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TELETYPEWRITER STATIONS
ORIENTATION AND DISTORTION TESTS

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1. GENERAL

1.01 This section covers the general requirements and procedures for transmission tests of teletypewriter station apparatus and supplements those requirements and procedures given in the P30 series of BSPs covering specific teletypewriter apparatus. ↰

1.02 This section is reissued:

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

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

(c) To change the title.

Changes are marked with marginal arrows. ↵

1.03 This section covers tests made locally at test centers and at servicing centers, and tests made over circuits (loop or leg) between test centers and teletypewriter stations. The division of responsibility between the test center and station forces is specified. Requirements are given for **check** tests and for **readjust** tests. Suggestions are given for adjusting the station apparatus to meet these requirements.

1.04 This section applies to the 5-unit code at 60, 75, and 100 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 readjust 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 suppresssors should not be disconnected 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 ele-

ment 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.

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 orientation limits found with biased signals, and in the second case the orientation setting midway between the orientation limits found with end-distorted signals.)

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 following 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 (see Part 9), 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 above are portable, although the X-75041 set does weigh 47 pounds. The 164C1 set is intended to supersede the 161A1 set, and may be used to measure total distortion of miscellaneous signals on working teletypewriter circuits, or of repeated test characters. Its accuracy is comparable to that of the 118C3 set. However, the 164C1 set must be carefully adjusted and special instruction in that process is desirable. The 118-type and X-75041 sets may be used to measure the total distortion of miscellaneous characters such as the standard test-sentence characters. Measurements made with the 118-type set, 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 reperforators are provided by the TP126791 test tape (see BSP Section P39.101).

(1) One part of the test message is for reperforators 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, each the length of a justified newspaper column, 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

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

119A2 Telegraph Signal Biasing Set
119B1 Telegraph Signal Biasing Set
119C1 Telegraph Signal Distorting Set

} The 119-type sets distort signals generated from an external source.

(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

(c) **Signals Having Steady Marking End-distortion and 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

(e) **Signals Having "Random" Switched Bias**

119A2 Telegraph Signal Biasing Set

119B1 Telegraph Signal Biasing Set

The signals will have end-distortion in varying amounts not exceeding the bias.

(f) **Signals Having Only Switched End-distortion**

119C1 Telegraph Signal Distorting Set

(g) **Signals Having Switched Combination Distortion**

119C1 Telegraph Signal Distorting Set

Note: The constructional features, circuits, and operating principles governing the use of the various test apparatus are described in the Bell System Practices listed in Part 9.

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 requirements 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 readjustment 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.

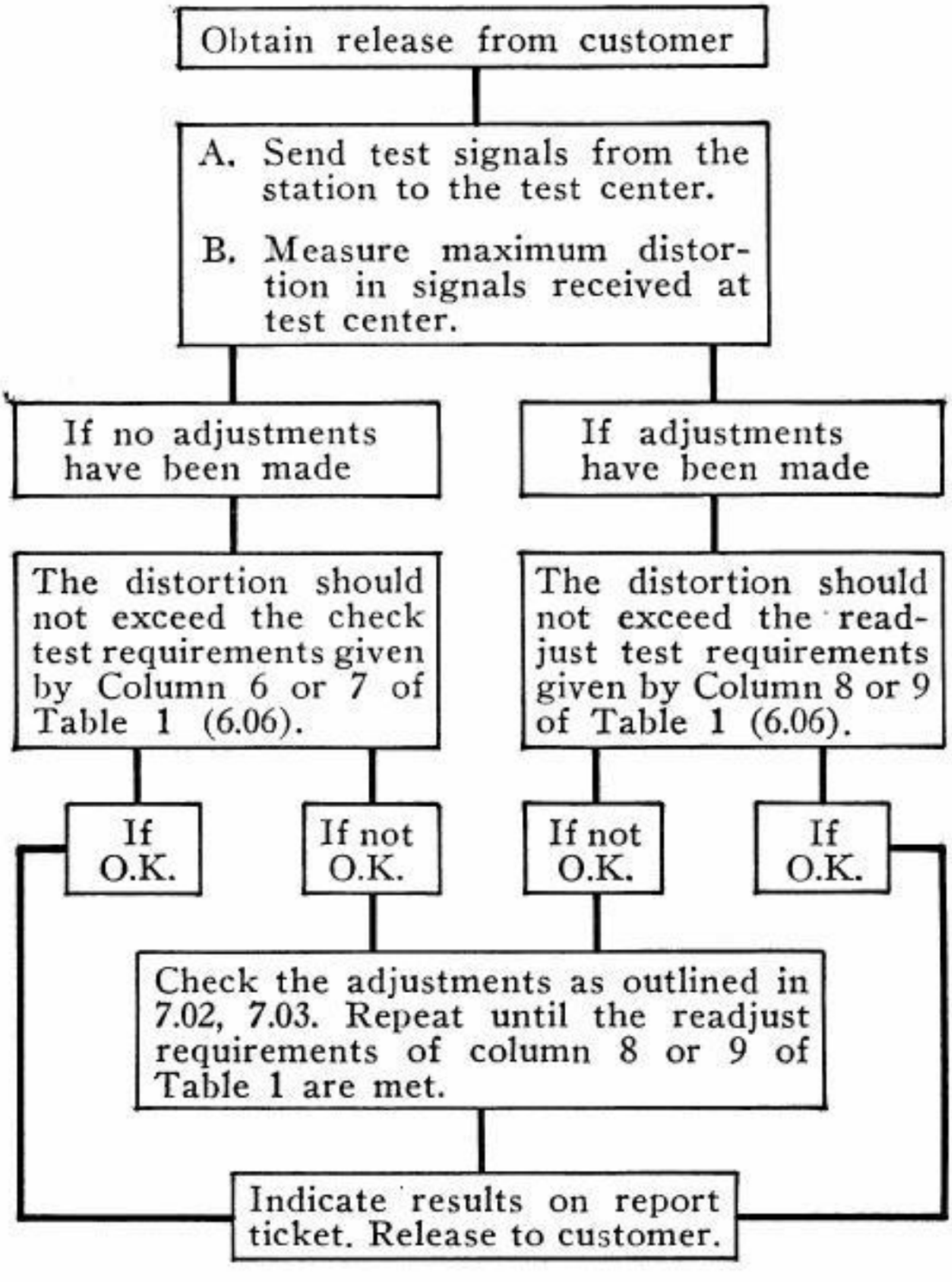
6. TEST PROCEDURE FOR REPEATERED CIRCUITS

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 Part 7.

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 by operating the pulse switches to LTRS. 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.

(11) Determine the upper orientation limit as prescribed in 3.06 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.

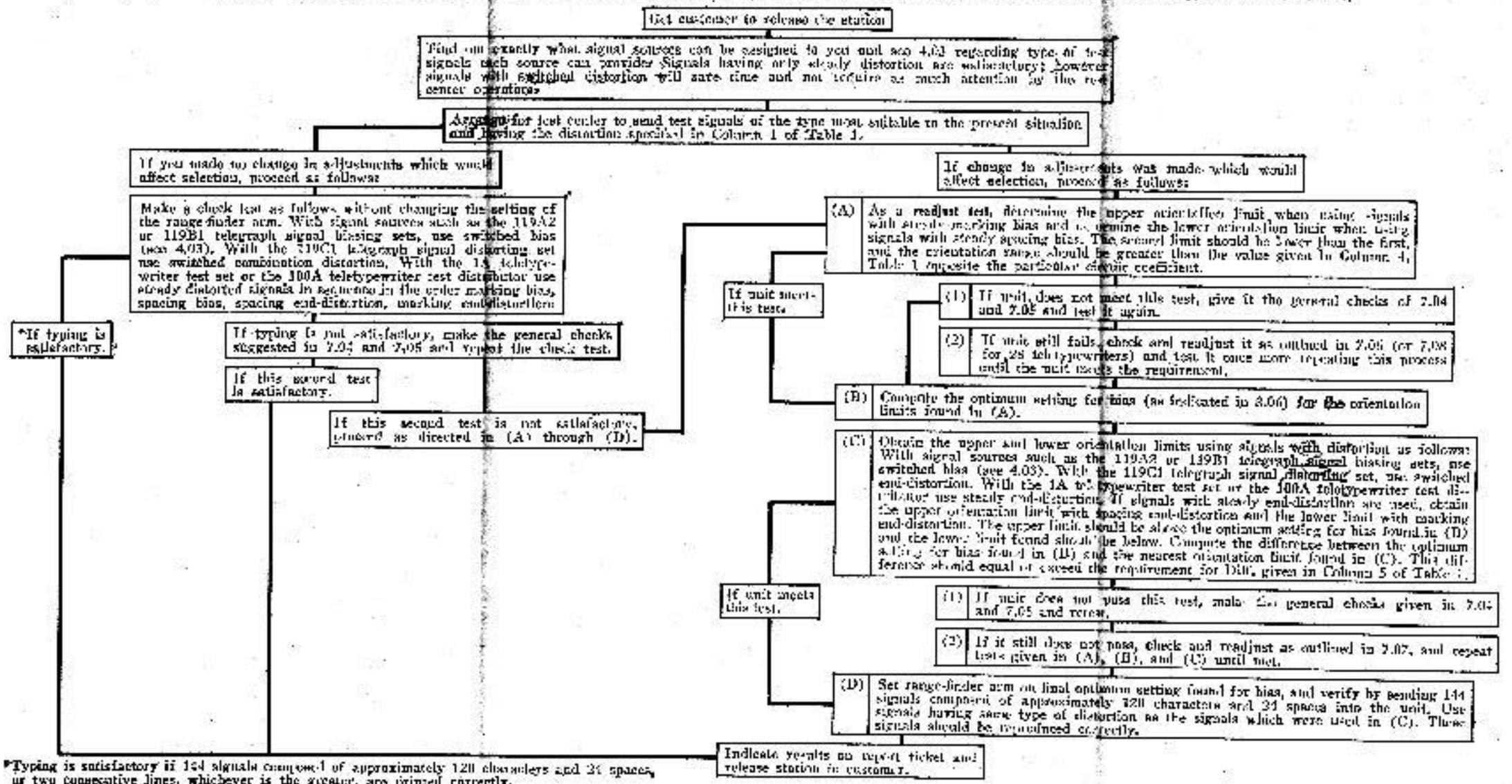
Circuit Coefficient (3.02)	Minimum Orientation Range with 20% Bias (3.06 through 3.09)	Minimum Difference A
0 (Local Test)	40	15
.1- .2	38	14
.3- .5	36	13
.6-1.0	34	12
1.1-1.5	30	10
1.6-2.0	28	9
2.1-2.5	26	8
2.6-3.0	24	7
3.1-3.5	22	6
3.6-4.0	20	5
4.1-4.5	18	4
4.6-5.0	16	3
5.1-5.5	14	2
5.6-6.0	12	1

Note: From the results of operations (11) and (13), 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 Part 7 of this section, 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

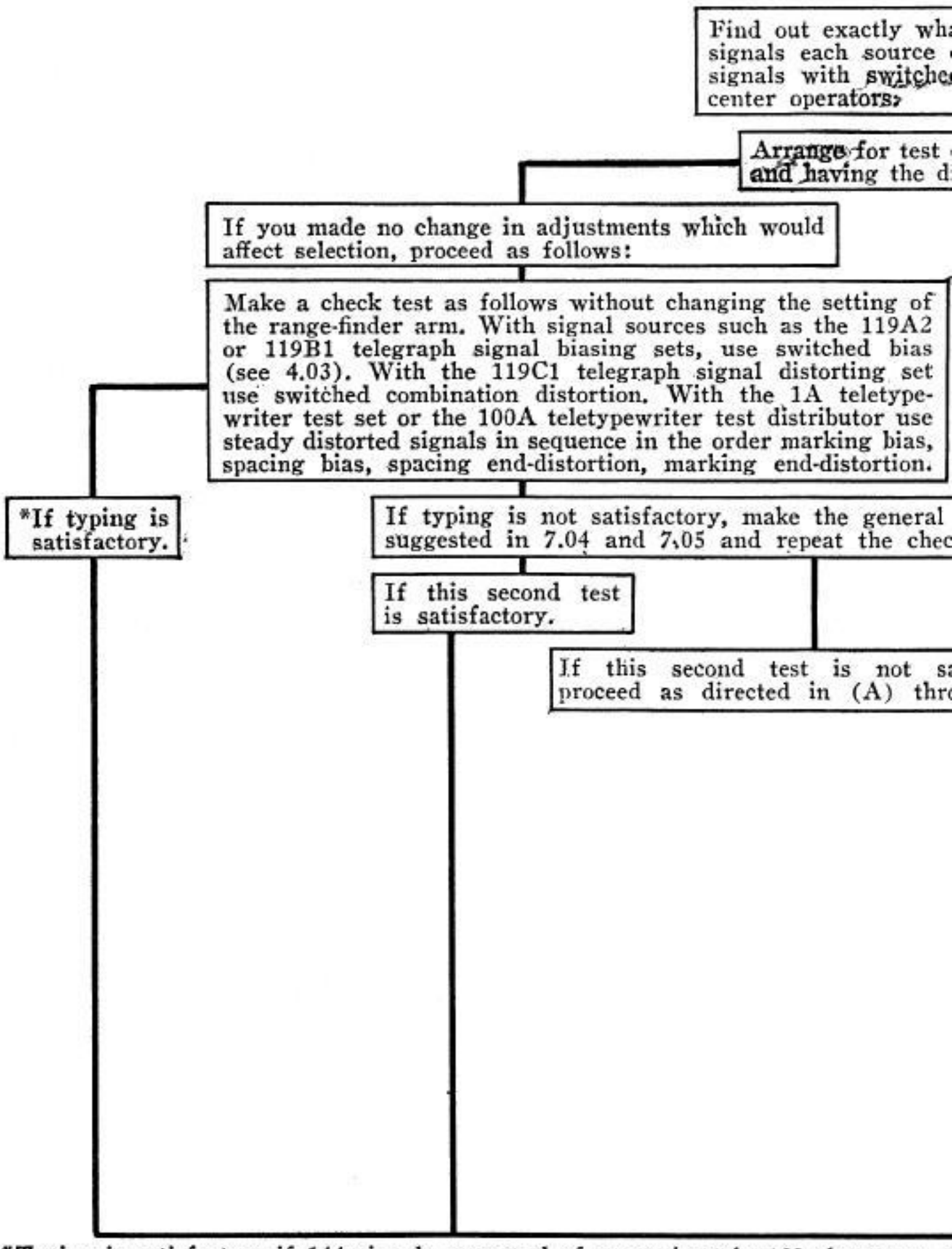
(For use where steady bias, steady end-distorted, switched bias, switched end-distorted, or switched combination miscellaneous signals are available.)



*Typing is satisfactory if 144 signals composed of approximately 120 characters and 24 spaces, or two consecutive lines, whichever is the greater, are printed correctly.

6.05 Receiving Tolerance Tests—Flow Chart B

(For use where steady bias, steady end-distorted, switched



*Typing is satisfactory if 144 signals composed of approximately 120 characters a or two consecutive lines, whichever is the greater, are printed correctly.

switched bias, switched end-distorted, or switched combination miscella

Get customer to release the station

exactly what signal sources can be assigned to you and see 4.03 regarding type of test
ch source can provide. Signals having only steady distortion are satisfactory; however
ith switched distortion will save time and not require as much attention by the test
erators.

ge for test center to send test signals of the type most suitable to the present situation
aving the distortion specified in Column 1 of Table 1.

If change in adjustmen
affect selection, proceed

setting of
he 119A2
ched bias
orting set
teletype-
ibutor use
king bias,
distortion.

he general checks
at the check test.

is not satisfactory,
n (A) through (D).

(A) As a **readjust test**, determine the u
with steady marking bias and deter
signals with steady spacing bias. The
and the orientation range should be
Table 1 opposite the particular circ

If unit meets this test.

(1) If unit does not m
and 7.05 and test it

(2) If unit still fails, c
for 28 teletypewrit
until the unit meets

(B) Compute the optimum setting for
limits found in (A).

(C) Obtain the upper and lower orien
With signal sources such as the
switched bias (see 4.03). With th
end-distortion. With the 1A telety
tributor use steady end-distortion.
the upper orientation limit with sp
end-distortion. The upper limit sho
and the lower limit found should b
setting for bias found in (B) and
ference should equal or exceed the

If unit meets this test.

(1) If unit does not
and 7.05 and retest.

(2) If it still does not
tests given in (A),

(D) Set range-finder arm on final optim
signals composed of approximatel
signals having same type of disto
signals should be reproduced corr

Indicate results on report ticket and release station to customer.

characters and 24 spaces,
ctly.

nbination miscellaneous signals are available.)

garding type of test
atisfactory; however
ttention by the test

present situation

change in adjustments was made which would
ct selection, proceed as follows:

test, determine the upper orientation limit when using signals
rking bias and determine the lower orientation limit when using
ady spacing bias. The second limit should be lower than the first.
tion range should be greater than the value given in Column 4,
e the particular circuit coefficient.

If unit does not meet this test, give it the general checks of 7.04 and 7.05 and test it again.

If unit still fails, check and readjust it as outlned in 7.06 (or 7.08 for 28 teletypewriters) and test it once more repeating this process until the unit meets the requirement.

optimum setting for bias (as indicated in 3.06) for the orientation
in (A).

pper and lower orientation limits using signals with distortion as follows:
sources such as the 119A2 or 119B1 telegraph signal biasing sets, use
(see 4.03). With the 119C1 telegraph signal distorting set, use switched
. With the 1A teletypewriter test set or the 100A teletypewriter test dis-
teady end-distortion. If signals with steady end-distortion are used, obtain
entation limit with spacing end-distortion and the lower limit with marking
. The upper limit should be above the optimum setting for bias found in (B)
limit found should be below. Compute the difference between the optimum
as found in (B) and the nearest orientation limit found in (C). This dif-
d equal or exceed the requirement for Diff. given in Column 5 of Table 1.

If unit does not pass this test, make the general checks given in 7.04 and 7.05 and retest.

If it still does not pass, check and readjust as outlined in 7.07, and repeat tests given in (A), (B), and (C) until met.

er arm on final optimum setting found for bias, and verify by sending 144
sed of approximately 120 characters and 24 spaces into the unit. Use
same type of distortion as the signals which were used in (C). These
be reproduced correctly.

d

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		Allowable Per Cent Distortion	
						Trans. Distr.	Key-board (Note 4)	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

1. Does not apply to 14- and 15-type units with pulling-magnet selectors at speeds higher than 60 wpm.
2. 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.
3. 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.
4. The keyboard requirements apply also to 1-type multiple transmitters and 14-type reperforator-transmitter units.

6.06 Test Requirements

TABLE 1

TEST REQUIREMENTS

Circuit Coefficient (3.02)	Station Receiving (6.04 & 6.05) (Note 1)				
	Check Tests (5.01)		Readjust Tests (5.02)		
	1	2	3	4	
	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 (No U Amo Dist Per
0 (Local Test)	35	34	72	10	
.1- .2	30	33	70	18	
.3- .5	30	31	68	16	
.6-1.0	30	29	66	14	
1.1-1.5	30	27	62	10	
1.6-2.0	25	25	60	18	
2.1-2.5	25	24	58	16	
2.6-3.0	25	22	56	14	
3.1-3.5	25	21	54	12	
3.6-4.0	25	20	52	10	
4.1-4.5	20	19	50	18	
4.6-5.0	20	18	48	16	
5.1-5.5	20	17	46	14	
5.6-6.0	20	16	44	12	

Notes

1. Does not apply to 14- and 15-type units with pulling-m 60 wpm.
2. Difference between the optimum setting for bias and t on random switched bias and switched or steady end-c limit above, and lower limit below, the optimum setting
3. Assumes no radio suppressors. When suppressors are u as follows:

   For circuits having coefficients 0 to .2 add 2 per cent dist .3 to 1.0 add 1 per cent distortion.
4. The keyboard requirements apply also to 1-type multip rator-transmitter units.

TABLE 1

TEST REQUIREMENTS

(6.04 & 6.05) (Note 1)			Station Sending (6.02 & 6.03) (Note 3)			
Readjust Tests (5.02)			Check Tests (5.01)		Readjust Tests (5.02)	
3	4	5	6	7	8	9
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		Allowable Per Cent Distortion	
			Trans. Distr.	Key-board (Note 4)	Trans. Distr.	Key-board (Note 4)
72	10	0	5	8	4	7
70	18	4	6	10	5	8
68	16	3	6	10	5	8
66	14	2	7	10	5	8
62	10	0	8	12	6	9
60	18	4	9	14	6	11
58	16	3	10	15	7	12
56	14	2	11	16	8	13
54	12	1	13	18	9	14
52	10	0	14	19	10	15
50	18	4	15	20	11	16
48	16	3	16	21	12	17
46	14	2	17	22	12	18
44	12	1	18	23	13	19

ype units with pulling-magnet selectors at speeds higher than

m setting for bias and the nearest orientation limit obtained switched or steady end-distortion (see Flow Chart B); upper low, the optimum setting for bias.

When suppressors are used, increase the allowable distortion

0 to .2 add 2 per cent distortion; for circuits having coefficients on.

pply also to 1-type multiple transmitters and 14-type reperfo-

7. ADJUSTMENTS

7.01 In the following, it is assumed that tests are made as indicated by the Flow Charts A and B. Adjustments should preferably be made in the order given below and only as many items should be checked as are necessary in order to locate and clear the trouble. When the trouble is located readjust or replace parts as necessary in order to meet the requirements.

Sending Distortion Reduction

7.02 **Test Centers**

(a) Check line or loop facilities for crosses, grounds, insulation, intermittent troubles such as hits, proper currents. Check lines for power interference and cross-fire. Check wave-shaping on loops. If regular circuit is unsatisfactory, either make it satisfactory or use a spare facility.

(b) Check repeater, including its relays.

(c) Check measuring equipment.

7.03 **Stations**

(a) Check sending relays, if provided.

(b) Check dc voltage.

(c) Check motor speed (if governed motor).

(d) Check adjustments of keyboards, multiple transmitters, and reperforator transmitters as follows:

(1) **Sending Contact Gap:** Contacts should be clean and free of pits and buildup. If the distortion requirement is exceeded by several per cent distortion and the measurements indicate the distortion to be mostly bias, adjustment of the contact-gap within permissible limits may prove helpful; adjust the start-contact toward minimum gap to reduce spacing bias; and toward maximum gap to reduce marking bias.

(2) **Sending Contact Pressure.**

(3) **Transmitting Mechanism:** If the keyboard or transmitter-distributor requirements are not met after making the above checks, check distortion using a 161A1 telegraph station test set, a 164C1 telegraph transmission measuring set, an X-75041 telegraph transmission measuring set, or a 118-type telegraph transmission measuring set. Instruction information listed in Part 9 should be followed. If relatively high peaks of distortion occur at intervals and distortion is low at other times in the case of 14 and 15 teletypewriter keyboards, consider providing the TP95317 set of parts to reduce the distortion peaks. If a 14-, 15-, or 20-type

typing unit is to be operated at .020 ampere, check the connections of the 5000-ohm shunt and verify its resistance. ↵

(e) Check the following features of 14 and 20 transmitter-distributors:

(1) **Distributor brushes**

(2) **Distributor ring and segments**

(3) **Main-shaft clutch**

(4) **Operating cam**

Receiving Tolerance Improvement—Test Centers

7.04 **General checks at test centers** should be made on the following items external to the teletypewriter before inspecting or readjusting the teletypewriter.

(a) Check source of test signals.

(b) Check repeaters and relays (if involved).

(c) Check line or loop facilities for cross, grounds, insulation, intermittent troubles such as hits, power interference, cross fire, and proper currents. If regular circuit is unsatisfactory, either make it satisfactory or use a spare facility.

Receiving Tolerance Improvement—Stations

7.05 **General Checks at Stations**

(a) Check line relay or station repeater relays.

(b) Check dc voltage.

(c) Check motor speed (if governed).

Receiving Tolerance Improvement—Teletypewriter Adjustments

Note: Check of the adjustments should be made in the order given.

7.06 **Steady-bias Tolerance Unsatisfactory—General:** Failure to meet the requirement is probably caused by unsatisfactory conditions within the teletypewriter, such as adjustments being outside specified limits. Adjustments of any part may necessitate readjustment of related parts, since the items in this list may not be in normal adjustment sequence. In checking adjustments, make sure the parts involved are free from dirt and excess oil and grease. If, after checking and making improvements as appears necessary, the requirement is still not met, the matter should be referred to your supervisor.

(a) **Adjustment of 14, 15, and 20 Units with Holding- or Pulling-magnet Selectors**

(1) **Selector Clutch:** The tension requirements should be met. The torque measurement of the clutch should result in a steady tension reading. Varying tension indicated by the spring balance indicates a jerking clutch and if this condition is encountered, the selector-cam friction washers should be checked.

(2) **Main-shaft Alignment:** Check that the selector-cam peaks line up with the selector levers. Also check that these parts are not worn unevenly. If shaft is repositioned, recheck the adjustment of the main-clutch throwout lever.

(b) **Adjustment of Selecting Mechanism—Pulling-magnet Teletypewriters of 14, 15, and 20 Type**

(1) If the adjustments are within the limits specified in the adjusting procedures, variations in the adjustments will have relatively little effect on the bias tolerance. Check the following for binds: **selector armature, range-finder** mechanism, **linkage** between **T-levers** and codebars. This last linkage should be checked with the selector lever for the corresponding codebar resting on a cam peak.

(2) Check the adjustment of the **armature stop screw** and **stopnut.**

(3) Check the adjustment of the **magnet bracket.** Upper and lower core ends should be parallel to the armature and have approximately equal clearances.

(4) Check the **locking wedge** adjustment. The locking wedge should not be excessively worn and should clear the locking lever within the limit specified.

(5) Check the **selector-armature-spring tension.**

(6) Check the operation of the **range-finder.** The engaging edges of the **triplatch** and **stoplever** should be sharp, not rounded.

(7) If after making the above checks the bias tolerance is still not met, it is suggested that the rest of the selector adjustments be checked, paying particular attention to the adjustment of the **sword-separator-plate leaf springs.**

(c) **Adjustment of Selecting Mechanism—Holding-magnet Teletypewriter of 14, 15, and 20 Type**

(1) Check the series connection of the coils used for .020-ampere operation. Check the resistance of the 5000-ohm shunt and its connections. Check the parallel

connection of the coils used for .060-ampere operation whether used with or without a line relay. If a 1000-ohm shunt is required, check its resistance and connections.

(2) Check for binds the **armature lever, selector arm, range-finder** mechanism, **linkage** between **T-levers** and **codebars.**

(3) Check that the rivets holding the armature to the armature lever are tight.

(4) Check the alignment of the pole faces with the armature.

(5) Check the **armature-lever-spring** tension.

(6) Check the operation of the **range-finder** mechanism. The engaging surfaces of the **triplatch** and **stoplever** should be sharp, not rounded.

(7) Check the adjustment of the **selector-magnet bracket.**

(8) Check the adjustment and condition of the **locking wedge** and the **selector-arm detent.**

(9) If the above adjustments are all within the specified requirements and the bias tolerance is not met, it is suggested that the rest of the selector adjustments be checked, paying particular attention to the adjustment of the **sword-separator-plate leaf springs.**

7.07 **"Random" Switched-bias from 119A2 or 119B1 Set, Switched-combination Distortion from 119C1 Set, or End-distortion Tolerance Unsatisfactory—General:** Failure to meet the requirement is generally caused by internal bias in the teletypewriter selecting mechanism and can be corrected by first determining the sign of such bias and then making refinements in the **selector-armature-spring tension** or other adjustments as noted below. If, after making such checks, the requirements are still not met, the difficulty is probably the result of a transmission impairment in the line or loop facilities and the matter should be referred to your supervisor.

Note: The sign of the internal bias is **marking** if the midpoint for switched bias is above the midpoint for steady bias, and is **spacing** if the midpoint for switched bias is below the midpoint for steady bias.

Refinement of the adjustments in 7.07(a) and (b) should be made to eliminate internal bias. The final setting for all adjustments should be within the specified limits.

Note: Except for the armature-spring and airgap adjustments in the following list, it is not necessary to recheck adjustments which have been checked in accordance with procedure in 7.06.

(a) **Adjustment of 14-, 15- and 20-type Pulling-magnet Selectors**

(1) Remove internal **marking bias** by bringing the armature airgap **(magnet bracket adjustment)** and **armature-spring tension** closer to their maximum limits. If refinement of these adjustments fails to correct the trouble condition in the teletypewriter, check the mechanism for binds as outlined in 7.06(b)(1). Check the adjustment of the **armature stopnut** and **stop screw.** Check that surfaces of the stopnut and armature are clean at the point of contact. Check the adjustment of the **range-finder.** Operation of the triplatch plunger should be free—without hesitation.

(2) Remove internal **spacing bias** by decreasing the airgap and the spring tension toward their minimum limits. If refinement of these adjustments fails to correct the trouble condition, check the mechanism for binds as outlined in 7.06(b)(1). Check the adjustment of the **armature stop screw** and **stopnut.** Check that the surfaces of the armature and stop screw are clean at the point of contact. Check the operation of the **range-finder** paying particular attention to the clearance between the **triplatch** and **stoplever** and the engaging surfaces of these parts.

(b) **Adjustment of 14-, 15-, and 20-type Holding-magnet Selectors**

(1) Remove internal **marking bias** by disconnecting the 1000-ohm shunt in the case of .060-ampere operation. Check that the 5000-ohm shunt is connected for .020-ampere operation and check its resistance. Then increase the **armature-lever-spring** tension. If these means fail to correct the trouble condition, check that the pole faces and armature are clean. Check for binds as outlined in 7.06(c)(2). Check the adjustment of the **selector-arm detent.** Check the adjustment of the **selector-magnet bracket adjusting arm.** Check the adjustment of the **range-finder.**

(2) Remove internal **spacing bias** by connecting the 1000-ohm shunt in the case of .060-ampere operation, if not already connected. Check that the 5000-ohm shunt is connected for .020-ampere operation and check its resistance. Then decrease the tension of the **armature-lever spring.** If this does not correct the trouble condition in the teletypewriter, in the case of .020-ampere operation, check the alignment of the pole faces with the armature. If the above changes do not correct the trouble condition, check for binds as outlined in

7.06(c)(2). Check the adjustment of the **selector-magnet-bracket adjusting arm.**

Note: The use of the 1000-ohm shunt is discussed in BSP Section P31.163.

7.08 **Adjustment of 28 Teletypewriters:**

(a) To improve receiving tolerance:

(1) Check line current.
(2) Check input signals.
(3) Check the selector-armature adjustment.
(4) Check the adjustment of the selector-magnet bracket.
(5) Check the selector-armature-spring tension.
(6) Check the following for binds: selector levers, start lever, push levers, and locking levers.

(b) To correct intermittent errors:

(1) Check line current.
(2) Check input signals.
(3) Check the setting of the range-finder arm.
(4) Check that the wires to the selector magnet are not loose.
(5) Check the adjustment of the selector-magnet bracket.
(6) Check the adjustment of the clutch stop-arm.

8. TEST PROCEDURES FOR NONREPEATERED CIRCUITS

8.01 The following procedure applies to tests between and at customers' stations of circuits which are **not** connected to a test center where sources of test signals and distortion measuring apparatus are available. It covers the usual test which should be made on routine maintenance inspections and upon trouble calls. The tests consist only of transmitting signals locally to the receiving unit and/or to other distant stations and determining orientation limits.

8.02 Signals to be used in this test are the test sentence characters given in 4.02, sent at a uniform rate from a keyboard or preferably from a tape sender (if available). If the test sentence cannot be sent readily, send the letters R and Y alternately.

8.03 Orientation limits are to be obtained following the procedure given in 3.06 through 3.09.

8.04 Reference should be made to Part 7 for information on adjustments to correct for distortion in senders and to correct for low margins in receiving apparatus.

8.05 The requirements to be met are:

(a) For tests at a station, sending locally to the unit under test, the orientation range should generally be 70 points or more.

(b) For tests to a distant station the orientation range should generally be 65 points or more.

8.06 Local circuit conditions may make it necessary to use special requirements in some cases, depending on layout and operating conditions, and in these cases the requirements should be obtained through the line of organization.

9. REFERENCE TO BELL SYSTEM PRACTICES

9.01 The following BSPs contain information used in conjunction with P30.002.

Title	Section No.
1A Teletypewriter Test Set	P31.403, P31.404, E45.418
100 Teletypewriter Test Distributor	P31.402
110A1 Automatic Multiple Sender	E45.414
110B1 Automatic Multiple Sender	E45.415
110C1 Multiple Sender	E45.413
118A1 and 118B1 Telegraph Transmission Measuring Sets	E45.423
119A2 Telegraph Signal Biasing Set	E45.416
119B Telegraph Signal Biasing Set	E45.417
119C1 Telegraph Signal Distorting Set	E45.419
161A1 Telegraph Station Test Set	P31.401, E45.422
164C1 Telegraph Transmission Measuring Set	P31.405, E45.438
X-75041 Telegraph Transmission Measuring Set	E45.430
Installation of TP106244 Resistor—1000-ohm Shunt for Holding-magnet Selector Coils Connected in Parallel	P31.163
Selector Mechanism—28 Teletypewriter—Requirements and Procedures	P34.001
Teletypewriter Selector Mechanisms—Requirements and Procedures	P32.001