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DS3 HIGH-CAPACITY DIGITAL SERVICE
MAINTENANCE AND TEST PROCEDURES

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**DS3 HIGH-CAPACITY DIGITAL SERVICE
MAINTENANCE AND TEST PROCEDURES**

1. GENERAL

1.01 This practice, intended primarily for use by Operations personnel, contains maintenance and test procedures to be used for initial turnup and trouble isolation on DS3 (44.736 Mb/s) digital high-capacity services.

1.02 When this BR is reissued, reasons for the reissue will be given here.

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

Overall Description
Engineering Considerations
Carrier engineering - B8ZS coding
Carrier operation - B8ZS verification test

1.04 The basic DS3 (44.736-Mb/s) high-capacity service is an all-digital, point-to-point private line as described in detail in BR 314-647-100. This BR provides maintenance and trouble sectionalization information for the basic service. It also gives information for the optional service function of central office multiplexing. It includes the responsibilities of the operations centers in maintaining DS3 circuits.

1.05 Operations centers such as the Special Service Center (SSC), the Switching Control Center (SCC), the Network Terminal Equipment Center (NTEC), the Facility Maintenance and Administration Center (FMAC), and the Maintenance Center (MC) are involved in maintaining DS3 service. Centers with similar functional descriptions may assume their responsibilities.

A. Special Service Center/Serving Test Center (STC)/Digital Service Node (DSN) Responsibilities

1.06 The plant control office (PCO) has overall responsibility for the provision and maintenance of DS3 circuits. If there are multiple SSCs/STCs on the circuit, one will be designated as the PCO. For most DS3 circuits, the PCO operates in an off-line mode, relying upon test assistance by the FMAC or Serving Wire Center (SWC) test group. The PCO and serving bureau (SVB) responsibilities for DS3 digital services include the following:

- (a) Act as the customer's contact in receiving trouble reports.
- (b) Initiate repair action on failed circuits.
- (c) If remote test capability is available, sectionalize and/or isolate trouble.
- (d) Contact the local FMAC (for unattended central offices [COs]) or SWC work group (for attended COs) to request test assistance. (Some FMACs have facility work groups with CO responsibilities.)
- (e) Track repair actions.

- (f) Provide updates to customer as to status of trouble..
- (g) Receive notification of repair.
- (h) Notify the customer of repair.
- (i) Close out the trouble report.

1.07 For circuits on which there is an on-line DSN or Serving Test Center, this DSN/STC will usually serve as PCO. The DSN/SSC/STC, FMAC, and MC must act with minimum delay in order to meet the specifications of circuit availability.

1.08 The off-line SVB is responsible for contacting 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:

- (a) Are you (the customer) receiving data?
- (b) If so, does it contain a high rate of errors, solid errors or an alarm indication signal?
- (c) Which direction of transmission is faulty?
- (d) What time of day and for how long has the trouble occurred?
- (e) Have you (the customer) checked the customer premises equipment (CPE)?
- (f) What self-tests have been performed?

B. Facility Maintenance Responsibilities

Central Office Multiplexer

1.09 The SSC responsible for the DS3 service may not be the center receiving the customer trouble report. The SSC responsible for the DS3 service should question either the customer or the referring center. These questions should be asked in addition to those in 1.08 to determine the following:

- (a) Are there any alarms present on the CPE?
- (b) Is the trouble confined to one or a few DS1 channels or does it appear to be on the entire group assigned to the DS3 circuit?

1.10 The FMAC is the center responsible for providing and maintaining interoffice facilities, as shown in Figs. 1 and 2. In areas that lack an FMAC, the NTEC or SSC will assume the responsibilities of an FMAC. The FMAC has the following responsibilities for DS3 digital services:

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

- (e) Notify the SVB of restored service.

1.11 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, as shown in Figs. 1 and 2.)

1.12 For DS3 circuits with the CO multiplexer function, the responsible center for the maintenance of the DS3 equipment in the CO and described in paragraph 1.10 is shown in Fig. 2. Responsibilities of the FMAC for DS3 service with the multiplexer function are as follows:

- (a) Provide test assistance to the local SVB
- (b) Identify common troubles in accordance with SVB identification or alarm status of the CO multiplexer and then perform the following:
 - (1) Monitor the circuit via the DSX-3 monitor jacks or a remote test system if available. If the DS3 circuit uses the M13 format, check for Bipolar Violations (BPVs) and frame bit errors. If the DS3 circuit uses the C-bit parity format, check for C-bit parity errors, Far-End Block Errors (FEBE) as well as BPVs and frame bit errors.
 - (2) Loop-back the interface to the CPE to separate possible customer troubles from network troubles (if loop-back is available).
 - (3) If item 2 indicates trouble in the network, loop back the CO multiplexer to separate CO and facility troubles.
 - (4) Depending on the results of item 3, repair either the facility or the multiplexer and ensure loopbacks have been removed.
 - (5) Notify the SVB when service is restored.
- (c) If the trouble has been identified by the SSC as affecting an individual DS1, perform the following:
 - (1) Patch to spare facility or backbone, if available.
 - (2) Test the appropriate multiplexer port card or digital cross-connection system (DCS, EDSX, B-DCS, or W-DCS) cross-connect.
 - (3) If the port card tests bad, replace it and notify the SVB.
 - (4) Notify the SVB that no trouble was found if unit tests good or the cross-connection is valid.

1.13 The Maintenance Center has the following responsibilities for DS3 digital services:

- (a) Receive SVB trouble referrals
- (b) Verify that a DS3 facility trouble exists
- (c) Isolate and repair DS3 troubles
- (d) Notify the SVB of the repair.

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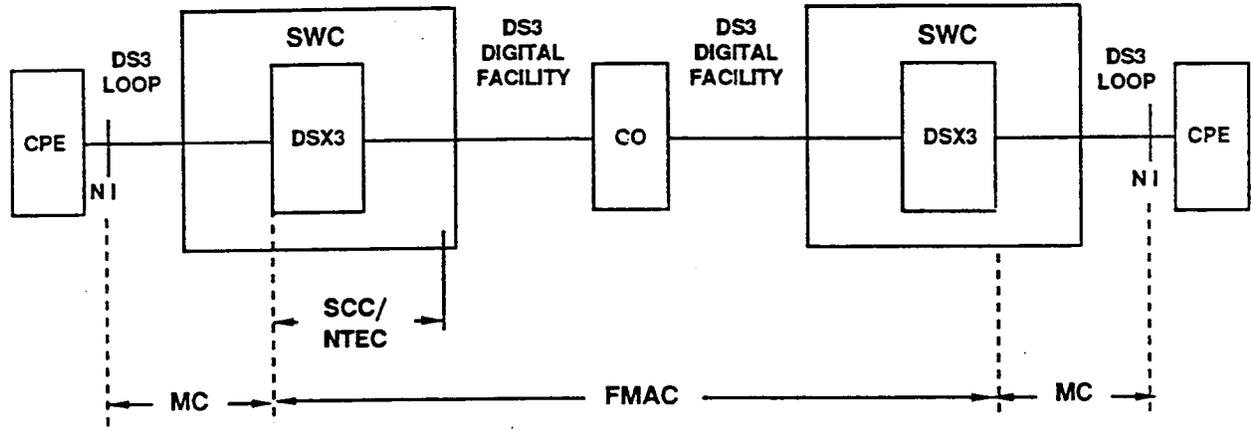


Fig. 1 - Circuit Arrangement and Operations Center Repair Responsibility

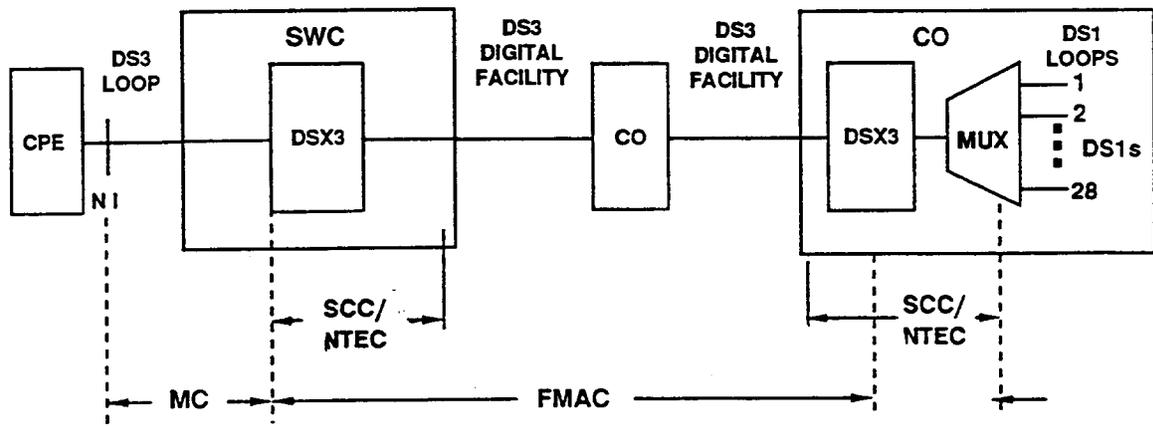


Fig. 2 - Multiplexer Arrangement and Operations Center Repair Responsibility

- LEGEND:
- CPE - Customer Premises Equipment
 - DSX-3 - Digital Service Cross Connect (Level Three)
 - FMAC - Facility Maintenance and Administration Center
 - NTEC - Network Terminal Equipment Center
 - MC - Maintenance Center
 - MUX - Multiplexer
 - NI - Network Interface
 - SCC - Switching Control Center
 - SWC - Serving Wire Center
 - * - May be Assigned to FMAC

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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 high-capacity digital systems.

2. Trouble Sectionalization Methods

2.01 The basic maintenance plan is to isolate troubles to the fiber loop or the interoffice facilities if used. After the customer has reported the trouble to the SVB, the SVB will coordinate trouble sectionalization and coordinate repair of the failed circuit.

2.02 To determine whether the circuit is in trouble or which part of the DS3 circuit has failed, the SVB will request test assistance as shown in Fig. 3. First it should be determined if there are 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 results of the test and/or trouble clearance to the SVB receiving the trouble.

2.03 If 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 DS3 facility via test access.

2.04 Test access for the DS3 facility is at the DSX-3 monitor jack. If the DS3 facility tests bad, the responsible CO test group should notify the SVB, which then refers the trouble to the MC. If the DS3 facility tests good, the responsible CO test group calls the SVB with the test results.

2.05 If the DS3 facility tests bad, the responsible far-end CO test group will request the MC to repair and restore the service. If the local fiber loops test good and it is suspected that interoffice facilities are in trouble, the control FMAC will be contacted for further test and analysis based on the alarm indications available to it. If no trouble is found on the DS3 facility and end-to-end testing by the facility-control FMAC reflects no trouble in the interoffice facilities, the SVB notifies the customer.

2.06 A series of monitoring and loopback tests have been devised to aid in trouble isolation. These tests include monitoring for pulses and BPVs and making error-rate measurements with a DS3 test set.

Central Office Multiplexer

2.07 The CO-multiplexer service functions requires modification of the trouble-sectionalization methods outlined above for the basic DS3 service. However, added maintenance features result from the additional equipment.

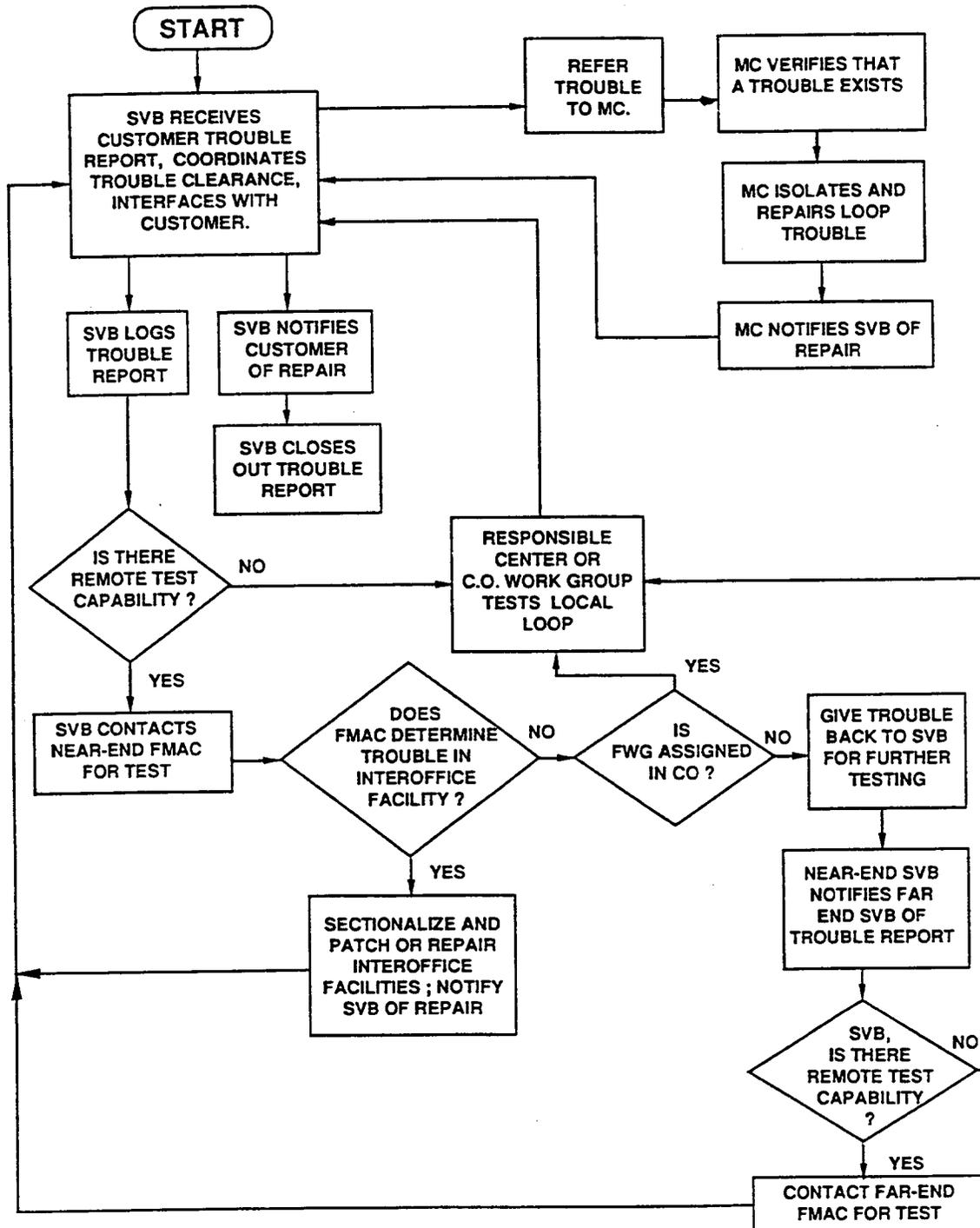


Fig. 3 - Flowchart of Trouble-Isolation Routine

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2.08 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 multiplexer or digital cross-connection system.

2.09 Three classes of trouble are likely to occur with the CO multiplexer function: common DS3 troubles, failures that affect groups of four DS1 channels (e.g., 1 to 4, or 25 to 28), and single-DS1 troubles. Common DS3 troubles can be caused by any part of the DS3 circuit between the CO multiplexers and the customer interface, in the CO multiplexer's common equipment, or in the CPE (cabling, or multiplexer). Problems affecting four channels at a time are generally associated with conversion from DS3 to DS2 level within the multiplexer, e.g. quad-port packs. Single-DS1 troubles are associated with per-DS1 port plugins in a multiplexer converting from DS2 to DS1 level, 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 Section 1.12.

Common DS3 Failures

2.10 Severe error rates, or a complete transmission failure, will cause alarms at both the CO multiplexer and the customer's terminal.

2.11 Following is a brief description of the more important alarm functions. The DS3 "Blue Signal" is also known as the Alarm Indication Signal (AIS). It is generated on the output of the DS3 facility during a loss of input signal. When a DS3 terminal (multiplexer, DCS, etc.) detects AIS, it will generate a Far-End Out-of-Frame (FEOOF) or "Yellow Alarm." The FEOOF signal is sent automatically from any terminal that has a local or "Red Alarm". All of these alarms will initiate trunk processing, such as disconnecting calls, stopping billing, and making circuits busy. By observing the alarms at the CO multiplexer and operating the DS3 terminal looping function and the CPE loopback, the circuit can be sectionalized. This sectionalization will isolate the trouble to the customer equipment, the multiplexer, or the DS3 circuit facilities.

2.12 To sectionalize a trouble on a DS3 service that uses the CO multiplexer function requires additional isolation effort. For example, if an Red Alarm is indicated, the SCC should direct the following work:

- (1) Dispatch a tester to the CO multiplexer location to perform loopback tests.
- (2) Loop back the multiplexer. If it is the trouble source, the Red Alarm will be lighted.
- (3) If the multiplexer is faulty, clear the fault and repeat (2).
- (4) If the multiplexer is clear (loopback indication is good and the Red Alarm is out), place a DS3 test set on the DS3 channel at the DSX-3 cross-connect panel looking toward the customer.
- (5) Loopback the DS3 terminal at the customer's premises. A Red Alarm on the DS3 terminal indicates a trouble on the digital line or the CPE.

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- (6) If the digital line is faulty, repair and repeat (4) and (5). If loopback indications are good (the Red Alarm is out), the trouble is in the customer's equipment.

2.13 For central-office multiplexing performed via a DCS, comparable procedures apply. The DCS may have the alarm lamps. If not, the maintenance display for the DCS frame gives the same information.

CPE for DS3 Digital Service

2.14 The CPE may have several features to aid in remote testing of the loop. Depending upon the format of the DS3 facility, the CPE may or may not have a loopback (LB). The loopback loops the signal input from the network after passing through the receiving circuitry of the CPE. Because the receiving circuit removes bipolar violations, test results may be distorted.

2.15 A test loopback normally requires a manual patch at the network interface unless the DS3 facility uses the C-bit parity format. Then the LB is activated by a repetitive code that the DS3 test set generates. The LB is activated or deactivated by a two-octet codeword transmitted 10 times followed by 10 repetitions of the appropriate two-octet DS3 or DS1 line codeword. More detailed information can be found in Section 7 of TA-TSY-000342.

2.16 The LB allows testing of the fiber loop. The exchange carrier is responsible for maintaining the fiber loop, but its maintenance responsibility ends at the network interface (NI). The CPE is maintained by the customer as usual.

3. MAINTENANCE

A. General

3.01 DS3 circuits can be grouped into two configurations: without and with interoffice facilities. The basic maintenance plan is to isolate digital service troubles to the fiber loop(s) or the interoffice facility.

3.02 When loop trouble is indicated by loopback tests, an exchange-carrier employee must be dispatched to the customer premises with test equipment to troubleshoot the 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 DS3 span, it may be necessary to dispatch to the intermediate fiber hub to sectionalize.

B. Circuit Arrangements

3.03 When interoffice facilities are part of the digital service, normal maintenance procedures apply. Any suitable digital facility may be used, such as a channel on a fiber system or a channel on digital radio (DR). The SVB test access is usually the DSX-3 monitor jacks themselves but may be miscellaneous jacks extended from the DSX-3 bay and mounted in a frame in one of these test centers. The on-line STC must have direct circuit test access. The DSX-3 or the DS3 test access arrangement must meet engineering requirements for cable restrictions and for equal-level testing.

C. Service Functions

Diverse Routing and Special Facilities

3.04 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. For services where only fiber facilities are permitted (service code HL), service restoration should be in accordance with the facility restriction.

Single-DS1 Failures

3.05 The single-DS1 channel troubles traced to the DS3 service with the CO multiplexer function are usually port-card troubles. The suspected card can be tested by forcing a protection switch.

3.06 Where a single-DS1 channel trouble occurs on a DS3 service that terminates in a DCS in the CO or at the customer's premises, the first check is to assure that cross-connections through the DCS are set correctly. The test-access function of the DCS allows splitting and monitoring access; so do DS3 test sets that intercept a single-DS1 channel in the DS3 bit stream. If the trouble isolates to the customer's equipment, maintenance-of-service charges generally apply.

3.07 The overall trouble clearance routine for DS3 digital service is given in flow-chart form in Fig. 3.

B8ZS-Related Troubles

3.08 Where the DS3 service is ordered for B8ZS operation on the DS1 channels, a failure that removes B8ZS capability may cause any of the following troubles:

1. A high error rate on the individual DS1 channels.
2. A high rate of impulse noise or C-notched noise on individual voice channels.
3. Intermittent loss of framing too short to cause an alarm.

The same type of failure will cause the DS1 channel to deliver the B8ZS signature pattern of 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 conventionally equipped (non-B8ZS) terminal or vice versa.

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3.09 It is recommended that, where a B8ZS-equipped DS1 service is involved, designation cards on DSX-3 frames be marked with the full designator (e.g., 77 HFZA 12345, 7006 T3Z, etc.) so that maintenance personnel know to expect a B8ZS signal.

4. TEST PROCEDURES

4.01 Figure 4 shows an example of the near-end of a digital service facility with the digital service node (DSN) patched for testing.

4.02 In order to ascertain whether a test set is performing within tolerances, 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.

5. INITIAL LINEUP TESTS

5.01 The initial lineup tests assume that the interoffice facilities, fiber loop systems or T3 spans have been tested and turned up according to normal procedure.

5.02 The initial test for DS3 digital service is performed from the DSX-3 cross-connect panel using the error-rate test set. The basic procedure is to perform a DS3 error test to the near-end of the facility with the far-end DSX-3 bay monitoring the output of the interoffice facility (if used). The far-end of the facility is tested in the same manner.

5.03 The initial acceptance test requires that one 40-minute test be performed using Framed Format. If the test results are less than 73 Errored Seconds (ES), accept the service. If the results are greater than 73 ES, perform three additional 40-minute tests. If three out of four test results are less than 84 ES, the DS3 service should be accepted. If three or more tests fail, repair the facility or change assignments. If two tests fail, repeat three 40-minute runs and follow the above procedure again.

5.04 The basic procedure is as follows:

- (1) Monitor for pulses (Chart 1) at the control DSX-3 cross-connect panel. If the requirements of the monitoring tests are not met, use the trouble isolation flowchart (Figure 3) to locate the trouble.
- (2) Perform a 40-minute error test from the control DSX-3 cross-connect panel to the near-end station. At the same time, the DSX-3 cross-connect panel at the far-end should monitor the output of the interoffice facility, if used, to determine its performance.
- (3) Repeat the above procedures for the far end of the facility with the control DSX-3 cross-connect panel monitoring the output of the interoffice facility. If the errored-second count is exceeded at the far end, repeat the test.

5.05 For trouble-reporting purposes on access services, the immediate-action limit is 219 ES in a five-minute period.

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6. PERFORMANCE MONITORING TEST

6.01 Monitoring of DS3 digital service facilities is accomplished using the error test set as given in Chart 1. This test determines if pulses are present on the facility and if errors are occurring in the pulses.

6.02 Monitoring for pulses and BPVs can be accomplished from either direction of transmission. However, all monitoring must be accomplished from the monitor jacks.

7. FACILITY QUALIFICATION (ERROR-RATE) TESTS

7.01 The error-rate test set is used to determine the performance of a DS3 digital facility between the DSX-3 cross-connect panel and the network interface before it is put into service. The test in Chart 2 is used to determine the performance of a facility between the DSX-3 cross-connect panel and the output of the DTE using an error-rate test set at the DSX-3 cross-connect panel.

A. Error Test

7.02 All error tests that are performed in connection with turning up the DS3 service should be logged in the circuit history file as a benchmark for future reference, such as during trouble isolation.

B. B8ZS Verification Test

7.03 If the DS3 service with CO multiplexing is intended to provide CCC via B8ZS coding on the DS1 channels, it is necessary to perform the B8ZS capability verification in BR 365-800-500. This test assures that DS1 port cards in DS1 to DS3 multiplexers are of types that support B8ZS coding and are optioned correctly for B8ZS. The test verifies the capability of the multiplexer or DCS.

C. End-to-End Test

7.04 The end-to-end test is used if in-service lines must be tested. A looped test can be made using Chart 2.

8. CHART PROCEDURES

8.01 This part provides test procedures for the testing of the DS3 test sets and initial lineup/trouble isolation of the DS3 digital service. It assumes that the error-ratio test set has been self-tested per the manufacturer's procedures.

Chart 1 - Performance Monitoring Test

8.02 The apparatus listing for this test is as follows:

- DS3 Error test set
- Cord with plugs (TNC or BNC) to fit the test set and the DSX-3 monitor jacks.

STEP	PROCEDURE
1	Have test trunk from DSN patched to digital facility to be tested.
2	Perform the self-test procedure for the error-ratio test set.
3	Set the options on the error set as follows: <ul style="list-style-type: none">• TEST: TIMED• TEST LENGTH: 00:40 (40 minutes)• FRAMING FORMAT: M13, C-BIT or UNFRAMED• RECEIVE INPUT: DSX
4	Verify that NO DATA, NO SYNC, and NO FRAME are indicated.
5	Plug a patch cord from the DS3 INPUT jack on the test set to the appropriate DSX MONITOR jack. Press the RESET/RESYNC switch. Requirement: The NO DATA, NO SYNC, and NO FRAME indications are off. The COUNT indicator is on. If the NO DATA indication remains, signal pulses are absent and a trouble is indicated.
6	If the data are indicated as present, observe the display for 10 seconds. Requirement: The display should show 000000 errors. If any errors are shown, reset the count and observed the display for another 10 seconds. If the display shows 000000 errors, no Far-End Block Errors (FEBEs) are present. If, however, errors are shown again, a trouble in the digital facility is indicated.
7	Disconnect the patch cord.

Chart 2 - Facility Qualification (Error Rate) Test

8.03 The apparatus for this test is as follows:

- DS3 Error test set
- Two patch cords (with TNC or BNC plugs) to fit the test set and the DSX-3 monitor jacks.

STEP	PROCEDURE
1	Perform the self-test procedure for the error test set per the manufacturer's instructions.
2	Set the controls on the error-ratio set as follows: <ul style="list-style-type: none">• TEST: TIMED• TEST LENGTH: 00:40 (40 minutes)• FRAMING FORMAT: M13, C-BIT or UNFRAMED• TRANSMIT INPUT: DSX• TRANSMIT TIMING: INTERNAL• X-BIT: OFF (Non-alarm state)• ERROR TYPE: LOGIC or BOTH• PATTERN: Set for any normal DS3 test pattern ($2^{23} - 1$, etc.)
3	Verify that NO DATA, NO SYNC and NO FRAME are indicated.

STEP	PROCEDURE
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4 Plug a patch cord from one of the DS3 OUTPUT jacks on the test set to the appropriate DSX-3 INPUT jack. Plug another patch cord from the DS3 INPUT jack on the test set to the appropriate DSX-3 OUTPUT jack. Press the RESET/RESYNC switch.

5 At the far end DSX-3 frame, install a loopback on the appropriate DS3 facility.

Requirement 1: The NO DATA, NO SYNC and NO FRAME indications are off, and the COUNT indicator is on. If the NO DATA, NO SYNC and NO FRAME indications remain on, the test pattern transmitted by the test set is not being returned. A trouble in the facility is indicated.

Requirement 2: If the NO DATA, NO SYNC and NO FRAME indications are off, any Far End Block Errors (FEBEs) in the received signal are counted on the display (see Note 1). When the test times out, the display shows the number of FEBEs. See Note 2.

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

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

Requirement 3: The ES count is at below the following figures for errored seconds.

Service	Installation		Main-tenance
	Minutes	ES	5 min
IntraLATA	40	84	252
LATA Access - Normal	40	73	219

6 Release the loopback at the NI. Disconnect both patch cords. Record test results in the history file for the circuit.

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9. ACRONYMS

9.01 The following terms receive multiple use in this practice.

B3ZS	Bipolar with 3 Zero Substitution
B8ZS	Bipolar with Eight-Zeroes Substitution
BPV	Bipolar Violation
CPE	Customer Premises Equipment
DCS	Digital Cross-Connection System
DSN	Digital Service Node
DSX	Digital Signal Cross-Connect
EFS	Error-Free Second(s)
ES	Errored Second(s)
ESF	Extended Superframe
FMAC	Facility Maintenance and Administration Center
FWG	Facility Work Group
IC	Interexchange Carrier
LATA	Local Access and Transport Area
MC	Maintenance Center
NCI	Network Channel Interface
NI	Network Interface
NTEC	Network Terminal Equipment Center
PBX	Private Branch Exchange
PCO	Plant Control Office
RSB	Repair Service Bureau
SCC	Switching Control Center
SF	Superframe
SSC	Special Service Center
STC	Serving Test Center
SVB	Serving Bureau
SWC	Serving Wire Center
CCC	Clear Channel Capability

10. REFERENCES

10.01 The following practices provide more detailed information.

PRACTICE	TITLE
BR 314-647-100	DS3 High-Capacity Digital Service—Overall Description
BR 365-800-500	Digital Carrier Systems—Verification Tests for B8ZS Capability
BR 855-351-190	Digital Carrier Systems—Application of B8ZS Coding
BR 880-612-100	DS3 High-Capacity Digital Service—Engineering Considerations

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