EXPECTED MEASURED LOSS CALCULATIONS FOR E-REPEATERED AND NON-REPEATERED TWO-WIRE TRUNKS

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1. GENERAL

1.01 This section describes procedures for calculating expected measured losses (EML) for 2-wire voice-frequency trunks including E-type repeatered trunks. These include interoffice trunks, tandem trunks and terminating links (toll-connecting trunks). Calculations for trunks working on carrier or hybrid-type repeaters are not included in this practice.

1.02 This section replaces Issue 1 for the following reasons:

(a) The tolerance between the expected and actual measured loss is reduced from ±1.5 db to ±1.0 db.

(b) E1 and E2 repeater irregularities are more fully discussed.

(c) Table A is revised to list cables by types.

(d) Tables C and D are revised to include #4 crossbar office data.

(e) Intermediate junction reflection losses are discussed. Table E provides values for these losses.

(f) This section was formerly titled "Calculation of One-Way, 1000-Cycle Transmission Loss for Two-Wire Voice-Frequency Exchange Trunks."

Since this is a general revision the use of arrows to denote changes has been omitted.

1.03 The computed EML provides maintenance forces with a design value for comparison with the actual measured loss (AML). This assists in determining that all equipment affecting transmission is properly connected and functioning. The EML should be recorded on the circuit order, circuit layout card and trunk record when the trunk is assigned. Routine and trouble investigation test results should be compared with the AML rather than the EML.

1.04 It is seldom possible to precisely calculate EML. However, using the methods described in this section it is possible to estimate EML within ±1.0 db. ***Care should be exercised to include office wiring, auxiliary trunk equipment etc, in estimating net loss.***

1.05 EML calculations and tests referred to in this practice are based on properly terminated 1000-cycle 1-milliwatt (1MW) test power. The transmission tests are made in accordance with instructions contained in Central Office Maintenance Tests and Inspections Practices. These tests are made by connecting 1MW to the trunk under test in the terminating office and measuring the power received at the originating office with a 13A- or similar-type transmission measuring set (TMS). The TMS reading is the AML. This is the loss which is estimated by the calculations described in this section.

2. CALCULATION OF EXPECTED MEASURED LOSS

2.01 EML consists primarily of:

(a) Cable facility loss (attenuation)

(b) Termination reflection loss

(c) Intermediate junction reflection loss

(d) Central office equipment and wiring loss

(e) Auxiliary trunk equipment loss

(f) E repeater gains

The arithmetic sum of the losses minus any E repeater gains (the algebraic sum of loss and gain) expressed in db, is the EML. Figs. 1 to 3 illustrate calculations of EML.

2.02 The cable facility loss is determined by the cable length, gauge, capacitance, type of loading (if any) and temperature. Corrections for temperature variations are not included in procedures herein described. The resulting discrepancy is allowed for in the ±1.0 db tolerance. Table A provides the 1000-cycle loss for various

types of nonquadded cables. The loss of a cable is calculated by multiplying the loss in db per mile or per 1000 feet by the cable length in the same units. When the cable facility is composed of more than one type of cable, the over-all loss is considered to be the sum of the individual losses.

2.03 Termination reflection losses occur at the junction of the cable facility and the connection to the central office equipment. The 1000-cycle characteristic impedance of nonquadded cable varies from 300 to 2200 ohms depending largely upon the type of cable and loading arrangement. Local and local tandem central offices are considered to be 900-ohm impedances. Toll offices are considered to be 600 ohms. In some trunk equipment, repeating coils with impedance ratios of 1.5 to 1.0 and 2.5 to 1.0 are used to approximately match impedances and minimize reflection losses. Table B provides reflection loss values with and without repeating coils between various cable facilities and 600- or 900-ohm terminations. In calculating EML a termination reflection loss is included for each end of the trunk, based on the predominant type of cable facility adjacent to the termination. The values in Table B assume the cable is long enough to take on a characteristic impedance. The characteristic impedance of a short trunk is governed largely by the office impedance rather than the cable facility impedance. Most cable facilities will be sufficiently long (3 db or more) to assume a characteristic impedance. The transmission engineer should be consulted when the use of the values in Table B appear to introduce a significant error on trunks less than 3 db long.

2.04 Intermediate junction losses result from current reflections occurring at the connection of 2 dissimilar impedances. Table E provides reflection loss values for intermediate junction impedance mismatches based on predominant types of cable facilities which are long enough to approach a characteristic impedance. EML calculations should consider only those intermediate losses resulting from junctions of nonloaded facilities longer than 3 db with loaded facilities, and junctions between different types of loading systems. Losses resulting from a junction of 2 types of loading systems, either or both of which are composed of more than one cable gauge, should be based on the predominant cable gauge in each system. Similarly, losses involving a nonloaded section of cable composed of more than one gauge should be based on the predominant gauge.

2.05 Central office equipment and wiring losses occur at both ends of a trunk. Tables C and D provide typical equipment and wiring losses at the originating and terminating ends, respectively, for various types of offices. Equipment and wiring losses should be measured for all offices. These values should be substituted for the typical values in Tables C and D. When measuring these losses care must be exercised to properly match the testing equipment impedance to the central office equipment.

2.06 The use of auxiliary trunk equipment to increase signalling and supervision ranges introduces an additional transmission loss in a trunk. These values should be obtained from the auxiliary equipment schematic drawing and included in the EML.

2.07 Repeater gains are used to improve the transmission of a circuit. The gain of a repeater is subtracted from the arithmetic sum of the trunk losses in order to obtain the net EML. Care should be exercised that the gain used is the 1000-cycle gain and not some other value. For E-type repeaters with shunt elements (E13 or E23), the gain specified in the strapping instructions should be used in making the calculations. For E1 or E2 repeaters, the measured 1000-cycle gain should be used in the calculations since the specified gain can not be predicted accurately due to the variation that is caused by impedance or terminal irregularities. This means that the calculations will have to be made after the repeater gain is measured.

3. SPECIAL CONSIDERATIONS

3.01 A tolerance of ± 1.0 db on EML calculations is provided to allow for a number of contingent losses. The more important losses of this type are:

(a) Attenuation changes resulting from temperature variations.
(b) End section departures from standard.
(c) Circulating current losses.

3.02 The characteristics of any conductor vary with changes in temperature. The losses tabulated in this section have been standardized for values at 68°F.

3.03 End section losses occur when the end loading section (section adjacent to central office) does not present the proper input impedance to the terminating impedance of the trunk. The termination reflection losses tabulated in this practice are based on a standard end loading section of 0.5 of a full loading section.

3.04 Circulating current losses result when currents are reflected back and forth between 2 impedance mismatches. These currents may be significant on repeatered trunks 3 db or less in length, tending to increase (re-enforce) or decrease (cancel) the line current. The resulting distortion depends upon the frequency and it is impossible to predict whether a "peak or valley" will occur at 1000 cycles. The use of E1- or E2-type repeaters constitutes an impedance irregularity in itself and may result in a loss or gain of several db. This irregularity is usually small (a few tenths of a db) when correctly designed E13 and E23 repeaters are used with properly matched test terminations.

Attached:

Figures 1 — 3
Tables A — E

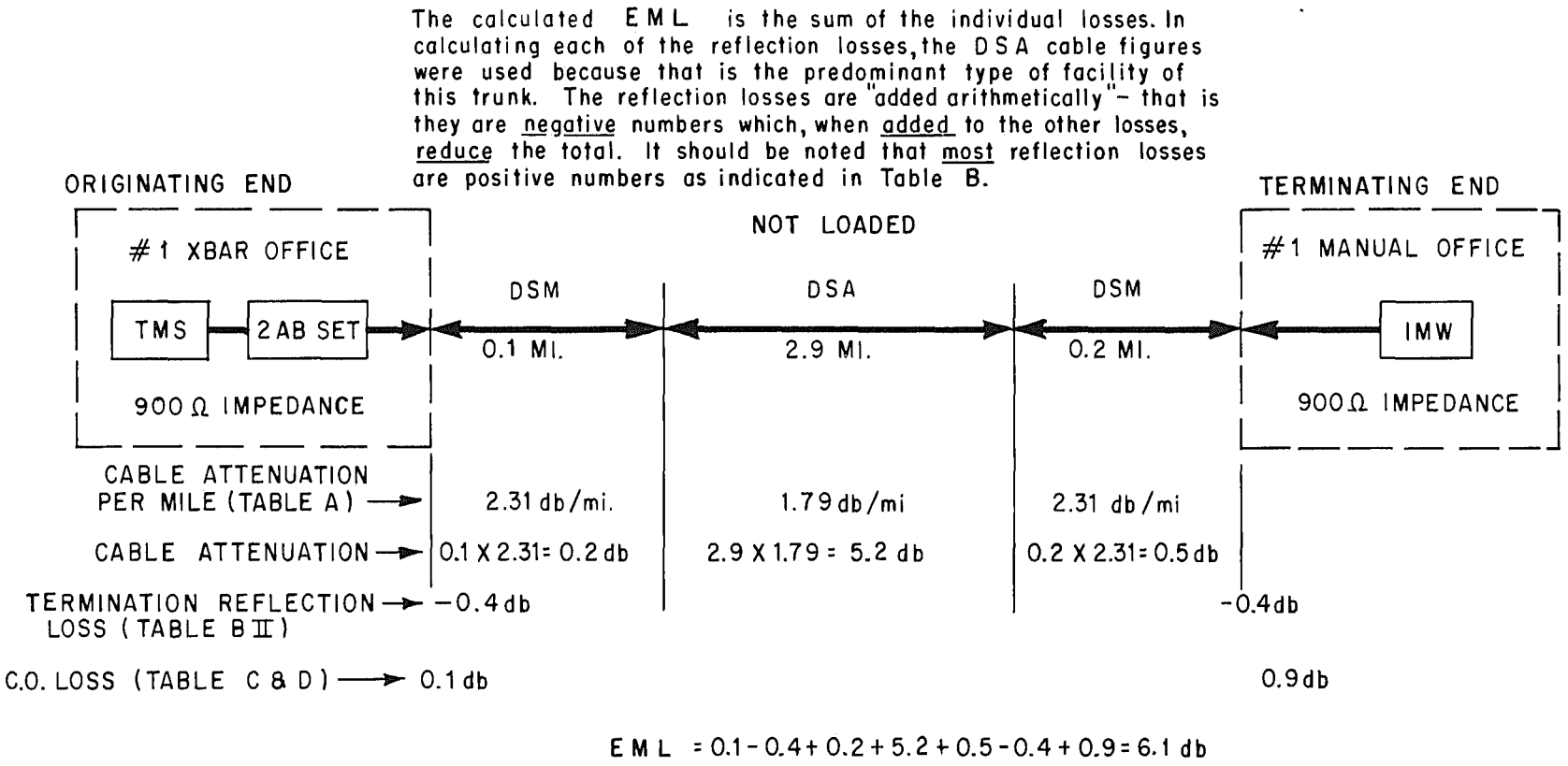
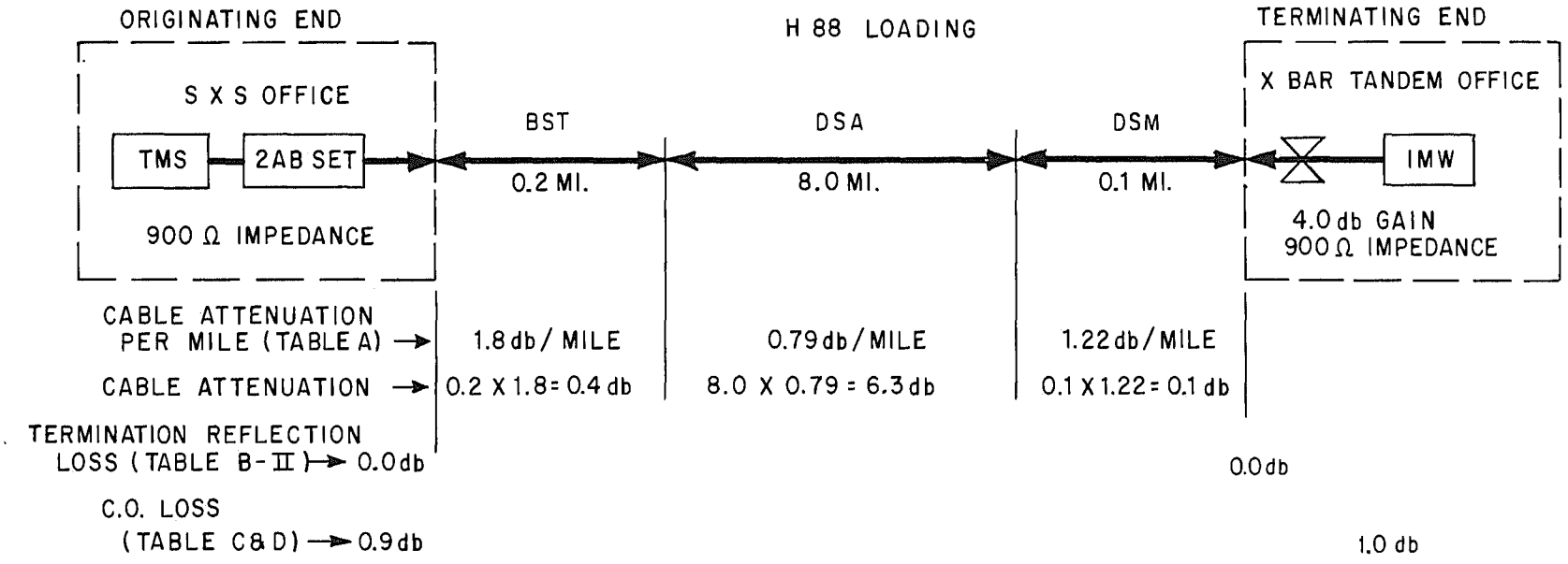


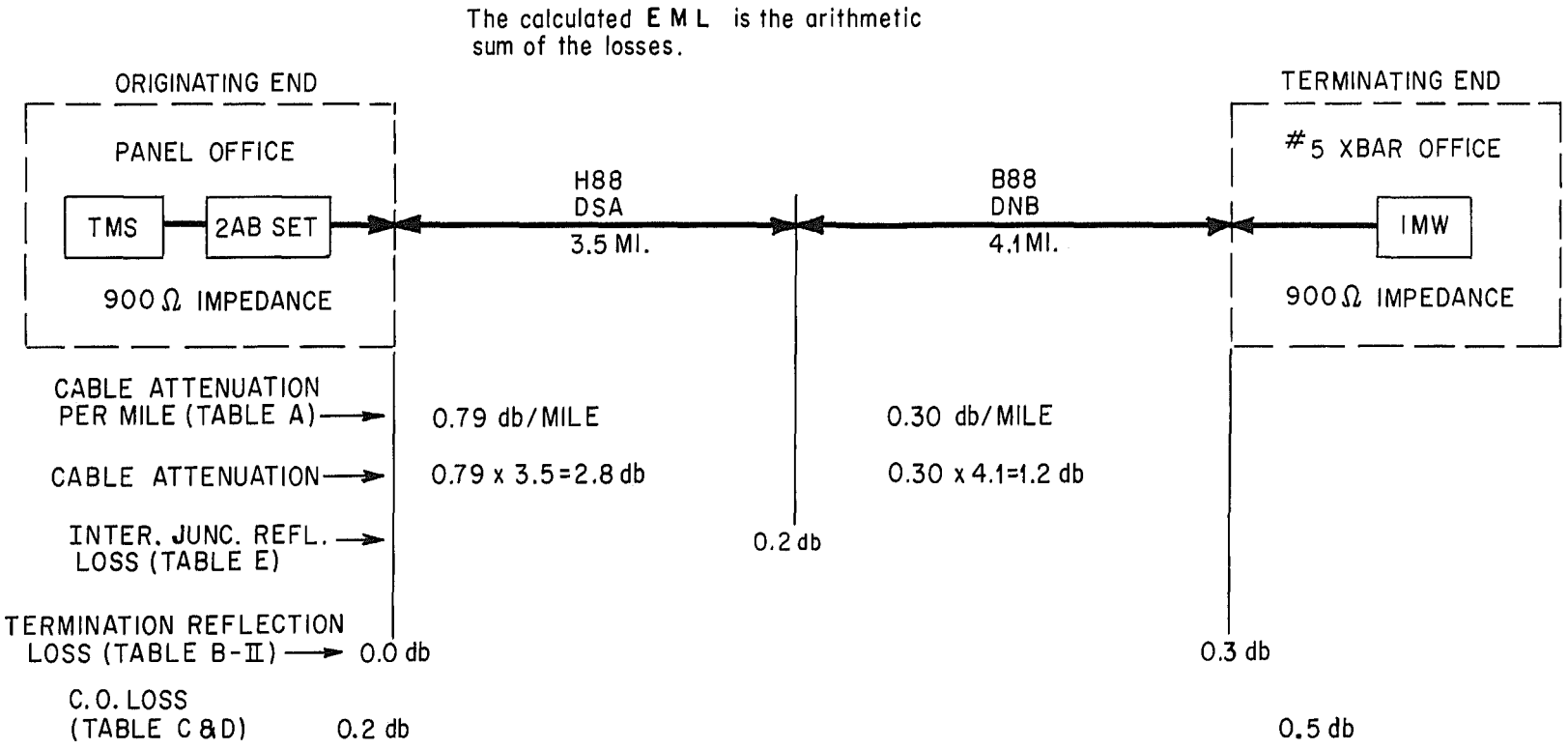
FIG.1 – EXAMPLE, EXPECTED MEASURED LOSS CALCULATION FOR NON-REPEATERED TRUNK.

The calculated EML is the arithmetic sum of the losses minus the repeater gain. This illustrates an H-88 loaded tandem trunk with Toll Access.



EML = 0.9 + 0.4 + 6.3 + 0.1 + 1.0 − 4.0 = 4.7 db

FIG. 2 – EXAMPLE, EXPECTED MEASURED LOSS CALCULATION FOR E-REPEATERED TRUNK



E M L =2.8 + 1.2 + 0.2 + 0.3 + 0.2 + 0.5=5.2 db

FIG. 3-EXAMPLE, EXPECTED MEASURED LOSS CALCULATION FOR NON-REPEATERED TRUNK WITH INTERMEDIATE JUNCTION REFLECTION LOSS.

TABLE A

NON-QUADDED TYPE CABLE

1000-Cycle Attenuation (Loss in DB)

68° F

TYPE LOADING	26 GA				24 GA				22 GA		19 GA				16 GA	
	LC		HC		LC		HC		HC		HC		LC		LC	
	Mile	1000 FT.	Mile	1000 FT.	Mile	1000 FT.	Mile	1000 FT.	Mile	1000 FT.	Mile	1000 FT.	Mile	1000 FT.	Mile	1000 FT.
N.L.	2.67	0.51	2.86	0.54	2.14	0.41	2.31	0.44	1.79	0.34	1.26	0.24	1.11	0.21	0.75	0.14
H 175	1.29	0.24	1.39	0.26	0.83	0.16	0.90	0.17	0.58	0.11	0.31	0.06	0.28	0.05	0.16	0.03
D 175	1.12	0.21	1.20	0.23	0.74	0.14	0.80	0.15	0.51	0.10	0.28	0.05	0.25	0.05	0.14	0.03
B 175	0.94	0.18	1.01	0.19	0.63	0.12	0.68	0.13	0.44	0.80	0.25	0.05	0.22	0.04	0.14	0.03
H 135	1.40	0.27	1.50	0.28	0.92	0.17	1.00	0.19	0.64	0.12	0.34	0.06	0.30	0.06	0.16	0.03
D 135	1.25	0.24	1.33	0.25	0.82	0.16	0.88	0.17	0.56	0.11	0.30	0.06	0.27	0.05	—	—
B 135	1.05	0.20	1.12	0.21	0.69	0.13	0.75	0.14	0.49	0.09	0.27	0.05	0.24	0.05	0.14	0.03
M 88	1.91	0.36	2.04	0.39	1.31	0.25	1.42	0.37	0.92	0.17	0.49	0.09	0.44	0.08	0.24	0.05
H 88	1.68	0.32	1.80	0.34	1.13	0.21	1.22	0.23	0.79	0.15	0.42	0.08	0.38	0.07	0.21	0.04
D 88	1.52	0.29	1.62	0.31	1.01	0.19	1.09	0.21	0.70	0.13	0.38	0.07	0.34	0.06	—	—
B 88	1.30	0.25	1.39	0.26	0.86	0.16	0.94	0.18	0.60	0.11	0.34	0.06	0.30	0.06	0.18	0.03
H 44	2.06	0.39	2.21	0.42	1.46	0.28	1.58	0.30	1.04	0.20	0.56	0.11	0.50	0.10	0.27	0.05

GAUGE	HC — HIGH CAPACITANCE	LC — LOW CAPACITANCE
16		TH, NH
19	CNB, ENB, FNB, AHB, CA1741	ANB, DNB, GNB, CA1727
22	ASA, BSA, CSA, DSA, ESA, AHA	
24	DSM, AKM	ASM, CSM, ESM
26	BST, AKT	CST

TABLE B — NON-QUADDED CABLE
1000-CYCLE REFLECTION LOSSES — DB

(I) 600-OHM TERMINATION — 1:1 RATIO COIL OR NO COIL*

LOADING	GAUGE 26	24	22	19	16
NL	−0.4	−0.6	−0.7	−0.5	−0.1
H175	—	—	—	1.1	1.1
D175	1.2	1.2	1.1	1.2	1.3
B175	1.7	1.6	1.6	1.8	1.8
H135	0.8	0.7	0.6	0.7	0.8
D135	1.0	0.9	0.8	0.9	—
B135	1.4	1.3	1.2	1.3	1.4
M88	0.3	0.2	0.1	0.2	0.2
H88	0.5	0.4	0.3	0.4	0.4
D88	0.6	0.6	0.5	0.6	—
B88	0.9	0.8	0.7	0.8	0.9
H44	0.1	0	0	0.1	0.1

(II) 900-OHM TERMINATION — 1:1 RATIO COIL OR NO COIL*
600-OHM TERMINATION — 1.5:1 RATIO COIL

LOADING	GAUGE 26	24	22	19	16
NL	−0.7	−0.6	−0.4	0.1	0.7
H175	—	—	—	0.4	0.4
D175	0.5	0.5	0.4	0.5	0.5
B175	0.8	0.8	0.7	0.9	0.9
H135	0.2	0.2	0.2	0.2	0.2
D135	0.4	0.3	0.3	0.4	—
B135	0.6	0.6	0.5	0.6	0.6
M88	−0.2	−0.1	−0.1	0	0
H88	0	0	0	0.1	0.1
D88	0.1	0.1	0.1	0.1	0.1
B88	0.3	0.3	0.2	0.3	0.3
H44	−0.3	−0.2	−0.1	0	0

(III) 900-OHM TERMINATION — 1.5:1 RATIO COIL
600-OHM TERMINATION — 2.5:1 RATIO COIL*

LOADING	GAUGE 26	24	22	19	16
NL	−0.5	−0.1	0.3	1.1	1.9
H175	—	—	—	0	0
D175	0.1	0.1	0	0.1	0.1
B175	0.2	0.2	0.1	0.2	0.2
H135	−0.1	0	0	0	0
D135	0	0	0	0	—
B135	0.1	0.1	0.1	0.1	0.1
M88	−0.2	0	0.1	0.2	0.2
H88	−0.1	0	0.1	0.1	0.1
D88	−0.1	0	0	0.1	—
B88	0	0	0	0	0
H44	−0.2	0.1	0.2	0.4	0.3

* These losses do not include the equipment loss of any coil but merely the mismatch reflection loss.

TABLE C

TYPICAL CENTRAL OFFICE EQUIPMENT AND WIRING LOSSES FROM OFFICE MAIN FRAME TO TEST LOCATION *

Originating End

		TYPICAL EQUIPMENT LOSS (db) AT ORIGINATING END TRUNKS TO		
TYPE OF OFFICE	TEST LOCATION	LOCAL OFFICES	LOCAL TANDEM	TOLL OFFICES OR TANDEM WITH TOLL ACCESS
#1 XB	OGT Board	0.1	0.1	0.7 ϕ
#4 XB	AOTC Test Frame	4.0	—	—
#5 XB	Master Test Frame	0.5	0.5	1.1 ϕ
	OGT Board	0.1	0.1	0.7 ϕ
Panel	OGT Board	0.2	0.2	0.8 ϕ
Manual	Switchboard	0.8 ϕ	0.8 ϕ	1.0 ϕ
Step-by-step	Outgoing Trunk Repeater	0.2	0.2	0.8 ϕ
	Outgoing Selector Multiple	0.3	0.3	0.9 ϕ
XB Tandem	OGT Board	0.1	0.1	—
Panel Tandem	OGT Board	0.2	—	—

* There will be considerable variation from office to office in originating and terminating equipment losses, due to wiring and equipment differences. ***Measured values are always to be preferred to the above "typical" values.***

ϕ Assumes presence of repeating coil in equipment path.

TABLE D

TYPICAL CENTRAL OFFICE EQUIPMENT AND WIRING LOSSES FROM OFFICE MAIN FRAME TO TEST LOCATION *

Terminating End

TYPE OF OFFICE	TEST LOCATION	TYPICAL EQUIPMENT LOSS (db) AT TERMINATING END TRUNKS FROM		
		LOCAL OFFICES	LOCAL TANDEM	TOLL OR TANDEM WITH TOLL
#1 XB	SD-96000 Test Line	0.7	1.3 ϕ	1.3 ϕ
#4 XB	" " "	2.0 †	—	—
#5 XB	" " "	0.5	1.1 ϕ	1.1 ϕ
Panel	" " "	1.1	1.7 ϕ	1.7 ϕ
Manual	" " "	0.9 ϕ	0.9 ϕ	0.9 ϕ
Step-by-Step	" " "	0.5	1.1 ϕ	1.1 ϕ
XB Tandem	" " "	1.0 ϕ	1.0 ϕ	—
Panel Tandem	" " "	1.2 ϕ	1.2 ϕ	—
" "	SD-96000 in Local Office in Same Building	2.3	2.3	—

* There will be considerable variation from office to office in originating and terminating equipment losses, due to wiring and equipment differences. ***Measured values are always to be preferred to the above "typical" values.***

ϕ Assumes presence of repeating coil in equipment path.

† Applies to Direct Distance Dialing trunks originating in #5 XBar offices.

TABLE E

REFLECTION LOSSES BETWEEN LONG LENGTHS OF NON-QUADDED CABLE

LOSSES IN DECIBELS

26	M88	−.1																													
	H88	−.2	0																												
	B88	−.2	0	0																											
	H135	−.2	0	0	0																										
24	NL	.1	.1	.1	.2	.2																									
	M88	−.1	0	0	.2	.2	−.1																								
	H88	−.3	0	0	.1	.1	−.1	0																							
	B88	−.2	0	0	0	0	.1	.1	.1																						
	H135	−.3	−.1	0	0	0	0	.1	0	0																					
	B135	−.1	.1	.1	0	0	.4	.3	.2	0	.1																				
22	NL	.3	.5	.5	.8	.7	.1	.2	.3	.7	.5	1.1																			
	M88	−.3	0	.1	.4	.3	−.3	0	.1	.3	.2	.6	−.1																		
	H88	−.4	.1	0	.2	.1	−.3	−.1	0	.2	.1	.4	0	0																	
	B88	−.4	.1	−.1	0	0	−.1	0	0	0	0	.1	.5	.2	.1																
	H135	−.4	.1	−.1	0	0	−.2	0	0	0	0	.1	.3	.1	.1	0															
	B135	−.2	0	0	0	0	.2	.2	.2	0	0	0	.9	.4	.3	.1	.1														
19 HC	NL	.9	1.1	1.3	1.7	1.6	.5	.8	1.0	1.6	1.4	2.1	.1	.5	.7	1.3	1.1	1.9													
	M88	−.4	0	.1	.4	.3	−.4	−.1	.1	.4	.3	.7	−.2	0	.1	.3	.2	.6	.3												
	H88	−.5	0	0	.2	.1	−.4	−.1	0	.2	.1	.4	−.1	0	0	.1	.1	.3	.5	0											
	B88	−.5	−.2	−.1	0	0	−.2	0	0	0	0	.1	.4	.2	.1	0	0	.1	1.2	.3	.1										
	H135	−.5	−.2	−.1	0	0	−.3	−.1	0	0	0	.2	.2	.1	0	0	0	.1	1.0	.2	.1	0									
	B135	−.3	0	0	0	0	.1	.2	.1	0	0	0	.8	.4	.3	0	.1	0	1.8	.5	.3	.1	.1									
19 LC	NL	.7	.9	1.0	1.4	1.3	.3	.5	.7	1.2	1.0	1.7	.1	.3	.4	1.0	.8	1.5	0	.1	.3	.9	.7	1.5							
	M88	−.4	−.1	0	.3	.2	−.4	−.1	0	.2	.2	.5	−.1	0	0	.2	.1	.4	.5	0	0	.2	.1	.4	.3						
	H88	−.5	−.1	−.1	.1	0	−.4	−.1	0	.1	0	.3	.1	0	0	.1	0	.2	.8	.1	0	0	0	.2	.5	0					
	B88	−.4	−.1	−.1	0	0	0	.1	.1	0	0	0	.6	.3	.2	0	0	0	1.5	.4	.2	0	0	0	1.2	.2	.1				
	H135	−.4	−.1	−.1	0	0	−.1	0	0	0	0	.1	.4	.2	.1	0	0	.1	1.3	.3	.1	0	0	0	1.0	.3	.1	0			
	B135	−.2	.1	.1	0	0	.4	.3	.2	.1	.1	0	1.1	.5	.4	.1	.2	0	2.2	.7	.5	.1	.2	0	1.8	.5	.3	.1	.1		
	H175	−.3	.1	0	0	0	.1	.2	.1	0	0	0	.7	.4	.2	0	.1	0	1.7	.4	.2	0	.1	0	1.3	.3	.1	0	0	0		
	B175	.1	.2	.2	.1	.1	.7	.6	.4	.1	.2	0	1.5	.8	.6	.2	.3	.1	2.6	1.0	.7	.2	.3	.1	2.2	.8	.5	.1	.2	0	.1	
16	NL	1.4	1.7	1.8	2.4	2.2	.8	1.2	1.5	2.2	2.0	2.8	.4	.9	1.2	2.0	1.7	2.6	.1	.8	1.1	1.9	1.6	2.5	.1	1.0	1.4	2.2	1.9	2.7	2.4	3.4
	H175	−.3	−.1	−.1	0	−.1	.1	.1	.1	0	0	0	.7	.3	.2	0	.1	0	1.7	.4	.3	0	.1	0	1.3	.3	.2	0	0	0	0	.1
		NL	M88	H88	B88	H135	NL	M88	H88	B88	H135	B135	NL	M88	H88	B88	H135	B135	NL	M88	H88	B88	H135	B135	NL	M88	H88	B88	H135	B135	H175	B175
		26					24						22						19 HC						19 LC							

	NL
	16