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NAFEC TECHNICAL LETTER REPORT

NA-79-36-LR

NA- 79-36-LR

DISTANCE MEASURING EQUIPMENT

TRAFFIC LOADING CAPACITY INVESTIGATION

(1979)

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by Harold Postel

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TABLE OF CONTENTS

	PAGE
ABSTRACT	1
PURPOSE	2
BACKGROUND	2
TEST CONFIGURATION	2
FIELD TEST RESULTS	3
CONCLUSIONS	5
RECOMMENDATIONS	6

LIST OF FIGURES

Figure 1. Test Configuration	7
Figure 2. Print of Data Collection Record	8
Figure 3. Print of Data Collection Record	9
Figures 4, 5, 6. Measured Interrogation Rate, Los Angeles, California	10-12
Figures 7, 8, 9, 10. Measured Interrogation Rate, Oakland, California	13-16

TABLES

Table 1 Range of DME Traffic Loading	4

ABSTRACT

This phase of the project was performed in response to FAA Form 9550-1, AAF-410-77-08, dated August 17, 1977, as extended by memo dated December 11, 1978. This report covers the findings of the Distance Measuring Equipment (DME) traffic counts from selected facilities. Several facilities tested during the data collection period in 1977 showed loading in excess of 50 percent. This report provides an update of the (DME) traffic loading at the Los Angeles, California and Oakland, California, VORTACS. The results show both facilities experienced an increase of approximately 20 percent in (DME) traffic loading. Further testing should be performed to provide periodic updates of (DME) traffic loading at other key facilities.

PURPOSE

To update current distance measuring equipment (DME) traffic loading at the Los Angeles, California VORTAC, and the Oakland, California VORTAC. The data obtained will provide an update of data previously collected.

BACKGROUND

Development of a method for recording the number of distance measuring interrogations to a very high frequency omnirange - TACAN (VORTAC) was assigned to the National Aviation Facilities Experimental Center (NAFEC) in March 1970. Report No. FAA-RD-71-109, dated February 1972, "Investigate and Analyze DME Traffic Load," details the method and approach actually developed. Application of the method is described in the following reports:

FAA-RD-74-93, Distance Measuring Equipment and Traffic Loading Capacity Investigation. 6/72.

FAA-78-48-LR, Distance Measuring Equipment Traffic Loading Capacity Investigation (1977), 7/78.

FAA-79-4-LR, Distance Measuring Equipment Traffic Loading Capacity at Key Biscayne, Florida, 2/79.

Several facilities tested during the data collection period in 1977 showed loading in excess of 50 percent. Some concern was also expressed as to whether any change in the signal-to-noise ratio occurred during commercial power failure when standby diesel power was in use. This report is a result of the tests performed at the Los Angeles, California VORTAC, and the Oakland, California VORTAC, to provide an update to establish the present level of traffic loading as compared with previous levels taken in 1974.

TEST CONFIGURATION

The measurement technique was employed at the Key Biscayne, Florida VORTAC (ref: NA-79-4-LR) during commercial power operation and during diesel power operation. The equipment consisted of a Hewlett Packard 5328A programmable counter, a Tektronix 4051 graphic system with a direct view storage cathode ray tube with full American National Standard Code for Information Interchange (ASCII) character set, General Purpose Interface Bus (GPIB), and a tape drive consisting of a

3M DC 300A cartridge with a capacity of 300K bytes which is an integral part of the 4051 graphic system, and a Hewlett Packard 59300A HP-IB digital clock which controlled the sampling time of the data being collected.

The test setup during this phase of the test is portrayed in Figure 1. Video output of the intermediate frequency (IF) amplifier from the RTB-2 was fed to the HP-5328A counter A input. (The video signal was taken from the beacon of the RTN-2 TACAN system or from the future-use jack on the rear of the GRN-9A receiver.) Terminals 13 and 14 on Terminal Board 11511 (the traffic overload warning to the RTC-2) was connected to the voltmeter portion of the HP-5328A counter. It should be noted that, in the AN/GRN-9 beacon, there is no interrogation overload circuitry. The output of the counter and an HP-59309A clock were connected to the 4051 terminal via an IEEE-488 instrumentation bus.

The programmable Hewlett-Packard 5328A counter has the capability of precisely measuring the trigger point which was used to insure that only valid interrogations above the noise would generate a count. It took 54 one-second video output samples per minute, averaged the samples, and then stored them on the 3MDC300A cartridge. The beacon test points were selected to record all interrogations being received before decoding takes place. At this test point, a count of 5400 pulses per second (PPS) represents a fully loaded system). A printout of data recorded during this operation is shown in Figure 2. The first column is the average of 54 interrogation counts taken during a 60-second period; the second column the date; the third the time; the fourth is a measure of the interrogation overload voltage; and the last column is the sequential number of the sample taken.

The average 48 volts shown for the interrogation overload voltage is the normal voltage measured at TB11511-13 and 14 in the RTB-2 receiver. When an overload condition occurs, this voltage goes to zero.

FIELD TEST RESULTS

Graphic displays of the time of day, versus percent of traffic loading, are shown in Figures 4 through 10. A fully loaded system would be indicated by a count of 5400 pps. The percent of loading was calculated by dividing the measured interrogation pulses by 54. The data displayed on the graphs were recorded at the rate of 54 samples per minute, averaged and then printed out as shown in Figures 2 and 3.

The range of (DME) traffic loading in percent past and present recorded at Los Angeles, California and Oakland, California are shown in the following tables:

Table 1 Range of DME Traffic Loading

Los Angeles, California

1 Traffic Loading %	2 Day of Week	3 Date	4 Traffic Loading %	5 Day of Week	6 Date
6-32	Tuesday	7/17/77	11-50	Tuesday	4/3/79
4-34	Wednesday	7/18/77	10-50	Wednesday	4/4/79
9-21	Thursday	7/19/77	16-52	Thursday	4/5/79

Oakland, California

1 Traffic Loading %	2 Day of Week	3 Date	4 Traffic Loading %	5 Day of Week	6 Date
1-18	Monday	7/12/77	3-28	Monday	4/2/79
1-13	Tuesday	7/17/77	2-40	Tuesday	4/3/79
1-12	Wednesday	7/18/77	2-37	Wednesday	4/4/79
1-13	Thursday	7/12/77	2-32	Thursday	4/5/79
1-18	Friday	7/13/77	2-38	Friday	4/6/79

The interrogation overload relay voltage being monitored at the Los Angeles, California VORTAC, went to zero volts at 0931 hours on April 3, 1979, for approximately 1 minute. The recorded data shown in Figure 2 does not show that the interrogation rate recorded during this period was at a level that would normally activate this relay. A count of approximately 2500 pulse pairs would normally activate this relay. One possibility of this relay becoming energized is the presence of an interferring CW signal.

Analysis of the data collected at the Los Angeles, California, and Oakland, California VORTACs showed that an increase in the interrogation rate was experienced at both facilities. The table below is a tabulation of the changes, which were derived from averaging the peaks of the interrogation rates during a five-day data collection period in 1977 and subtracting the results from the average of the data collected during a similar five-day period in 1979.

Facility	Percent Change Interrogation Rate
Los Angeles, California	+20%
Oakland, California	+22%

To prove that the standby diesel generator did not introduce noise into the receiver, during interruption of commercial power, the one at the Los Angeles VORTAC was operated during April 5, 1979. No increase in noise level or other effect on operation of the beacon was noted. Figure 5 is a plot of the data collected during this operation.

CONCLUSIONS

1. The Los Angeles, California VORTAC is being interrogated at rates in excess of 50 percent during heavy traffic periods.

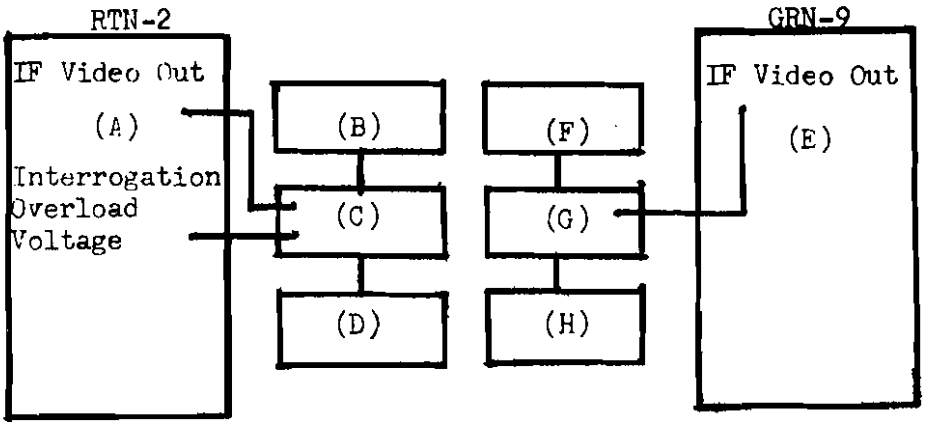
2. The standby diesel generator did not adversely affect beacon operation

RECOMMENDATIONS

1. That other facilities be retested to provide further inputs as to trends in traffic increase.

2. Funds be made available to purchase additional equipment to monitor more facilities utilizing remote monitoring techniques.

This project was accomplished under NPD 04-309, Subprogram 042-306-810. For further information, contact Harold Postel, ANA-120, or Edward M. Sawtelle, NAFEC Program Manager, ANA-120, telephone FTS-8-346-3913, commercial 609-641-8200, extension 3913.



A - RTN-2 Beacon Receiver
B - Tektronix 4051 Terminal
C - Hewlett-Packard 5328A Programmable Electronic Counter
D - Hewlett-Packard 59309A Clock
E - GRN-9 Beacon Receiver
F - Tektronix 4051 Terminal
G - Hewlett-Packard 5328A Programmable Electronic Counter
H - Hewlett-Packard 59309A Clock

Figure 1. Test Configuration

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Figure 2. Print of Data Collection Record

Interrogations	Date	Time	Interr. Voltage	Sample Number
LAX,LA,CALRTB-2	04:03:08:53:48			
1923.778	3	8 54	48.3	1
1896.833	3	8 55	48.5	2
2312.148	3	8 56	48.4	3
2173.556	3	8 57	48.3	4
2141.463	3	8 59	48.4	5
2202.796	3	9 0	48.4	6
2175.852	3	9 1	48.4	7
2100.685	3	9 2	48.4	8
2315.259	3	9 3	48.3	9
2486.556	3	9 4	48.3	10
2364.852	3	9 5	48.4	11
2453.056	3	9 6	48.3	12
2688.148	3	9 7	48.4	13
2568.833	3	9 8	48.3	14
2634.241	3	9 9	48.3	15
2699.037	3	9 10	48.3	16
2504.370	3	9 11	48.5	17
2096.815	3	9 12	48.3	18
2392.963	3	9 13	48.3	19
2094.444	3	9 14	48.3	20
2404.944	3	9 15	48.3	21
2621.611	3	9 16	48.4	22
2218.074	3	9 17	48.4	23
2438.630	3	9 18	48.3	24
2085.630	3	9 19	48.3	25
2122.852	3	9 20	48.4	26
2092.481	3	9 21	48.4	27
1847.648	3	9 23	48.3	28
1826.907	3	9 24	48.4	29
1448.318	3	9 31	0.0	30 ←
1812.759	3	9 32	48.4	31
1610.870	3	9 33	48.4	32
1830.519	3	9 34	48.4	33
1547.759	3	9 35	48.4	34

Figure 3. Print of Data Collection Record

Interrogations	Date	Time	Interr. Voltage	Sample Number
LAX,LA,CAL	RTB-2	04:05:08:31:40		
2179.148	5 8	32	48.5	1
2072.019	5 8	33	48.5	2
2095.463	5 8	34	48.5	3
2696.722	5 8	35	48.5	4
2899.759	5 8	36	48.4	5
2110.444	5 8	37	48.5	6
1800.889	5 8	38	43.4	7
2021.093	5 8	40	48.5	8
1688.296	5 8	41	48.4	9
1576.259	5 8	42	48.5	10
1998.685	5 8	43	48.5	11
2235.722	5 8	44	48.4	12
1968.333	5 8	45	48.5	13
2203.815	5 8	46	48.4	14
2292.204	5 8	47	48.4	15
1996.778	5 8	48	48.4	16
2021.889	5 8	49	48.5	17
2101.111	5 8	50	48.3	18
1879.093	5 8	51	48.4	19
2266.685	5 8	52	48.4	20
2123.759	5 8	53	48.5	21
2080.944	5 8	54	48.4	22
1838.741	5 8	55	48.4	23
2304.222	5 8	56	48.4	24
1798.389	5 8	57	48.4	25
2156.667	5 8	58	48.5	26
2029.537	5 8	59	48.4	27
1756.963	5 9	0	48.4	28
1980.444	5 9	1	48.4	29
1943.333	5 9	2	48.4	30
1931.185	5 9	4	48.4	31
1994.648	5 9	5	48.4	32
1874.685	5 9	6	48.5	33
1779.056	5 9	7	48.4	34

FIGURE 4
Measured Interrogation Rate

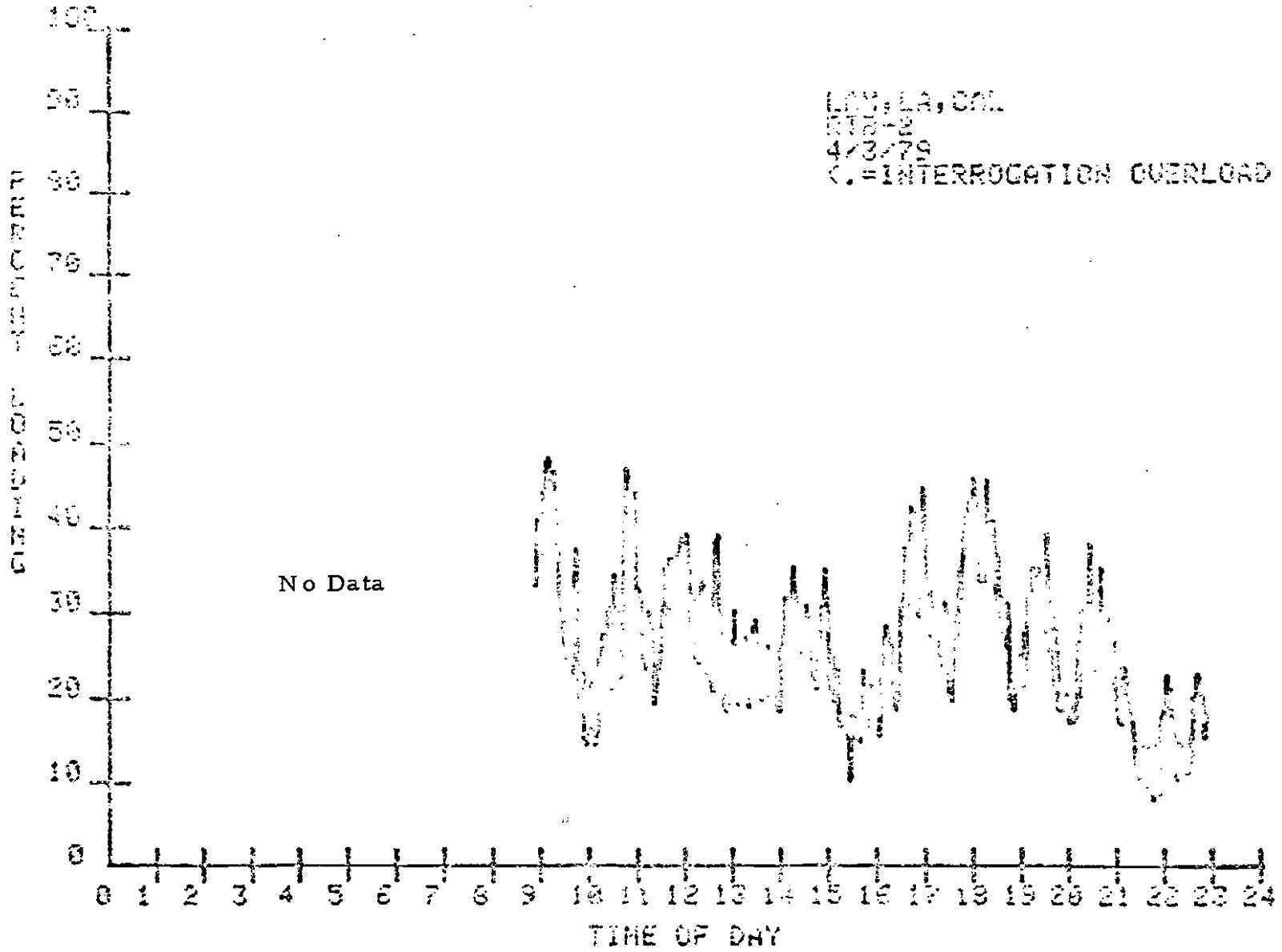


FIGURE 5 - Measured Interrogation Rate

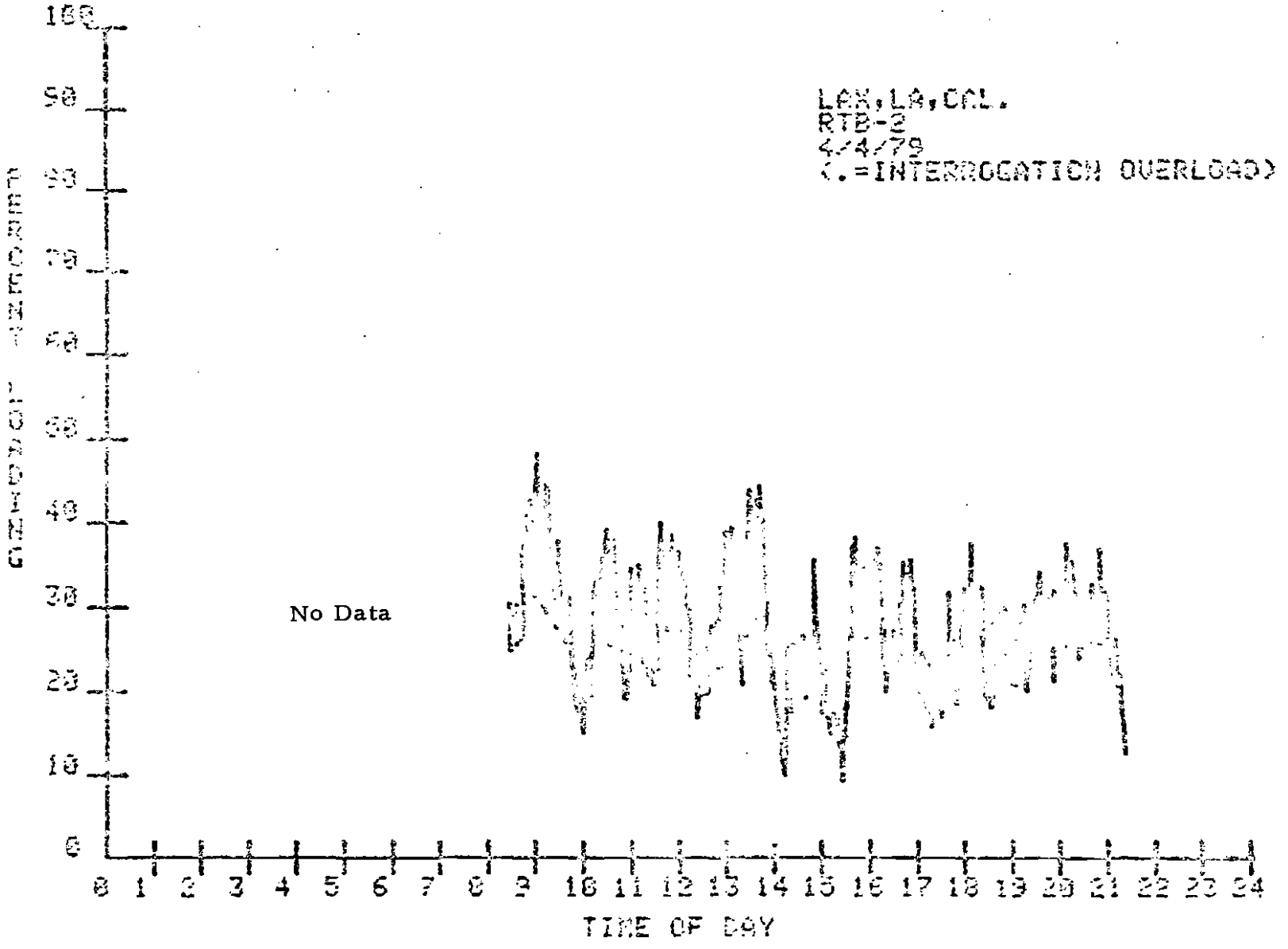


FIGURE 6 - Measured Interrogation Rate

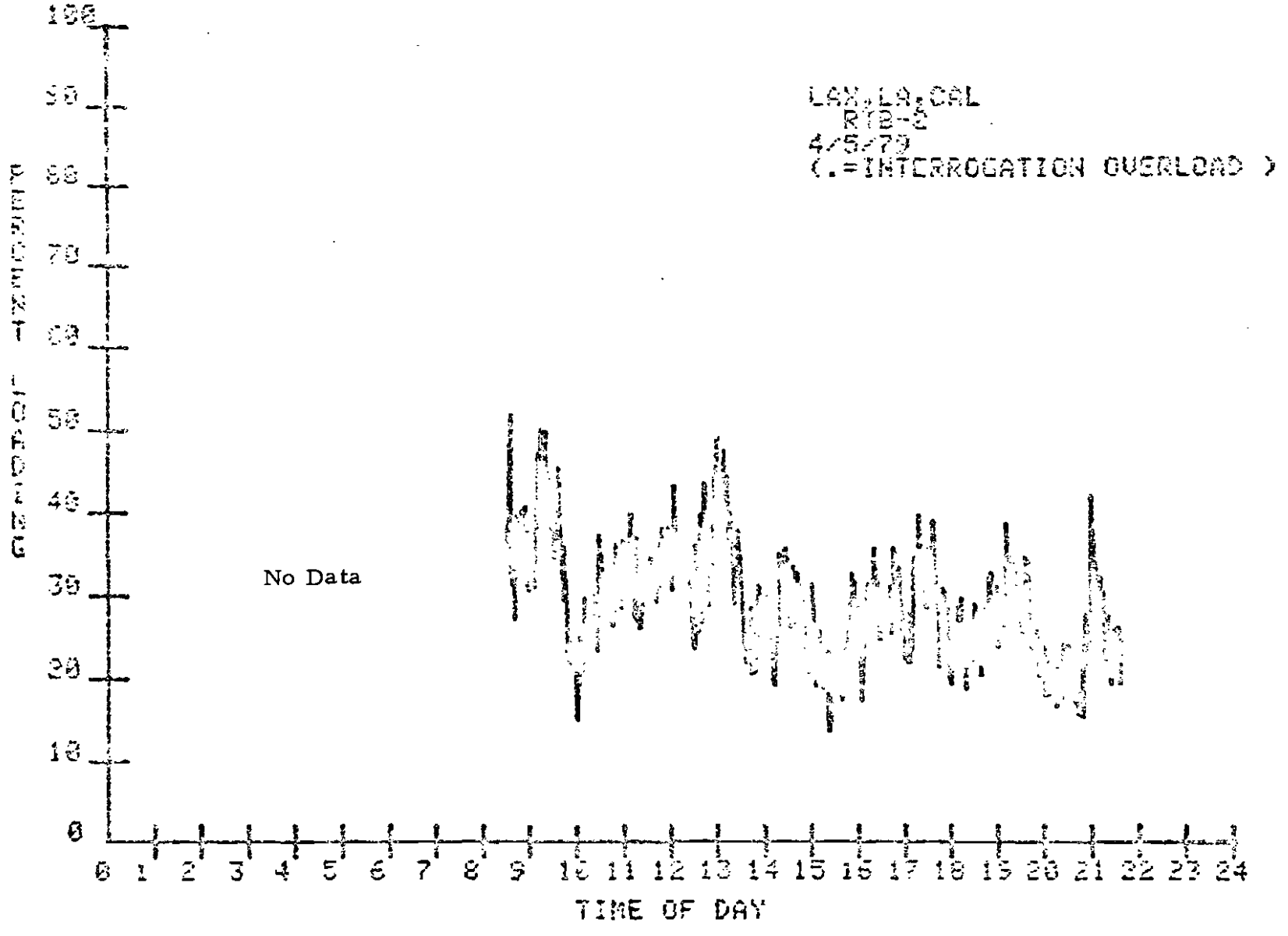


FIGURE 7 - Measured Interrogation Rate

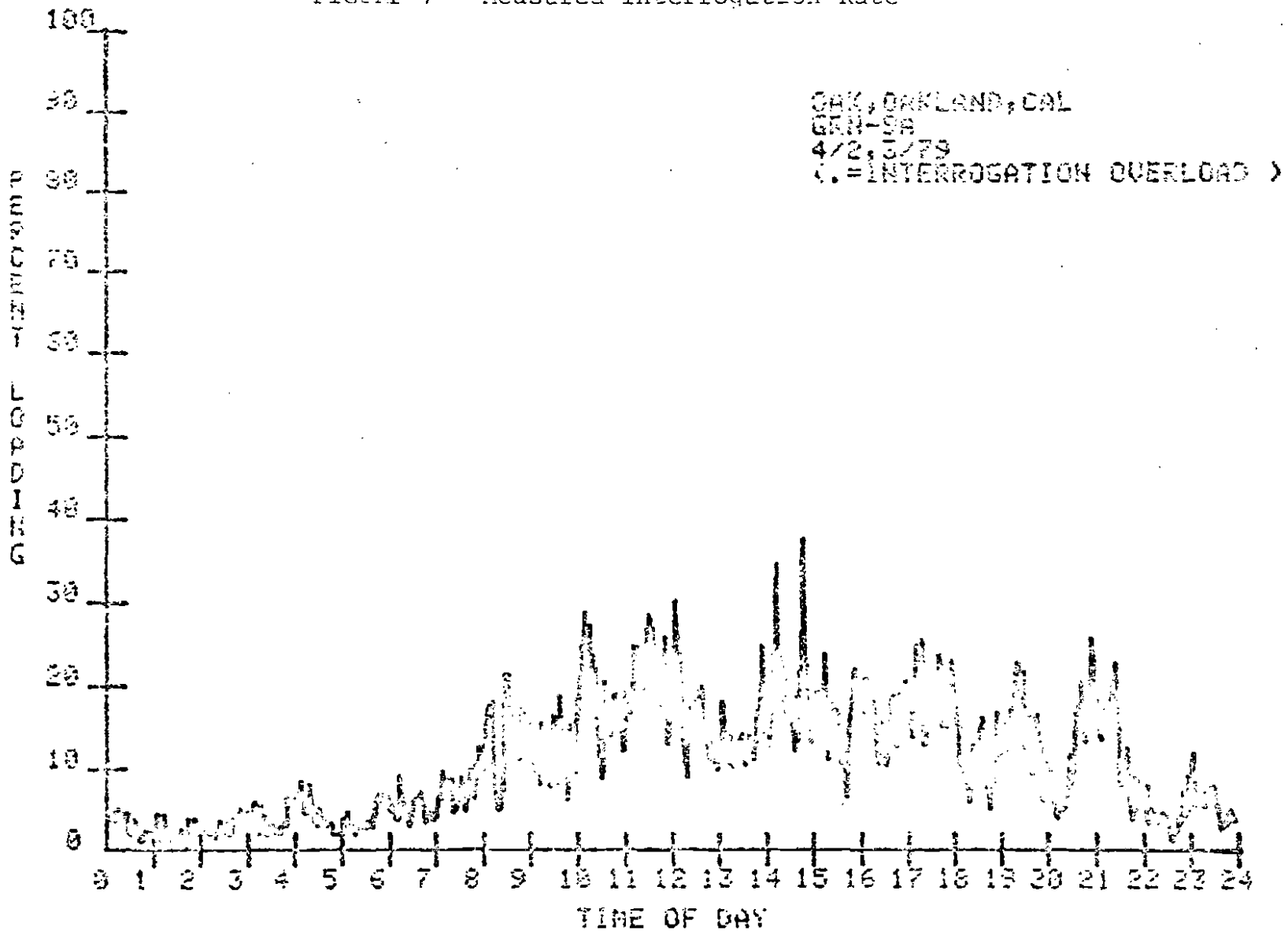


FIGURE 8 - Measured Interrogation Rate

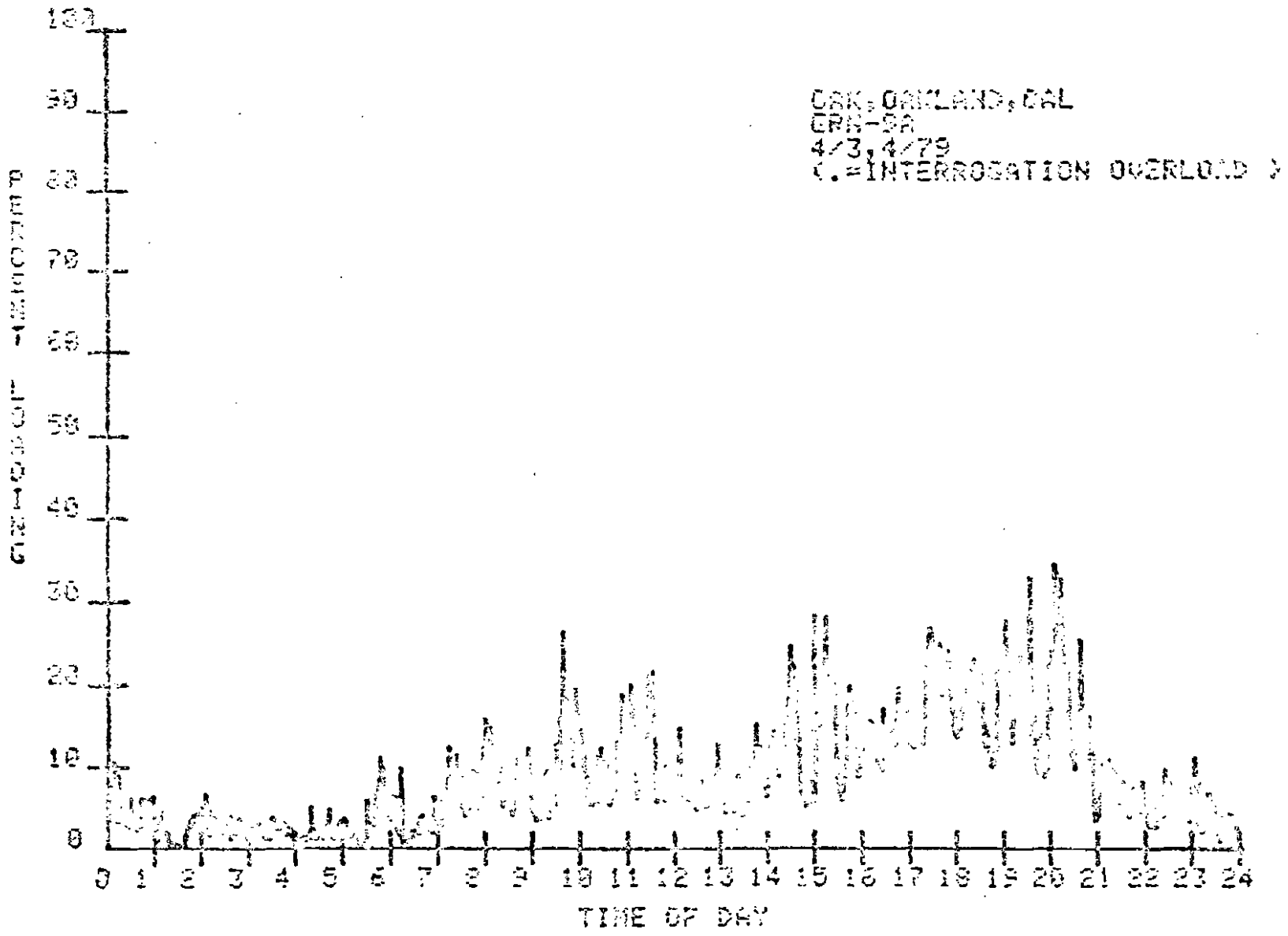


FIGURE 9 - Measured Interrogation Rate

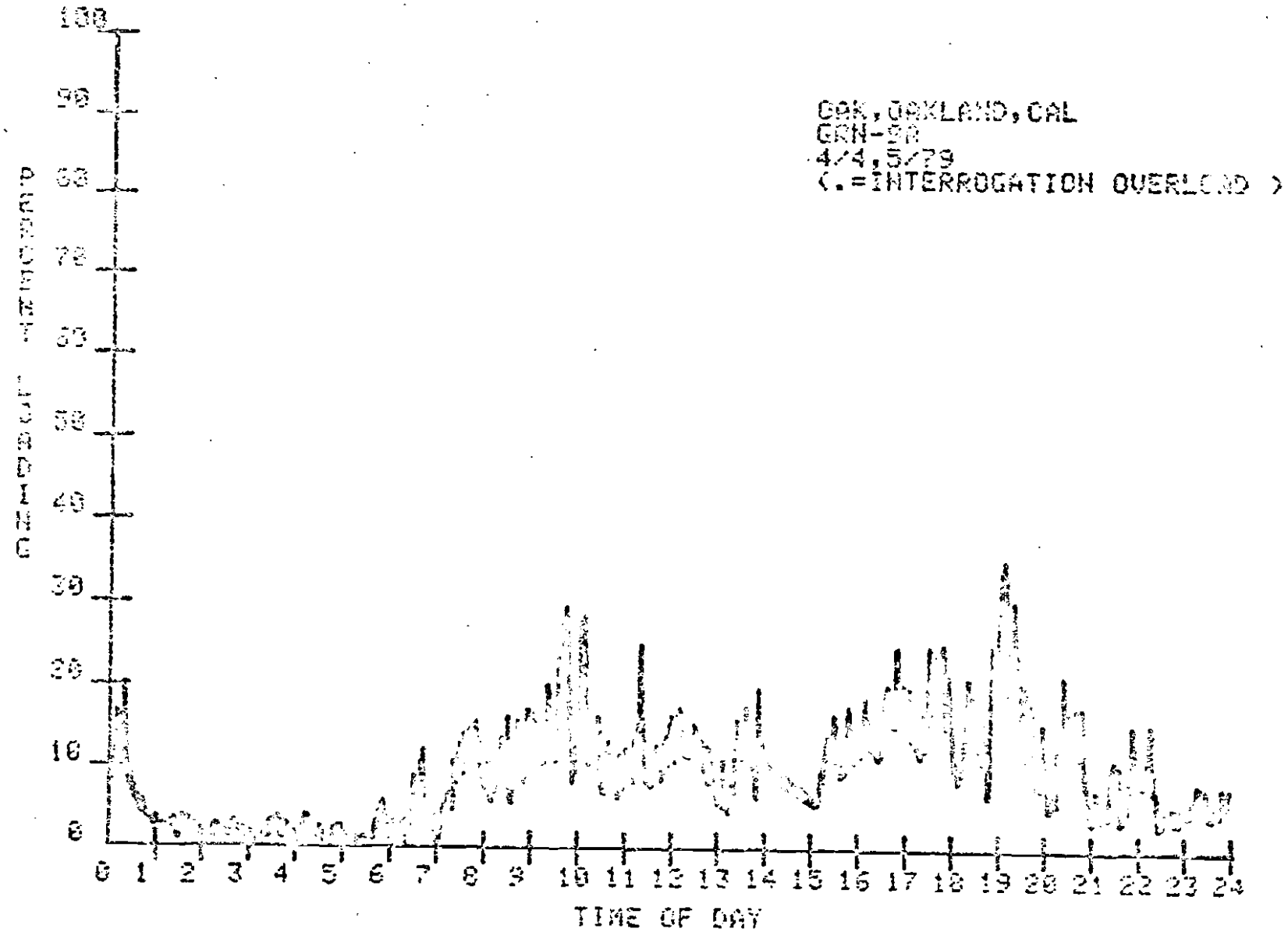
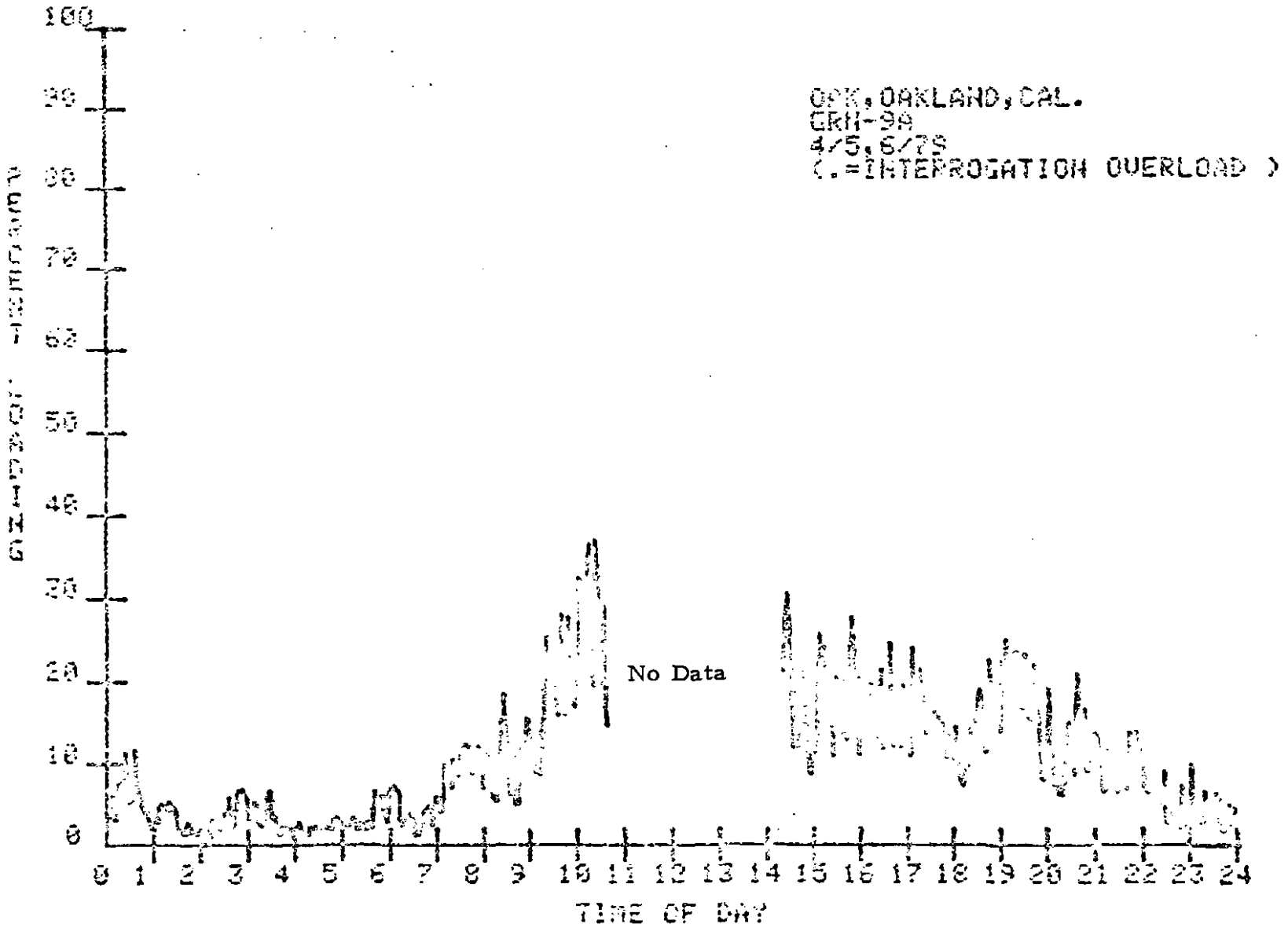


FIGURE 10 - Measured Interrogation Rate



APPENDIX A

Distribution

AAF-1
AAF-400 (5)
AED-1
AEM-1
ANA-1
ANA-2 (2)
ANA-4 (2)
ANA-5
ANA-64 (3)
ANA-100
ANA-120 (25)
ANA-200
ANA-400
ANA-500
ANA-600
ANA-700
ARD-1
ARD-700
ATF-1
AWE-1
AWE-437