Bellcore
Bell Communications Research

Bellcore Practice
BR 314-645-500
Issue 4, January 1991

DS-1 HIGH-CAPACITY DIGITAL SERVICE

MAINTENANCE AND TEST PROCEDURES

BR 314-645-500
Issue 4, January 1991

Produced by Project 422241, part of the End-to-End Transmission and Performance Product.

DS-1 HIGH-CAPACITY DIGITAL SERVICE MAINTENANCE AND TEST PROCEDURES

CONTENTS PAGE

1.0 INTRODUCTION

1.01 This practice, intended primarily for use by Operations personnel, contains maintenance and test procedures for initial turnup and trouble isolation on DS-1 (1.544 Mb/s) digital high-capacity services.

1.02 This BR is being reissued for the following reasons:

- To merge the material formerly in BR 314-645-300 into a single practice.
- To reflect the use of a DS-1 connector ("smart jack") at the customer's premises.
- To show the channel service unit (CSU) at the customer's premises as being customer-premises equipment (CPE).
- To incorporate the "access" version of DS-1 service and Integrated Services Digital Network (ISDN) primary-rate access.
- To add material on clear-channel capability (CCC) and bipolar-with-eight-zeroes-substitution (B8ZS) coding.
- To convert the test requirements into a form not tied to a specific test set.
- To add "stress" testing.
- To perform general modernization.

Since this is a complete reissue, arrows to show changes are omitted.

1.03 Related practices for design and installation of these services are as follows:

BR 314-645-100	DS-1 High-Capacity Digital Service - Overall Description
BR 880-610-100	DS-1 High-Capacity Digital Service - Engineering Considerations
BR 855-351-100	Digital Carrier Systems - Application of B8ZS Coding
BR 365-800-500	Digital Carrier Systems - Verification Tests for B8ZS Capability

1.04 As described in detail in BR 314-645-100, DS-1 high-capacity service is an all-digital, point-to-point private line. It may be used for intraLATA applications, including access lines for ISDN and Switched Multimegabit Data Service (SMDS). It is also used widely for access from an interexchange carrier (IC) terminal to a customer's location. This BR provides maintenance and trouble-sectionalization information for this service. It includes the responsibilities of the operations centers in maintaining service. It also covers maintenance of the optional service functions of automatic protection switching, central office multiplexing, and transfer arrangement.

2.0 OPERATIONS CENTERS

2.01 Operations centers such as the Special Service Center (SSC), the Serving Test Center (STC), the Switching Control Center (SCC), the Network Terminal Equipment Center (NTEC), the Facility Maintenance and Administration Center (FMAC), the Digital Service Node (DSN), and the Maintenance Center (MC) are involved in maintaining DS-1 service. Centers with similar functional descriptions may assume their responsibilities.

A. SSC/STC/DSN Responsibilities

2.02 The plant control office (PCO) has overall responsibility for the provision and maintenance of DS-1 circuits. If there are multiple SSCs/STCs on the circuit, one will be designated as the PCO. For most DS-1 circuits, the PCO operates in an off-line mode, relying upon test assistance by the FMAC or Serving Wire Center (SWC) test group. Where a suitable remote test system is available, the Special Service Center may perform remote testing, as for voicegrade special services. The PCO and serving bureau (SVB) responsibilities for DS-1 digital services are defined in practice 660-005-011. They include the following:

- Act as the customer's contact in receiving trouble reports.
- Initiate repair action on failed circuits.
- Contact the local FMAC (for unattended central offices [COs]), SWC work group (for attended COs), or SSC to request test assistance. (Some FMACs have facility work groups with CO responsibilities.)
- Track repair actions.
- Receive notification of repair.
- Notify the customer of repair.
- Close out the trouble report.

2.03 For circuits on which there is an on-line DSN or STC, this DSN/STC usually serves as PCO. The SSC/STC/DSN, FMAC, and MC must act promptly in order to meet the specifications of circuit availability for intraLATA services.

2.04 The off-line SVB is responsible for notifying the appropriate center upon receipt of a customer trouble report. When the customer reports the trouble condition, several questions should be asked. These are as follows:

- Are you (the customer) receiving data?
- If so, does it contain solid errors, a high ratio of errors, or an alarm indication signal (all ones)?
- On a service using Extended Superframe format, is there an indication of high Cyclic-Redundancy-Check (CRC) errors?
- Which direction of transmission is faulty?
- What time of day and for how long has the trouble occurred?
- Have you (the customer) checked the CPE?
- What self-tests have been performed?

B. Trouble Reporting - Central Office Multiplexer

2.05 The SSC responsible for the DS-1 service may not be the center receiving the customer trouble report. The SSC responsible for the DS-1 service should question either the customer or the referring center. Necessary information, beyond questions in 2.04, is the following:

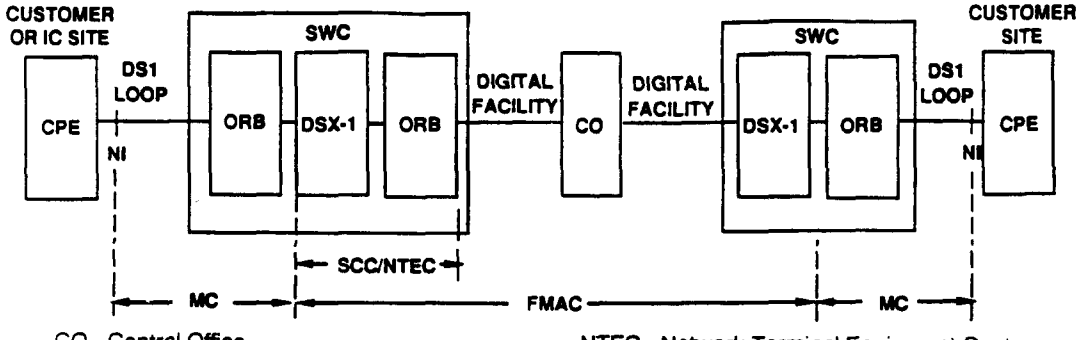
- Are there any alarms present on the CPE?
- Is the trouble confined to one or a few individual channels or does it appear to be on the entire group assigned to the DS-1 circuit?

C. Trouble Reporting - Transfer Arrangement

2.06 When this service function is provided on the DS-1 service, the SSC needs the following additional information:

- Does the trouble exist in both positions of the transfer key or in just one?
- If the trouble is in just one position, which branch appears to be at fault?

2.07 The FMAC is the center responsible for providing and maintaining interoffice facilities as shown in Fig. 1. In COs that lack an FMAC, the NTEC or SSC will assume its responsibilities. The FMAC has the following responsibilities:



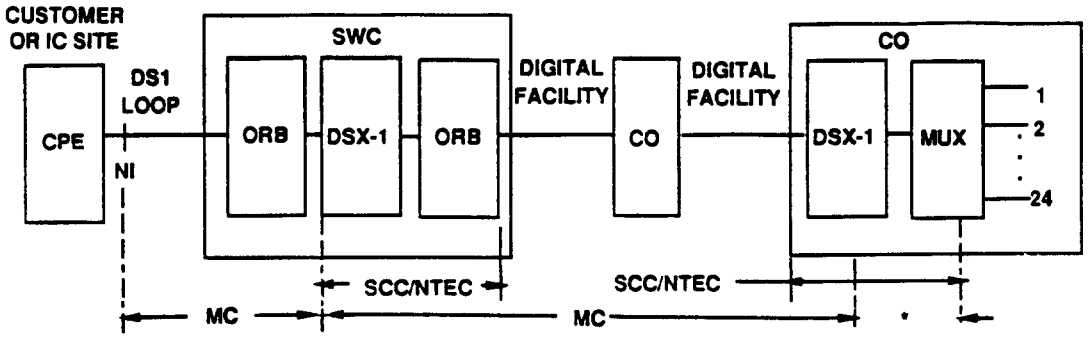
CO - Central Office
DSX-1 - Digital System Cross-Connect, Level 1
CPE - Customer Premises Equipment
FMAC - Facility Maintenance and Admin. Center
MC - Maintenance Center
NTEC - Network Terminal Equipment Center
ORB - Office Repeater Bay
NI - Network Interface
SCC - Switching Control Center
SWC - Serving Wire Center

Fig. 1 - Circuit Routing and Operations-Center Repair Responsibilities

- Provide test assistance to the local SVB for testing interoffice facilities.
- Perform remote testing if the local FMAC has remote test capability.
- Inform SVB of test results.
- Dispatch a work group to repair the facility and restore service if the interoffice test results are bad.
- Notify the SVB of restored service.

D. **Facility Maintenance Responsibilities - Central Office Multiplexer**

2.08 The provision and maintenance of digital equipment in central office locations are the responsibilities of the SCC/NTEC. (In some instances FMAC may be assigned this responsibility.) For DS-1 circuits with the CO multiplexer function, the responsible centers for the maintenance of the DS-1 equipment in the CO are shown in Fig. 2. Responsibilities of the FMAC for DS-1 service with the multiplexer function are as follows:



CO - Central Office
DSX-1 - Digital System Cross-Connect, Level 1
CPE - Customer Premises Equipment
FMAC - Facility Maintenance and Admin. Center
Mux - Multiplexer (Channel Bank or DCS)
* May be assigned to FMAC

NI - Network Interface
NTEC - Network Terminal Equipment Center
ORB - Office Repeater Bay
SCC - Switching Control Center
MC - Maintenance Center
SWC - Serving Wire Center

Fig. 2 - CO Multiplexer and Operations-Center Repair Responsibilities

- Provide test assistance to the local SVB.
- Identify common troubles in accordance with SVB identification or alarms from the CO multiplexer, and then perform the following:
- Monitor the circuit on a bridging basis, using a physical DSX connection or a remote test system as available. If the channel uses superframe (SF) format, check for framing-bit errors and code violations. If it operates with Extended Superframe (ESF) format, check for framing-bit errors and CRC errors.
- Loop back the interface to the CPE to separate most of the possible customer troubles from network troubles. Note that if the interface device does not include a loopback feature and the CPE fails, the loopback test will give the same result as a network failure.

- If trouble is indicated in the network, loop back the CO multiplexer to separate CO and span troubles.
- Depending on the results of this test, repair either the facility or the multiplexer and ensure loopbacks have been restored.
- Notify the SVB when service is restored.

2.09 If the trouble has been identified by the SSC as affecting an individual circuit, perform the following:

- Test the appropriate multiplexer channel unit or digital cross-connection system (DCS) cross-connect.
- If the channel unit tests bad, replace it and notify the SVB.
- Notify the SVB that no trouble was found if unit tests good or the cross-connection is valid.

E. Facility Maintenance Responsibilities - Transfer Arrangement

2.10 For DS-1 circuits with the transfer arrangement (shown in Fig. 3), the SCC/NTEC is responsible for the maintenance of the DS-1 equipment shown in Figs. 1 and 2. Responsibilities of the SCC/NTEC are as follows:

- Provide test assistance to the local SVB.
- Obtain remote test access or dispatch a tester to the CO associated with the suspected circuit, branch, or backbone to perform a loopback test.
- Notify the SVB of test results.

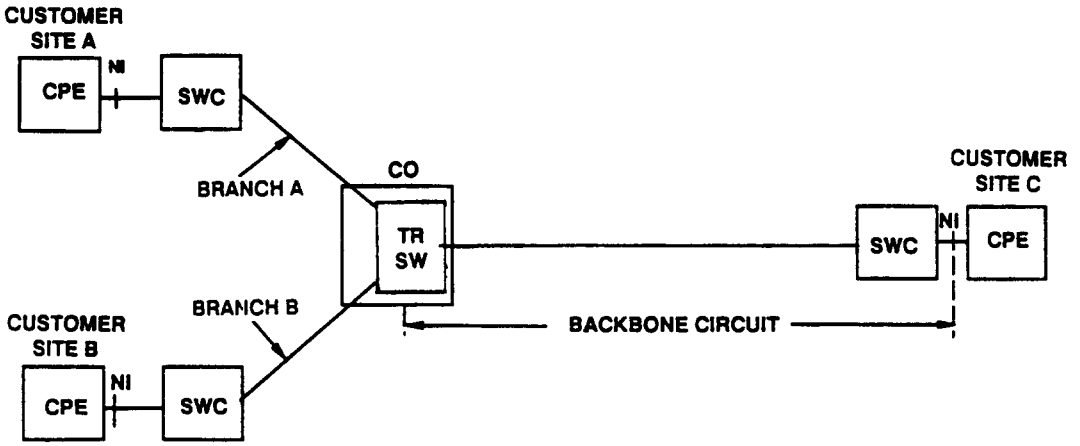


Fig. 3 - Transfer Arrangement

2.11 The Maintenance Center has the following responsibilities:

- Receive SVB trouble referrals.
- Verify that a loop trouble exists.

- Isolate and repair loop troubles.
- Notify the SVB of the repair.

2.12 If an MC does not exist, a Repair Service Bureau (RSB) or FMAC will perform the above tasks in accordance with the local responsibilities for repair of digital loop carrier systems.

F. Facility Maintenance Responsibilities - Automatic Protection Switching (APS)

2.13 When the APS function, diagrammed in Fig. 4, is provided to the serving CO, the MC monitors the alarms on the switch unit and responds to them.

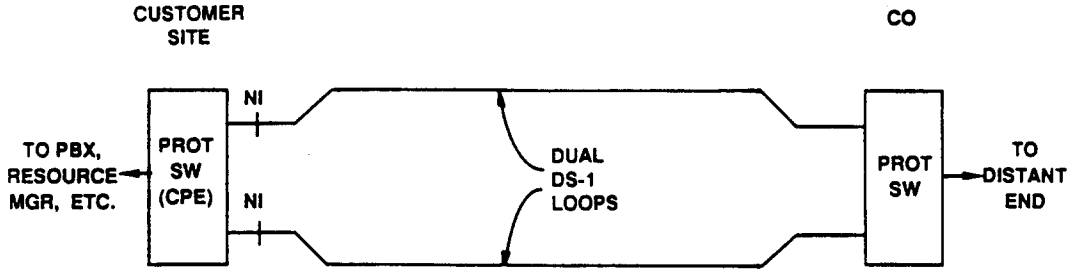


Fig. 4 - DS-1 Service with Automatic Protection Switching

3.0 TROUBLE SECTIONALIZATION TECHNIQUES

3.01 The basic maintenance plan is to isolate troubles to the loop (fiber or T1 span) or the interoffice facilities (T1/T1C span, fiber, or radio). After the customer has reported the trouble to the SVB, the SVB will coordinate trouble sectionalization and coordinate repair of the failed circuit.

3.02 To determine whether the circuit is in trouble or which part of the DS-1 circuit has failed, the SVB will request test assistance. First it should be determined if there are remote or on-line STC testing capabilities. If there are, that office or center should be contacted for sectionalization testing. The outcome of this testing determines what further sectionalization is required. The office or center should report the test results and/or trouble clearance to the SVB receiving the trouble.

3.03 If there is no remote test access available and/or local-loop testing is required from the serving central office, the appropriate center or CO work force should be contacted. The majority of this work activity will be assigned to the NTEC or SCC personnel. In metropolitan areas where there is a full-time facility work group (FWG) reporting in a central office, the FMAC will be assigned this work activity as shown in Figs. 1 and 2. The CO work force should first test the loop via test access. For older circuits with separate loopback control circuits, this is the CO where the loopback control is terminated and where suitable interoffice communications and equipment are available. The loopback relay requires a minimum of 20 volts and 15 mA to operate. For later installations with digitally controlled loop-

back, testing may be done from any DS-1 access point on the circuit, either a DSX-1 bay or a digital cross-connect system.

3.04 Test access for the loop is at the DSX-1 or the office repeater bay (ORB). If the loop tests bad, the responsible CO test group should notify the SVB, who then refers the trouble to the MC. If the loop tests good, the responsible CO test group calls the SVB with the test results.

3.05 If the loop tests bad, the responsible far-end CO test group will request the MC to repair and restore the service. If the loops test good and it appears that interoffice facilities are in trouble, the control FMAC will be contacted for further test and analysis. If no trouble is found on the loops and end-to-end testing by the facility-control FMAC reflects no trouble in the interoffice facilities, the SVB notifies the customer.

3.06 A series of monitoring and loopback tests have been devised to aid in trouble isolation. These tests include monitoring for absence of pulses; bipolar violations (BPVs); framing-bit errors; and, on ESF signals, CRC errors. They provide for making error-ratio measurements with a DS-1 test set.

Service Functions

3.07 The three service functions, APS, CO multiplexer, and transfer arrangement, require modification of the trouble-sectionalization methods outlined above for the basic DS-1 service. However, in all three cases, added maintenance features result from the additional equipment or the configuration of the service function.

Automatic Protection Switching

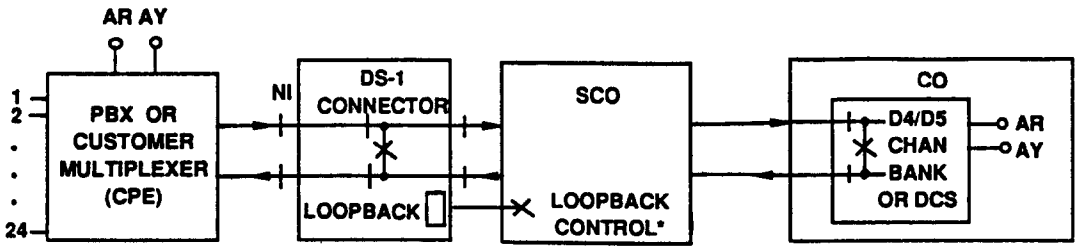
3.08 The basic maintenance plan for DS-1 service is modified when automatic protection switching is applied since the loop portion of the circuit is monitored by the APS equipment. Therefore, sectionalization of the loop portion equipped with an APS is not required. However, cooperative end-to-end tests of the CO and CPE switches may be required with the customer's personnel.

CO Multiplexer

3.09 For DS-1 circuits with the CO multiplexer function, the multiplexer must be isolated in addition to the loop or interoffice facility, if used. This maintenance complication is offset by the fact that only one end of the circuit terminates on the customer's premises and the alarms are an integral part of the D-type channel bank or digital cross-connection system as shown in Fig. 5. Both the customer and the exchange carrier have access to information at their ends from alarms: red (AR) and yellow (AY).

Transfer Arrangement

3.10 For DS-1 circuits with the transfer arrangement, the transfer point can be used to sectionalize the trouble to either of two branches or to the backbone circuit as shown in Fig. 3. If ambiguous test results occur, it may be necessary to determine whether the failure is in the DS-1 facilities or in the control system (private-



*Loopback controlled from office that has circuit control.

Fig. 5 - Central-Office Multiplexer Configuration

line or dial-in) used to operate the transfer switch.

4.0 MAINTENANCE

A. General

4.01 DS-1 circuits can be grouped into two configurations: without and with interoffice facilities. The basic maintenance plan is to isolate digital service troubles to the loop or the interoffice facility.

4.02 When loop trouble is indicated by loopback tests, fault location can be performed from the CO on spans that have fault-locate lines. Otherwise a tester must be dispatched to the customer premises with equipment to troubleshoot the T1 repeatered facility from the customer premises to the CO. Where the loop uses a channel on a high-capacity fiber system, extended to the customer's premises via a T1 repeatered span, it may be necessary to dispatch to the intermediate fiber terminal to sectionalize.

4.03 The isolation and repair of T1 repeatered spans follow normal practices. However, restoration often differs from standard procedures. In particular, the usual procedure for restoring service on a failed T1 interoffice span is to patch in a maintenance line. If the trouble is isolated to a loop span, however, the actual cause of the trouble must be identified and cleared before service can be restored unless a spare has been provided.

B. Circuit Arrangements

4.04 When long-haul facilities are part of the digital service, normal maintenance procedures apply. Such facilities include a channel on a fiber system, a T1 outstate (T1OS) protected span, a channel on a T1C system, or a channel on digital radio.

4.05 The SVB test access is usually the DSX-1 jacks but may be miscellaneous jacks extended from the DSX-1 bay and mounted in a frame in one of these test centers. Test access may also be via a DCS. The on-line STC must have direct circuit test access. The DS-1 test access arrangement must meet engineering requirements for cable restrictions and for equal-level testing. This may require the construction of intraoffice T1 spans using special intraoffice repeaters or extended cross-connect

package (EXCP) repeaters. Some offices, especially those with large amounts of digital loop carrier, have separate "loop" and "interoffice" DSX bays.

C. CPE for DS-1 Digital Service

4.06 The CPE may have several features to aid in remote testing of the loop. All such units have a loopback (LB), which loops the signal input from the network after passing through the receiving circuitry of the CPE. Because the receiving circuit may remove bipolar violations, test results may be distorted.

4.07 The LB is controlled by one of two methods, depending on the type of CPE: (a) a separate pair of wires, the remote test control pair, or (b) a repetitive bit pattern on the T1 bit stream.

4.08 The remote test control pair, used on early-vintage channel service units (CSUs) that were generally provided by the exchange carrier, is used to activate the LB by applying dc current. The pair should be extended and terminated on the DSX-1 or DS-1 test access frame at a staffed location with testing responsibility, but within dc range limits.

4.09 If the LB is activated by a repetitive code, the DS-1 test set generates the code on the DS-1 channel to activate or deactivate the LB. For services using SF format, the LB is activated by a five-second application of a repeated five-bit code, 00001. The LB is released by a five-second application of a repeated three-bit code, 001. The code should be framed, but need not be, to match older test sets.

4.10 For services intended to use the ESF format, loopback is controlled by ESF data-link messages. Command to activate an ESF loopback of a CSU is a 16-bit message sent at least 10 times, 11111111 01110000, with the leftmost bit sent first. The command to deactivate is 11111111 00011100. (Some existing ESF equipment uses nonstandard, proprietary loopback codes.) The LB allows testing of the loop and the critical circuitry of the CSU. The test procedures are specified below. The exchange carrier is responsible for maintaining the loop, but its maintenance responsibility ends at the network interface (NI). The CPE is maintained by the customer as usual.

4.11 In early-vintage CPE, the line loopback (LLB) with regeneration and the loopback (LB) without regeneration may be activated over a remote-test control pair. The polarity of the current in the control pair selects the desired function. The LLB is an option; not all CPE has it.

4.12 Fault locating may be done from the serving central office. If there is an LLB in the CPE, single-ended fault location is possible from the CO. If there is no LLB, a exchange-carrier employee must be dispatched to the customer premises to provide a loopback or fault-locate signal.

D. "Smart Jack" at the Network Interface

4.13 DS-1 circuits of current vintage may include an interface unit, a DS-1 Connec-

tor, at the customer premises. It provides minimum test features, specifically a code-controlled test loopback. This LB disconnects all customer-premises cable and the CSU, returning the test code to the STC.

4.14 Out-of-service loopback testing to the DS-1 Connector may be done to sectionalize trouble between the network and the customer installation. In some companies, the DS-1 connector is always optioned for ESF, regardless of how the service is framed; testing is always with ESF. In others, the DS-1 connector framing is optioned to agree with the service frame pattern, or the connector may adapt to the pattern it receives. Local instructions will give details. Loopback codes for the DS-1 connector are as follows:

Framing Option	Activate	Deactivate
SF	11000	11100
ESF	11111111 00101000	11111111 00100100

The patterns are sent with the leftmost bit first. SF codes are to be transmitted for at least five seconds. ESF codes are to be sent on the ESF data link a minimum of 10 times.

E. Service Functions

Automatic Protection Switching

4.15 Maintenance of the APS function is covered in the practices appropriate to the specific unit, for example 365-200-504 or 365-250-110. The APS generally operates on a loss of signal, a degraded signal, or the results of ESF monitoring. Where clear-channel capability (CCC) via B8ZS is not used, it also monitors the line signal for bipolar violations (BPVs). The APS usually provides a visual indication of switch status at the switch location.

Diverse Routing and Special Facilities

4.16 In a few cases, the customer has ordered route diversity for the spare line, and has been billed special-construction charges for the special span. In these cases, the WORD document will include the notation CRD (Customer-Requested Diversity). Diversity must be maintained at all times except for emergency service-restoration facilities.

4.17 In other cases, the exchange carrier is offering fiber-only service. In these cases, service restoration must be solely via fiber facilities.

CO Multiplexer

4.18 Two classes of trouble are likely to occur with the CO multiplexer function: common DS-1 troubles and per-circuit (per-DS0) troubles. Common DS-1 troubles can be caused by any part of the DS-1 circuit between the CO multiplexer and the customer interface, in the CO multiplexer's common equipment, or in the CPE (cabling, CSU, PBX, "T1 resource manager," or multiplexer). The per-circuit troubles are associated with per-circuit equipment in a channel bank, usually the chan-

nel plug-in, or with a cross-connection in a DCS (CO or CPE). In any case of trouble, the initial effort should be to isolate multiplexer troubles from connecting-circuit troubles. Connecting-circuit troubles can be diagnosed from methods given in 1.13 above.

Common DS-1 Failures

4.19 An error ratio of about 10^{-3}, or a complete transmission failure, will cause alarms at both the CO channel bank and the customer's terminal. A complete discussion of channel-bank functions and alarms is given in practice 365-170-100. Following is a brief description of the more important channel-bank alarm functions. At the alarm control unit (ACU) of the channel bank, the red AR alarm lights from an incoming failure, while the yellow AY alarm lights from an alarm signal received from the far-end terminal. The yellow-alarm signal is sent automatically from any terminal that has a red alarm. Either of these alarms initiates trunk processing, such as disconnecting calls, stopping billing, and making circuits busy. By observing the alarms at the CO channel bank and operating the channel-bank looping function and the CPE loopback, the circuit can be sectionalized. This sectionalization will isolate the trouble to the customer equipment, the channel bank, or the DS-1 circuit facilities.

4.20 To sectionalize a trouble on a DS-1 service that uses the CO multiplexer function requires additional isolation effort. For example, if an AR lamp is lighted, the SCC should direct the following work:

- Have a tester at the CO multiplexer location perform loopback tests at the channel bank. Loop back the channel bank by operating the three-position key switch on the ACU to the loop-terminal (LT) position (or, on "smart" banks, typing a loop-terminal command from the keyboard). If the channel bank is the trouble source, the red AR lamp on the ACU will be lighted. If the channel bank is faulty, clear the fault and repeat the loopback. If the channel bank is clear (loopback indication is good and the red AR lamp is out), place the channel bank in the line-loop (LL) mode by operating the three-position key on the ACU to the LL position.
- Operate the loopback unit at the customer's premises. A red AR light on the ACU indicates a trouble on the digital line or the CPE. If the digital line is faulty, repair and repeat these tests.
- If both the LT and LL loopback indications are good (the red AR lamp is out), the trouble is in the customer's equipment.

4.21 For central-office multiplexing performed via a DCS, comparable procedures apply. The DS-1 port card on the DCS may have the AR/AY lamps. If not, the maintenance display for the DCS frame gives the same information.

Per-Channel Failures

4.22 The per-channel troubles traced to the DS-1 service with the CO multiplexer function are usually incorrect DCS cross-connections or channel-unit problems. A

suspected voice channel unit can be tested using the maintenance bank. Under manual switch control, the maintenance bank test set will check channel units for proper tone transmission, signaling, unwanted interference, trunk processing and 20-Hz ringing detection.

4.23 A data channel unit can be checked by substituting a known good unit. The options on the replacement (error corrction, etc.) should be set correctly.

4.24 Faulty voice channel units should be replaced with units tested with the maintenance bank or the channel access unit as described in practice 365-170-100. Where a single-channel trouble occurs on a DS-1 service that terminates in a DCS in the CO or at the customer's premises, the first check is to assure that channel cross-connections through the DCS, and related options like signaling, are set correctly. For example, a DS0 channel carrying a 56 kb/s digital data circuit may be capable of passing data, but not control bits, if the DCS is misoptioned.

4.25 The test-access function of the DCS allows splitting and monitoring access; so do DS-1 test sets that intercept one channel in the DS-1 bit stream. If the trouble isolates to the customer's equipment, local policy on billing maintenance-of-service charges applies.

Transfer Arrangement

4.26 The transfer switch provides a sectionalization aid as shown in Fig. 3. If the DS-1 circuit operates normally when Branch A is active, then Branch B is faulty, and vice versa. If the DS-1 circuit has trouble in both switch positions, then the backbone portion of the circuit is probably faulty. After the branch or backbone circuit in trouble has been isolated, restore service by following the methods described in 3.02.

B8ZS-Related Troubles

4.27 Where the service is ordered for B8ZS operation, a failure that removes B8ZS capability may cause a high error ratio on the DS-1 service or its individual channels, a high rate of impulse noise or C-notched noise on individual channels, or intermittent loss of framing too short to cause an alarm. The same type of failure will cause the channel to deliver the B8ZS signature pattern containing ones, instead of all zeroes, when no signal is applied at the far end. BR 365-800-500 gives fuller details on these troubles, which result from B8ZS signals entering a (non-B8ZS) terminal set up for bipolar (alternate-marks-inverted) operation or vice versa.

4.28 It is possible for a customer whose DS-1 service is provided entirely on T1 spans to change terminals so that they use B8ZS coding. If the circuit is later rearranged to use fiber facilities, the customer's equipment may go into trouble unless the channel units on the fiber multiplexers are set up to pass B8ZS.

4.29. It is recommended that, where a B8ZS-equipped service is involved, designation cards on DSX-1 frames be marked with the full designator (e.g., 77 HCZA 12345, 77 IPZC 12345, 7006 T1Z, etc.) so that maintenance personnel know to ex-

pect a B8ZS signal.

General

4.30 The overall trouble clearance routine for DS-1 digital service is given in flowchart form in Fig. 6. This is a generalized flow; local practices may provide more specific instructions.

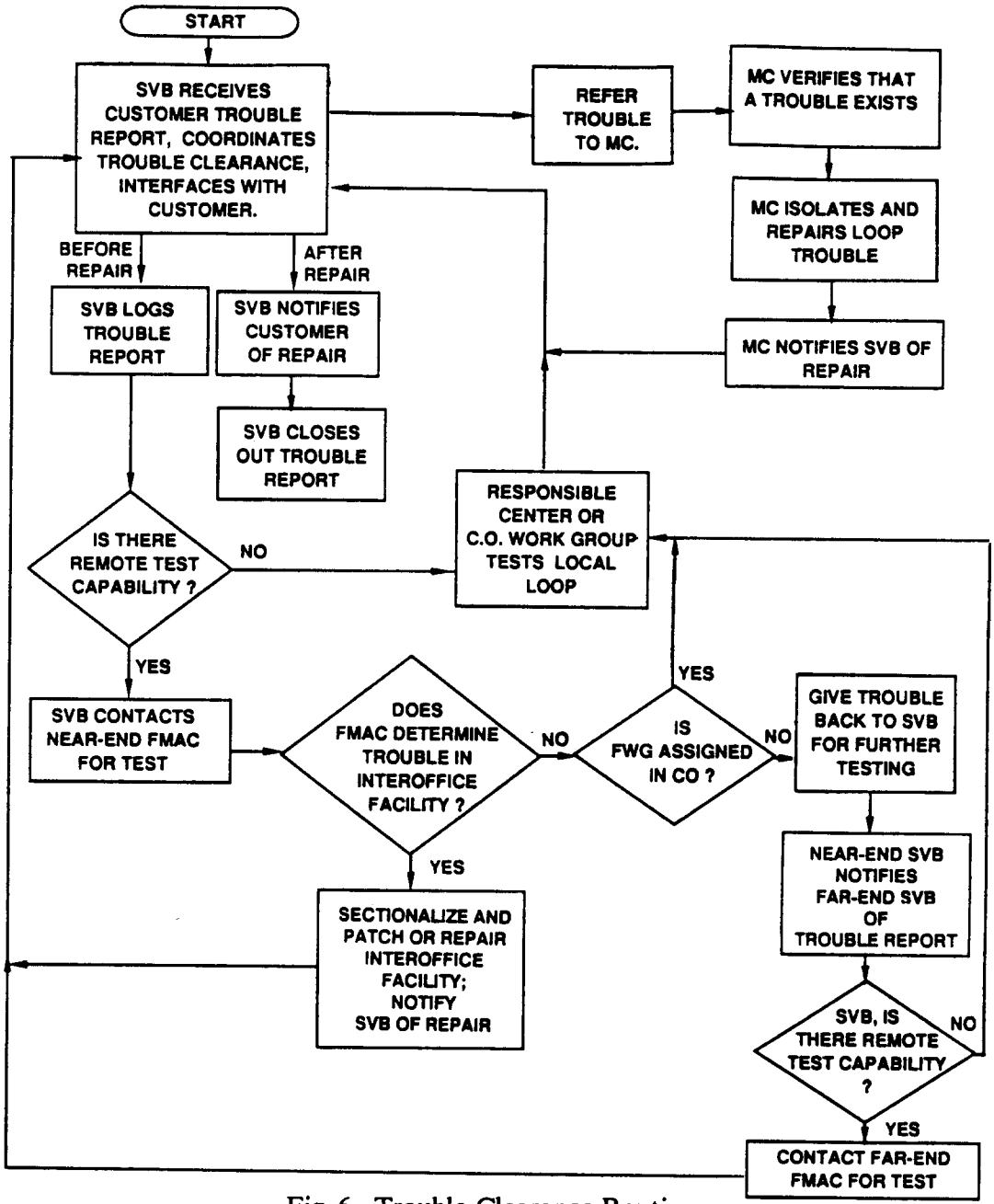


Fig. 6 - Trouble-Clearance Routine

5.0 TEST PROCEDURES

5.01 Fig. 7 shows an example of the near-end of a digital service facility with the digital service node (DSN) patched for testing. Access from a remote test system gives the same result. In order to verify that a test set is working normally, a self-testing procedure should be performed before use. If the self-test is not automatic, the operating instructions or the test menu on the set will give this procedure.

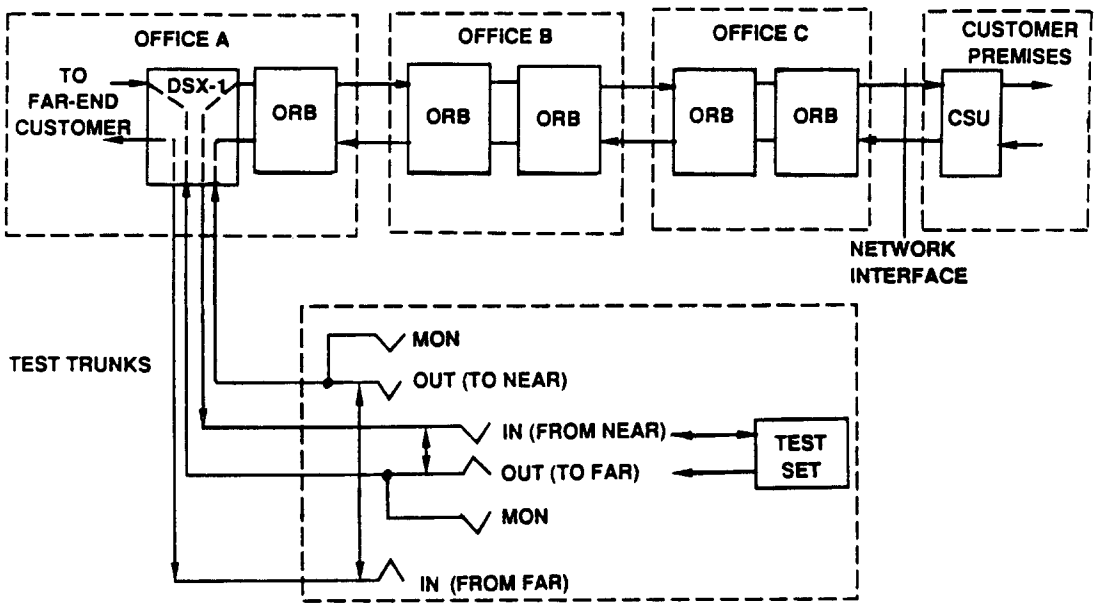


Fig. 7 - DS-1 Circuit, Patched for Testing

Initial Lineup Tests

5.02 The initial lineup tests assume that the interoffice facilities and loop fiber systems, if used, and T1 spans have been tested and turned up according to normal procedure. Local practices may require use of the Digital Data System qualification test in practice 365-228-500 before turning up service.

5.03 The initial test for DS-1 digital service is performed from the DSX-1 or other jack access point using the error-ratio test set. The basic procedure is to perform a DS-1 error test to the near-end of the facility with the far-end DSX-1 monitoring the output of the interoffice facility (if used). The far-end of the facility is tested in the same manner.

5.04 The initial acceptance test requires that three 15-minute tests be performed, with at least one of them being performed during the busy part of the day. Results in all three 15-minute periods should meet the ES limit. The objectives are being met if the errored-second count does not exceed the following figures at either

DSX-1: for intraLATA services, 80 ES; for LATA-access services (ordinary and ISDN), 20 ES; for ISDN PRA lines, 5 ES.

- If one of the 15-minute measurements exceeds the limit, repeat one run.
- If this run meets the limit, accept the facility.
- If all three tests fail, repair the facility or change assignments.
- If two tests fail, repeat three 15-minute runs and follow the above procedure again.

5.05 The basic procedure is as follows:

- Monitor for pulses and, on a non-B8ZS service, bipolar violations (Chart 1) at the control DSX-1.
- If the requirements of the monitoring tests are not met, use the trouble-isolation flowchart (Fig. 6) to locate the trouble.
- Perform a 15-minute error test from the control DSX-1 to the near-end station. At the same time, the DSX-1 at the far-end should monitor the output of the interoffice facility, if used, to determine its performance.
- Repeat the above procedures for the far end of the facility with the control DSX-1 monitoring the output of the interoffice facility.
- If the errored-second count is exceeded at the far end, repeat the test.

For trouble-reporting purposes on LATA-access services, the immediate-action limit is 60 ES in a five-minute period.

Monitoring Test

5.06 Monitoring of DS-1 digital service facilities is accomplished using the error test set as given in Chart 2. This test determines if pulses are present on the facility and if unwanted bipolar violations (BPVs) are occurring in the pulses. For services using B8ZS coding, a test set is needed that can recognize the B8ZS pattern.

5.07 Monitoring for pulses and BPVs can be done from either direction of transmission. However, all monitoring must be done from the monitor jacks. Care must be taken not to remove signal from a T1 span line except as instructed.

Error-Ratio Tests

5.08 The error-ratio test set is used to determine the performance of a DS-1 digital facility between the DSX-1 and the network interface. The test in Chart 3 is used to determine the performance of a facility between the DSX-1 and the customer premises using an error-ratio test set at the DSX-1.

5.09 A "stress test" is used by some ICs to stress the channel. This test, agreed upon by the Digital Testing Workshop of the Industry Carriers Compatibility Forum, supplements the normal test using a quasi-random signal source (QRSS) test pattern. The pattern is F0100010000000000000000100 for a service using bipolar (alternate-marks-inverted) coding. The test signal should be framed. This code just meets the requirements of an average of least one "1" in every eight bits and no string of zeroes longer than 15. For a service using B8ZS coding, the code is

10000000, which is the longest string of zeroes available. By stressing marginal regenerators, the test helps locate "dribbling-error" problems that cannot be found with the QRSS pattern. They are generally performed on request of the IC, after the circuit has passed the normal test with a QRSS signal, but may be required routinely as a Region policy. *Note*: certain older APS units may not pass the sequence of 15 zeroes.

5.10 The test procedure and error limits are as given in Chart 2.

A. Error Test

5.11 Error tests that are performed in connection with turning up the DS-1 service must be logged in the circuit history file as a benchmark for future reference, such as during trouble isolation.

B. B8ZS Verification Test

5.12 If the DS-1 service is assigned to any facility other than T1 span lines and is intended to provide CCC via B8ZS coding, it is necessary to perform the B8ZS-capability verification in BR 365-800-500. This test assures that DS-1 port cards in high-capacity multiplexers (DS-1-to-DS-3, for example) are of types that support B8ZS coding and are optioned correctly for B8ZS. If CO multiplexing is included, the test verifies the capability of the channel bank or DCS.

C. Automatic Protection Switching

5.13 The initial installation and maintenance tests for the APS function are given in Chart 3, End-to-End T1-Line Qualification Test.

D. Transfer Arrangement

5.14 The initial line installation test for this function should be made for each branch of the overall circuit. Each branch and backbone circuit should be treated as an independent DS-1 circuit.

E. End-to-End Test

5.15 The end-to-end test is used if in-service lines must be tested. The APS test is to be done by performing the tests in Chart 3 if the facilities (T1, T1C) utilize APS equipment for span protection. A looped test can be made using Chart 4.

6.0 CHART PROCEDURES

6.01 This part provides test procedures for the testing of the DS-1 test sets and initial lineup/trouble isolation of the DS-1 digital service.

Chart 1 - Monitoring Test

The apparatus listing for this test is as follows:

- DS-1 error test set
- Cord with plugs (310-type, "bantam," or special) to fit the test set and the DSX-1.

STEP	PROCEDURE
1	Have test trunk from test position patched to digital facility to be tested.
2	Perform the self-test procedure on the error-ratio test set.
3	Set the options on the error set as follows: VIOLATIONS ERROR-SECONDS SYNC MODE to AUTO DISPLAY INTERVAL (SEC) to HOLD COUNT INTERVAL (BITS) to CONT COUNT INTERVAL (MIN) to 0 (zero).
4	Verify that NO DATA, NO SYNC, and SYNC LOSS are indicated.
5	Plug a patch cord from the DS-1 INPUT jack on the test set to the appropriate MON jack. Press the RESET/RESYNC switch.

Requirement 1: The NO DATA, NO SYNC, and SYNC LOSS indications are off. The COUNT indicator is on. If the NO DATA indication remains, signal pulses are absent and a trouble is indicated.

6	With data indicated as being present, observe the display for 10 seconds.

Requirement 2: The display should show 000 errors. If B8ZS coding is being used, the B8ZS indication should be present. If any errors are shown, reset the count and observed the display for another 10 seconds. If the display shows 000 errors, no bipolar violation is present. If, however, errors are shown again, a trouble in the digital facility is indicated.

7	Disconnect the patch cord.

Note: If the test set shows that the B8ZS pattern is present when no signal is being applied at the far end, an intermediate multiplexer is probably optioned incorrectly for ordinary bipolar operation. See BR 365-800-500 for more details.

Chart 2 - Error-Ratio Test to Network Interface

The apparatus listing for this test is as follows:

- DS-1 error test set
- Two cords (310-type, "bantam," or special) to fit the test set and the DSX-1.

The test normally uses a QRSS test code. However, if an IC requests a stress test, the code will be a framed 3-in-24 pattern.

STEP	PROCEDURE
1	Have test trunk and remote test control pair (if used) patched from the test position to the digital facility to be tested.
2	Perform the self-test procedure for the error test set per the manufacturer's instructions.
3	Set the controls on the error-ratio set as follows: ERRORS ERROR-SECONDS PATTERN to QRSS (or 3-IN-24 for a stress test) SYNC MODE to MANUAL SELF TEST to NORMAL DISPLAY INTERVAL (SEC) to HOLD COUNT INTERVAL (BITS) to timer COUNT INTERVAL (MIN) to number of minutes required (5 for trouble isolation or 15 for initial lineup).
4	Verify that NO DATA and NO SYNC are indicated.
5	Plug a patch cord from one of the DS-1 OUTPUT jacks on the test set to the appropriate OUT jack. Plug another patch cord from the DS-1 INPUT jack on the set to the appropriate MON jack. Press the RESET/RESYNC switch.
6	Send the loopback code and observe the returned signal.

Requirement 1: The NO DATA and SYNC LOSS indications are off, and the COUNT indicator is on. If the NO DATA and SYNC LOSS indications remain on, the signal transmitted from the test set is not being returned and a trouble is indicated in the facility.

Requirement 2: If the NO DATA and SYNC LOSS indications are off, any errored seconds in the received signal are counted on the display (see Note 1).

Note 1: During the counting interval, if the number of errors displayed exceeds the limit for the entire counting interval or the OVERFLOW is on, stop the test since a large number of errors is present.

Requirement 3: When the COUNT INTERVAL (MIN) times out (COUNT indication off), the display shows the number of errored seconds. The errored-seconds count is at or below the following figures. See Note 2.

Note 2: In order to have a valid count at the end of the counting interval (COUNT indicator off), all indicators must be off. If any indicator (e.g., SYNC LOSS) is on, the error-ratio test is invalid and must be repeated.

	Installation		Maintenance		
Service	Min.	ES	Min.	ES	Pattern
IntraLATA	15	80	5	240	QRSS
LATA Access - Normal	15	20	5	60	QRSS
Stress Test	5	7	5	60	3-in-24
ISDN LATA Access - Normal	15	20	5	60	QRSS
Stress Test	5	7	5	60	3-in-24
ISDN Primary-Rate Access Line	15	8	5	QRSS	24

Requirement 4: For LATA-access services, the bit-error ratio reads 10^{-7} or less (per Network Operations Forum agreement).

7 For LATA-access and ISDN LATA-access services, run the 15-minute normal acceptance test three times. If the ES count is excessive, up to two retests are permitted.

8 Release the loopback at the NI.

9 Disconnect both patch cords. Record test results in the history file for the circuit.

Chart 3 - End-to-End Qualification Test

The apparatus listing for this test is as follows:

- DS-1 error test set
- Two cords (310-type, "bantam," or special) to fit the test set and the DSX-1.

This test may be performed in one direction of transmission at a time or in both directions at once. For this test, designate one end of the line under test as the transmitting end and the other as the receiving end. If both directions are to be tested simultaneously, omit Step 11. *Note*: some Regions require a 3-in-24 stress test and may also require a power-supply stress pattern.

STEP	PROCEDURE
1	At the transmitting end, apply a framed QRSS test pattern to the circuit.
2	At the receiving end, reset the counter on the test set.
Requirement 1:	Count display is all zeros.
Requirement 2:	POWER and COUNT indicators are on; all others are off.
3	Count the number of errored seconds for a 15-minute period during the business day, preferably during the busy hour.
Requirement 3:	The ES count is not to exceed the turnup limit during the 15-minute period: 45 for intraLATA, 20 for LATA access, 5 for ISDN PRA.
Requirement 4:	All indicators on the test set (except POWER) are off.
4	If the requirements of Step 3 are not met, isolate the malfunctioning facility section (DS-1 channel or span) by repeating Steps 1 through 3 at the receiving end of each span. Locate the trouble within the malfunctioning section according to practice 365-800-002 (for spans).
5	On a protected service, insert errors from the test set toward the facility.
6	Adjust the test set to insert errors slightly below the threshold setting of the switch (for example, 5×10^{-7} if the switch is set to 10^{-6}).
7	Degrade the error-ratio input to a level slightly above the threshold setting of the switch (for example, 5×10^{-6}).
Requirement 5:	service transfers to the protection line.
If the transfer occurs successfully, go to Step 10; otherwise, to Step 8.	
8	Recheck the error threshold setting and components of the APS.
9	Retest the switch.
10	Ensure that a DS-1 signal is being supplied to the line.
11	Repeat Steps 1 through 11 for the other direction of transmission.
12	If the requirements of Step 3 are met, remove all test equipment.

Chart 4 - Looped Line Test

The apparatus listing for this test is as follows:

- DS-1 error test set
- 135-ohm terminating plug (386B or equivalent)
- Patch cord (310-type, "bantam," or special) to match the test set and DSX-1.

STEP	PROCEDURE
1	If the T1 line to be tested is in service, switch traffic to the protection line.
2	Ensure that T1-line qualification tests have been passed, if required locally.
3	Have the line under test looped at the APS at the far end, either by sending the loopback code or by manual means.
4	Terminate the receiving side of the repeater with a 386B plug.
5	Depress RESET/RESYNC.
Requirement 1: Count display is all zeros.	
Requirement 2: POWER and COUNT indicators are on; all others are off.	
6	Count the number of errored seconds for a 15-minute period during the business day, preferably during the busy hour.
Requirement 3: The errored-second count is 45 or less for an intraLATA service, 20 for a LATA access service, or 5 for ISDN primary-rate access.	
Requirement 4: All indicators on the test set (except POWER) are out.	
7	If the requirements of Step 5 are met, remove all test equipment and have the loop removed at the far end.
8	If the requirements of Step 5 are not met, isolate the malfunctioning span by repeating Steps 1-5 with the line looped at the receiving end of each span. Locate the trouble within the malfunctioning span according to practice 365-800-002. *Note*: If it is suspected that the requirement was not met because of an unusual, nonrecurring event such as maintenance work, the line should be retested the next business day.
9	Ensure that a DS-1 signal is being supplied to the line.

7.0 ACRONYMS

7.01 The following terms receive multiple use in this practice.

APS	Automatic Protection Switch
B8ZS	Bipolar with Eight-Zeroes Substitution
BPV	Bipolar Violation
CCC	Clear Channel Capability
CPE	Customer Premises Equipment
CRC	Cyclic Redundancy Check
CSU	Channel Service Unit
DCS	Digital Cross-Connection System
DSN	Digital Service Node
DSX	Digital Signal Cross-Connect
ES	Errored Second(s)
ESF	Extended Superframe
FMAC	Facility Maintenance and Administration Center
IC	Interexchange Carrier
ISDN	Integrated Services Digital Network
LATA	Local Access and Transport Area
MC	Maintenance Center
NI	Network Interface
NTEC	Network Terminal Equipment Center
ORB	Office Repeater Bay
PBX	Private Branch Exchange
PCO	Plant Control Office
PRA	Primary-Rate Access
QRSS	Quasi-Random Signal Source
RSB	Repair Service Bureau
SCC	Switching Control Center
SSC	Special Service Center
STC	Serving Test Center
SVB	Serving Bureau
SWC	Serving Wire Center

8.0 REFERENCES

8.01 The following practices, in addition to those listed in 1.03 above, provide more detailed information.

365-170-100	D4 Channel Bank - Description
365-200-100	Digital Transmission Systems - T1 Digital Line - General Description
365-228-500	Digital Data System Qualification Test - T1 Digital Line - Digital Transmission Systems