DS-1 FACILITY TURNUP ACTIVITIES DIGITAL DATA SYSTEM

CONTENTS PAGE

1. GENERAL

1.01 ▶This section includes activities for the turnup of a DS-1 facility used in the Digital Data System (DDS). Emphasis is placed on the long-haul facility data under voice (DUV) and on the short-haul facility T1 digital line since these are currently the primary facilities as used in DDS.◀

1.02 This section is reissued for the following reasons:

(a) Add information on the newly approved short-haul and long-haul faciliteis (Tables A and B)

(b) Add turnup activity information to Fig. 3

(c) Add information on facility acceptance criteria

(d) Add glossary to section.

Revision arrows are used to emphasize the more significant changes.

1.03 A DS-1 facility, as defined for DDS use, consists of two ▶hub office digital system cross-connects (DSX-1) terminals connected by a 1.544-Mb/s digital transmission line. Various equipment is connected to the DSX-1 cross-connects to provide different services. For DATAPHONE®Digital Service, equipment such as T1 data multiplexers (T1DMs), T1WB4 data-voice multiplexers (T1WB4s), or T1WB5 data-voice multiplexers (T1WB5s) are used. Also, the D3B or D4B channel banks, equipped with dataport channel units, may be used in place of the DDS multiplexers in the hybrid office application. Dataport channel units are also used in a SLC* 96 Subscriber Loop Carrier System to provide DATAPHONE Digital Service.

1.04 Between digital serving areas (DSAs), a single long-haul DS-1 facility is used or several long-haul facilities are used in tandem (composite digroup facility). At present, the 1A Radio Digital System (1A-RDS) is the primary long-haul facility, also called DUV.◀ The 1A-RDS is equipped with 1A radio digital terminals (1A-RDTs) which converts a 1.544-Mb/s digital signal to a form suitable for transmission over microwave radio. For DUV, the long-haul DS-1 facility always terminates in a T1DM. Other approved facilities for long-haul usage in DDS are listed in Table A.

1.05 Within a DSA, the primary short-haul facility (T1 digital line) terminates in T1DMs, T1WB4s, T1WB5s, D-type channel banks, or SLC 96 system terminals. Other short-haul digital facilities being used in DDS are T1C, T1D, T1/OS, T2, T4M, and digital radio at 6 and 11 GHz (Table B).

1.06 Typical terminating arrangements for a DUV long-haul facility and for T1 lines are shown in Fig. 1 and 2. These terminals are equipped with in-service monitoring arrangements that generate

* Trademark

alarms when an unsatisfactory signal is received. These monitoring arrangements can be used instead of test equipment to determine the acceptability or qualification of a DS-1 facility. A DS-1 facility between T1DMs can be monitored by the Digital Transmission Surveillance System (DTSS). This system is an enhancement to DDS. It provides the means for monitoring the performance of DS-1 digroup facilities used for DDS. The performance information, gathered on a digroup basis, is used to identify trouble in the receive direction of transmission. Preservice testing is recommended on each digital facility for use in DDS which normally uses the KS-20908 and KS-20909 data test sets. The DTSS can be used for acceptability testing where the DS-1 digroup facility terminates in a T1DM.

1.07 Figure 3 provides the activities in flowchart form that are required to turn up a DS-1 facility for service. Figure 4 provides a facility alarm verification test for a DUV facility and a T1 digital line. This test determines whether the terminal equipment is properly connected. The alarm verification test is not required for D-type channel banks or SLC 96 system terminals when using dataport channel units. The absence of alarms after equipment interconnections verifies that the DS-1 facility is functioning properly. The presence of alarms indicates a trouble condition that must be sectionalized according to Section 314-903-300.

1.08 ▶The control of preservice testing for a composite digroup facility is the T1DM office or the wideband test bay location that is listed on the facility order layout record. This entity becomes the facility control office and is responsible for gathering test results from all the offices providing the various facility carrier technologies eg, DUV, etc. The facility control office is also responsible for meeting the preservice requirements of the overall digroup facility.◀

DS-1 SIGNAL ACCESS UNIT

1.09 The DS-1 signal access unit (DSAU) provides full duplex access to a DS-1 signal which facilitates centralized maintenance and testing of the DDS at the DS-0 level. Each DASU is dedicated to a single DS-1 line. Some offices have DSX-1 appearances on both sides of a DSAU. The DSAU provides the following features when used in conjunction with a Bit Access Test System (BATS) or an Automatic Bit Access Test System (ABATS):

(a) Digital data can be monitored at the DS-1 signal level.

(b) Bipolar violation can be detected in the DS-1 signal.

(c) Test codes can be inserted into any one of the channels in the DS-1 multiplexed signal after frame synchronization with the signal has been achieved.

1.10 Additional information on DSAUs is documented in Sections 314-960-100 and 314-960-300. Refer to Section 107-605-100 for a description of BATS and to Section 314-901-520 for a description and operation of ABATS.

T1 LINE PROTECTION

1.11 A protection or standby line for local DDS access is recommended when (1) the working station line is longer than 15 miles, (2) the working line carries more than 20 stations, or (3) no T-carrier restoration control center (TRCC) is in charge of restoration of backbone and maintenance lines. The 15 miles refer to actual route and not airline miles. The 20 stations refer to the total of all actual working stations (not forecasted) on interstate, intrastate, and official DDS service.

1.12 Existing protection should be removed from all systems in the DDS network that do not meet the above protection criterion. Span lines reserved for protection of pending TRCC controlled systems of up to 15-mile lengths should be released. Where the working and protection lines have different lengths, the longer line should be released unless it is better adapted for easy restoration.

1.13 Should T1 line protection be justified, protection is provided on a 1-for-1 basis. The working and protection lines are double-fed at the transmitting terminal, and the decision to switch is made and executed only at the receiving terminal. Each direction of transmission is monitored independently. Where feasible, separate physical routes are used for the working and protection lines as long as the protection line is not longer than 25 percent or less than the working line.

1.14 The T1 line is monitored by the T1 automatic standby unit (T1ASU) or an optional unit. The T1ASU uses two detectors. One detects bipolar violations (BPV) and expands them into 30-millisecond pulses, and the other recognizes the absence of a pulse in 16 or more time slots. A continuous output

from either detector initiates a protection switch in 1 second when a line fails or when the BPV rate is greater than approximately 1 per second (1 error in 10^6 bits). When the T1ASU detects that the failed primary line has returned to normal, the switch back to the primary line is initiated either automatically or manually (preferred).

2. INSTALLATION AND INTERCONNECTION

2.01 The check list of activities in Fig. 3 provides a generalized procedure for turning up a DS-1 facility for service. The flowchart user determines the completeness of each item and, when necessary, performs the required work or refers the item to the appropriate group for completion.

2.02 Equipment bays, shelves, and installer-provided cross-connects should have been installed and tested according to the current installation handbook and performance requirement sections. Typical cross-connections for a long-haul facility and for a DSA interoffice facility are shown in Fig. 5 and 6, respectively.

2.03 Figure 7 shows data customers served via dataport channel units from D4 channel banks and a SLC 96 system. A carrier system consists of a central office terminal connected by DS-1 facilities to a remote terminal. The DS-1 facilities used by dataport channel units are covered by normal T-carrier turnup procedures. These procedures are documented in the Bell System Practice as referenced in Table B. The ***qualification tests are not necessary for DS-1 facilities used by dataport channel units (D4 channel banks and the carrier system terminals).***

3. ▶ALARM VERIFICATION TEST

3.01 After the components of a DS-1 facility have been installed and interconnected, a facility alarm verification test should be performed to determine whether all equipment has been interconnected properly and is operating satisfactorily. Figure 4 contains an alarm verification test for the 1A-RDS (DUV) and the T1 digital line. Some alarm indications are given in Table C for the more common equipment in use today. Assistance is required at the far end to perform this test for the 1A-RDS and the T1 digital line.

4. FACILITY ACCEPTANCE CRITERIA

4.01 The DDS quality guarantee of 99.5 percent error-free-seconds (EFS) is stated at the 56-kb/s service rate and are generally evaluated in a 24-hour time frame for maintenance purposes. For convenience, service requirements specified at the 56-kb/s rate are equated to the requirements for a 64-kb/s DS-0 channel. Where possible, testing should be done using DS-0 criteria, but because DDS multiplexing equipment is not always available at facility terminals, it might be necessary to use performance criteria and evaluations at the DS-1 rate. However, testing at the DS-1 rate requires knowledge of the relationship between DS-0 channel errored seconds (CES) and DS-1 line errored seconds (LES). This relationship, known as an N factor, is defined as the average number of DS-0 channels experiencing an errored second as a result of one DS-1 errored second.

4.02 The N factor may not, in all cases, describe accurately the relationship between the DS-0 and DS-1 rates. In those cases where the acceptance criteria for the DS-1 rates are met but DS-0 rates are exceeded, the DS-0 rate is the controlling criteria. These cases require extra effort to identify and correct the problem. Where the problem cannot be identified, the case should be referred to transmission engineers for resolution.

4.03 The N factor for T1 and DUV have been established; therefore, the acceptance criteria and turnup test can be made at the 1.544-mb/s rate. The N factor for the newly approved facilities in Tables A and B have not been established and finalized; however, some preliminary N factors have been established. To establish an N factor for a newly approved facility, a ***characterization test*** is recommended by using a new device called Digital Performance Analysis and Recording System (DIPARS) in conjunction with a KS-20775 error rate test set, model 271B type or equivalent. The procedures for an error performance evaluation test are documented in the appropriate Bell System Practice division according to the type of facility.

4.04 Whenever one facility is added to one or more facilities, a composite long-haul facility is formed. Each facility of a different technology must be tested and meet that technology requirement. Then ***composite digroup test*** must be made from end-to-end (T1DM to T1DM or hub office DSX-1 to hub office DSX-1), for 48-continuous hours. If the composite test (end-to-end) fails, corrective action must be taken and the composite digroup test made again for another 48-continuous hours. The test fails whenever the allocated error seconds are exceeded or

if the error seconds are greater than 260 error seconds for a composite long-haul facility. The composite digroup test may be made by using either the DTSS or the KS-20908 data test set.

4.05 The ***DTSS*** may be used to make the composite digroup test on a particular digroup. The technician contacts the Digital Network Administration Center (DNAC) and requests a test of a particular digroup. The test ***must*** be conducted for 48-continuous hours. To substantiate the test, several DTSS reports may be used such as the 24-hour summary/exception and the weekly report for the particular digroup.

4.06 The ***KS-20908 data test set*** (receiver) is connected to make an error performance test on a particular digroup (Fig. 8). A test set is connected at each receive end of the digroup under test. The test is made for 48-continous hours with the total error count not exceeding the allocated errors for that digroup.

5. GLOSSARY

5.01 Listed below are some of the more common terms associated with the DS-1 turnup activities.

Channel Errored Second (CES): An errored second measured at the DS-0 rate.

Characterization Test: A test that determines the N factor for a particular facility.

Composite Digroup: A digroup circuit consisting of two or more facilities in tandem.

Composite Digroup Test: An error run test made from end-to-end (eg T1DM to T1DM) that includes more than one type of facility.

Digroup: A digital facility that is between a pair of hub office DSX-1 cross-connects and normally has terminal equipment connected such as T1DMs or D-type channel banks.

Data Over Voice (DOV): This type of facility derives two DS-1 digital channels from the spectrum in the mastergroup 7 slot (19.66 to 21.38 MHz) on L4 carrier. For L5 carrier, four DS-1 signals are encoded and modulated; two at 20.52 MHz and two at 22.28 MHz.

DS-0: A digital signal at the 0 level or at the 64-kb/s rate.

DS-1: A bipolar return-to-zero signal at the 1.544-Mb/s rate.

Digital Transmission Surveillance System (DTSS): A system that monitors at the DS-0 rate the errored second performance of digroups used in DDS.

Data Under Voice (DUV): A system that provides for the transmission of one DS-1 signal over a microwave radio link.

Errored Second (ES): A 1-second interval that contains at least 1 bit in error.

Line Errored Second (LES): An errored second that is detected at the DS-1 rate.

N Factor: A value that indicates the average number of DS-0 channels experiencing an errored second as a result of one DS-1 errored second.

Technology: For this section, it refers to facility technology such as DUV, DOV, DOM, Vidar 20 Mb/s, A5 M/bs etc.◆

◆TABLE A◆

LONG-HAUL FACILITIES

TYPE OF FACILITY	DDS MILEAGE	PERCENT OF 56-KB/S ERROR FREE SECONDS	PERCENT OF DS-1 ERROR FREE SECONDS	N-FACTOR	PERCENT OF ERROR SECONDS PROPRATED BY MILEAGE	PRESERVICE TEST DURATION	BELL SYSTEM PRACTICE
Data Under Voice (DUV)	4000	99.75	99	5.75	Almost	4 days at 1.544 Mb/s	356-454-510
Vidar 20 Mb/s	4000	99.75	*	*	Yes	2 weeks	356-456-300LL
Data Over Voice (DOV)	4000	99.75	*	6†	Yes	4 days	—
Data on Master-Groups (DMG-1)	4000	99.75	*	*	Yes	2 weeks	356-460-000
Lightwave Digital Line (FT3)	4000	99.75	*	*	Yes	2 weeks	356-560-100
Microwave Radio 45 Mb/s	4000	99.75	*	*	Yes	2 weeks	422-501-100
Composite Digroup Facility	No Restriction	99.7 (260 ES)	Never exceed 260 error seconds	*	Sum of error seconds of each facility	Test each facility, then composite for 48 hours	314-903-200

* Not available

† Preliminary N-factor

TABLE B

SHORT-HAUL FACILITIES

TYPE OF FACILITY	DDS MILEAGE	PERCENT OF 56-KB/S ERROR FREE SECONDS	PERCENT OF DS-1 ERROR FREE SECONDS	N-FACTOR	PERCENT OF ERROR SECONDS PROPRATED BY MILEAGE	PRESERVICE TEST DURATION	BELL SYSTEM PRACTICE
T1 Digital Line	50	99.975	99.73	2.1	No	2 hours at 1.544 Mb/s	365-200-300 365-228-500
T1C Digital Line	50	99.975	99.73	2.1	No	2 hours at 1.544 Mb/s	365-271-000
T1D Digital Line	50	99.975	99.73	2.1	No	2 hours at 1.544 Mb/s	365-272-000
T1/OS Outstate Digital Line	100	99.975	99.73	2.1	No	1 week	365-224-600
T2 Digital Line	250	99.975	*	*	No	1 week	365-500-501
T4M Digital Line	250	99.975	*	*	No	1 week	365-550-100
6-GHz Microwave Radio	125	99.975	99.81	3†	Yes	2 weeks	421-200-135
11-GHz Microwave Radio	125	99.975	99.81	3†	Yes	2 weeks	421-200-135

* Not available

† Preliminary N-factor

TABLE C

ALARM AND DISPLAY INDICATIONS

EQUIPMENT DISPLAY	TEST LOCATION							
	T1ASU				DSX-1 (LONG HAUL)			
	FAR-END OUTPUT OPEN		NEAR-END OUTPUT OPEN		NEAR-END OPEN		FAR-END OPEN	
	ALARM	DISPLAY	ALARM	DISPLAY	ALARM	DISPLAY	ALARM	DISPLAY
T1DM (Direct)								
Near End	Major	□	None	□ *				
Far End	None	□ *	Major	□				
T1DM (Chain)								
Near End	Major	□	Major	□				
T1WB4/5 (Direct)								
Near End	Major	RCV IN FAIL						
Far End			Major	RCV IN FAIL				
T1WB4 (Data-Voice)								
Near End	Major	RCV IN FAIL						
Far End			Major	RCV IN FAIL				
D Bank or COT†								
Near End	Major	RED	Major	YELLOW				
Far End	Major	YELLOW	Major	RED				
T1WB4/5 (Chain)								
Hub Office								
Near End	Major	RCV IN FAIL						
Downstream			Major	RCV IN FAIL				
Chain Office								
Near End	Major	RCV IN FAIL‡ TRMT IN FAIL§						
Far End			Major	TRMT IN FAIL‡ RCV IN FAIL§				
1A-RDS								
T1DM								
Near End					None	□ *	Major	□
Far End					Major	□	None	□ *
1A-RDT¶								
Near End					Major	DS-1 SIG LOSS	None	None
Far End					None	None	Major	DS-1 SIG LOSS

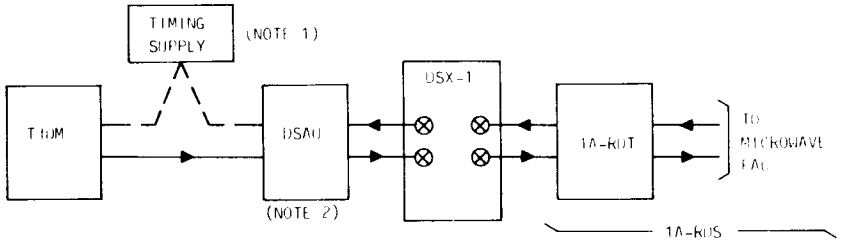
* If the K option (hub office) is used in the BCPA circuit, the □ (yellow) display does not generate an alarm. See Section 314-916-100 for other options and alarm combinations.

† COT (Central Office Terminal) and remote terminal provides a SLC 96 Subscriber Loop Carrier System

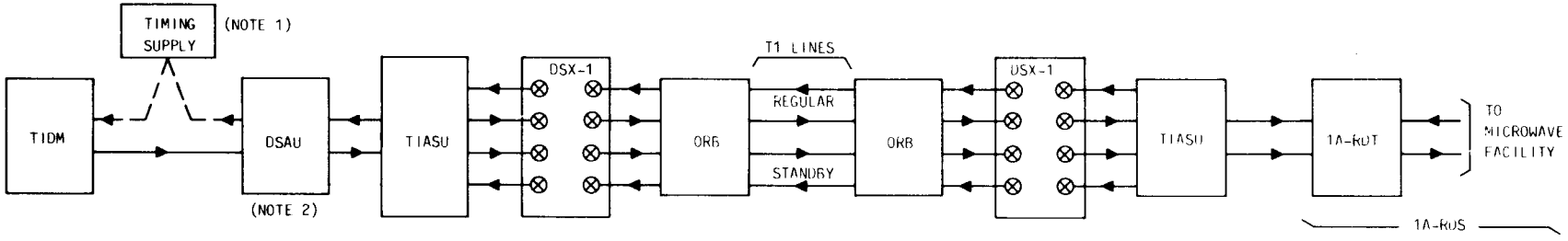
‡ The far end is the upstream office.

§ The far end is the downstream office.

¶ The 1A-RDS alarm and display may be delayed as much as 20 seconds.



A. TERMINATING ARRANGEMENT WITH 1A-RDT IN HUB OFFICE



B. TERMINATING ARRANGEMENT WHEN T1 LINE IS USED FOR CONNECTING HUB OFFICE WITH 1A-RDS TERMINAL IN ANOTHER OFFICE

LEGEND:

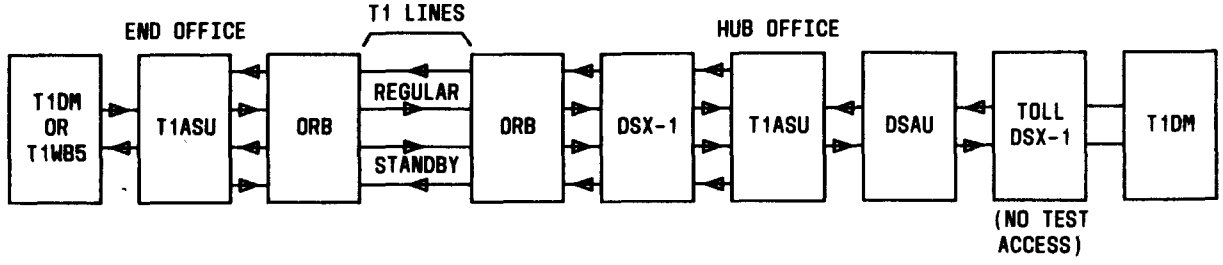
⊗ CROSS-CONNECTION POINT

⊗ WIRE PAIR

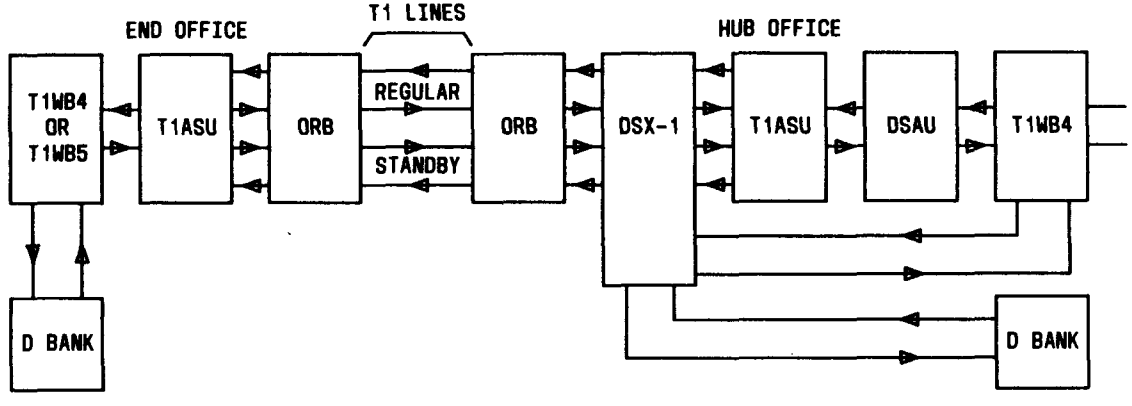
NOTES:

1. TIMING SUPPLY CONNECTION ONLY TO DS-1 FACILITIES PROVIDING NETWORK SYNCHRONIZATION.
2. DS-1 SIGNAL ACCESS UNIT (HUB OFFICE ONLY)

Fig. 1—Typical Data Under Voice Facility Terminating Arrangements

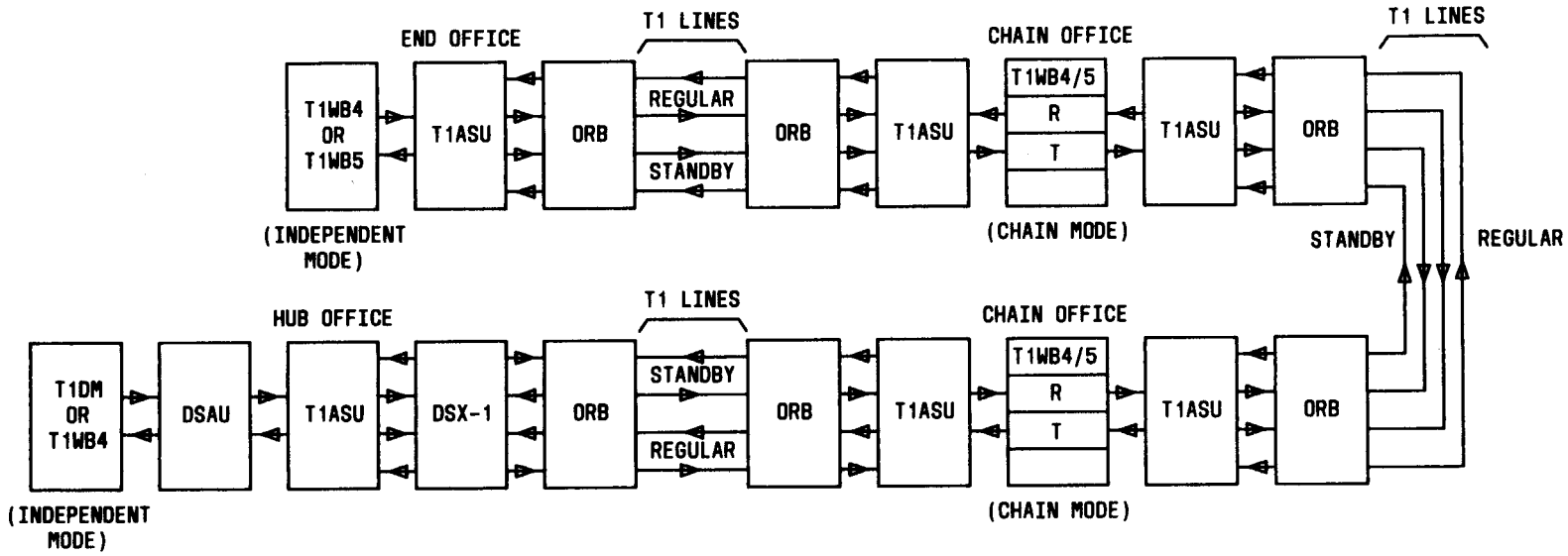


A. DIRECT LINE TERMINATING IN T1DMs OR T1WB5s (ALL DATA)



B. COMBINED DATA-VOICE OPERATION

Fig. 2—Typical Terminating Arrangements for DS-1 Facility Using T1 Line (Sheet 1 of 2)



C. CHAIN OPERATION (DATA ONLY) WITH EITHER T1DM OR T1WB4 AT HUB OFFICE

Fig. 2—Typical Terminating Arrangments for DS-1 Facility Using T1 Line (Sheet 2 of 2)

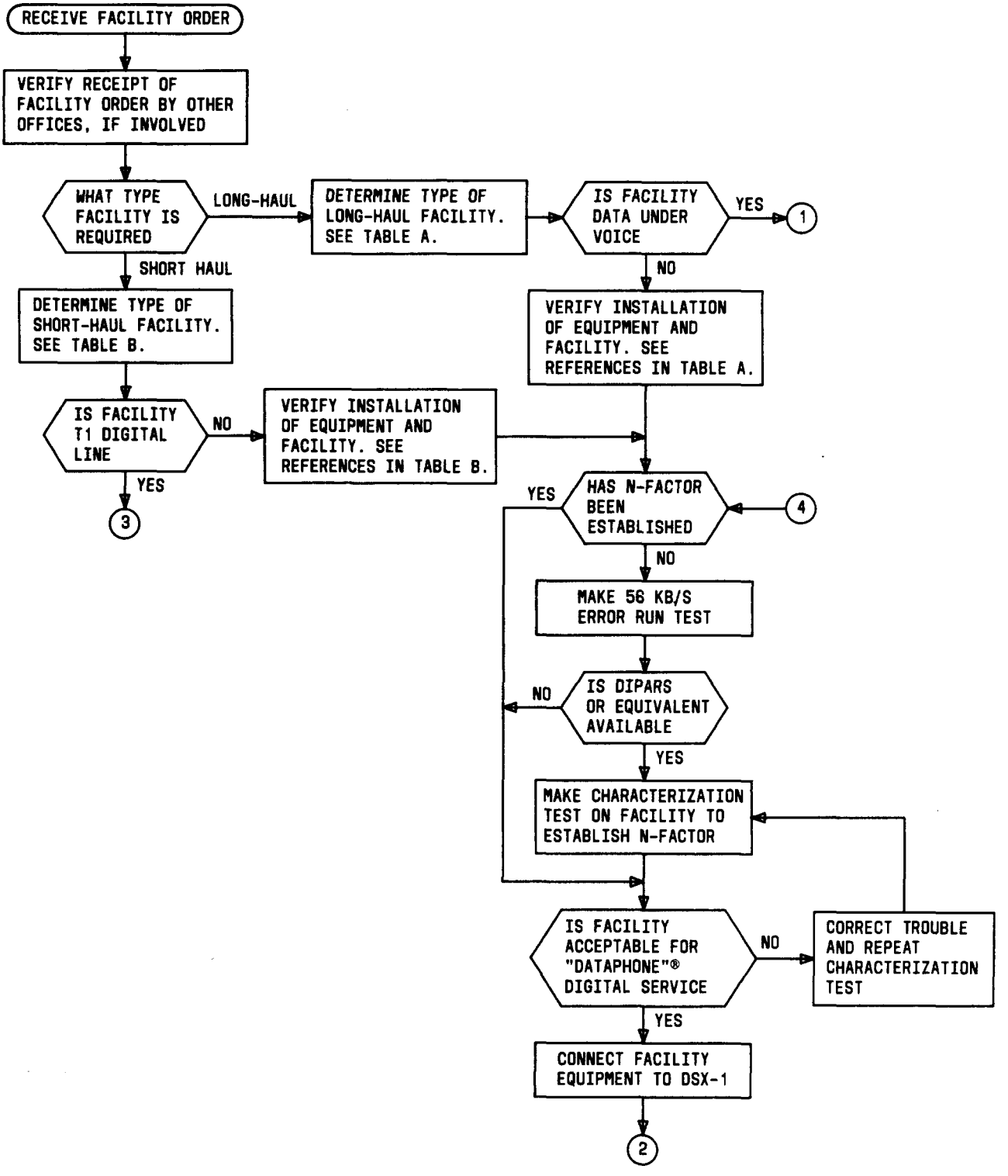


Fig. 3—Turnup Activities (Sheet 1 of 4)

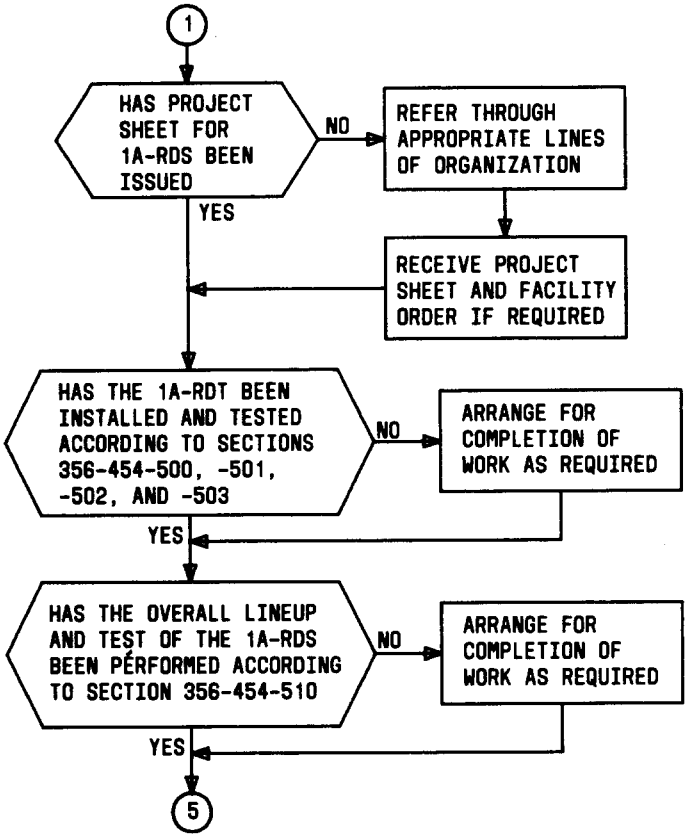


Fig. 3 — ⧫Turnup Activities (Sheet 2 of 4)⧫

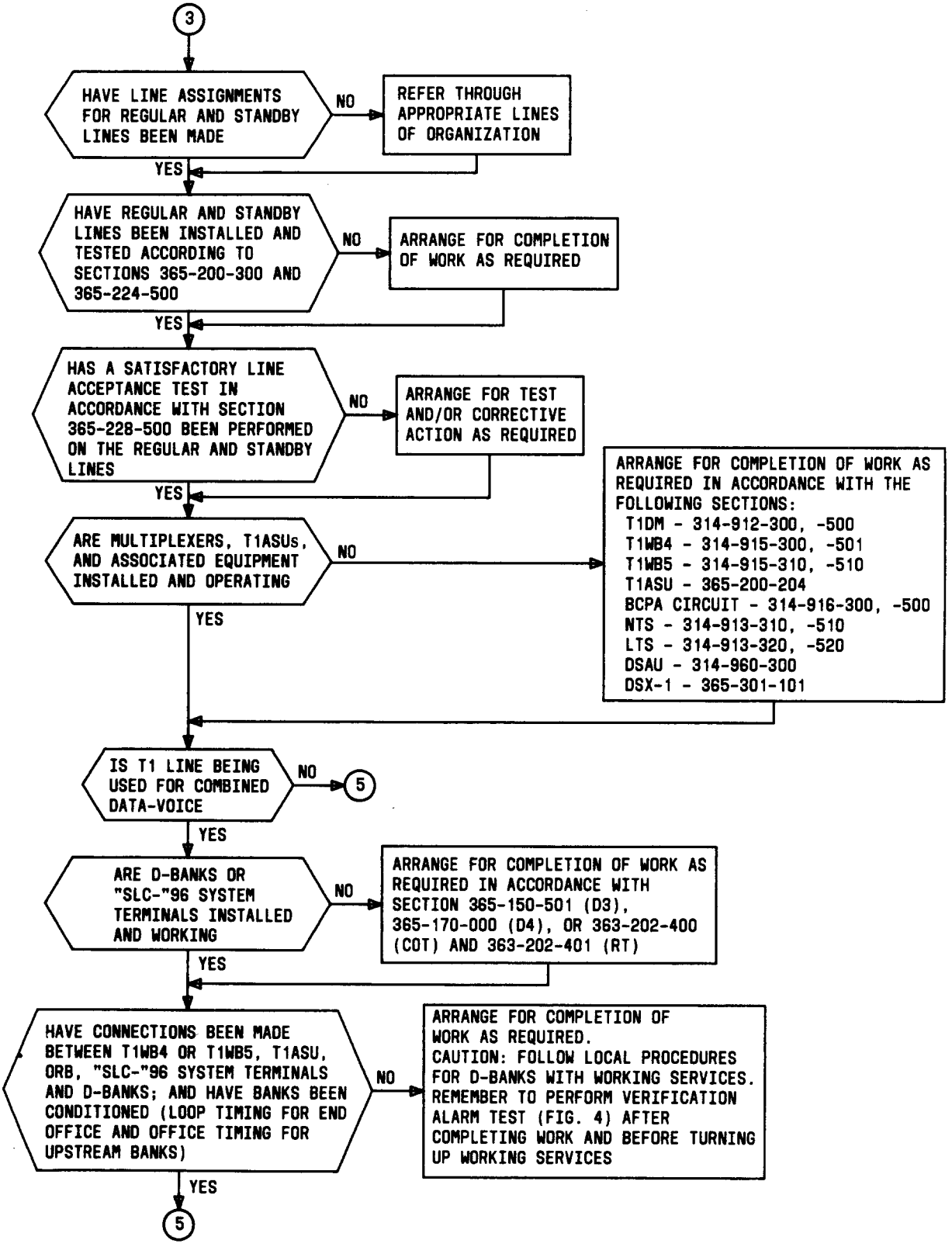


Fig. 3 — ◗Turnup Activities (Sheet 3 of 4)◖

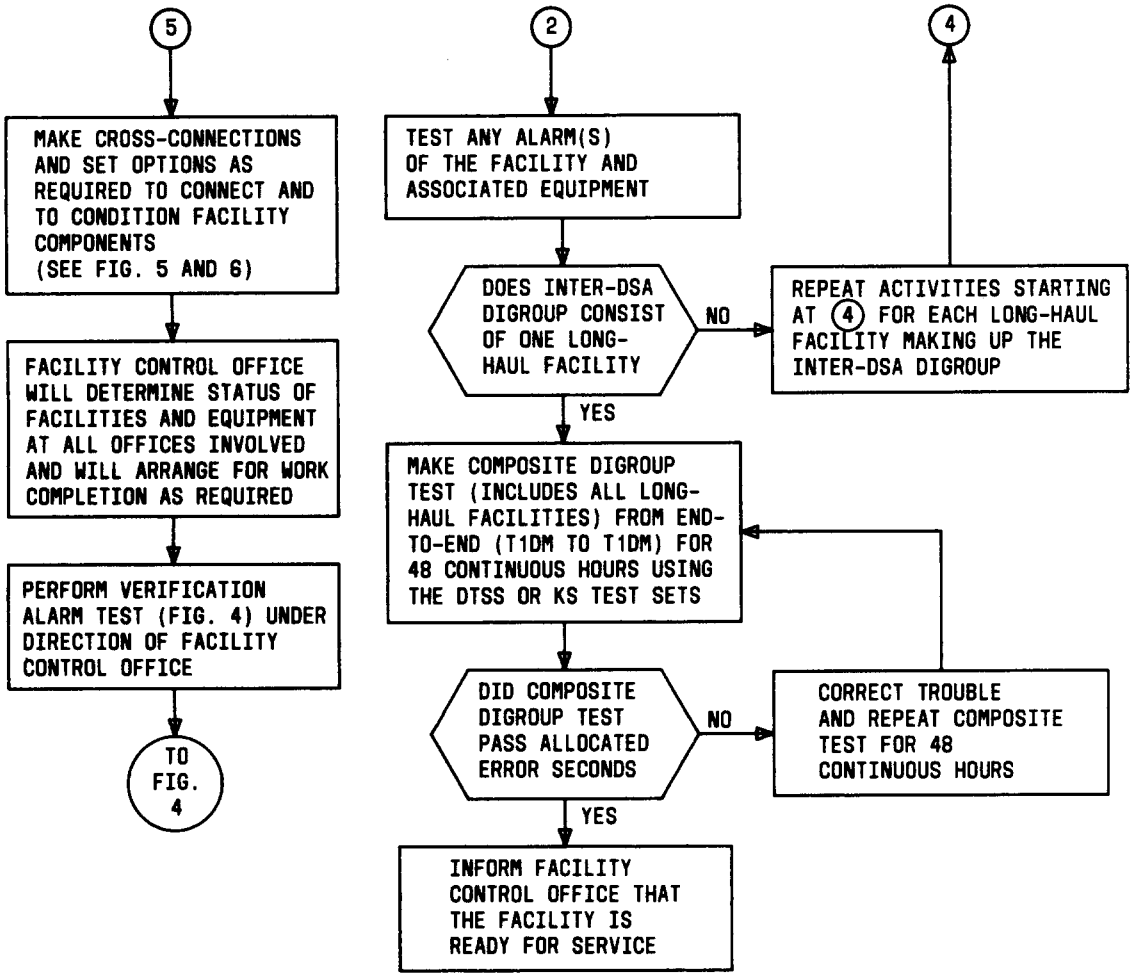


Fig. 3 — ▶Turnup Activities (Sheet 4 of 4)◀

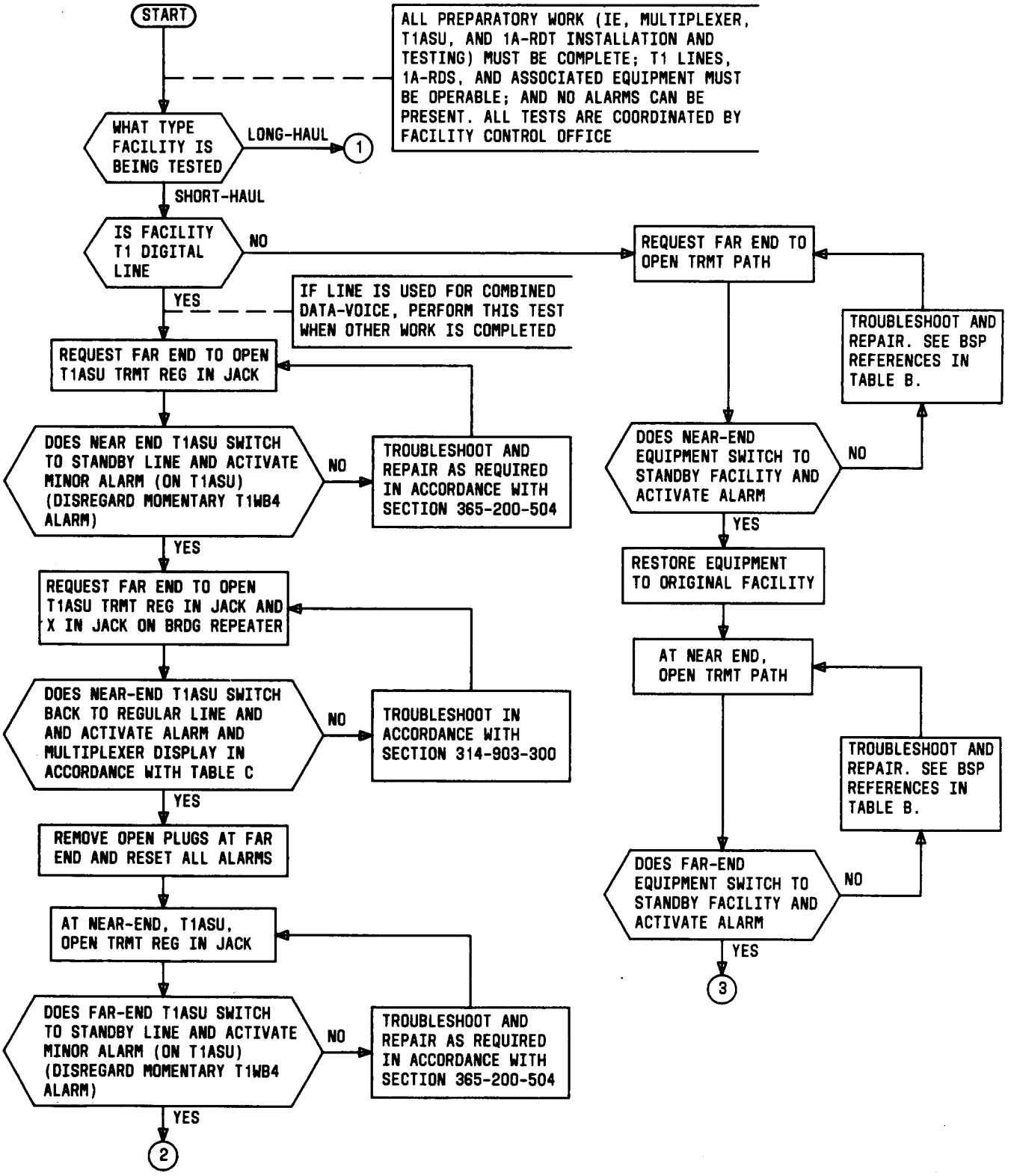


Fig. 4—Facility Alarm Verification Test (Sheet 1 of 2)

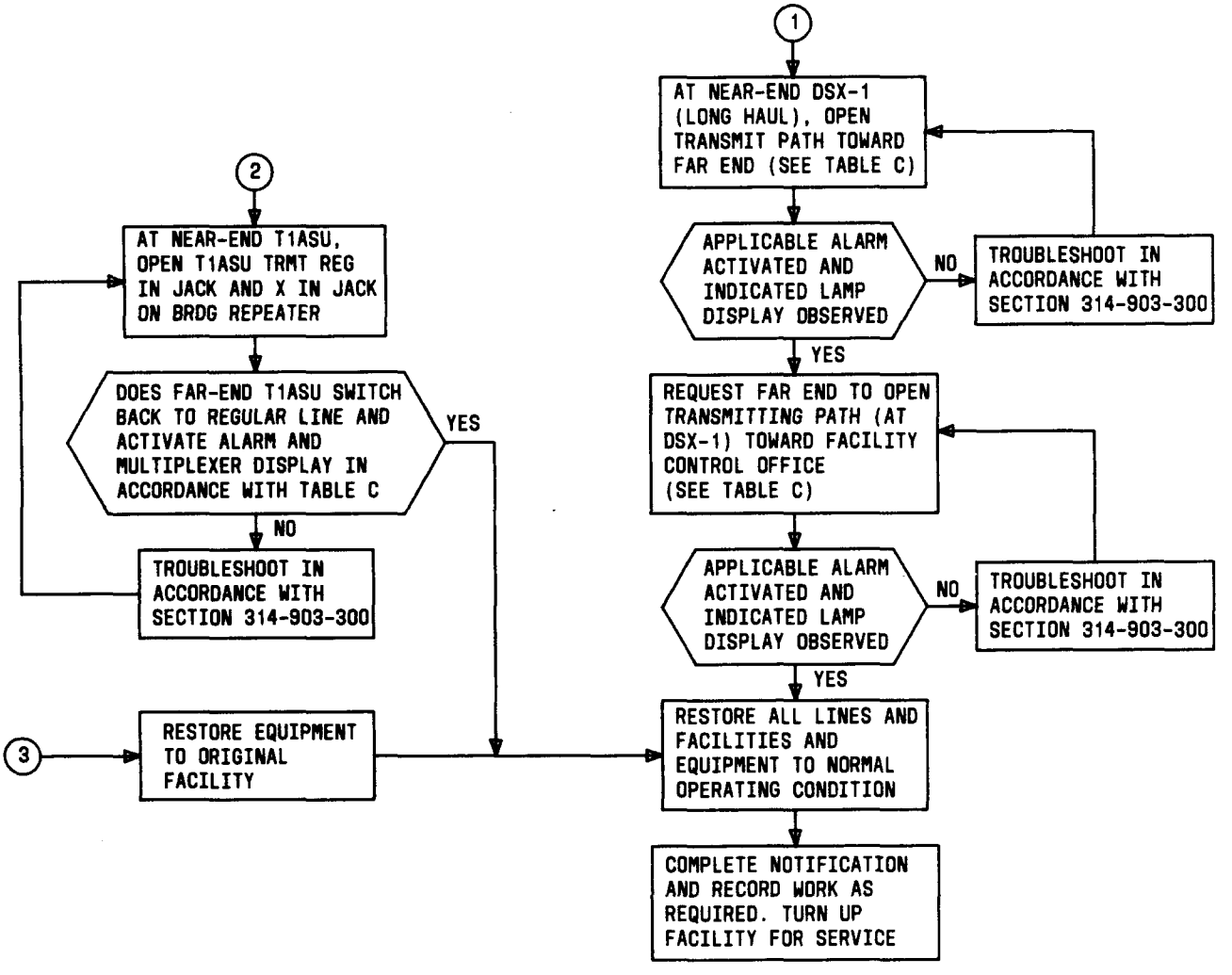
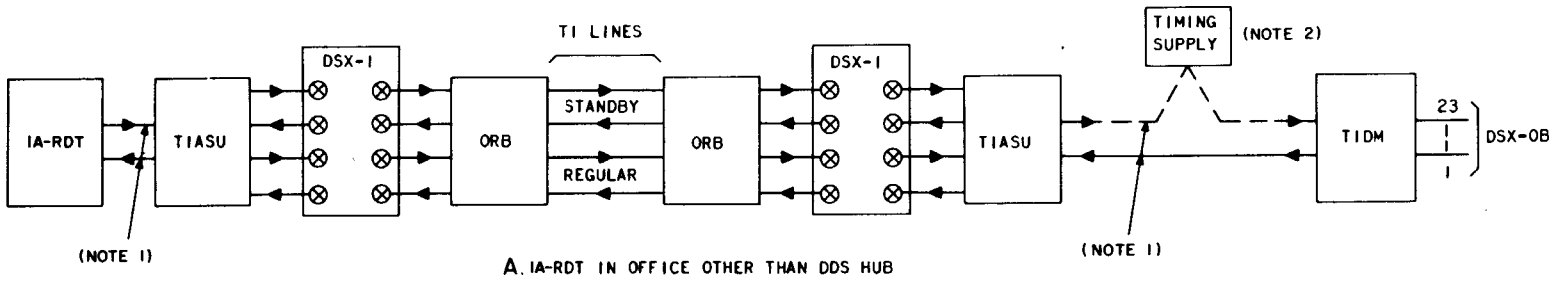
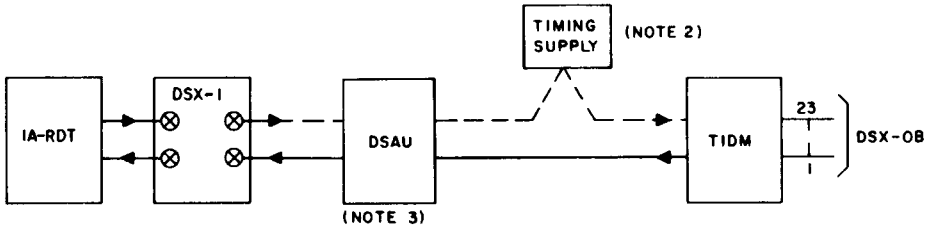


Fig. 4—Facility Alarm Verification Test (Sheet 2 of 2)



A. IA-RDT IN OFFICE OTHER THAN DDS HUB



B. IA-RDT IN SAME OFFICE AS DDS HUB

NOTES:

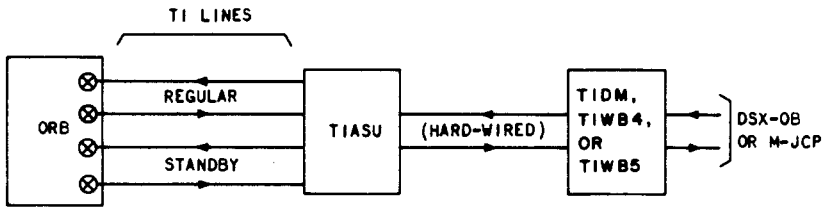
1. AN OPTIONAL TOLL DSX-1 MAY BE PROVIDED HERE IN SOME LOCATIONS (NO TEST ACCESS).
2. TIMING SUPPLY CONNECTION ONLY TO DS-1 FACILITIES PROVIDING NETWORK SYNCHRONIZATION.
3. DS-1 SIGNAL ACCESS UNIT

LEGEND:

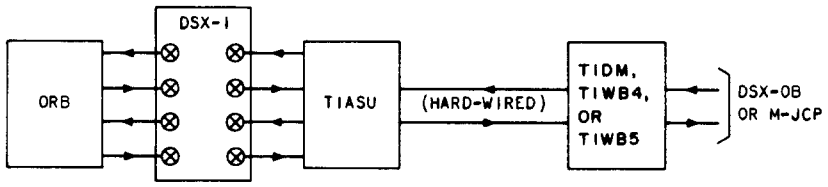
⊗ CROSS-CONNECTION POINT

— WIRE PAIR

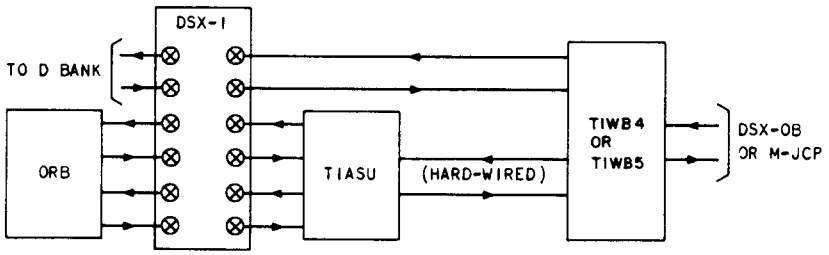
Fig. 5—Typical Long-Haul Facility Cross-Connections



A. TYPICAL CROSS-CONNECTION FOR TI LINE WITHOUT DSX-1



B. TYPICAL CROSS-CONNECTION FOR TI LINE WITH DSX-1



C. TYPICAL CROSS-CONNECTION FOR TI LINE USING COMBINED DATA-VOICE OPERATION

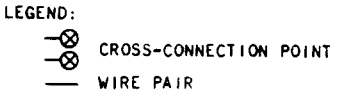


Fig. 6—Typical Cross-Connection Arrangements for DS-1 Facility Using T1 Line

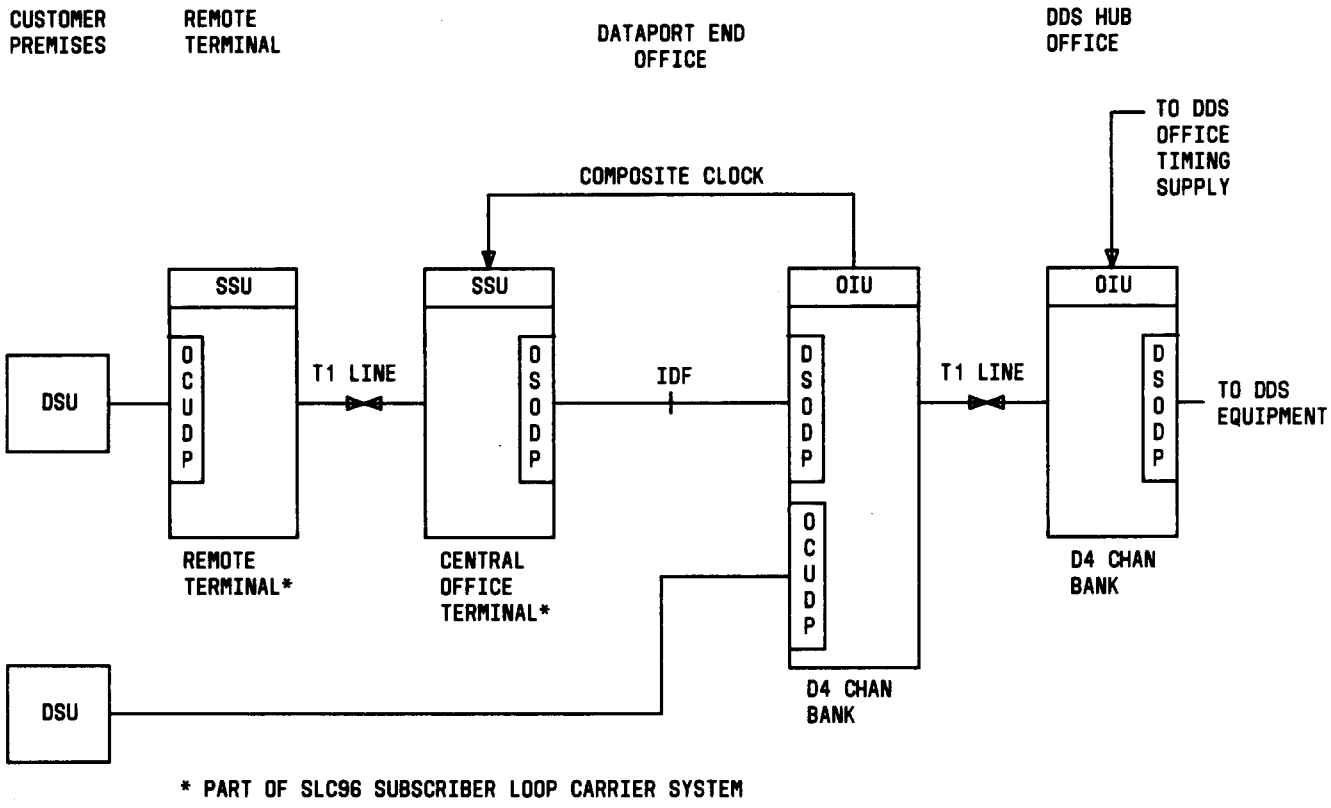
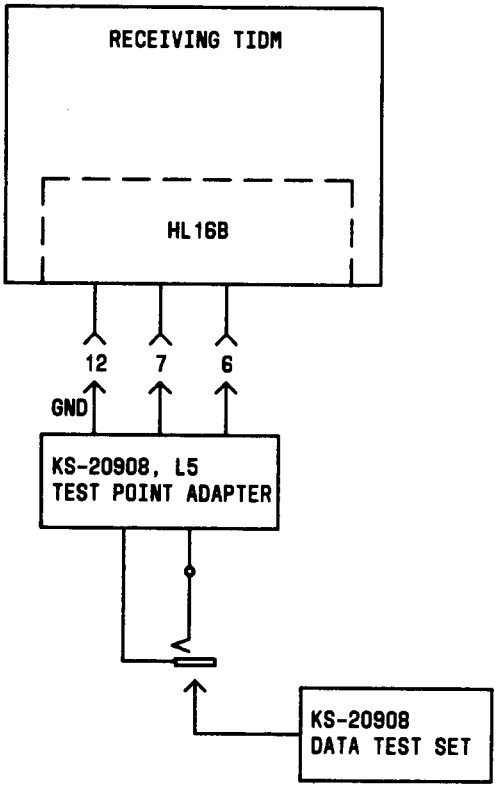


Fig. 7—Data Customers Served via Dataport Channel Units



SWITCH SETTINGS

INPUT - LOGIC, FAR
COUNTER - EXT PULSES
COUNTER MODE - RESET
POWER - ON

Fig. 8—Error Performance Test Connections