MAINTENANCE OF LARGE CATV SYSTEMS

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The San Diego CATV System began operation in 1962. Today it is the largest system in the United States with more than 49,000 subscribers and 660 miles of distribution plant. The system employs 64 technicians and installers and has a fleet of 51 trucks and vans. Three head-ends are needed to cover the area of the system. A Micro-wave link connects the system to the origination studio. Two-way radio is used extensively for communications but also controls non-duplication switching of the three head-ends from a central point.

In 1970 the City of San Diego passed an Ordinance governing the performance of CATV systems within the city boundary. Some of the technical specifications of this Ordinance are shown in Figure 1. While these specifications seem very reasonable, it must be realized that these are minimums for any point in the system including the subscriber's termination. This fact, coupled with long amplifier cascades, make exceeding these specification minimums more difficult. During the nine years it has been in operation, Transvideo has developed maintenance methods and procedures which make it possible to accomplish this. The main areas of maintenance fall into seven categories which I will discuss briefly.

HEAD-END MAINTENANCE

The three head-ends are routinely maintained by one highly trained technician. This man and his equipment are completely separate from the rest of the system so that he can give his undivided attention to this important function. Each week the head-ends are checked for signal levels, AGC and AFC action and the quality of video on each channel. Spurious frequency generation is investigated using a spectrum analyzer. A frequency counter is utilized to check the output carrier frequency of processors and modulators. Each month input levels to the antenna system and processors are checked for quality and level. Signal to noise and signal to hum are read and recorded. Every six months processors and other equipment are checked for alignment and response. Two forms have been developed for head-end maintenance. Figure 2 is used to record data at the various inspection

times. Figure 3 is used in conjunction with the antenna system at time of installation and serves as a record of equipment configuration and signal condition on each channel.

TRUNK MAINTENANCE

The San Diego system is divided into service areas and technicians are assigned to each area. They normally work only in this part of the system and become very familiar with it. The condition of the trunk system is mainly determined by a series of test-monitor points strategically located in each of the three systems (Figure 4). Each maintenance day begins with a check of channel levels and quality at each of these points by the assigned technician. The result of these checks is relayed to the chief technician by radio who can then take proper remedial action. Most of the maintenance and trouble calls are dispatched by radio which eliminates delay. After reporting the monitor points the technician continues with routine balancing and system check out. Figure 5 shows the form used by the technician to report defective equipment in his area.

The test monitor points were established by inserting directional couplers in an output line of bridger amplifiers. This provides the highest signal level on the system so that the noise figure of the signal level meter will not be a factor. The signal to noise ratio of all channels at each monitor point is logged every three months using methods covered in NCTA Standards 005-C. This is done during non-broadcasting hours. Relative signal to noise readings can be taken during normal service hours by reading the noise above channel six or below channel seven. Care must be taken, however, that no FM or Commercial radio stations are present. Figure 6 is a compilation of some of the results obtained using these methods.

Monitor points are also used to determine cross modulation levels and system stability. Twenty-four hour recordings are made of one low-band and one highband channel at three months intervals. Figure 7 is a condensed recording showing proper action of the system. Figure 8 shows an abnormal system condition with improper AGC action or thermal control. Finally, the monitor points are used in conjunction with a spectrum analyzer to check for spurious products. (Figure 9) This form is used to record the above monitor point data. (Figure 10 and 11). These forms are used as records for each amplifier in the system.

SYSTEM RADIATION MAINTENANCE

In each service area routine radiation checks are made following the methods outlined in FCC Rules and Regulations Part 15 sub-part D.

Not only are non-subscribers protected, but system integrity to the high level signals of local broadcasters is maintained.

DIRECT PICK-UP PROCEDURES

Due to the number of Los Angeles signals carried by the system, it is necessary to carry the local channels 6, 8, 10, 12 on the system on frequency.

Much testing and evaluation is necessary to minimize the direct signal present at most subscribers' sets. Hilly terrain and the fact that two transmitters are located in Mexico prevent a uniform approach to the problem. Switches, better shielded drop cable, balanced transiormers, high subscriber signal level, grounding and other methods are used to combat this problem. Naturally, none of these methods will work if the direct signal penetrates the distribution system. This makes the system integrity check used in radiation work doubly important. The form shown here in Figure 12 is used for both radiation and direct pick-up work.

DISTRIBUTION AND SUBSCRIBER MAINTENANCE

The mobility of the area trunk maintenance men is duplicated by the service technicians who cover the distribution plant and subscriber maintenance. These men are also assigned to specific areas and receive most of their calls by radio. The subscriber call is taken by a dispatcher who logs it in his Daily Work Report (Figure 13) and radios the call to the service man. At the home, all the channel levels are read and recorded as well as an analysis of the problem. A separate form is used (Figure 14) for each service call and turned into the dispatcher at the end of the day. Considerable importance is attached to subscriber level readings as these random samples of the system often serve as a good indication of conditions of the distribution plant. Any cases of direct pick up are also noted and passed on to a special group handling this work. A similar procedure is used for new installations.

COLLECTION AND ANALYSIS OF SYSTEM DATA

System data is derived from two sources--trunk maintenance and subscriber maintenance. Trunk data is derived from the form shown

previously and is put into program form for computer analysis by the system chief technician. Subscriber data is derived by the dispatcher. When he receives the subscriber trouble call he verifies it against his work sheet and then fills out a Customer Service Call form (Figure 15). Data for the computer is taken from this card. Each month this information is fed to the computer which is programmed to analyze it by types of trunk and subscriber trouble, solutions to the problem, subscriber identity including phone number, technician identity etc. The computer tabulation allows us to determine the efficiency of maintenance being performed in an area and indirectly indicates plant conditions. The constant flow of data from these service areas is used to determine the overall system status and dictates what action is needed. Using these methods, we have been able to detect developing problems before they became the cause of widespread outage.

EQUIPMENT REPAIR

Complete records are kept on equipment from the time it is initially installed. Bench technicians work independently from the rest of system maintenance. In such a large system a constant program of equipment repair is necessary and vital.

SUMMARY

In conclusion let me point out that the degree and complexity of system maintenance obviously increases with system size. When large numbers of subscribers are involved, it becomes mandatory to keep ahead of developing system problems. If I were to pick the most important maintenance feature of the San Diego system it would have to be the establishment and full utilization of monitor points. An example of the effectiveness of this program is the decrease in subscriber trouble calls this past year. At the beginning of 1970 we were averaging a ratio if trouble calls/month to subscribers of over 3.5%. In May of this year the trouble call ratio was 1.2% or about 30% of the 1970 figure.

San Diego Ordinance Specifications

Minimum Subscriber Level . . . . . 0 dBmV at 75 Ohms

Minimum S/N at Any Point . . . . . 34 dB at 4 MH_z

Cross Modulation at Any Point . . . . . −46 dB at 32° F

Spurious Products . . . . . −46 dB

Hum Modulation . . . . . 3 %

Multiburst Response . . . . . F.C.C. Sec. 73.687 (a)

Radiation . . . . . F.C.C. Part 15 Subpart D

Figure — 1

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ANTENNA SITE OPERATIONAL REPORT FORM

Location: Date:

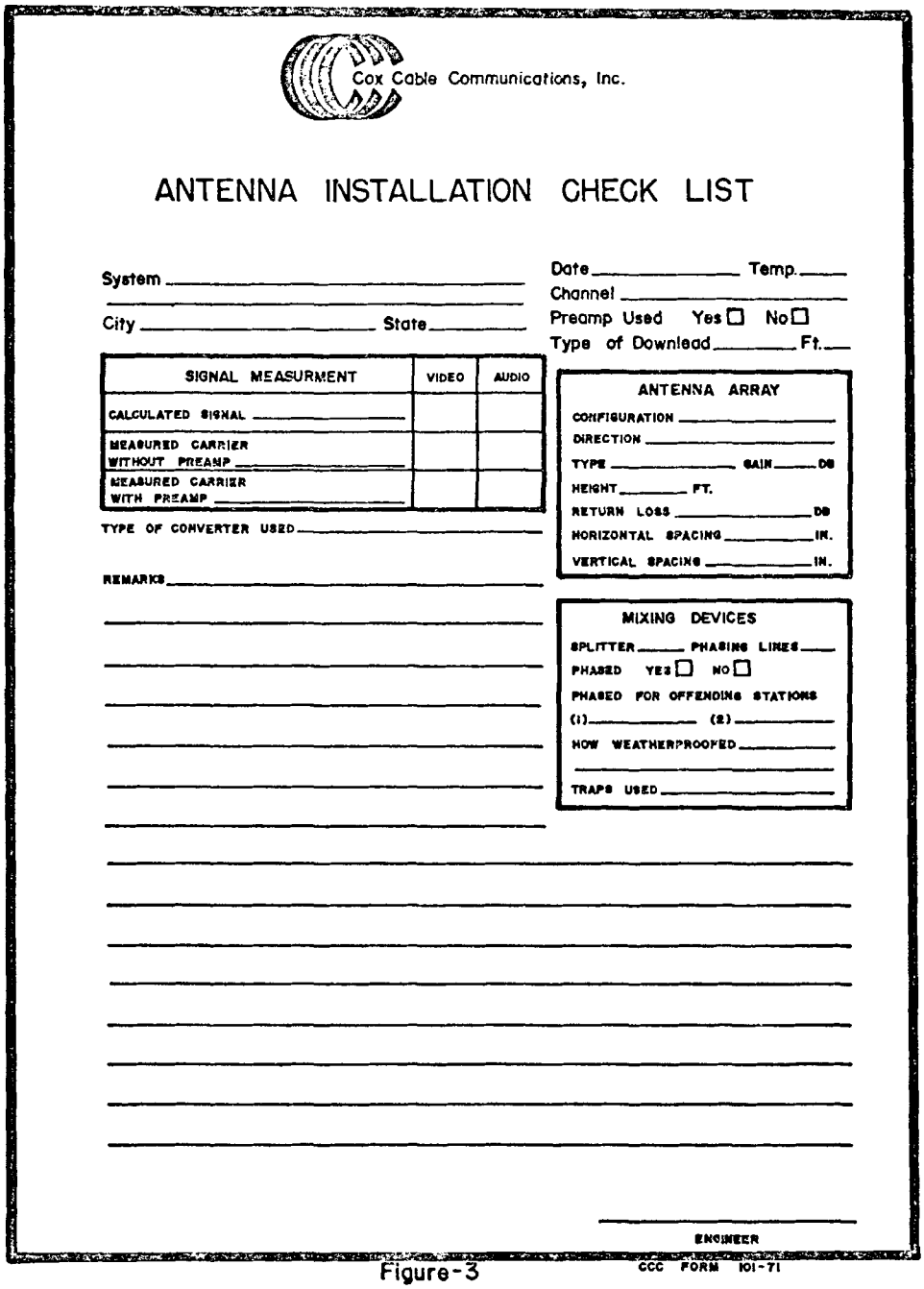
Com. Ch.	Date Tube	Date Aligned	S/N Ratio	AGC Oper.	St. By Carrier	Operating Levels	Trap Al. Date	Beats, Problems or Component Change-Outs
2						in / out		
3						in / out		
4						in / out		
5						in / out		
6						in / out		
7						in / out		
8						in / out		
9						in / out		
10						in / out		
11						in / out		
12						in / out		
13						in / out		

Pre-Amp Ch.				Levels	UHF Conv. Ch.	Date Tube	Date Aligned	S/N Ratio	Output Level	Mixing Network
				in / out						tube
				in / out						align
				in / out						sweep
				in / out						
				in / out	Hi CCG	Out	Tube			
				in / out	Lo	Out	Tube			

Remarks:

Signed: Title: Approval:

Figure – 2



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ANTENNA INSTALLATION CHECK LIST

System _____ Date _____ Temp. ____

_____ Channel _____

City _____ State _____ Preamp Used Yes ☐ No ☐

Type of Downlead _____ Ft. ____

SIGNAL MEASURMENT	VIDEO	AUDIO
CALCULATED SIGNAL _____		
MEASURED CARRIER WITHOUT PREAMP _____		
MEASURED CARRIER WITH PREAMP _____		

TYPE OF CONVERTER USED _____

REMARKS _____

ANTENNA ARRAY

CONFIGURATION _____

DIRECTION _____

TYPE _____ GAIN ____ DB

HEIGHT _____ FT.

RETURN LOSS _____ DB

HORIZONTAL SPACING _____ IN.

VERTICAL SPACING _____ IN.

MIXING DEVICES

SPLITTER ____ PHASING LINES ____

PHASED YES ☐ NO ☐

PHASED FOR OFFENDING STATIONS

(1) _____ (2) _____

HOW WEATHERPROOFED _____

TRAPS USED _____

_____

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Figure-3

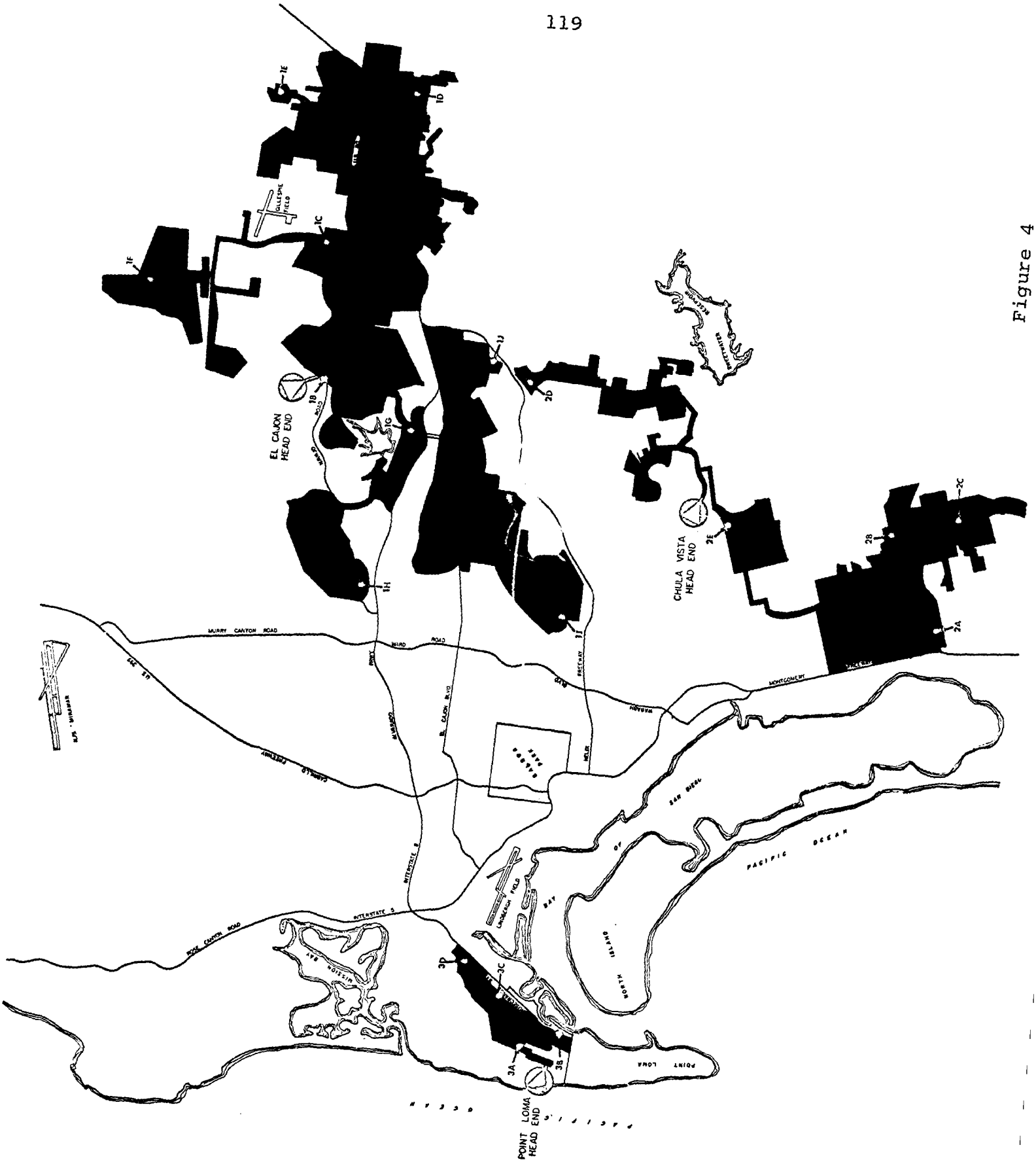

EL CAJON HEAD END
CHULA VISTA HEAD END
POINT LOMA HEAD END
MURRY CANYON ROAD
MISSION BAY
SAN DIEGO BAY
PACIFIC OCEAN
POINT LOMA
NORTH ISLAND
LINDBERGH FIELD
GILLESPIE FIELD
MONTGOMERY

Figure 4

TRUNK PROBLEM REPORT

Location _____ Date _____

	In	Out		In	Out
Ch. 2			7		
3			8		
4			9		
AGC			10		
5			11		
6			12		
			13		

Pad _____

Equal. _____

Problem _____

Type of Equipment _____

Remarks:

Turned in By:

Completed By:

Date _____

Figure - 5

Location	Amplifier Cascade	Theoretical S/N	Actual S/N	NCTA 005-C S/N	Band Edge S/N					
					Ch. 2	73.5 MHz	Ch. 6	Ch. 7	Ch. 13	
EL CAJON										
1B	2	53	53.7	49.2	34	48	53	55	51	
1C	14	44.6	46.2	43.1	33	44	44	49	47	
1D	30	41.2	42.5	41.6	36	41	40	45	44	
1E	31	41.1	41.8	40.7	32	42	46	44	46	
1F	27	41.7	42.9	39.6	31	39	43	44	35	
1G	13	44.9	42.6	43.3	34	37	40	41	32	
1H	24	42.2	42	42	36	40	41	44	36	
1I	35	40.6	38	41.4	33	38	38	39	31	
1J	28	41.5	40.7	40.4	36	41	41	44	39	
CHULA VISTA										
2A	26	41.9	41.4							
2B	27	41.7	39.7							
2C	33	40.9	38.3							
2D	18	43.5	45.6							
2E	6	48.2	49.2							
POINT LOMA										
3A	2	53	49.6							
3B	8	47	43.3							
3C	9	46.5	42.5							
3D	16	44	39.3							

Figure – 6

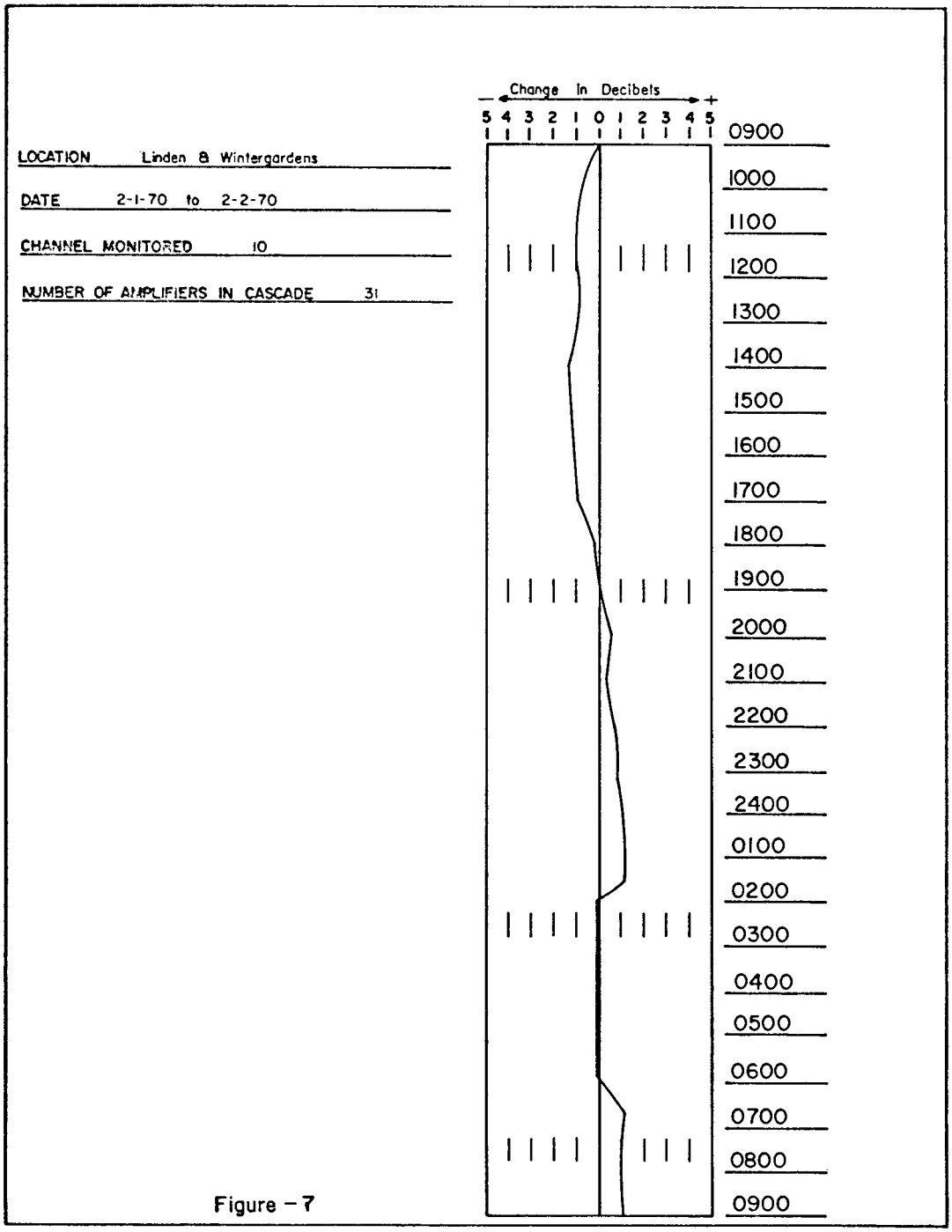

LOCATION Linden & Wintergardens
DATE 2-1-70 to 2-2-70
CHANNEL MONITORED 10
NUMBER OF AMPLIFIERS IN CASCADE 31
Change In Decibels
5 4 3 2 1 0 1 2 3 4 5
0900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900

Figure – 7

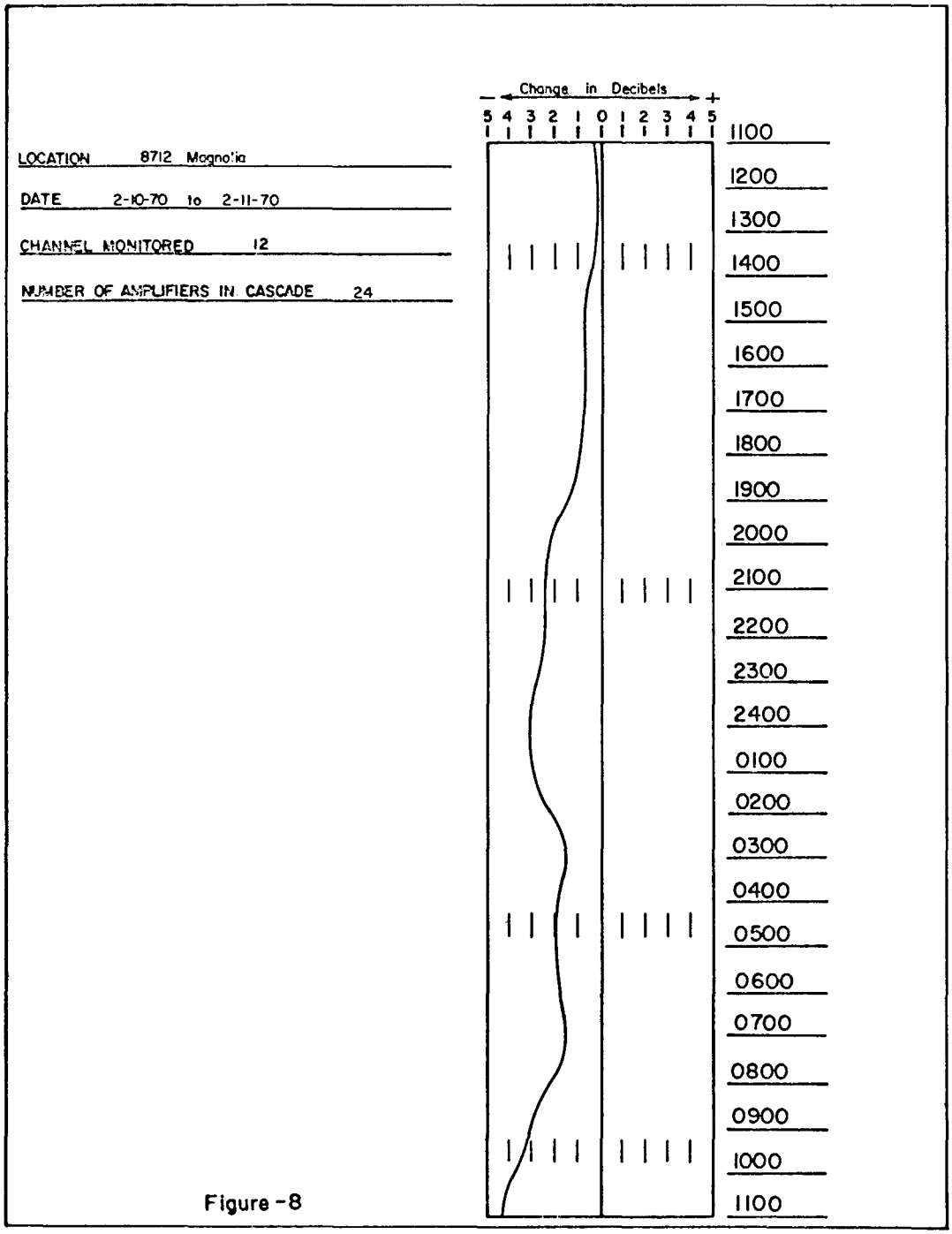
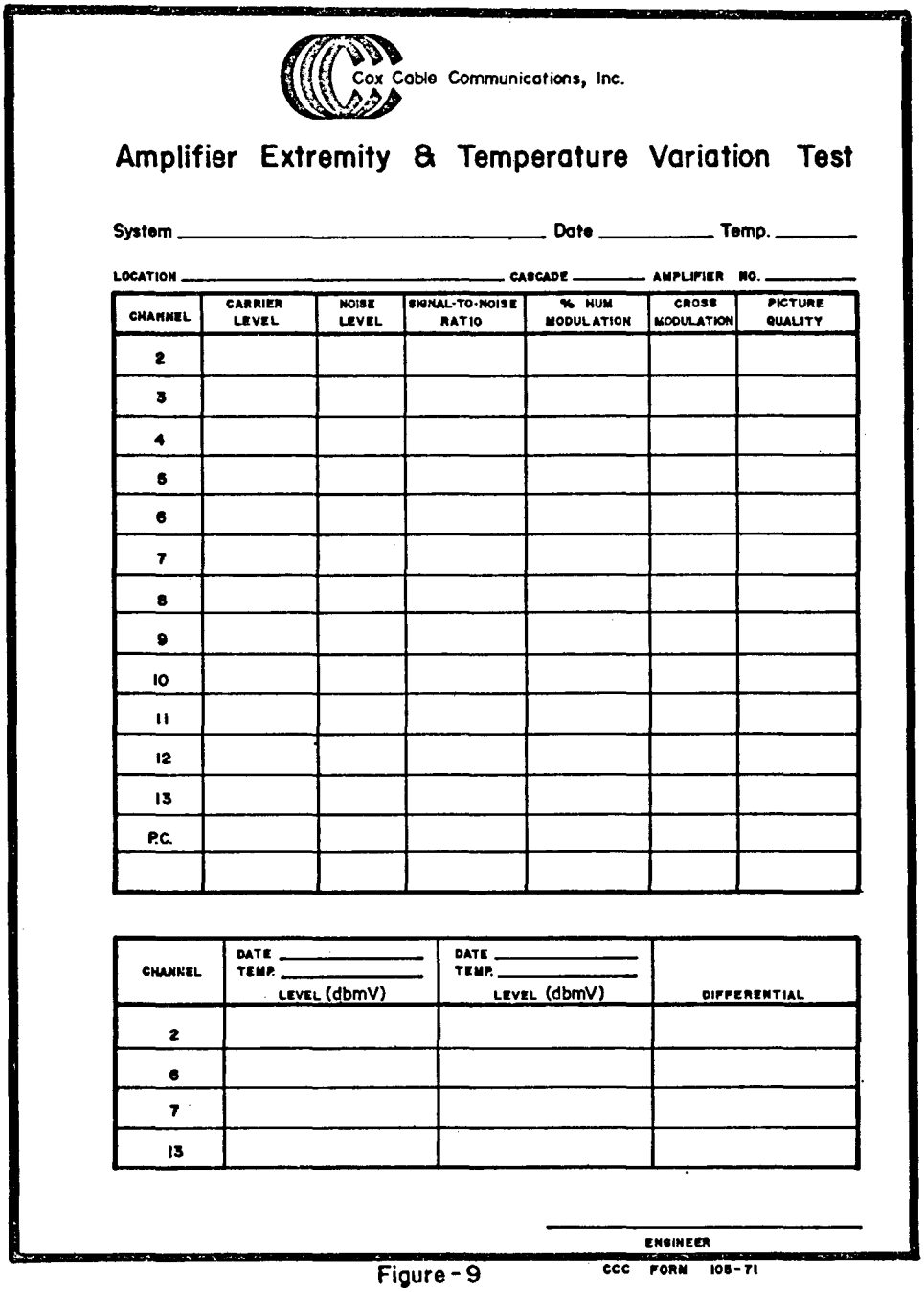

LOCATION 8712 Magnolia
DATE 2-10-70 to 2-11-70
CHANNEL MONITORED 12
NUMBER OF AMPLIFIERS IN CASCADE 24
Change in Decibels
5 4 3 2 1 0 1 2 3 4 5
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
1100

Figure -8



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Amplifier Extremity & Temperature Variation Test

System _____ Date _____ Temp. _____

LOCATION _____ CASCADE _____ AMPLIFIER NO. _____

CHANNEL	CARRIER LEVEL	NOISE LEVEL	SIGNAL-TO-NOISE RATIO	% HUM MODULATION	CROSS MODULATION	PICTURE QUALITY
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
P.C.						

CHANNEL	DATE _____ TEMP. _____ LEVEL (dbmV)	DATE _____ TEMP. _____ LEVEL (dbmV)	DIFFERENTIAL
2			
6			
7			
13			

_____
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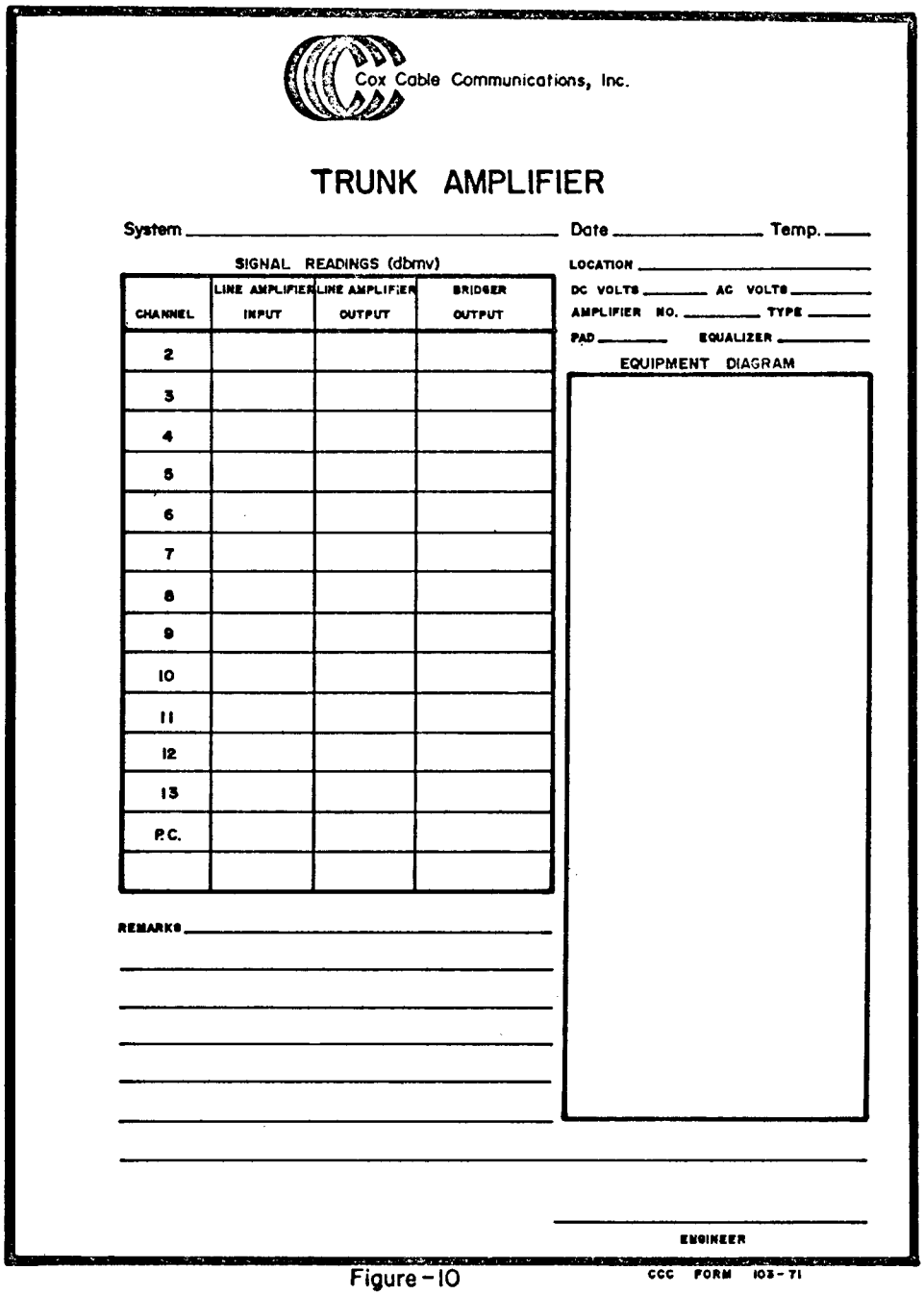
Figure - 9



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TRUNK AMPLIFIER

System _____ Date _____ Temp. _____

SIGNAL READINGS (dbmv)

CHANNEL	LINE AMPLIFIER INPUT	LINE AMPLIFIER OUTPUT	BRIDGER OUTPUT
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
P.C.			

LOCATION _____

DC VOLTS _____ AC VOLTS _____

AMPLIFIER NO. _____ TYPE _____

PAD _____ EQUALIZER _____

EQUIPMENT DIAGRAM

REMARKS _____

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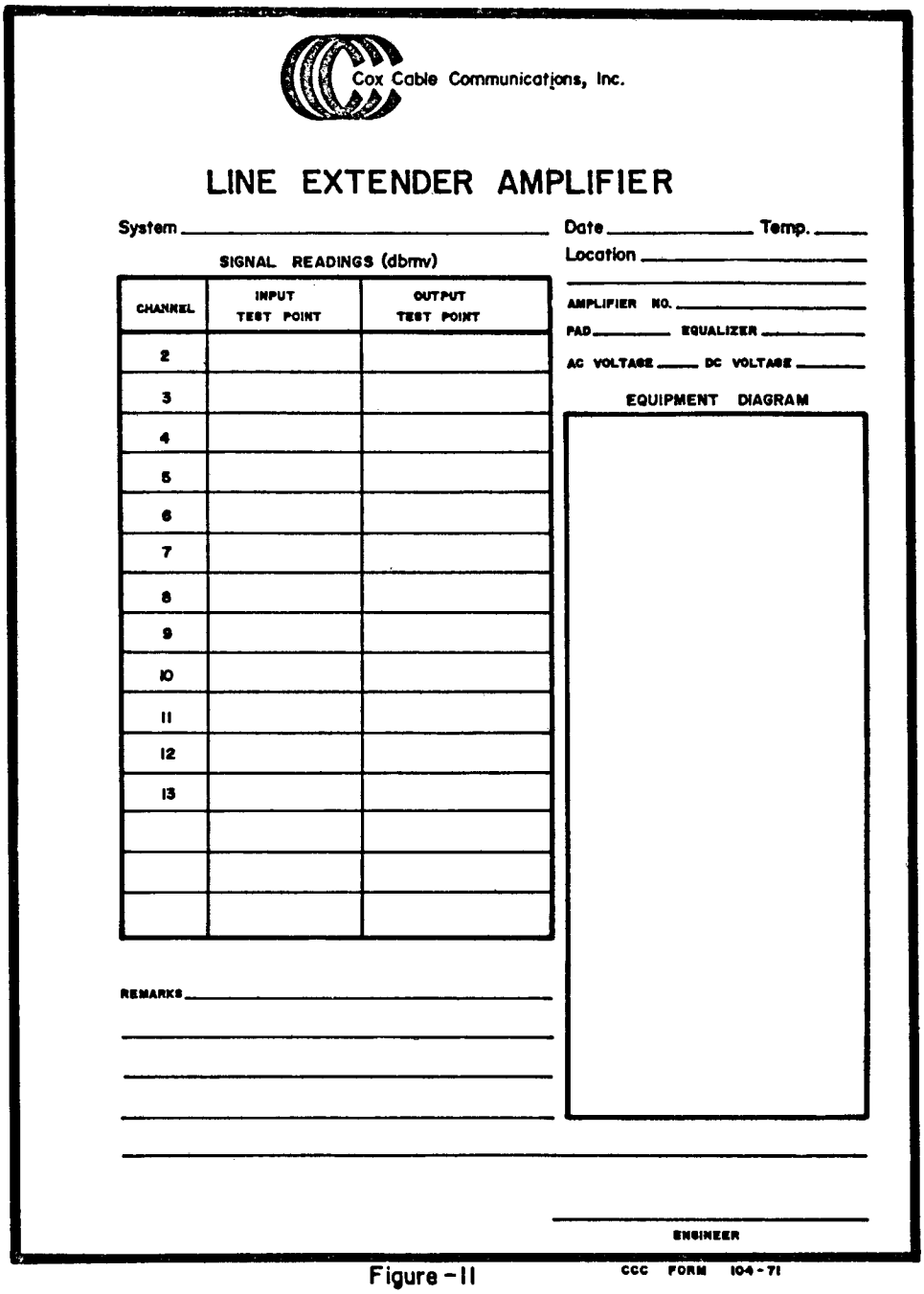
Figure - 10



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LINE EXTENDER AMPLIFIER

System _____ Date _____ Temp. _____

Location _____

_____

AMPLIFIER NO. _____

PAD _____ EQUALIZER _____

AC VOLTAGE _____ DC VOLTAGE _____

SIGNAL READINGS (dbmv)

CHANNEL	INPUT TEST POINT	OUTPUT TEST POINT
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		

EQUIPMENT DIAGRAM

REMARKS _____

_____

_____

_____

_____

_____

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Figure - 11

NAME _____ ADDRESS _____

DIVISION _____ DATE _____

DIRECT PICKUP REPORT

1. System trunk and feeder cable radiation

   SECTION _____

   SLM TYPE _____

   CALIBRATION DATE _____

   ANTENNA USED _____ ANTENNA GAIN _____

   CHANNEL MEASURED _____

   DISTANCE FROM CABLE _____

   RADIATION LEVEL IN MICROVOLTS _____

   ACTION TAKEN: ☐ NONE ☐ SPLICE ☐ CONNECTOR ☐ CABLE BREAK

   NEW RADIATION LEVEL AFTER REPAIR (IN MICROVOLTS) _____

2. DIRECT PICKUP ON CUSTOMER SERVICE DROP

   (a) Leakage found on cable _____ set _____

   (b) Method used to test leakage: converter _____ shielded set _____

   (c) Other methods _____

   (d) Channels affected _____

ACTION TAKEN

   (a) New house drop _____ Type cable used _____

   (b) Transformer _____ Type _____

   (c) Switch Transformer _____ Type _____

   300 OHM side of switch connected to: ☐ Rabbit ears
   ☐ Built in antenna ☐ Outdoor antenna ☐ Nothing

   (d) Pickup results _____

   _____

   _____

Signal 1st reading 2 _____ 6 _____ 8 _____ 10 _____ 13 _____

Signal adjusted to 2 _____ 6 _____ 8 _____ 10 _____ 13 _____

Figure – 12

DAILY WORK REPORT SERVICE **CABLE TV** CALLS

DATE

	Name	Address	Phone	Trouble	TBW Code	Appt. Time	Tech	Code	Time
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									

Figure-13

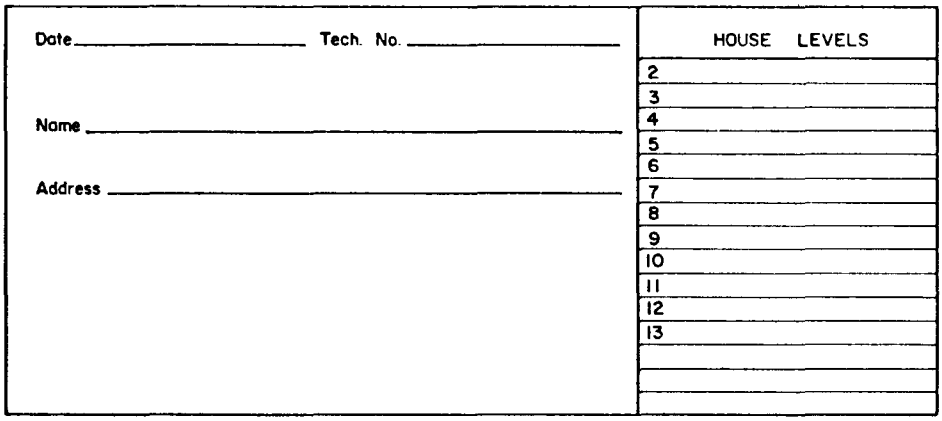

Figure – 14

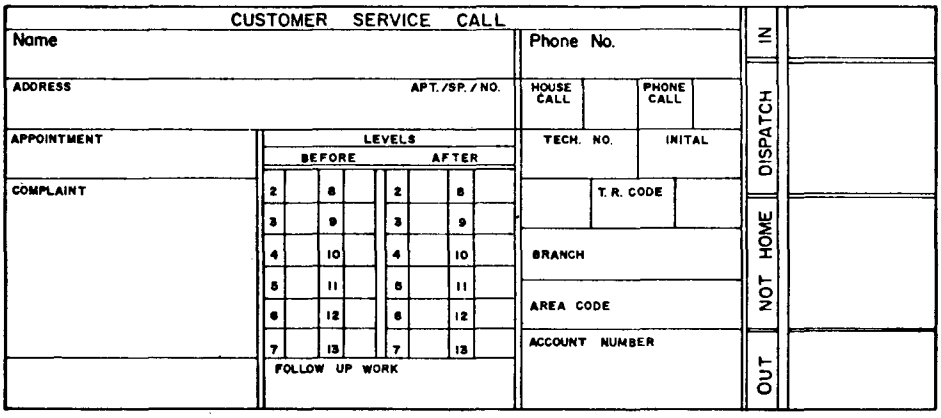

Figure – 15