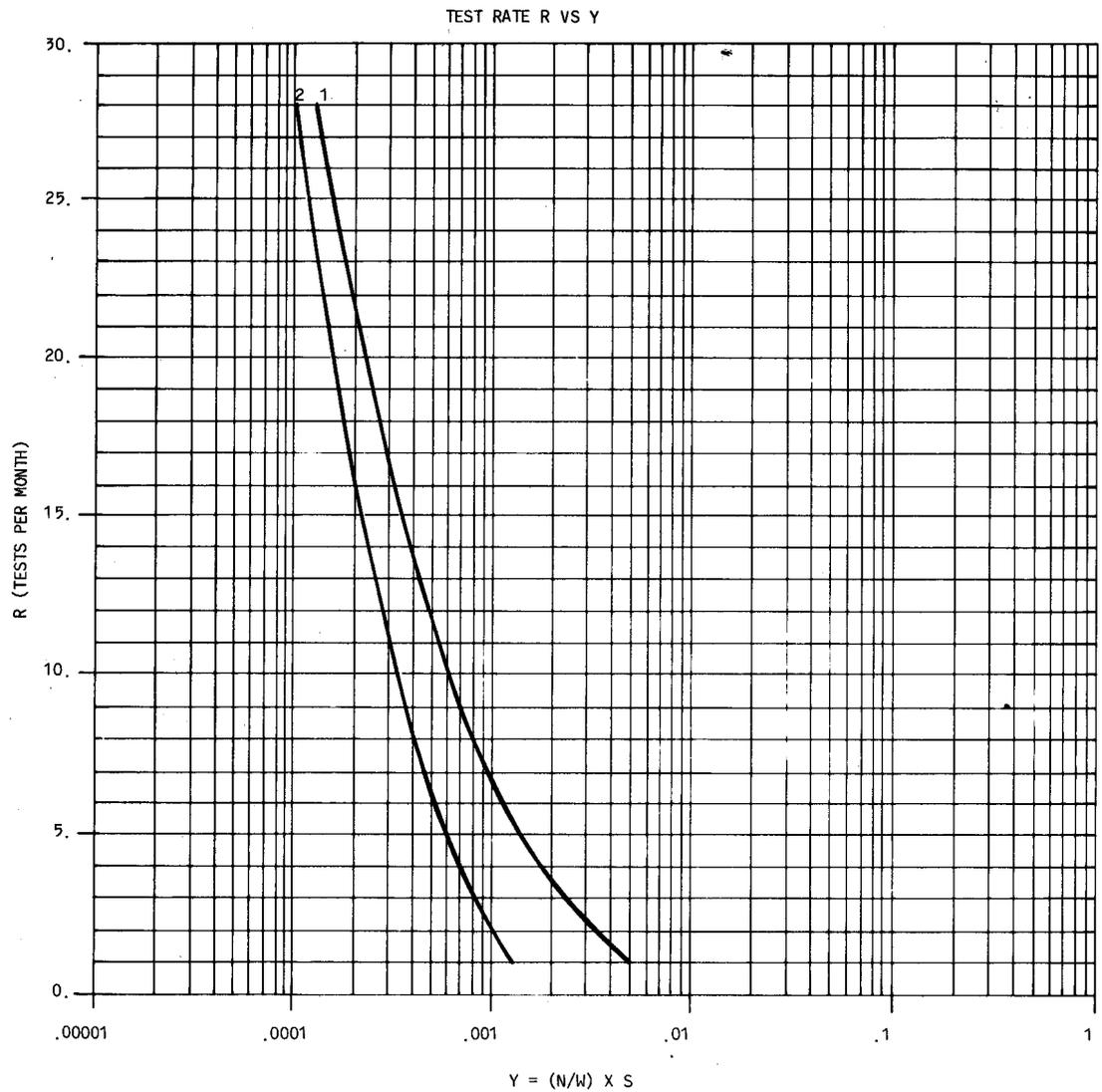
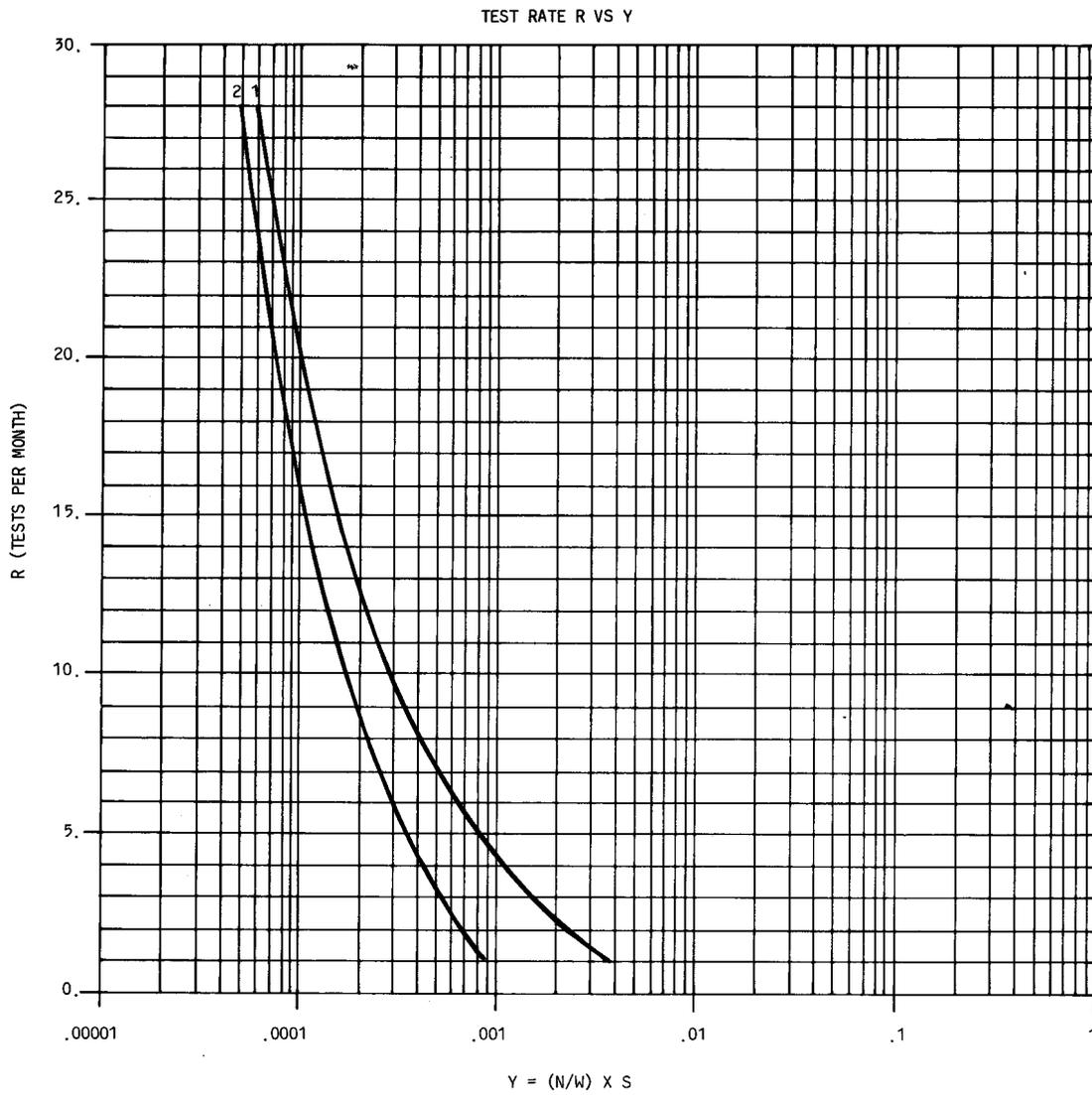


Fig. 10—Graphs Depicting Tests Per Month (R) Versus Y for Various Machine Types (Sheet 2 of 4)



<u>CURVE #</u>	<u>MACHINE TYPE</u>
1	XB WITH LOW-STUCK SENDER TRACING AND SURVEILLANCE - ONE WEEK PROCESSING TIME
2	XB WITH LOW-STUCK SENDER TRACING AND SURVEILLANCE - TWO DAYS PROCESSING TIME

Fig. 10—Graphs Depicting Tests Per Month (R) Versus Y for Various Machine Types (Sheet 3 of 4)



CURVE #	MACHINE TYPE
1	XB WITH HIGH-STUCK SENDER TRACING AND SURVEILLANCE - ONE WEEK PROCESSING TIME
2	XB WITH HIGH-STUCK SENDER TRACING AND SURVEILLANCE - TWO DAYS PROCESSING TIME

Fig. 10—Graphs Depicting Tests Per Month (R) Versus Y for Various Machine Types (Sheet 4 of 4)

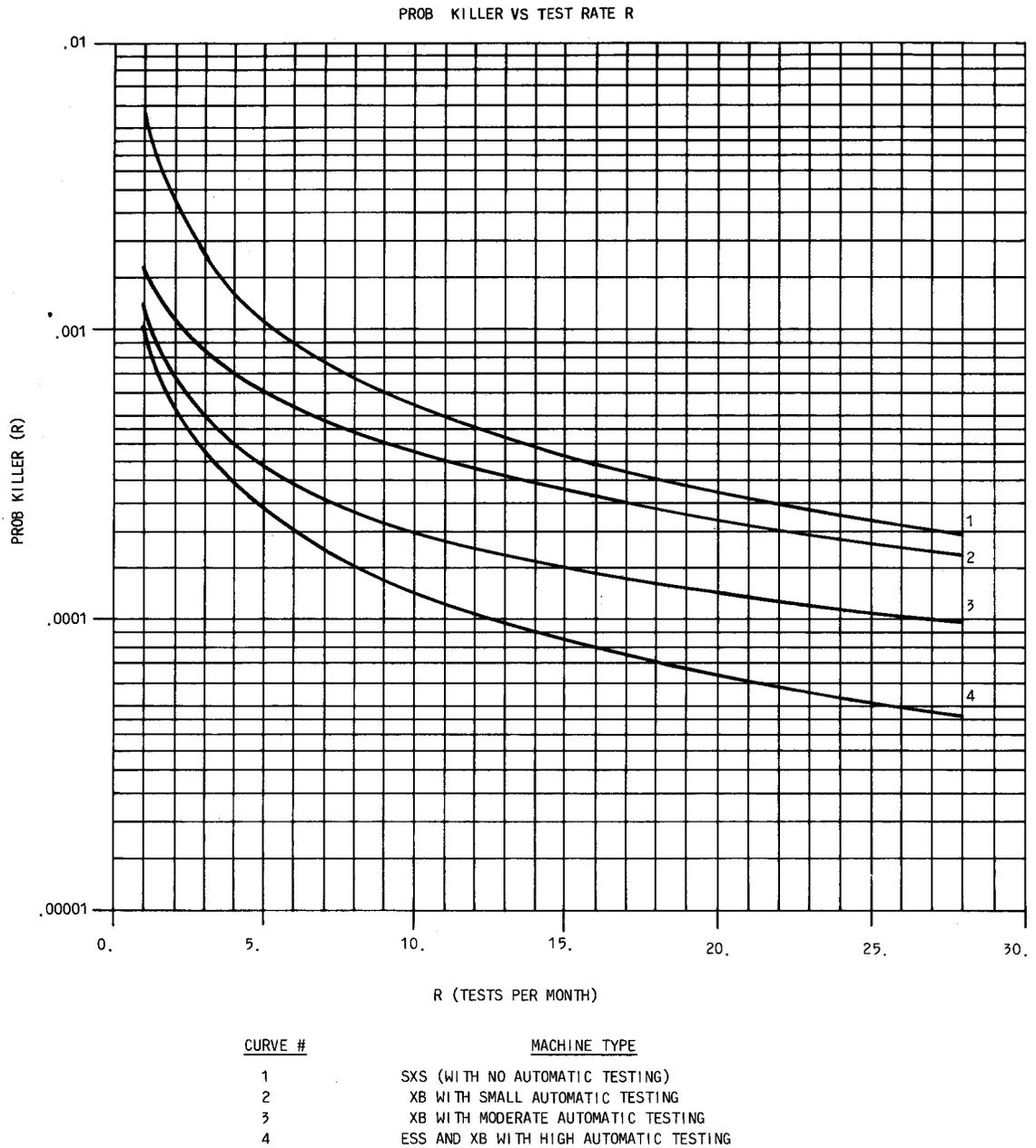


Fig. 11—Graph Depicting the Probability of a Killer Occurring Versus Test Rate (R) for Various Machine Types (Sheet 1 of 4)

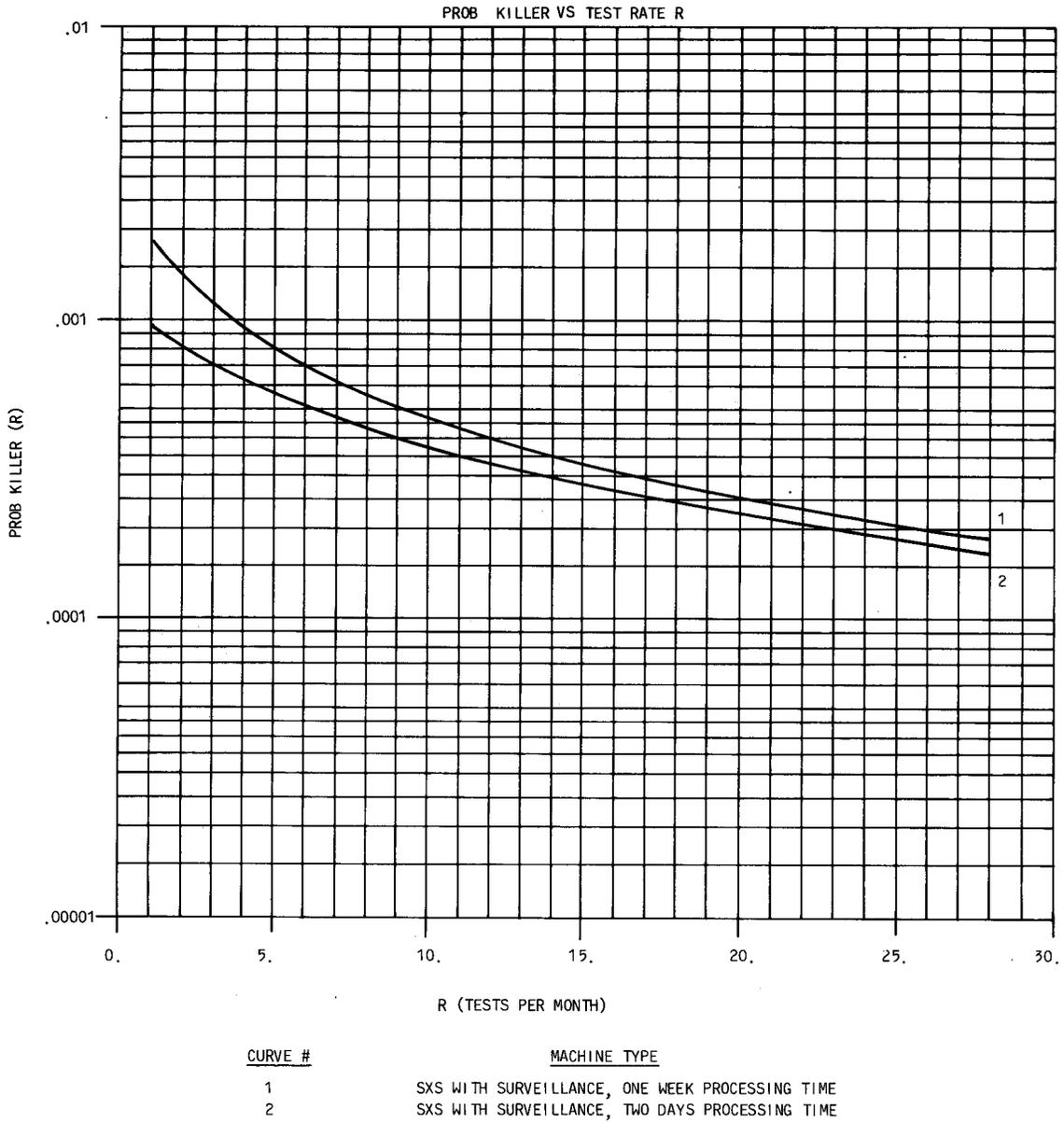
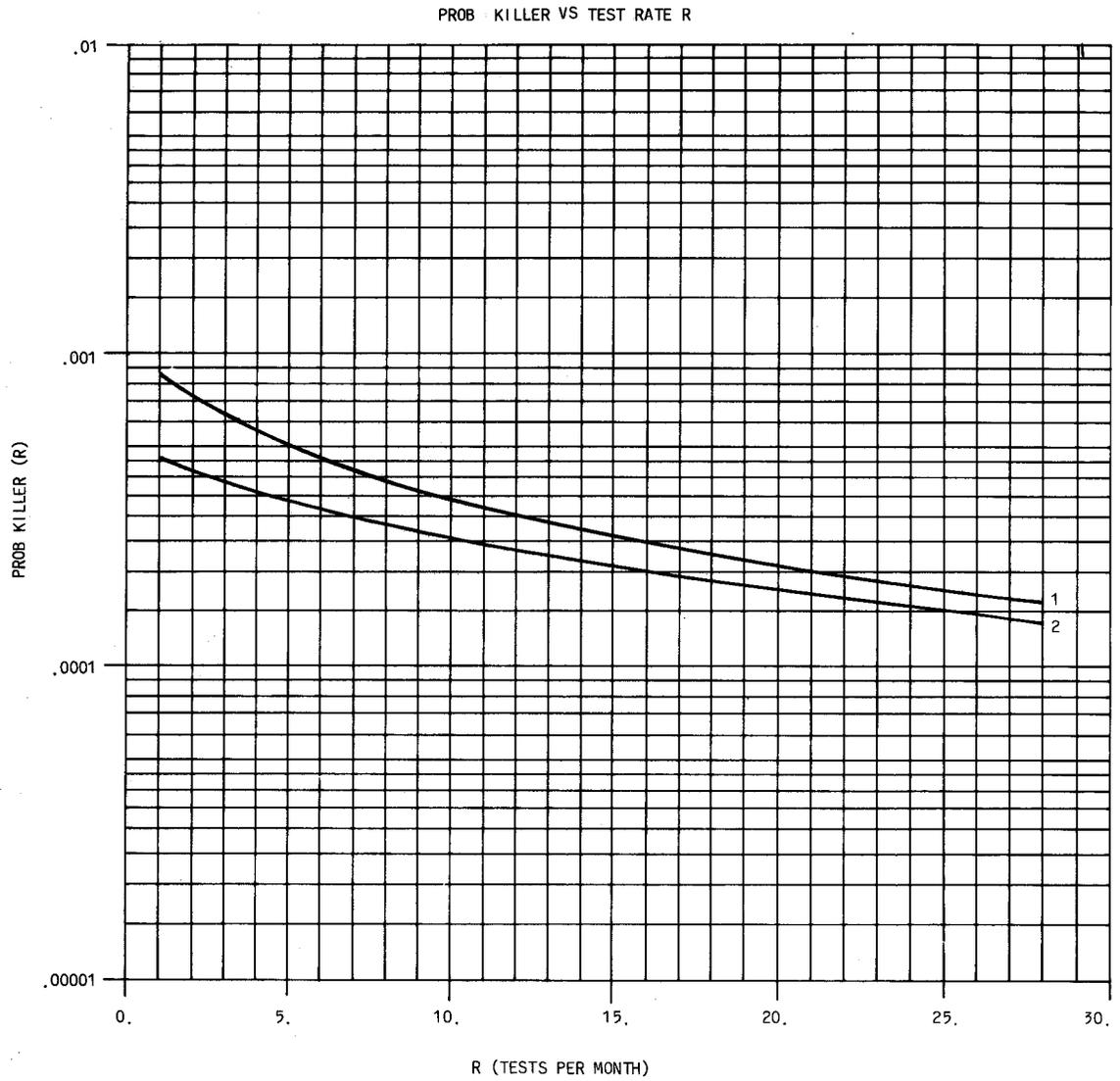


Fig. 11—Graph Depicting the Probability of a Killer Occurring Versus Test Rate (R) for Various Machine Types (Sheet 2 of 4)



CURVE #	MACHINE TYPE
1	XB WITH LOW-STUCK SENDER TRACING AND SURVEILLANCE - ONE WEEK PROCESSING TIME
2	XB WITH LOW-STUCK SENDER TRACING SURVEILLANCE - TWO DAYS PROCESSING TIME

Fig. 11—Graph Depicting the Probability of a Killer Occurring Versus Test Rate (R) for Various Machine Types (Sheet 3 of 4)

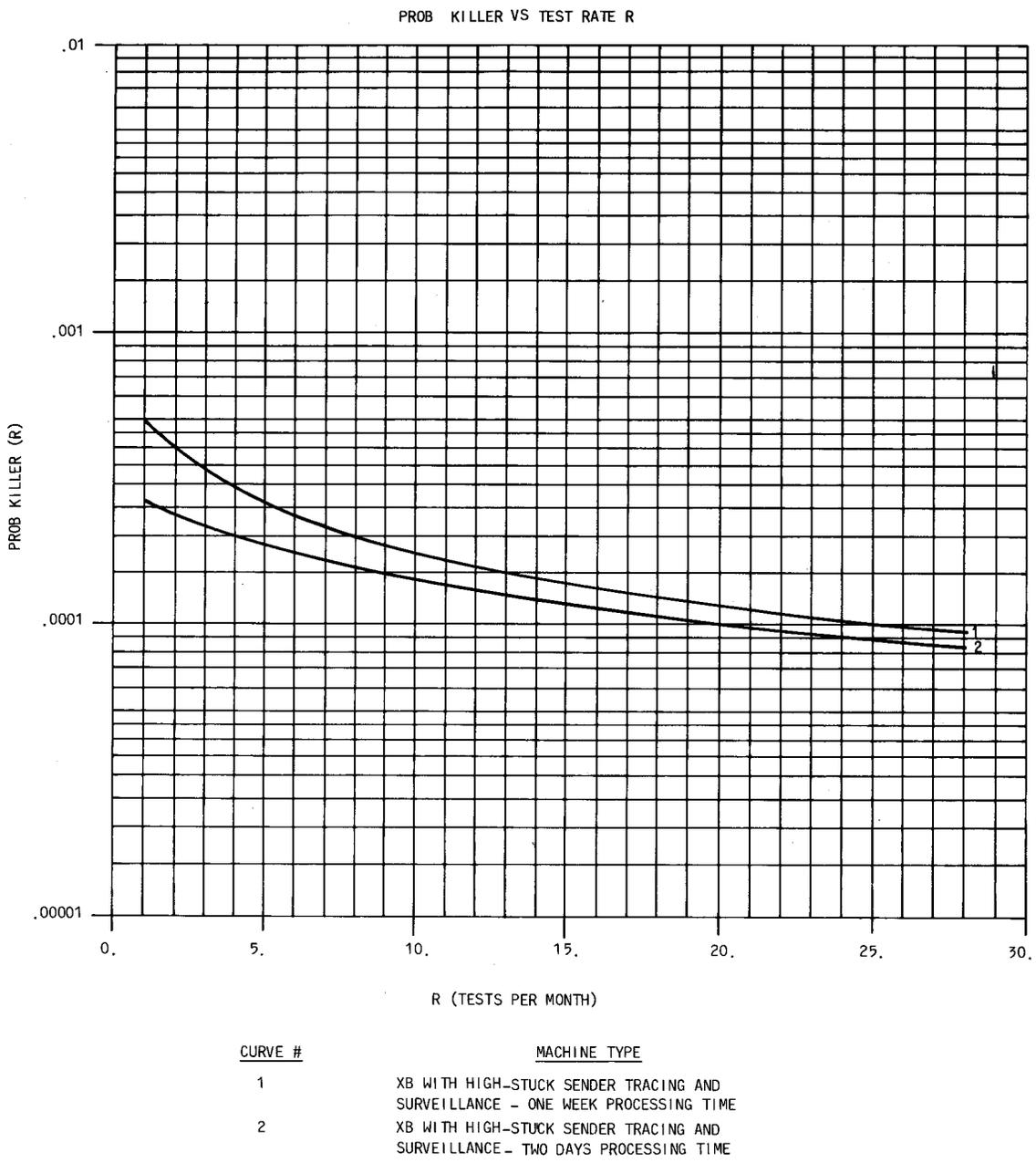


Fig. 11—Graph Depicting the Probability of a Killer Occurring Versus Test Rate (R) for Various Machine Types (Sheet 4 of 4)

FORM 1a, PAGE 1
 FOR SXS, ESS, AND 5XB ONLY
 MACHINE TYPE:

a GROUP SIZE	HIGH USAGE				FINALS			
	b NO. OF GROUPS	c NO. OF TRUNKS a X b	d TRUNK GROUP WEIGHT	e WEIGHT X NO. OF GROUPS b X d	b' NO. OF GROUPS	c' NO. OF TRUNKS a X b'	d' TRUNK GROUP WEIGHT	e' WEIGHT X NO. OF GROUPS b' X d'
1			1.2				.01	
2			2.9				.16	
3			5.1				.52	
4			7.6				1.1	
5			10				1.8	
6			13				2.7	
7			17				3.7	
8			20				4.8	
9			24				6.1	
10			28				7.5	
11			31				9.0	
12			36				11	
13			40				12	
14			44				14	
15			48				16	
16			53				18	
17			58				20	
18			62				22	
19			67				25	
20			72				27	
21			77				29	
22			82				32	
23			87				34	
24			93				37	
25			98				40	
26			103				42	
27			109				45	
28			114				48	
29			120				51	
30			126				54	
31			131				57	
32			137				60	
33			143				63	
34			149				67	
35			155				70	
36			161				73	
37			167				77	
38			173				80	
39			179				83	
40			185				87	

↑
SMALL
SERVICE
PROTECTION

↑
LARGE
SERVICE
PROTECTION

↑
SMALL
SERVICE
PROTECTION

↑
LARGE
SERVICE
PROTECTION

Fig. 12—Form 1a—Blank (Sheet 1 of 4)

FORM 1a, PAGE 2

a GROUP SIZE	HIGH USAGE				FINALS			
	b NO. OF GROUPS	c NO. OF TRUNKS a X b	d TRUNK GROUP WEIGHT	e WEIGHT X NO. OF GROUPS b X d	b' NO. OF GROUPS	c' NO. OF TRUNKS a X b'	d' TRUNK GROUP WEIGHT	e' WEIGHT X NO. OF GROUPS b' X d'
* 41 TO 42			195				92	
43 TO 44			207				100	
45 TO 46			220				108	
47 TO 48			233				115	
49 TO 50			247				123	
** 51 TO 55			267				136	
56 TO 60			301				157	
61 TO 65			336				179	
66 TO 70			372				202	
71 TO 75			409				226	
76 TO 80			446				251	
81 TO 85			484				277	
86 TO 90			523				304	
91 TO 95			562				331	
96 TO 100			601				359	
101 TO 110			662				402	
111 TO 120			744				461	
121 TO 130			828				523	
131 TO 140			914				587	
141 TO 150			1001				654	

* USE THE "LARGER" NUMBER OF TRUNKS FOR GROUP SIZE
 ** USE THE "MIDDLE" NUMBER OF TRUNKS FOR GROUP SIZE

Fig. 12—Form 1a—Blank (Sheet 2 of 4)

FORM 1a, PAGE 3

a GROUP SIZE	HIGH USAGE				FINALS			
	b NO. OF GROUPS	c NO. OF TRUNKS a X b	d TRUNK GROUP WEIGHT	e WEIGHT X NO. OF GROUPS b X d	b' NO. OF GROUPS	c' NO. OF TRUNKS a X b'	d' TRUNK GROUP WEIGHT	e' WEIGHT X NO. OF GROUPS b' X d'
151 TO 160			1089				722	
161 TO 170			1178				792	
171 TO 180			1270				863	
181 TO 190			1362				936	
191 TO 200			1454				1011	
201 TO 225			1621				1147	
226 TO 250			1861				1346	
251 TO 275			2106				1552	
276 TO 300			2355				1765	
301 TO 325			2608				1985	
326 TO 350			2864				2210	
351 TO 375			3123				2441	
376 TO 400			3637				2676	
401 TO 425			3653				2916	
426 TO 450			3922				3159	
451 TO 475			4192				3407	
476 TO 500			4464				3658	

Fig. 12—Form 1a—Blank (Sheet 3 of 4)

FORM 1a, PAGE 4

SUMMATIONS:

MACHINE TYPE: _____

FOR ALL GROUPS FROM THIS MACHINE TYPE:

$N_{ALL} =$ _____ SUM ALL OF COLUMNS c AND c'

$W_{ALL} =$ _____ SUM ALL COLUMNS e AND e'

SMALL SERVICE PROTECTION:

$N_{SP} =$ _____ SUM COLUMNS c AND c' DOWN TO "SMALL SERVICE PROTECTION" LINES.

$W_{SP} =$ _____ SUM COLUMNS e AND e' DOWN TO "SMALL SERVICE PROTECTION" LINES.

$N_{NET} = N_{ALL} - N_{SP} =$ _____

$W_{NET} = W_{ALL} - W_{SP} =$ _____

LARGE SERVICE PROTECTION:

$N_{SP} =$ _____ SUM COLUMNS c AND c' DOWN TO "LARGE SERVICE PROTECTION" LINES.

$W_{SP} =$ _____ SUM COLUMNS e AND e' DOWN TO "LARGE SERVICE PROTECTION" LINES.

$N_{NET} = N_{ALL} - N_{SP} =$ _____

$W_{NET} = W_{ALL} - W_{SP} =$ _____

ENTER THE ABOVE VALUES INTO THE FOLLOWING TABLE:

ALL GROUPS		SMALL SERVICE PROTECTION		LARGE SERVICE PROTECTION	
N_{ALL}	W_{ALL}	N_{NET}	W_{NET}	N_{NET}	W_{NET}
		N_{SP}	W_{SP}	N_{SP}	W_{SP}

TRANSFER TO FORM 2:

COL B	COL C	COL D	COL E	COL H	COL I
-------	-------	-------	-------	-------	-------

Fig. 12—Form 1a—Blank (Sheet 4 of 4)

FORM 1b, PAGE 1
 FOR 1XB AND XBT ONLY
 MACHINE TYPE:

a GROUP SIZE	HIGH USAGE				FINALS			
	b NO. OF GROUPS	c NO. OF TRUNKS a X b	d TRUNK GROUP WEIGHT	e WEIGHT X NO. OF GROUPS b X d	b' NO. OF GROUPS	c' NO. OF TRUNKS a X b'	d' TRUNK GROUP WEIGHT	e' WEIGHT X NO. OF GROUPS b' X d'
1			1.2				.01	
2			2.9				.16	
3			5.2				.54	
4			7.9				1.2	
5			11				2.0	
6			14				3.2	
7			16				4.5	
8			22				6.1	
9			26				8.0	
10			31				10	
11			35				12	
12			40				15	
13			45				18	
14			51				21	
15			56				24	
16			62				27	
17			67				31	
18			73				34	
19			79				38	
20			86				42	
21			92				46	
22			99				51	
23			105				55	
24			112				60	
25			119				65	
26			126				70	
27			133				75	
28			140				80	
29			148				85	
30			155				91	
31			163				96	
32			170				101	
33			178				108	
34			186				113	
35			194				119	
36			202				125	
37			210				132	
38			218				138	
39			226				144	
40			234				151	

SMALL
SERVICE
PROTECTION

SMALL
SERVICE
PROTECTION

LARGE
SERVICE
PROTECTION

LARGE
SERVICE
PROTECTION

Fig. 13—Form 1b—Blank (Sheet 1 of 4)

FORM 1b, PAGE 2

a GROUP SIZE	HIGH USAGE				FINALS			
	b NO. OF GROUPS	c NO. OF TRUNKS a X b	d TRUNK GROUP WEIGHT	e WEIGHT X NO. OF GROUPS b X d	b' NO. OF GROUPS	c' NO. OF TRUNKS a X b'	d' TRUNK GROUP WEIGHT	e' WEIGHT X NO. OF GROUPS b' X d'
41 TO 42			238				153	
43 TO 44			250				158	
45 TO 46			265				166	
47 TO 48			280				174	
49 TO 50			295				181	
** 51 TO 55			325				195	
56 TO 60			370				225	
61 TO 65			420				255	
66 TO 70			453				287	
71 TO 75			500				324	
76 TO 80			550				360	
81 TO 85			595				397	
86 TO 90			645				424	
91 TO 95			692				459	
96 TO 100			740				492	
101 TO 110			810				540	
111 TO 120			905				613	
121 TO 130			1010				680	
131 TO 140			1110				750	
141 TO 150			1210				810	

* USE THE "LARGER" NUMBER OF TRUNKS FOR GROUP SIZE
 ** USE THE "MIDDLE" NUMBER OF TRUNKS FOR GROUP SIZE

Fig. 13—Form 1b—Blank (Sheet 2 of 4)

FORM 1b, PAGE 3

a GROUP SIZE	HIGH USAGE				FINALS			
	b NO. OF GROUPS	c NO. OF TRUNKS a X b	d TRUNK GROUP WEIGHT	e WEIGHT X NO. OF GROUPS b X d	b' NO. OF GROUPS	c' NO. OF TRUNKS a X b'	d' TRUNK GROUP WEIGHT	e' WEIGHT X NO. OF GROUPS b' X d'
151 TO 160			1310				893	
161 TO 170			1410				975	
171 TO 180			1510				1060	
181 TO 190			1620				1140	
191 TO 200			1740				1220	
201 TO 225			1900				1380	
226 TO 250			2180				1580	
251 TO 275			2450				1770	
276 TO 300			2740				2010	
301 TO 325			3020				2230	
326 TO 350			3320				2470	
351 TO 375			3630				2700	
376 TO 400			3940				2950	
401 TO 425			4250				3220	
426 TO 450			4500				3480	
451 TO 475			4840				3700	
476 TO 500			5150				3950	

Fig. 13—Form 1b—Blank (Sheet 3 of 4)

FORM 1b, PAGE 4

SUMMATIONS:

MACHINE TYPE: _____

FOR ALL GROUPS FROM THIS MACHINE TYPE:

$N_{ALL} =$ _____ SUM ALL OF COLUMNS c AND σ

$W_{ALL} =$ _____ SUM ALL COLUMNS e AND e'

SMALL SERVICE PROTECTION:

$N_{SP} =$ _____ SUM COLUMNS c AND σ DOWN TO "SMALL SERVICE PROTECTION" LINES.

$W_{SP} =$ _____ SUM COLUMNS e AND e' DOWN TO "SMALL SERVICE PROTECTION" LINES.

$N_{NET} = N_{ALL} - N_{SP} =$ _____

$W_{NET} = W_{ALL} - W_{SP} =$ _____

LARGE SERVICE PROTECTION:

$N_{SP} =$ _____ SUM COLUMNS c AND σ DOWN TO "LARGE SERVICE PROTECTION" LINES.

$W_{SP} =$ _____ SUM COLUMNS e AND e' DOWN TO "LARGE SERVICE PROTECTION" LINES.

$N_{NET} = N_{ALL} - N_{SP} =$ _____

$W_{NET} = W_{ALL} - W_{SP} =$ _____

ENTER THE ABOVE VALUES INTO THE FOLLOWING TABLE:

ALL GROUPS		SMALL SERVICE PROTECTION		LARGE SERVICE PROTECTION	
N_{ALL}	W_{ALL}	N_{NET}	W_{NET}	N_{NET}	W_{NET}
		N_{SP}	W_{SP}	N_{SP}	W_{SP}

TRANSFER TO FORM 2:

COL B	COL C	COL D	COL E	COL H	COL I
-------	-------	-------	-------	-------	-------

Fig. 13—Form 1b—Blank (Sheet 4 of 4)

FORM 3 OPTIMIZATION-NOMINAL SOLUTION
 CAROT CAPACITY CC = _____ TESTS/MONTH

A			B			C			D			E			F			G			H			I			J			K			L			M			N			O			NOMINAL TEST RATES R
MACHINE TYPE	N _{ALL}	W _{ALL}	N/W	Y*(FORM 2 COL L)	S* = Y*/(N/W)	Y = $\frac{N}{W}S$	R	R x N _{ALL}	Y = $\frac{N}{W}S_0$	R	R x N _{ALL}	Y = $\frac{N}{W}S_1$	R	R x N _{ALL}	Y = $\frac{N}{W}S_2$	R	R x N _{ALL}	Y = $\frac{N}{W}S_3$	R	R x N _{ALL}	Y = $\frac{N}{W}S_4$	R	R x N _{ALL}	Y = $\frac{N}{W}S_5$	R	R x N _{ALL}	Y = $\frac{N}{W}S_6$	R	R x N _{ALL}	Y = $\frac{N}{W}S_7$	R	R x N _{ALL}													
						Y = $\frac{N}{W}S$	R	R x N _{ALL}	Y = $\frac{N}{W}S_0$	I																																			
						Y = $\frac{N}{W}S$	R	R x N _{ALL}	Y = $\frac{N}{W}S_0$	I																																			
						Y = $\frac{N}{W}S$	R	R x N _{ALL}	Y = $\frac{N}{W}S_0$	I																																			
						Y = $\frac{N}{W}S$	R	R x N _{ALL}	Y = $\frac{N}{W}S_0$	I																																			
						Y = $\frac{N}{W}S$	R	R x N _{ALL}	Y = $\frac{N}{W}S_0$	I																																			
						Y = $\frac{N}{W}S$	R	R x N _{ALL}	Y = $\frac{N}{W}S_0$	I																																			
						Y = $\frac{N}{W}S$	R	R x N _{ALL}	Y = $\frac{N}{W}S_0$	I																																			

SUM OF THIS COLUMN
 COP (S) = _____
 COP (S₀) = _____
 COP (S₁) = _____
 COP (S₂) = _____
 COP (S₃) = _____
 COP (S₄) = _____
 COP (S₅) = _____
 COP (S₆) = _____
 COP (S₇) = _____

Fig. 15—Form 3—Blank

FORM 4 SCALING AND SERVICE PROTECTION

SERVICE PROTECTION
CAROT CAPACITY: CC = _____ TESTS/MONTH

MACHINE TYPE	B		C		D		E		SCALING										FINAL TEST RATES					
	R		FROM COL B	COL E X COL B	MINIMUM TESTING				Z = 1	Z =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	Z =	TEST AT R _{SP} ?	TEST RATE
	N _{NET}		R X N _{NET}	1 X N _{NET}	1																			
	N _{SP}		R X N _{SP}	R _{SP} X N _{SP}	R _{SP} =																			
	R =								ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N _{NET} =				1																		N _{NET}	
	N _{SP} =				R _{SP} =																		N _{SP}	
	R =								ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N _{NET} =				1																		N _{NET}	
	N _{SP} =				R _{SP} =																		N _{SP}	
	R =								ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N _{NET} =				1																		N _{NET}	
	N _{SP} =				R _{SP} =																		N _{SP}	
	R =								ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N _{NET} =				1																		N _{NET}	
	N _{SP} =				R _{SP} =																		N _{SP}	
	R =								ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N _{NET} =				1																		N _{NET}	
	N _{SP} =				R _{SP} =																		N _{SP}	
	R =								ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =	ZR =		
	N _{NET} =				1																		N _{NET}	
	N _{SP} =				R _{SP} =																		N _{SP}	

SUM OF COL D _____
(COMPARE AGAINST CC)

SUM OF ENTRIES IN COL D FOR WHICH "✓" APPEARS S₁ = _____

SUM OF ENTRIES IN COL C IF NOT CHECKED S₂ = _____

CALCULATE (CC-S₁)/S₂ = NEW Z = _____ AND WROTE IN NEXT COLUMN

Fig. 16—Form 4—Blank

FORM 6a	NOMINAL SOLUTION		
MACHINE TYPE	TEST RATE	TEST INTERVAL	SCHEDULE CODE

Fig. 18—Form 6a—Blank

FORM 6b		SMALL/LARGE SERVICE PROTECTION			
MACHINE TYPE	TRAFFIC CLASS	TRUNK GROUP SIZE	TEST RATE	TEST INTERVAL	SCHEDULE CODE

Fig. 19—Form 6b—Blank