

TELETYPEWRITER STATIONS ORIENTATION AND DISTORTION TESTS

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1. GENERAL

1.01 This section contains requirements and procedures for transmission tests of teletypewriter station apparatus.

1.02 This section is reissued: ↗

- (a) To include information on the use of the 119C1 signal distorting set. ↘

(b) To add information on the test procedure for the reperforator of the 28 reperforator-transmitter operating at 200 words per minute.

(c) To clarify the information, particularly in the sense of including information on the limitations of certain of the testing equipment.

(d) To change the title.

Changes are marked with marginal arrows. ↘

1.03 This section indicates the responsibilities of the test center and station personnel and gives test procedures and test requirements. It includes tests to SOTUS units, multiple transmitters and reperforator transmitters.

1.04 This section applies to the 5-unit code at 60, 75, 100, and 200 speeds, to the 6-unit code at 53 and 66 speeds, and to TWX and private-line stations, both at the time of installation and at subsequent maintenance inspections. ↘

2. RESPONSIBILITIES OF TESTING PERSONNEL

2.01 The suggested duties of the testing personnel at test centers and at stations are as follows.

(a) *Test Centers*

(1) Maintain records of the test requirements and test results for the individual legs and loops.

(2) Control the release of the station from service and the restoration of service to the station.

(3) Determine what transmission tests are required and when the test requirements are met.

(4) Cooperate in any investigation in cases where the requirements are not met by usual procedures.

(b) *Stations*

- (1) Initiate test.
- (2) Make readjustments to meet the requirements.

3. TEST METHOD

General

3.01 The *testing method* consists of (1) measuring the distortion of signals produced by the station transmitting apparatus and (2) determining the tolerances of the station receiving apparatus to distorted or undistorted signals. Procedures are given for these tests.

3.02 Table 1 (6.06) gives check test and re-adjust test requirements for circuits having telegraph transmission coefficients from 0 to 6. Requirements are given for values of distortion in the test signals and corresponding distortion tolerances and orientation ranges for reception at the station, and for allowable distortion in the signals transmitted by the station. The coefficients are transmission ratings indicative of the long time performance of circuit parts and are assigned to circuits in accordance with BSP AB82.026. Table 1 does not give a general relation between coefficients and distortion and should be used only in connection with the tests covered in this section.

↗ **3.03** All tests should be made using the type of transmission normally employed in service; for instance, neutral transmission should not be substituted where polar or effective polar is used normally. It is desirable to avoid testing over a line section in addition to the leg or loop to the station. Testing over line sections increases the difficulty of making the tests and interpreting the results, and in addition gives less accurate results. In case a line section is involved the coefficient of the line section should be added to that of the loop or leg in determining the values of distortion in the test signals from Table 1. Use of portable testing equipment is recommended in order to avoid testing over a line section.

3.04 Any equipment or connections which are used in the normal operation of the circuit under test shall be retained during the test, that is, line relays, spark killers, and radio frequency interference suppressors should not be discon-

nected if they are normally used nor should the number of teletypewriters in the circuit be changed.

Definitions Pertaining to Distortion

↗ **3.05** Telegraph signal distortion is the time displacement of the mark-to-space or space-to-mark transitions with respect to their occurrence in a perfect signal and is expressed in percentage of the length of a signal element.

(a) *Bias*: Displacement of space-to-mark transitions.

(1) *Marking (or Positive) Bias*: *Advances* space-to-mark transitions (lengthens the marking interval).

(2) *Spacing (or Negative) Bias*: *Delays* space-to-mark transitions (shortens the marking interval).

(3) *Switched Bias*: Produces a continuous sequence of alternations between marking and spacing bias. In switched bias as produced by the 119C1 signal distorting set, the alternation always comes during the stop element so there will be no end-distortion. In switched bias as produced by the 119A2 and 119B1 telegraph signal biasing sets, the alternation comes at varying points, thus introducing end-distortion, and this can be termed "random" switched bias.

(b) *End-distortion*: Displacement of mark-to-space transitions.

(1) *Spacing End-distortion*: *Advances* mark-to-space transitions (shortens the marking interval).

(2) *Marking End-distortion*: *Delays* mark-to-space transitions (lengthens the marking interval).

(3) *Switched End-distortion*: Produces a continuous sequence of alternations between marking and spacing end-distortion.

(c) *Switched-combination Distortion*: Produces a continuous sequence of marking end-distortion, marking bias, spacing end-distortion, and spacing bias.

(d) *Characteristic Distortion*: A displacement of signal transitions resulting from the persistence of transients caused by preceding transitions. These transients may be electrical, where characteristic distortion arises in

a transmission path; or mechanical, where the distortion arises in relays or other apparatus. With changing signal combinations characteristic distortion varies from signal to signal.

(1) *Negative* characteristic distortion *shortens* the short signal elements and *lengthens* the long ones, regardless of whether they are marks or spaces.

(2) *Positive* characteristic distortion *lengthens* the short signal elements, and *shortens* the long ones.

(e) *Systematic Distortions*: All types of distortion with the exception of fortuitous, considered together, are called systematic distortion, because they occur with some regularity and obey certain constant laws.

(f) *Fortuitous Distortion*: A random distortion of telegraph signals such as that commonly produced by interference. Common sources of fortuitous distortion are crossfire, power induction, and lightning hits.

(g) *Total Distortion*: The net total of all types of distortion (bias, end-distortion, characteristic and fortuitous).

Definitions of Orientation Limits, Ranges, and Margins

3.06 The range through which the range-finder arm may be moved over the orientation scale of the selector without causing errors while receiving signals, is called the *orientation range*. The upper and lower limits of the orientation range are called *orientation limits*. For a given orientation setting lying between the orientation limits, the ranges from that setting to the orientation limits are called its upper and lower *orientation margins*. The orientation setting midway between the orientation limits is the *optimum point* for the type of signals being received. (Thus we speak of the *optimum point for bias* or the *optimum point for end-distortion*, these being in the first case the orientation setting midway between the *upper limit found with marking bias* and the *lower limit found with spacing bias*, and in the second case the orientation setting midway between the *upper limit found with spacing end-distortion* and the *lower limit found with marking end-distortion*.)

3.07 Procedure for Determining Orientation Limits on Typing Units

(a) Test signals should be sent from the test center into the unit. In the case of 14 and 15 units equipped with holding-magnet selectors, these test signals must have at least 20 per cent distortion because of a mechanical limitation in this type of selecting mechanism which otherwise prevents determining the upper range limit. While receiving these test signals, move the range-finder arm gradually toward either end of the range until the signals are no longer received correctly.

(b) Then move the range-finder arm back delicately by small changes, remaining a few moments at each step to give a chance for errors to appear, until a point is just reached at which the signals are printed correctly. Verify this setting by clamping the arm allowing a total of 144 signals composed of approximately 120 characters and 24 spaces, or two consecutive lines, whichever is the greater, to be printed correctly. This range setting is one of the *orientation limits* defined in 3.06.

(c) Determine the other *orientation limit* in a similar manner.

(d) The lower orientation limit subtracted from the upper orientation limit gives the *orientation range*.

(e) The optimum point for the signals being received lies halfway between the upper and lower orientation limits.

3.08 Procedure for Determining Orientation Limits of Reperforators: If means are not available at the station for determining whether or not the tape is correctly punched, then a recurring series of characters may be used. The combination of Z, R, Space, repeated in that sequence, forms a series of punched holes resembling V's in the tape in which it is easy to detect an error. About 100 of these V's should be received correctly for the determination of an orientation limit by the procedure described for typing units in 3.07.

3.09 Procedure for Determining Orientation Limits of SOTUS Units: The preferred procedure is to transmit a series of alternate R and Y signals, that is, RYRYRY, etc, from a tape or other suitable transmitter, and determine the orientation limits of the SOTUS unit follow-

ing the procedure given in 3.07 with the exception that an error is indicated by the flag on the unit → operating from white to red. In certain cases where alternate RY signals are not available and → tests are made using recurring Y signals obtained from a 100A test distributor it should be recognized that this is a less severe test than ↗ the test with RY signals. The 1A teletypewriter test set can be equipped with the TP122391 set of parts (Specification 5679S) for transmission ↘ of alternate R and Y signals.

4. TEST APPARATUS

4.01 Distortion Measuring: Distortion in the signals sent from transmitters and keyboards may be measured on a 118-type telegraph transmission measuring set, an X-75041 telegraph transmission measuring set, a 161A telegraph station test set, or a 164C1 telegraph transmission measuring set. The 118-type set is not portable; the other sets mentioned are portable, although the X-75041 set does weigh 47 ↘ pounds. The 161A1 set may be used only to measure systematic distortion of selected test characters such as BLANK, T, O, M, V, and ↗ LTRS, and reversals. The 164C1 set may be used to measure total distortion of miscellaneous test signals on working teletypewriter circuits, ↘ or of repeated test characters. The 118-type and X-75041 sets may be used to measure the total distortion of miscellaneous characters such as the characters of the standard test sentence. ↗ Measurements made with the 118-type sets, the 164C1 set, and the X-75041 set are usually reported in terms of total distortion and bias. The amount of total distortion is given first, then a letter (either M or S) indicating the type of bias, and last the amount of bias. A typical report might be 5S2, indicating 5 per cent total distortion and 2 per cent spacing bias.

4.02 Standard Test Signals

→ (a) The standard test signals for 5-unit code tests are as follows:

THE QUICK BROWN FOX JUMPED
OVER A LAZY DOG'S BACK 1234567890
*** SENDING

→ This message occupies the space of 72 characters. To prepare a tape containing this sentence, operate the keyboard in the order given below, striking the space bar when (space) is indicated.

THE (space) QUICK (space) BROWN
(space) FOX (space) JUMPED (space)
OVER (space) A (space) LAZY (space)
DOG FIGS ' LTRS S (space) BACK (space)
FIGS 1234567890 LTRS (space) *** (space)
SENDING CAR-RET CAR-RET LINE-
FEED LTRS

↗ ***Identifying characters, no more than three may be inserted here. When only one or two identifying characters are used, add spaces to make three.

(b) The standard test signals for use in testing 6-unit 20-type teletypewriters and perforators are provided by the TP126791 test tape.

(1) One part of the test message is for re-perforators and consists of the codes "(RUB-OUT) (UR) (UR) (UR) (UR)" repeated 30 times. This forms a distinct pattern in the tape that can readily be scanned for errors.

(2) The second part of the test message is for 20 teletypewriters and consists of a modified fox sentence occupying the space of 56 characters and using all the letters of the alphabet and all the numerals (numerals printed in red). The actual copy on the teletypewriter is printed in two columns, with the second column one line space below the first. This arrangement permits the copy to be readily scanned for errors.

The quick brown fox jumps over
the lazy dog! 1234567890
The quick brown fox jumps over
the lazy dog! 1234567890
The quick brown fox jumps over
the lazy dog! 1234567890
The quick brown fox jumps over
the lazy dog! 1234567890
The quick brown fox jumps over
the lazy dog! 1234567890
↘

4.03 Sources of Signals: Receiving tolerances are obtained by determining the orientation limits as in 3.07 for test signals having various predetermined amounts and types of distortion. The available sources provide signals as follows:

→ (a) *Undistorted Miscellaneous Test Signals*

1A Teletypewriter Test Set
14-type Transmitter-Distributor

- 100A Teletypewriter Test Distributor
(repeated signals only) ↗
110A1 Automatic Multiple Sender ↗
110B1 Automatic Multiple Sender ↗
110C1 Multiple Sender ↘
- (b) **Signals Having Steady Marking Bias and Steady Spacing Bias**
- 1A Teletypewriter Test Set
100A Teletypewriter Test Distributor ↗
(repeated signals only)
119A2 Telegraph Signal Biasing Set
119B1 Telegraph Signal Biasing Set
119C1 Telegraph Signal Distorting Set
119C2 Telegraph Signal Distorting Set ↘
- (c) **Signals Having Steady Marking End-distortion or Steady Spacing End-distortion**
- 1A Teletypewriter Test Set
100A Teletypewriter Test Distributor ↗
(repeated signals only) ↗
- (d) **Signals Having Switched Bias**
- 119C1 Telegraph Signal Distorting Set ↗
119C2 Telegraph Signal Distorting Set
- (e) **Signals Having "Random" Switched Bias**
- 119A2 Telegraph Signal Biasing Set
119B1 Telegraph Signal Biasing Set
- (f) **Signals Having Only Switched End-distortion**
- 119C1 Telegraph Signal Distorting Set
- (g) **Signals Having Switched Combination Distortion**
- 119C1 Telegraph Signal Distorting Set
119C2 Telegraph Signal Distorting Set

Note: The J70122BM electronic distributor should be used to generate the signals for the 119C2 telegraph signal distorting set when testing the 28 reperforator-transmitter operating at 200 words per minute.

Note: In adjusting holding-magnet type selectors to meet the tolerance requirements for bias and end-distortion, the necessary tension required in the armature-lever spring is very dependent upon the wave shape of the driving signal. If the selector has been adjusted to meet the tolerance re-

quirements with a signal having a virtually square wave, such as is produced by a 1A teletypewriter test set, and is then tested with signals from a relay signal source, such as the 119-type telegraph signal biasing or distorting sets, it will generally fail to meet the standard tolerance requirements. However, if the tension of the armature-lever spring is increased, equally satisfactory tolerances can be obtained with the relay source. This difference in operation is due to the sloping character of the mark-to-space transition of the signal transmitted from the contacts of a relay equipped with a capacity-resistance spark killer. The armature-lever-spring tension will be less for a holding magnet selector which is adjusted on a signal wave having essentially a vertical mark-to-space transition, since the rapid fall of the current in the magnet permits the armature to release sooner than when the selector is adjusted on a signal wave having a sloping mark-to-space transition which causes the magnet current to fall off gradually. Thus when a selector magnet is adjusted on a signal having virtually a square wave, and then operated without re-adjustment on a signal transmitted from relay contacts equipped with a spark killer, the delay in the armature release will produce the equivalent of marking internal bias and thus cause a considerable change in the bias and end-distortion tolerance of the unit. It is therefore desirable that the teletypewriter be adjusted whenever possible with the same type of signal it will receive when installed at the station. ↘

5. WHEN TO APPLY TEST AND READJUST REQUIREMENTS

5.01 Check test requirements should be applied on routine inspections, prior to or upon installation of new and reconditioned equipment, and previous to or after making any change in the adjustments when trouble is suspected.

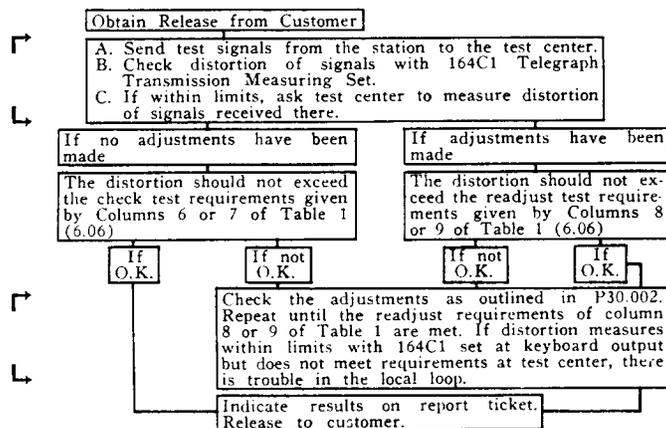
5.02 Readjust test requirements should be applied whenever the check test requirements are not met, after reconditioning equipment, and whenever changes which affect transmission have been made in the settings or adjustments of the station equipment or in the line or loop connecting circuits.

6. TEST PROCEDURE FOR REPEATERED CIRCUITS

6.01 The following test procedures apply to tests between teletypewriter stations and test centers. Tests may also be made locally at teletypewriter servicing centers and test centers following these procedures but in this case cooperation with the distant station is not required, the tester having control of his own test signals and transmission measuring sets.

6.02 *Sending distortion tests* of teletypewriter keyboards, reperforator transmitters, multiple transmitters and transmitter-distributors should be made using Flow Chart A as a guide. Miscellaneous test signals having the test characters given in 4.02, should be used, if practicable and should be sent by keyboard or tape transmitter depending on which type of equipment the customer uses. In the case of transmission from a keyboard these test signals should preferably be typed by hand at a uniform speed approaching the normal speed of the machine. If this cannot be done without making mistakes in typing, send some other familiar test sentence or send the letters R and Y alternately. Adjustments to be made in order to meet the requirements are covered in BSP Section P30.002.

6.03 *Sending Distortion Tests — Flow Chart A*



6.04 *Receiving Tolerance Tests:* The procedure to be followed in testing the *tolerance* of the station receiving apparatus depends on the types of signals available.

(a) When miscellaneous test signals having steady bias, steady end-distortion, switched bias, switched end-distortion, or switched combination of bias and end-distortion are available, follow the provisions of 6.05.

(b) When only undistorted miscellaneous test signals are available, proceed as follows, observing however the restriction that although such undistorted signals may be used for testing 28 teletypewriters, and for testing 14 and 15 teletypewriters equipped with pulling-magnet selectors, such test signals cannot be used to determine margins of 14 and 15 teletypewriters equipped with holding-magnet selectors (see 3.07).

Check Tests Using Undistorted Miscellaneous Signals

- (1) Note the "as-found" setting of the range-finder arm.
- (2) Raise the range-finder arm to a position above that setting by an amount equal to the required *orientation margin* given in Column 2, Table 1, opposite the proper *circuit coefficient*. This check test can be considered satisfactory if 144 consecutive signals composed of approximately 120 characters and 24 spaces are printed without error. Lower the range-finder arm to a position below the setting found in (1), by an amount equal to that same *orientation margin* and repeat the test.
- (3) If test (2) is satisfactory reset the range-finder arm to the position found in (1) and release to customer.
- (4) If test (2) is unsatisfactory, make the readjust tests.

Readjust Tests

- (5) Obtain the *orientation range* as prescribed in 3.06 through 3.09. This *orientation range* must be at least equal to that called for in Column 3 of Table 1 (6.06). Set the range-finder arm midway between the orientation limits just found.

(c) Where undistorted, 20 per cent biased, and 20 per cent end-distorted *repeated characters* only are available, as from a 100A test distributor, proceed as follows:

Note: When using the 100A test distributor, it may be necessary occasionally to resynchronize it with the teletypewriter by operating the pulse switches to LTRS (toggle switches 1 through 5 to ON). Synchronization should be checked after any errors are received.

Check Tests Using 100A Test Distributor

- (1) Note the "as-found" setting of the range-finder arm.
- (2) Raise the range-finder arm to a position above that setting by an amount 20 less than specified in Column 1, Table 1, for the particular circuit coefficient.
- (3) Send several LTRS signals having 20 per cent marking bias into the unit to permit the teletypewriter to fall into step, and then send one hundred and forty-four FIGS signals having 20 per cent marking bias into the unit. The teletypewriter should remain in the FIGS position without typing.
- (4) Repeat test (3) with 20 per cent spacing end-distorted signals.
- (5) Lower the range-finder arm to a position below the setting found in (1) by an amount equal to 20 less than specified in Column 1, Table 1, for the particular circuit coefficient.
- (6) Make tests as in (3) using signals having 20 per cent spacing bias.
- (7) Make tests as in (3) using signals having 20 per cent marking end-distortion.
- (8) If tests (3), (4), (5), (6), and (7) are successful, reset the range-finder arm at the setting found originally in (1) and release to customer.
- (9) If any test was unsatisfactory, make the following readjust tests.

Readjust Tests Using 100A Test Distributor

- (10) Send several LTRS signals having 20 per cent marking bias into the unit to permit the teletypewriter to fall into step, and then send FIGS signals having 20 per cent marking bias into the unit. Receiving repeated characters makes it possible for the machine to drop out of synch occasionally. If this occurs, operation of the 3d pulse key to "mark" (reverting to the "LETTERS" code) will cause it to drop back into synchronism.
- (11) Determine the upper orientation limit as prescribed in 3.07 through 3.09.
- (12) Repeat operations (10) and (11) with signals having 20 per cent spacing end-distortion.

- (13) Repeat operation (10) with signals having 20 per cent spacing bias.
- (14) Determine the lower orientation limit.
- (15) Repeat operations (10) and (14) with signals having 20 per cent marking end-distortion.
- (16) The results of operations (10) through (15) for teletypewriters with holding magnets, operating at 60, 75, or 100 wpm speeds, and for teletypewriters with pulling magnets operating at 60 wpm speed, should conform to the table which follows.

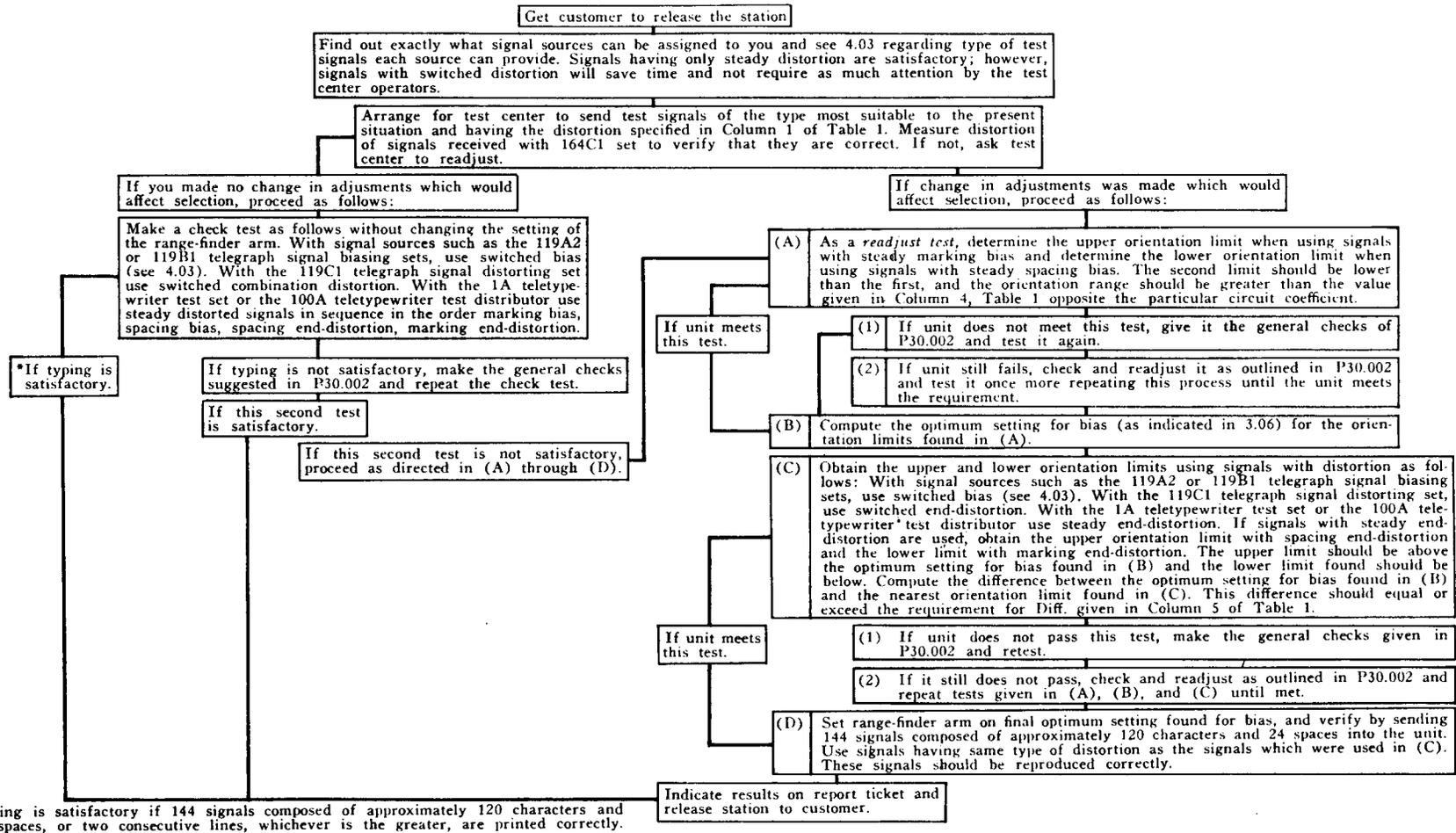
CIRCUIT COEFFICIENT (3.02)	MINIMUM ORIENTATION RANGE WITH 20% BIAS (3.06 THROUGH 3.09)	MINIMUM DIFFERENCE A
0 (Local Test)	40	15
.1- .2	38	14
.3- .5	36	13
.6-1.0	34	12
1.1-1.5	30	10
1.6-2.0	28	9
2.1-2.5	26	8
2.6-3.0	24	7
3.1-3.5	22	6
3.6-4.0	20	5
4.1-4.5	18	4
4.6-5.0	16	3
5.1-5.5	14	2
5.6-6.0	12	1

Note: From the results of operations (11) and (14), calculate the optimum point for bias as indicated in 3.06. Then the upper orientation limit using spacing end-distortion found in operation (12) should be above that optimum point for bias, and the lower orientation limit using marking end-distortion found in operation (15) should be below. Also neither of these last two orientation limits should be closer to the optimum point for bias than the Minimum Difference A.

- (17) If the results do not conform, check and readjust the unit as suggested in BSP Section P30.002 and then when it is in order, release to the customer with the range-finder arm set at the optimum point for bias.

6.05 Receiving Tolerance Tests—Flow Chart B

(For use where steady bias, steady end-distorted, switched bias, switched end-distorted, or switched combination miscellaneous signals are available.)



Note: With the 119C2 telegraph signal distorting set (and the J70122BM electronic distributor) use switched combination distortion to determine the distortion tolerance of the reperforator of the 28 reperforator-transmitter operating at 200 words per minute.

6.06 Test Requirements

TABLE 1
TEST REQUIREMENTS

Circuit Coefficient (3.02)	STATION RECEIVING (6.04 & 6.05) (NOTE 1)					STATION SENDING (6.02 & 6.03) (NOTE 3)				↙
	CHECK TESTS (5.01)		READJUST TESTS (5.02)			CHECK TESTS (5.01)		READJUST TESTS (5.02)		
	1	2	3	4	5	6	7	8	9	
	Using Distorted Signals % Distortion in Signals	Orientn. Margin Using Unbiased Signals (6.04b)	Minimum Orientn. Range Using Unbiased Signals (3.06 to 3.09)	Minimum Orientn. Range Using Amount of Steady Bias Per Col. 1 (3.06 to 3.09)	Min. Diff. (Note 2) Using Amount of Distortion Per Col. 1	Allowable Per Cent Distortion Trans. Distr.	Key- board (Note 4)	Allowable Per Cent Distortion Trans. Distr.	Key- board (Note 4)	
0 (Local Test)	35	34	72	10	0	5	8	4	7	
.1- .2	30	33	70	18	4	6	10	5	8	
.3- .5	30	31	68	16	3	6	10	5	8	
.6-1.0	30	29	66	14	2	7	10	5	8	
1.1-1.5	30	27	62	10	0	8	12	6	9	
1.6-2.0	25	25	60	18	4	9	14	6	11	
2.1-2.5	25	24	58	16	3	10	15	7	12	
2.6-3.0	25	22	56	14	2	11	16	8	13	
3.1-3.5	25	21	54	12	1	13	18	9	14	
3.6-4.0	25	20	52	10	0	14	19	10	15	
4.1-4.5	20	19	50	18	4	15	20	11	16	
4.6-5.0	20	18	48	16	3	16	21	12	17	
5.1-5.5	20	17	46	14	2	17	22	12	18	
5.6-6.0	20	16	44	12	1	18	23	13	19	

Notes:

- Does not apply to 14- and 15-type units with pulling-magnet selectors at speeds higher than 60 wpm.
- Difference between the optimum setting for bias and the nearest orientation limit obtained on random switched bias and switched or steady end-distortion (see Flow Chart B); upper limit above, and lower limit below, the optimum setting for bias.
- Assumes no radio suppressors. When suppressors are used, increase the allowable distortion as follows:
For circuits having coefficients 0 to .2 add 2 per cent distortion; for circuits having coefficients .3 to 1.0 add 1 per cent distortion.
- The keyboard requirements apply also to multiple transmitter units and 14-type reperforator-transmitter units.
- The reperforator of a 28 reperforator-transmitter operating at 200 words per minute should be capable of tolerating 20 per cent marking and spacing bias and 20 per cent marking and spacing end-distortion at a single setting of the range finder.