

**PERFORMANCE REQUIREMENTS**  
**GENERAL**  
**GENERAL EQUIPMENT REQUIREMENTS**

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**1. GENERAL**

**1.01** This section covers those performance requirements which have a general application. It supplements and forms a part of, and defines the terms used in each specific performance requirements section. It replaces those parts of performance requirement specifications X-65500 to X-65800, inclusive, dealing with the general requirements and definitions covered herein.

**1.02** This section is reissued to bring the information it contains into agreement with the latest practices. Since this reissue covers a general revision, the arrows ordinarily used to indicate changes have been omitted.

**1.03** Unless otherwise specified, equipment shall meet the requirements in this section insofar as they apply, as well as the requirements in the individual performance require-

ments sections, at the time of turnover to the telephone company. This applies to reconditioned Western Electric equipment as well as new equipment. The requirements in the individual section supersede the requirements in this section.

**1.04** In those cases where bulletins, notes, handbooks, or specifications furnished by the manufacturer cover the circuit operation test and no performance requirements in this series are available, the requirement shall function as outlined in the bulletins, notes, etc at turnover to the telephone company.

**1.05** When inspections are made in accordance with inspection procedures, these inspections shall, unless otherwise specified, be completed on a circuit prior to the start of performance requirement tests on that circuit.

**1.06** In some older performance requirement sections of this series of practices, the requirements are covered in "Data Sheets" attached to the section. Where reference is made to these sections, it also includes the data sheets attached to them.

**1.07** Where installation and test of plug-in units or separable power supply units are specified only in plant series BSPs, such testing should not be done by the installer except at the request of the telephone company. Where such a request is made, the testing should be in accordance with the applicable plant series section.

**2. DEFINITIONS**

**A. General**

**2.01** *Circuit operation tests* are those tests made on apparatus and wiring of a circuit, a circuit feature, an entire circuit, or a combination of circuits to determine whether the equipment involved will satisfactorily perform all its supervisory, signaling, switching,

transmission, or any other design intent function. In switching systems, some individual sections refer to circuit operation tests on a routine and supplementary basis. Others are written on a volume or concentrated load test basis.

**2.02 Routine tests** are those tests made on equipment of such a nature that tests need to be repeated at specified intervals in order to insure a serviceable condition.

**2.03 Supplementary tests** are those tests made once on the equipment to insure a serviceable condition before turnover to the telephone company. Some sections specify that the supplementary tests shall be made within a specified interval before turnover to the telephone company.

**2.04 Cycle of Test:** The application of a circuit test, as defined in the individual section, to all circuits covered by a particular routine and which are to be accepted as a unit constitutes a cycle of test. The number of circuits covered in a cycle will depend on whether the telephone company desires to accept, at one time, all the equipment installed or to accept it in smaller units, for example, two sections, 100 lines, etc. In either case, the cycle will be determined by the acceptance unit. No tests are repeated on the same cycle, except repeat tests after trouble is encountered and cleared. Where only one test circuit is used, each cycle of test is completed before another cycle is started. Where more than one test circuit is used, the circuits under test may be divided into suitable groups. In such cases, any one test circuit may start retesting its group of circuits without waiting for the other test circuits to complete their assignments.

**2.05 Frequency of Test:** The frequency of test requirements gives the minimum and maximum number of cycles of test that may be made in a specified number of working days. The requirements are stated by giving the number of cycles of test, followed by a dash and the number of working days. For example 1-6 means 1 cycle per 6 working days.

**2.06 Troubles:** A trouble is any condition in a circuit which prevents it from responding properly to the test.

**2.07 Discounted Troubles:** Troubles may be discounted when they are definitely located and cleared in the test equipment or in the associated circuits used for test. In the case of additions and changes, troubles may also be discounted when they are definitely located in those parts of the circuit obviously not affected by the additions and changes. Troubles disclosed during testing are charged to the test involved when they are not definitely located or when they are located in the circuit under test.

**2.08 Circuit Failure:** A circuit failure consists of one or more troubles encountered on a circuit which cannot be discounted.

**2.09 Maximum Cumulative Percent Failure:** The maximum cumulative percent failure is the maximum circuit failure percentage permissible during the last required number of cycles of routine test.

**2.10 Permissible Number of Failures over Required Number of Cycles of Test:** The permissible number of failures over the required number of cycles is computed from the following formula where "P" is the maximum cumulative percent failure, "L" is the last number of cycles, and "N" is the number of circuits in the acceptance unit.

$$\text{Permissible Number of Failures} = \frac{P \times L \times N}{100}$$

In making this computation, the following factors are observed.

- (a) If the permissible number of failures is a whole number and a fraction, the fraction is discarded.
- (b) If the permissible number of failures is a fraction, it is considered as one permissible failure unless otherwise specified.

**2.11 Concentrated Load Tests:** These tests involve the direction of simultaneous calls to a specific circuit, part of a circuit, or a group of circuits. These tests are designed to check the ability of a circuit to operate under heavy traffic conditions.

**2.12 Volume Tests:** These tests are made to detect trouble conditions which result when traffic conditions are simulated by originating a large volume of requests for service from a circuit or a combination of circuits.

**2.13 Exercise Tests:** These tests are made to keep the installed equipment in a simulated operating condition until turnover or cut-over. Upon completion of all other testing, exercise tests are sometimes specified.

## B. Transmission

**2.14** Transmission tests on a circuit include measurements of losses, gains, return losses, crosstalk, noise, signal levels, frequency, data copy, etc. The requirements to be met are specified on the circuit drawings or in the individual performance requirement sections. Information on transmission test requirements tables is given in Section 005-121-101.

**2.15 Gain and Loss Tests:** These tests are measurements of gain (amplification) or loss (attenuation) of circuits or apparatus under test.

**2.16 Return-loss tests or singing-point tests** are measurements to determine how good an impedance match has been achieved between two parts of a circuit, for example, between a line facility and its balancing network. Both return loss and singing point are measured in terms of db loss and are functions of the ratio of the impedance of the two parts of the circuit. The better the impedance match, the greater the measured loss.

**2.17 Longitudinal-to-metallic impedance balance** is a measure of the insensitivity of a circuit to induced noise. A high degree of balance is desirable and indicates a close match between the impedance to ground of the two conductors of the metallic circuit.

**2.18 Noise tests** are measurements of the electrical noise in the equipment under test that may affect the quality of signal transmitted.

**2.19 Crosstalk coupling tests** are measurements of the unwanted coupling between two circuits. Crosstalk is expressed in db of coupling loss or crosstalk units.

**2.20 Talking (or tone) tests** are tests made to check the talking path for continuity through various pieces of equipment to a terminating point. A tone between 400 and 1000 cycles is preferred instead of talking. Unless otherwise specified in the individual section, talking tests are made in one direction.

**2.21 Electron Tube Reference Voltage:** The definition of electron tube reference voltage and the method for determining it are covered in Section 024-720-801.

## C. Telegraph and Data

**2.22 Telegraph signal quality tests** are measurements of orientation range, bias, distortion, bias tolerance, bit rate, error rate, clock signal synchronization recovery, etc where the requirement is a specified quality of signal transmission or reception.

**2.23 Orientation range** is the amount, in percent of a signal element, that the time of selection can be shifted, with respect to the incoming start signal, without causing errors to be typed. When the limits of orientation ranges obtained from perfect signals and from signals under test are compared properly, a measure of the quality of signals under test is obtained.

**2.24 Bias** is the displacement of space-to-mark signal element transitions from their proper position in relation to the beginning of the start pulse. It is expressed in terms of percent deviation from the unit pulse width.

**2.25 Marking bias** is a displacement of the space-to-mark transitions so that they occur before their proper positions.

**2.26 Spacing bias** is a displacement of the space-to-mark transitions so that they occur after their proper position.

**2.27 Bias tolerances** are the amounts of marking and spacing bias that a receiving device will accept without failure.

**2.28 Center of bias tolerance** is the setting of a receiving device at which it will accept equal amounts of marking and spacing bias without failure.

**2.29 Total distortion** is the summation of the jitter, bias distortion, and other forms of distortion which may combine to affect the quality of telegraph signals. It is indicated by a telegraph transmission measuring set as a percent deviation from the unit pulse width.

**2.30 Peak distortion** is the largest total distortion of signals noted during a period of observation.

**2.31 End distortion** is a displacement of mark-to-space signal element transitions from their proper position in relation to the beginning of the start pulse.

**2.32 Marking end distortion** is a displacement of the mark-to-space transitions so that they occur later than their proper positions.

**2.33 Spacing end distortion** is a displacement of the mark-to-space transitions so that they occur earlier than their proper positions.

**2.34 Fortuitous distortion** is a random distortion of signals such as that commonly produced by interference.

**2.35 Delay distortion** is that form of distortion which occurs when the rate of change of phase shift with frequency departs from linearity over the required transmission band of a circuit or system. It is normally expressed in units of microseconds.

**2.36 Attenuation distortion** is that form of distortion which occurs when the attenuation with frequency departs from its lowest or constant value over the required transmission band of a circuit or system. It is normally expressed in units of db.

### 3. REQUIREMENTS

#### A. General

**3.01 Alarms and Safety Equipment:** A check shall be made to insure proper operation of all office alarms (audible and visual) and other safety devices.

**3.02 Test of Test Equipment:** All features of test circuits shall be verified by a supplementary test. However, those features used in

circuit operation test need not be duplicated. The test equipment may be supplemented by Western Electric Company test equipment when making equivalent tests.

**3.03 Apparatus Covers:** Unless otherwise specified in the individual sections, performance requirements shall be met with all covers of apparatus in place.

**3.04 Continuity tests** shall be made on all wiring run by the installer which is not tested by the circuit operation, transmission, or other tests. It is permissible to make continuity tests before inspection requirements covered in applicable sections have been met. On circuits with optional wiring, a check shall be made that the specified wiring is furnished. A proper polarity check (visual or electrical) shall be made of all electrolytic capacitors, diodes, transistors, etc. During installation, when pairs, quads, or other grouping are indicated, the grouping should be verified.

**3.05** The test equipment used to make continuity tests on circuits containing transistors, diodes, dry-reed relays, electrolytic capacitors, etc should not have an open circuit voltage or a short-circuit current exceeding the rated voltage or current of the component under test.

**3.06** Other precautionary notes on semiconductors such as transient voltages, mechanical shock, etc may be obtained from the "Western Electric Guide in Use and Handling of Transistors and Diodes" and Section 032-173-301.

**3.07 Fusing:** A test shall be made to verify all fusing, including a test of its associated battery and ground wiring for freedom from opens and crosses. Verification shall insure the proper location, designation, capacity, and type of each fuse. The responsibility for the above requirements lies with the organization (manufacturing or installation) that wires and installs the fusing and its associated equipment.

**3.08 Grounds:** One of the most important considerations from a noise and protection standpoint is the proper routing of circuit

ground buses, ground leads, and frame or cabinet ground connections. Grounds should be checked against the appropriate system drawing and in addition the following should be complied with.

- (a) A check shall be made to insure that commercial service is in accordance with the National Electric Code. It is important that the neutral lead not be ground except at the main service entrance.
- (b) A check shall be made on equipment using commercial power that neither side of the input cord (except the ground lead on 3-wire cords) is connected to its chassis or framework.
- (c) A check should be made that the ground bar is connected to the office ground supply and that continuity exists.
- (d) A check shall be made to insure that protection grounding is provided and in accordance with Section 802-001-180.

**3.09 Contact Protection:** A test shall be made of all contact protection and surge absorption features. This test shall consist of an electrical check and visual inspection to determine that:

- (a) The proper network is present (visual or electrical)
- (b) The network is properly wired into the circuit (electrical)
- (c) All components of the network are neither shorted, crossed, nor opened (electrical)

The word **network** in (a), (b), and (c) means a coded network unit or capacitor, resistor, inductor, diode, etc, individually or in combination forming a protection circuit. Noninductive resistors which are part of assembled coils and inductors which are part of network units used for contact protection purposes may be disregarded in meeting (c). The responsibility for the above requirement rests with that organization (manufacturing or installation) that installs and wires the networks to the unit.

**3.10 Plug-In Units:** A visual check shall be made to determine that all plug-in apparatus or equipment is properly located and

seated in its assigned position. Before seating or removing any apparatus or equipment, special care should be taken that this is done in accordance with the system drawing or special procedures.

**3.11 Parts Shipped Loose:** A check shall be made that parts or components that are shipped loose are of the proper type and number and are properly installed.

**3.12 Test of Shielded Connections:** On field assembled and wired equipment, continuity of all wiring to apparatus cores, apparatus cases, apparatus and equipment shields, and to the shields on shielded wiring shall be checked to insure that the circuits are properly connected and wired in accordance with wiring diagrams or circuit schematics and the requirements specified in the general equipment requirement sections in this series of practices covering wiring requirements. Where the connection is at more than one point on the apparatus or shielded wire, each point shall be verified by visual inspection.

**3.13 Wiring of Repeating Coils:** When transmission tests are made on field assembled and wired repeating coils, verification shall be made to see that the line and drop windings are connected properly to the external circuit.

**3.14 Safeguarding Against Permanent Magnetization of Apparatus:** Care shall be exercised when testing circuits or apparatus containing coils, mercury contact relays, square loop cores, ferrite sheets, etc which may be permanently injured through magnetization by direct or excessive alternating current. Ordinary direct current buzzers and similar testing equipment shall not be used for making continuity tests on these equipments.

**3.15 Circuit Operation Tests:** All features for which equipment is provided shall be checked for proper operation as covered by the circuit drawings and circuit descriptions. When test equipment is supplied in the office for performing a test, the equipment under test shall be tested for all features that can be checked by the test equipment unless otherwise specified.

**3.16 Routine Tests:** Routine tests shall be made within the frequency specified in the sections covering specific requirements during acceptance cycles for each routine. The maximum cumulative percentage requirements shall be met at the time of turnover to the telephone company.

**3.17 Supplementary Tests:** Equipment shall meet the requirements for supplementary tests by the time of turnover to the telephone company. Where specified, the interval between the time of turnover to the telephone company and the time that the supplementary test requirements have been met shall not exceed the specified length of time.

**3.18 Repeat Tests:** Repeat tests shall be run on a circuit after a failure is encountered and the trouble condition is cleared. Tests shall also be made on adjacent circuits where these are involved.

**3.19 Routine Tests Under Two or More Conditions:** When more than one condition of test can be obtained by operating keys, the test equipment shall be operated under each condition approximately equal periods of time. Where these conditions are automatically changed by the test equipment, it will not be necessary to operate the corresponding keys.

**3.20 Use of Standard Test Equipment:** Standard test equipment, or its equivalent if either is available, shall be used for making the circuit operation test specified in the individual performance requirements sections.

**3.21 Performance of Routine Tests Without Test Equipment:** Where no maintenance testing equipment is available for performing a routine test specified in an individual performance requirement section, operating tests shall be made on the circuits at the same frequency as the routine tests and, in addition, a current flow check shall be made of those relays which work through an external circuit as a supplementary test shortly before turnover to the telephone company.

**3.22 Concentrated load tests** shall be performed and shall meet the requirements as specified in the individual sections. All troubles encountered shall be cleared.

**3.23 Volume tests** shall be performed as specified in the individual sections. All troubles encountered shall be cleared.

**3.24 Exercise Tests:** All troubles disclosed during exercise tests shall be cleared and recorded.

## **B. Transmission**

### **General**

**3.25** Transmission tests shall be performed on all circuits which contain transmission requirements on its associated schematic and in other supplementary information. On shop assembled equipment and unless otherwise specified, only 1000-cycle tests shall be made by the installer prior to turnover.

**3.26** On modifications of and additions to existing equipment, transmission tests shown in transmission requirements tables and transmission notes on circuit drawings shall be made as outlined above on all circuits containing transmission apparatus (except as specified below) where transmission apparatus is added, removed, or changed or where it is probable that crosses, opens, grounds, or other wiring trouble would be introduced into the circuit in making the modification. Transmission tests shall not be made on modifications of circuits which do not affect either the transmission apparatus or the wiring. It will not be necessary to make loss tests of individual pieces of apparatus unless the transmission test requirements for the overall circuit are not met.

**Exception:** On circuits using apparatus rated "Manufacture Discontinued" for which loss limits are not covered on the circuit drawing, transmission tests need not be made.

**3.27 Stability for Transmission Tests:** Unless otherwise specified in the individual sections, all units containing electronic apparatus shall have a warm-up period (in their normally operated position) of at least 15 minutes prior to transmission tests.

**3.28 Measuring Equipment:** When transmission tests are made as specified in the transmission requirements tables and transmission notes on circuit drawings and other sup-

plementary information, the requirements shall be met using test equipment as specified in the BSPs or standard J test equipment or its equivalent. Unless otherwise specified, transmission tests imply the use of 600-ohm test equipment.

### **3.29 Return-Loss and Singing-Point Tests:**

When return-loss and singing-point tests are specified on circuit drawings, the return loss test shall be made if return-loss measuring equipment is available. Singing-point tests shall be made only when return-loss measuring equipment is not available. Singing-point requirements given in terms of gain refer to the gain of the repeater at 1000 cycles.

### **3.30 Allowance for Losses in Wiring, Cords,**

*Etc:* In most cases, transmission test requirements shown on circuit drawings do not include losses in switchboard wiring, switchboard cords, test circuits, relay and key contacts, etc. Allowances of 0.1 db, 0.2 db, 0.3 db, etc, should be made to compensate for losses in the conductors between frames, repeating coil racks, switchboard positions, etc. The allowances shall be based on actual measurement of the circuit or of representative circuits with the transmission apparatus removed.

**3.31** Where the limits for one test are specified in terms of another test, both test shall be made under similar conditions.

**3.32 Changes in Wiring or Apparatus:** If wiring or apparatus in the transmission circuit is changed after transmission tests are made, it will be necessary to repeat the transmission tests. On shop assembled and shop tested equipment, changes in wiring or apparatus in the transmission circuit shall be followed by the transmission tests for field assembled equipment.

### **C. Telegraph**

#### **General**

**3.33** Telegraph signal quality requirements shall be met at time of turnover on all central office telegraph equipment.

**3.34 Total Distortion Tests:** Bias, peak, or total distortion tests shall be made with a telegraph transmission measuring set such as

the 118, 119, 164, or the 900 series or equivalent. The circuit under test shall meet the limits specified in the individual performance requirements section.

**3.35 Bias Tests:** Bias tests shall be made preferably with a bias measuring set using reversals. If a bias measuring set is not available, a 118, 900 series, or equivalent type transmission measuring set may be used.

## **4. CONDITIONAL REQUIREMENTS**

### **A. Service Adjustments**

**4.01** Some performance requirement sections of this series of practices specify service adjustments. These are transmission measurements coupled with corresponding adjustments of the transmission circuit. A set of requirements is specified for each type of line facility with which the equipment may be used. These tests are not intended to impose additional or more severe requirements on the equipment. On installations where these tests have been specified by the telephone company, it is necessary for them to furnish to the installer data concerning the type of line facilities to be used with each circuit under test.

### **B. Trouble Location Tests (Transmission)**

**4.02** Some performance requirement sections of this series of practices and some transmission test requirement tables specify trouble location tests. These tests are transmission tests of individual pieces of apparatus or of portions of the transmission circuit. The Individual Apparatus Losses shown in the transmission test requirement tables are also trouble location tests. It is not necessary for the Western Electric installer to make these trouble location or individual apparatus tests unless the circuit fails to meet the overall transmission tests. These requirements are provided as an aid in detecting faulty apparatus and meeting overall test requirements.

**4.03 Individual Apparatus Losses:** The connections of apparatus to the transmission measuring set shall be the same (with the exception of tests on capacitors) as is used in the respective transmission circuits. For example, series-connected apparatus shall be tested in series and shunt-connected apparatus shall be

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tested in shunt. Unless otherwise specified, all capacitors shall be tested in shunt regardless of their connection in the respective transmission circuits.

**5. TEST REPORTS AND RECORDS**

**5.01** All reports shall show the state, city, office, and order number and shall have the proper approval.

**5.02 *Test Reports of Tests Other Than Routine Tests:*** At the time of turnover a report of all tests, other than routine tests (5.03), shall be furnished to the telephone company. These reports shall be furnished to the Quality Assurance Center of the Bell Telephone Laboratories, Incorporated as required. This report shall show the following information.

- Date of test
- Name of test
- Circuit
- Number installed
- Number of troubles found

**5.03 *Routine Test Reports:*** At the time of turnover, a report showing the following information for each completed and partial cycle of routine test, shall be furnished to the telephone company and to the Quality Assurance Center of the Bell Telephone Laboratories, Incorporated, as required.

- Date of test (daily)
- Name of routine
- Frequency of test — Min — Max
- Maximum cumulative percentage failure over last-cycles

Permissible number of failures over last-cycles

Number of circuits installed

Number of circuits tested (daily)

Number of circuit failures (daily)

Number of circuit failures for each completed cycles

Number of circuit failures over last number of cycles

**5.04 *Special Test Reports***

(a) The requirements for reports of measurements to be made available for inspection by the customer at the time of turnover and the requirements for reports of measurements to be turned over to the local representative of the telephone company in the offices where the equipment is installed are specified in the performance requirement sections covering specific requirements. A copy of each report shall be furnished to the Quality Assurance Center of the Bell Telephone Laboratories, Incorporated, as required.

(b) A report of all service adjustment test measurements shall be turned over to the local representative of the telephone company in the office where the equipment is installed. A copy of each report shall be furnished to the Quality Assurance Center of the Bell Telephone Laboratories, Incorporated, as required.

**5.05 *Detailed Record of Test Troubles:*** The detailed records of all test troubles together with their causes, when found, shall be furnished to the Quality Assurance Center of the Bell Telephone Laboratories, Incorporated, as required.