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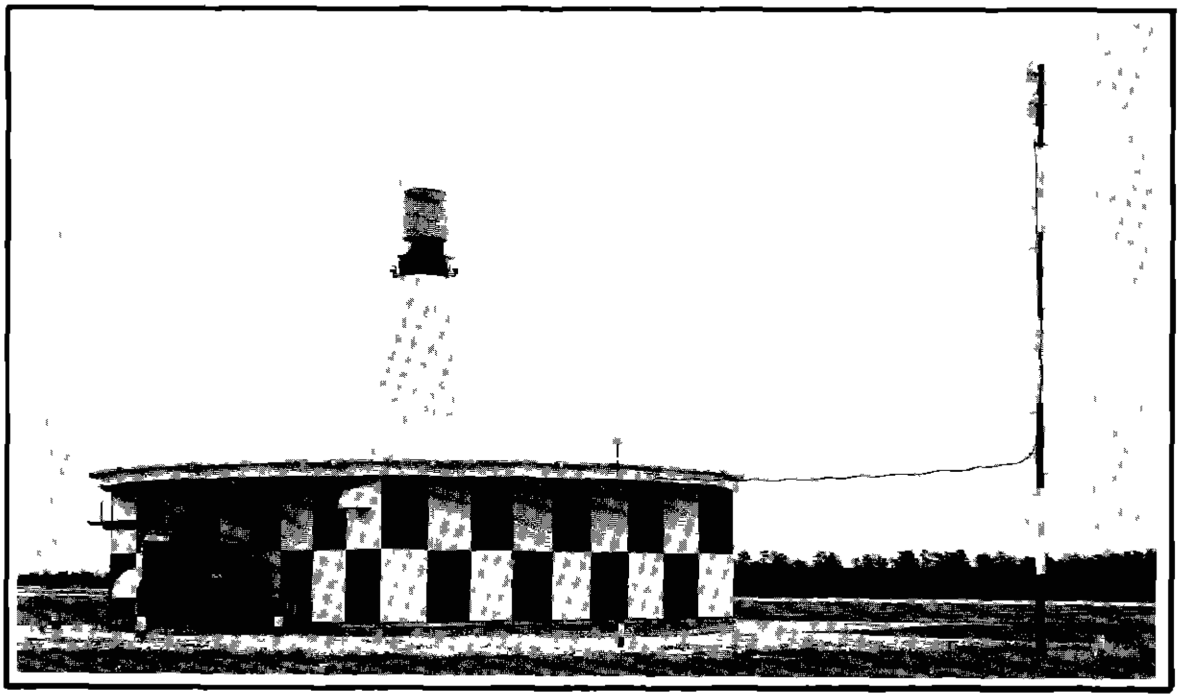

FINAL REPORT

STUDIES OF TACAN MONITOR ANTENNA LOCATIONS

TECHNICAL DEVELOPMENT REPORT NO 408

MAY 1959

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Prepared by

TEST AND EXPERIMENTATION DIVISION
Atlantic City New Jersey

FINAL REPORT

STUDIES OF TACAN MONITOR ANTENNA LOCATIONS
TECHNICAL DEVELOPMENT REPORT NO. 408

TASK ASSIGNMENT NO. 59-436

PREPARED BY

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May 1959

This report has been reviewed and is approved for distribution.

Joseph D. Blatt
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Federal Aviation Agency

Test and Experimentation Division
National Aviation Facilities Experimental Center
Atlantic City, New Jersey

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TA 59-436

STUDIES OF TACAN MONITOR ANTENNA LOCATIONS

ABSTRACT

Studies and tests have been conducted to determine the proper location for a TACAN facility monitor antenna. Although the tests were limited to exploration of the near and far-field areas of AN/URN-3 and AN/GRN-9 TACAN antenna radiation patterns, the advisability of employing far-field monitoring with all TACAN antennas is established.

Unsafe and ambiguous bearing signal monitoring was experienced with near-field monitor antenna locations Near-field monitoring was possible with an AN/URN-3 antenna but not with an AN/GRN-9 antenna

The use of a horn-type monitor antenna mounted 50 feet or more from a TACAN antenna is recommended.

PURPOSE

The purpose of this task was to determine requirements for location of a TACAN monitor antenna A basic consideration was that a monitor antenna and its support should not introduce a course error of more than .2°.

SUMMARY

The studies and tests were conducted at the FAA Technical Development Center (TDC), Indianapolis, Indiana. The monitor equipment used in the tests was the MX-1627/URN-3. Near-field monitoring was found to be difficult and undesirable. Far-field monitoring is considered essential to satisfactory monitoring of the bearing signal elements. Use of a horn-type monitor antenna is recommended to provide greater freedom from the effects of vehicular traffic in the vicinity

INTRODUCTION

With the rapid implementation of TACAN throughout the nation as a navigational system, it became necessary to install military equipment for an interim period at VORTAC facilities until civil TACAN equipment became available. The TACAN beacon transponder and antenna to be used for this interim period was of the AN/GRN-9 type. The monitoring equipment used with this beacon equipment was the military Radio Frequency Monitor MX-1627/URN-3 and its associated 1/4-wave AT-592/URN-3 antenna. Although the manufacturer of the MX-1627/URN-3 monitor had recommended a monitor antenna location for the AN/URN-3, there was considerable doubt as to whether this position would be satisfactory for the different radiation pattern of the AN/GRN-9 antenna. Therefore, the CAA Office of Air Navigation Facilities (OANF) requested that monitor antenna location studies be carried out for the purpose of establishing a configuration of monitoring antennas which would work for the military AN/GRN-9 transponder and its associated MX-1627/URN-3 monitor equipment.

During the first phase of the monitoring antenna location studies, the AN/GRN-9 antenna and monitoring equipment were not available. Since the AN/URN-3 antenna was available, work was conducted and completed to gain as much experience as possible in the monitoring antenna location studies before the arrival of the AN/GRN-9 antenna and monitoring equipment. It was considered that the signal requirements and monitor antenna location for the AN/GRN-9 antenna would, in general, follow the requirements for the AN/URN-3 antenna. While the radiation patterns later were found to differ greatly, the monitor signal requirements and the bearing error measurement techniques were found to be the same for both antennas. The experience gained with the AN/URN-3 greatly simplified the following work with the AN/GRN-9 antenna.

DISCUSSION

Upon receipt of the MX-1627/URN-3 monitor, the monitor signal requirements were determined in order to establish the signal level and quality that would be necessary from the monitoring antenna for the proper operation of a stable and reliable monitor. The formulation of signal requirements dictated the latitude that could be taken in positioning the monitoring antennas. Once the proper configuration of monitoring antennas had been established and was furnishing a signal which would meet the requirements of the monitor, the course error in space created by such a configuration of monitoring antennas had to be determined. This was one of the initial problems encountered in the monitor antenna location studies. The established goal set by OANF was a maximum error of plus or minus 0.2° bearing error introduced in space by the monitoring antenna. With the proper arrangement of equipment and technique, the course error in space was measured to the accuracy which was required for meeting the established minimum course error.

a. Monitor Signal Requirements: Since the monitor signal requirements dictate the latitude which may be taken in positioning the monitoring antenna, certain basic requirements were determined for the proper operation of the MX-1627/URN-3 military monitor.

The signal level requirements were as follows:

1. The average amplitude of the composite r-f signal at the monitor input terminals must be of sufficient level to provide an AGC voltage at TP-305 of minus 3.5 volts in a properly operating monitor.

2. The modulation index for the 15-cps and 135-cps components should be approximately 15 to 20 per cent each.

The signal quality requirements were as follows:

1. The quality of the signal received by the monitoring antenna and supplied to the monitoring equipment should permit adjustment of the monitor equipment to provide monitoring of the TACAN beacon to the tolerances for which the monitor was designed.

2. The waveform of the 135-cps signal should be identical in each 40° sector for the proper operation of the 135-cps monitor bearing circuits.

3. The detected monitor signal should have adequate quality to assure nonambiguous monitoring within the capabilities of the monitor.

The tests which were conducted to determine a suitable monitoring antenna position were based on these requirements.

b Determination of Signal Levels. In the exploration of the signal radiated from the TACAN antenna, an adequate signal level, for the proper operation of the military monitor, was available to a distance of 75 feet from the TACAN antenna This was determined on a properly operating AN/URN-3 beacon and monitor The minimum modulation index for the 15-cps and 135-cps components required for azimuth monitoring was found to be 8 and 6 per cent, respectively, for a typical MX-1627/URN-3 monitor in order to generate each of the monitoring tolerance gates required in the monitor. The maximum peak modulation level for the combined 15-cps and 135-cps signals that could be tolerated and still assure adequate reception of the random and reference pulses was approximately 50 per cent Modulation percentages required for each component were approximately 15 to 20 per cent to assure reliable monitoring and to allow for some minor variations and deterioration in the monitor circuits

c. Determination of Signal Quality. In studying the design and performance of the MX-1627/URN-3 monitor, it became apparent that proper monitoring of the 15-cps and 135-cps azimuth signals imposed stringent requirements on the quality of the signal from the monitoring antenna This was found especially true of the 135-cps signal. The military monitor was designed to monitor the TACAN bearing information to the following tolerances. 15-cps tolerance plus or minus 4 5°, and the 135-cps tolerance plus or minus 0 6°. Since these tolerances were typical operational values, they required that the detected signal from the monitoring antenna approach the ideal waveform. In order to understand the effects of waveform distortion on the monitoring of the bearing signals, a brief description of the monitor bearing circuits is desirable.

Monitoring of the bearing information of the TACAN beacon is accomplished by comparing the reference pulses with the zero-axis crossover points of each of the two modulation components. The monitor samples both the 15-cps and the 135-cps bearing information in separate circuits These circuits are essentially alike, and for this reason, the 15-cps bearing circuit will be described as an example

With the detection of the modulation envelope, the 15-cps and 135-cps modulation components are separated and fed to separate phase-shifting networks The 15-cps sine wave is then filtered and shaped into a trigger pulse. This trigger pulse, initiated at the zero-axis crossing of the sine wave, triggers a multivibrator which generates a tolerance gate. This gate is centered by means of phase-shifting circuits and compared in time with the decoded North reference pulse in a coincidence detector

The output of the coincidence detector is fed to an alarm circuit, which is duty-cycle sensitive. This alarm circuit provides a visual indication by extinguishing an indicator lamp under alarm conditions (loss of coincidence). The 135-cps bearing circuit operation is the same as the one described above except that eight of the nine tolerance gates are compared with eight auxiliary reference pulses. Thus, the bearing circuits of the military monitor are designed to operate with no alarm when the decoded reference bursts are coincident with the tolerance gates.

The waveform of the 135-cps component had to be identical in each 40° sector to assure that each of the monitor tolerance gates was simultaneously coincident with the corresponding auxiliary reference pulses. If the 135-cps waveform was identical in each 40° sector, the eight auxiliary reference pulses could be centered in eight of the nine 135-cps tolerance gates. An illustration of this is given in Fig. 1, Waveform A, which shows the coincidence conditions obtained from an idealized waveform illustrated in Fig. 2. Note that each of the auxiliary reference pulses was centered in its respective tolerance gate. If, however, the waveform of the 135-cps signal varied in phase from cycle to cycle because the monitoring antenna did not see a uniform and essentially distortion-free signal, there were less than eight 135-cps gates coincident with their corresponding auxiliary reference pulses. This is illustrated in Fig. 1, Waveforms C and D, and in Fig. 3. With this amount of distortion, the monitor could not be adjusted to monitor the bearing information reliably or to the correct tolerance.

A slight amount of 135-cps waveform distortion could be tolerated, as shown in Fig. 1, Waveform B, and Fig. 4. Note that all eight of the reference pulses were coincident with their respective tolerance gates, but were not all centered in the gates. This, however, allowed monitoring to the desired tolerance, provided that the nonuniformity of the interval between gates was very small and that the tolerance gate width could be narrowed sufficiently.

The effects of higher order distortions of the monitored signal are illustrated in Fig. 5, Waveforms A, B, and C. This shows that only three auxiliary reference pulses were coincident with their respective tolerance gates. Since the alarm in the monitor was duty-cycle sensitive, due to the integrating action of the alarm circuit, it was possible to adjust the monitor to show no alarm with only three such coincidences. In this situation, monitoring was not reliable or stable, since a shift in the bearing signal could result in the coincidence of three or more other coincidence groups. Under certain conditions, a situation such as this could develop and broaden the tolerance of the monitor.

An ambiguous condition could also be created if the monitor tolerance was adjusted with less than the required eight coincidence pulses present. An illustration of such a condition is shown in Fig. 5, Waveform A. Here the 135-cps waveform was such that three tolerance gates were coincident with three reference pulses, and the remaining pulses were displaced.

Assume that the monitor initially was adjusted to provide the required monitoring tolerance on the basis of the three coincidences illustrated in Fig. 5. If, in time, the bearing-in space should change in excess of the preset tolerance, as illustrated in Fig. 5, Waveform B, the monitor would alarm as it should, but if the signal should continue to drift in the same direction, or if the initial shift were great enough, the monitor could pick up another group of coincidence pulses as shown in Fig. 5, Waveform C. Under these conditions, the monitor would not alarm while the bearing-in space had actually shifted outside the preset desired tolerance of the monitor.

In respect to the above examples, the monitor had to be furnished a signal of such quality as to enable the alarm circuits to be adjusted with all of the proper coincident pulses for which it was designed. Adjustment of the monitor-bearing circuits with less than eight coincident pulses resulted in unreliable monitoring.

d. Bearing Error Measurements. To establish the bearing error introduced by a monitoring antenna configuration, a suitable technique had to be established for measuring small bearing changes in the radiated bearing information from the TACAN antenna. Since the bearing changes to be determined were to be in the order of plus or minus 0.2° or less and be repeatable, it was felt that ground-based measuring techniques, rather than aircraft-type flight-checking methods, would have to be employed. These ground-based measuring techniques consisted of locating detecting antennas on a common reference radial at specific elevations and distances from the TACAN antenna. These detecting antennas would sample the bearing information at their respective locations and detect any bearing change which would occur due to the presence of a monitoring antenna configuration. In making these error measurements, it was recognized that the environment of the surrounding structures would introduce bearing errors in the radiated signal, but even though these errors would be present, they would remain constant. Therefore, any change in bearing recorded from the detecting antennas would be due to the monitor antenna configuration only. This technique was decided upon and used for all subsequent bearing-error measurements.

Initially, two detecting antennas were used, mounted on a utility pole and connected to an RT-220A/ARN-21 interrogator. The detecting antennas were of the DID-DME 1/4-wave type with the first at the same elevation as the center of the TACAN antenna (horizon), and the second at 8.6° above the horizon. The detected error was measured and recorded on a Sanborn chart recorder directly from the d-c voltage applied to the vertical needle of the ID-249 course deviation indicator in the RT-220A/ARN-21 equipment. The major difficulty in this method was the continuous oscillatory hunting of the ID-307 (bearing indicator) servo system from which the ID-249 is driven. Capacitor damping of the d-c indicator circuit was found to be effective in averaging the deviations. With this approach, tests to determine the bearing error in space caused by the monitoring antenna, its mounting assembly, and coaxial cable were made by employing the equipment arrangement illustrated in Fig. 6. With this arrangement and the technique described below, it was possible to detect bearing changes of 0.05° reliably.

The procedure and technique employed in making ground-based error measurements as described above, after calibration of the recorder, were as follows:

Step 1. A zero-error reference reading was established and recorded with the monitor assembly removed from the field of the TACAN antenna. This was done for each of the detecting antennas. The respective recordings were continued for at least 30 seconds in order to obtain a good average and to permit the detection of any transient or unusual errors.

Step 2. To determine the degree of course error introduced, the monitor antenna was installed on the zero-reference radial and recordings were made to establish the effect of monitoring antenna and its assembly in this position. These recordings were made for each of the detecting antennas.

Step 3. The second step was repeated with the monitor antenna positioned throughout 360° in azimuth in 10° increments.

The initial tests concerning the establishment of a monitoring antenna configuration consisted of an exploratory action in the near-field of the AN/URN-3 antenna. These tests determined the signal level quality of the radiated signal at various distances and elevations from the TACAN antenna. The exploratory probing action was made on a specific radial and in a horizontal reference plane through the bottom edge of the radome cylinder of the AN/URN-3 TACAN antenna. This probing action resulted in the development of a monitoring antenna configuration such as that shown in Fig. 7. Tests then were conducted to determine the bearing error introduced by this assembly. Test data indicated that the bearing errors introduced by the monitoring antenna and its mounting assembly did not exceed 0.2°. Further tests with this monitoring antenna configuration at different frequencies indicated the necessity for some vertical adjustment in the monitoring antenna position to compensate for frequency change. With the use of the MX-1627/URN-3 monitor, it was determined that this monitoring antenna configuration in the near-field, with its compensating change in vertical height, would meet all of the stated requirements. Flight tests were also conducted to determine if any gross errors were introduced at high altitudes. The results of these tests indicated that no apparent gross errors were introduced, and the mounting assembly shown in Fig. 7 was considered adequate for the operation of the MX-1627/URN-3 monitoring antenna with the AN/URN-3 antenna.

The same series of tests which were conducted on the AN/URN-3 antenna were carried out on the AN/GRN-9 antenna. The signal from the monitoring antenna was fed directly into the MX-1627/URN-3 monitor. An oscilloscope connected to the monitor-detector output provided the means for a visual observation of the radiated signal. By photographing and recording the information seen at the particular azimuth coincident tubes of the monitor, an accurate indication of the signal quality was determined. The 15-cps and 135-cps modulation components varied radically as the monitor antenna was moved through the first 30 feet from the AN/GRN-9 antenna. Using the field monitor, areas which provided adequate modulation in the near-field of the AN/GRN-9 antenna were plotted as shown in Fig. 8. It should be noted that while these areas provided adequate modulation for the generation of the tolerance gates, except for two locations, the waveform of the detected signal was distorted to the extent that it would not provide reliable monitoring. In the far-field, 50 to 75 feet, it was found that the radiated signal closely approached the ideal waveform, with the proper modulation percentages for each component. It was determined that the 15-cps and 135-cps modulation components are not "formed" sufficiently in space near the AN/GRN-9 antenna to provide a signal of adequate quality for reliable monitoring by the MX-1627/URN-3 monitor. Certain areas were found in the near-field, however, which did provide a signal of adequate quality for monitoring. The two points marked A and B in Fig. 8 were the only locations found in the near-field of the AN/GRN-9 antenna which met the monitor signal requirements described earlier. The location marked A was the position of the monitor antenna proposed by Rome Air Development Center for use with the AN/URN-3 TACAN antenna. At the request of the Office of Air Navigation Facilities, Rome Air Development Center furnished the Technical Development Center with one of the Fiberglas supporting structures which they had developed for mounting the MX-1627/URN-3 monitoring antenna to the AN/URN-3 antenna. This structure was used in positioning the monitoring antenna in the near-field of the AN/GRN-9 antenna at location A, Fig. 8. This same Fiberglas support was found to be usable in an inverted position for mounting the monitor antenna at location B described in Fig. 8. When it was determined that both of the above monitoring antenna locations met the monitor signal requirements, tests were conducted to determine the bearing error introduced by the monitoring antennas and their Fiberglas supports.

The techniques for determining bearing error used for the AN/URN-3 then were applied to the AN/GRN-9 monitoring antenna positions A and B, as described in Fig. 8. In order to improve the environmental conditions of the TACAN antenna, a new site was obtained away from surrounding buildings. At this new site, an AN/TRN-6 mobile TACAN unit was used as the signal source for the AN/GRN-9 antenna. The equipment is illustrated in Fig. 6 and was installed at site No. 1 for the AN/GRN-9 tests. The detecting antennas were mounted to a utility pole 74 feet from the AN/GRN-9 antenna. One detecting antenna was mounted on the horizon or at the same height as the center of the AN/GRN-9 antenna, and a second detecting antenna was mounted 8.65° above the horizon. The detecting antenna was located at this angle because it was found that maximum course error was present at this angle.

Bearing-error data were first collected with the monitor antenna located at point A, as shown in Fig. 8. The results of the measurements are shown in Fig 9 The error spread was 1 05° along the horizon, and 2.60° at an elevation angle of 8 6° above the horizon

Bearing-error data were obtained for the monitor antenna at position B, as shown in Fig 8 The same procedure was followed as in the bearing-error measurements made on the monitoring antenna position A The results of the measurements are shown in Fig 10 The bearing-error spread along the horizon was determined to be 0 55°, and the error spread at 8.6° above the horizon was 1 75°

In order to check the validity of ground-based error measurements, the AN/GRN-9 antenna was moved to a different site At site No 2 the bearing-error measurements were repeated with the monitor antenna at position B At this site, bearing-error measurements could be obtained at two different laboratories simultaneously, to verify the measuring technique These laboratories were located approximately 2,300 feet from the AN/GRN-9 antenna with a horizontal separation of 19° in azimuth The elevation of the two sites was determined The bearing-error curves were corrected for the azimuth difference of the two laboratories In an analysis of the data, which is shown in Fig 11, it should be noted that the phase and magnitude of the 135-cps errors agreed closely The 15-cps error spread, detected at a vertical angle of 0 86° with respect to the horizon, was 2.35°, while the 135-cps error spread was 0 65° The 135-cps error spread at the other laboratory, with the detecting antenna at an elevation of 0.78° with respect to the horizon, was also 0.65°.

Further efforts were made to detect gross errors in space due to the monitoring antenna through orbital flights at various altitudes to 10,000 feet by using the theodolite measuring technique. The theodolite-checked flights showed no gross errors, but were not considered accurate enough to check the bearing error to the accuracy of plus or minus 0 2° The error data obtained from the theodolite flights with and without the monitor antenna in place are shown in Figs. 12, 13, 14, and 15

In view of the bearing-error introduced by the monitoring antenna when in the near-field of the AN/GRN-9 antenna, further investigations were conducted in the far-field of the AN/GRN-9 antenna The radiated signal, at distances of 50 to 75 feet from the TACAN antenna, was found to meet all the monitor signal requirements necessary for the proper operation of the monitor.

The Office of Air Navigation Facilities requested that further studies be carried out for the purpose of determining the proper mounting position of the MX-1627/URN-3 monitoring antenna on a metallic pole in the far-field of the AN/GRN-9 antenna. These studies were made to determine the proper spacing of the monitoring antenna from the metallic pole for good signal level and quality, and also to determine the effect of moving vehicles in the area of the monitoring antenna Site No 1, previously described, was used for this study The utility pole was wrapped with metallic foil in order to simulate a metal pole, and a monitor antenna mounting bracket was fabricated which would permit varying the spacing of the monitor antenna from the reflecting surface of the utility pole

In order to measure the effect of monitor antenna to pole spacing on available monitoring signal level, the AN/GRN-9 antenna (nonrotating) was driven by a continuous-wave (cw) signal generator The monitor antenna was connected to a suitable receiver and indicator in a manner which would permit recording the change in signal level as the monitor antenna-to-pole spacing was varied in small increments

Relative signal strength was recorded for the monitoring antenna and a plot of these data is shown in Fig. 16 It was determined that a spacing of from 8 to 10 inches was required for optimum adjustment due to frequency change. The beacon was operated on Channels 20 to 63 for the low-band AN/GRN-9 antenna Waveform distortion within the range of adjustment was found to be negligible, and the signal level and quality were evaluated on the basis of a properly operating monitor and in accordance with the monitor signal requirements.

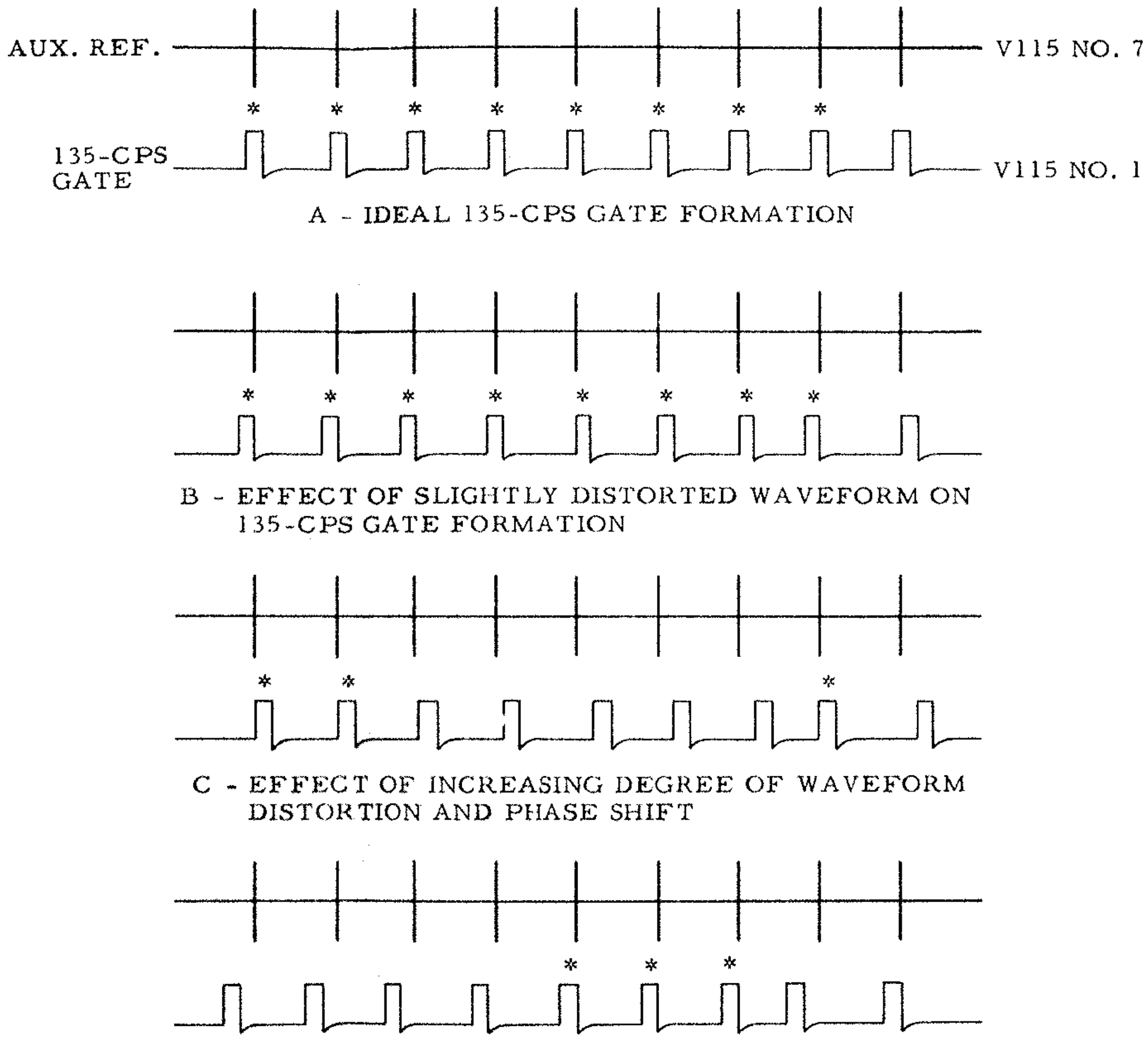
Tests were conducted to determine the effects of moving vehicles on the detected signal. The monitor was adjusted for the proper tolerance with the antenna-to-pole spacing adjusted at optimum. A half-ton panel truck was driven in a spiral about the AN/GRN-9 antenna to a maximum radius of approximately 75 feet from the AN/GRN-9 antenna At a radius of 37 and 49 feet from the AN/GRN-9 antenna and between the AN/GRN-9 antenna and the monitor antenna, as shown in Fig. 14, the monitor indicated an alarm on the 135-cps information. These alarm indications were present only momentarily as the vehicle was driven through a specific area, but if the vehicle remained in one of these specific areas, the alarm condition would continue This alarm condition was caused by a phase shift in the received signal It should be recognized that the TACAN antenna and monitoring antenna were located only 20 feet above the ground and would be more susceptible to reflective surfaces than in a typical installation, illustrated in Fig. 17.

CONCLUSIONS

Near-field monitoring of TACAN facilities employing the AN/URN-3 antenna is possible but should be avoided Far-field monitoring should be employed with all TACAN antennas to avoid the criticalness of monitor antenna positioning and the high potential for unsafe monitoring inherent to near-field monitoring.

Monitoring antennas should be located at a radius of 50 feet or more from a TACAN antenna and at an elevation corresponding to the center of a TACAN antenna The MX-1627 monitor has been found to have adequate sensitivity for use with URN-3 TACAN facilities wherein the monitor antenna is 75 feet distant

Where freedom from the effects of vehicular traffic is desirable, a horn-type monitor antenna of small dimensions should be used



A - IDEAL 135-CPS GATE FORMATION

B - EFFECT OF SLIGHTLY DISTORTED WAVEFORM ON 135-CPS GATE FORMATION

C - EFFECT OF INCREASING DEGREE OF WAVEFORM DISTORTION AND PHASE SHIFT

D - EFFECT OF INCREASING DEGREE OF WAVEFORM DISTORTION AND PHASE SHIFT

NOTE: *SYMBOL MEANS COINCIDENCE OF 135-CPS GATE AND AUXILIARY REFERENCE GROUPS.

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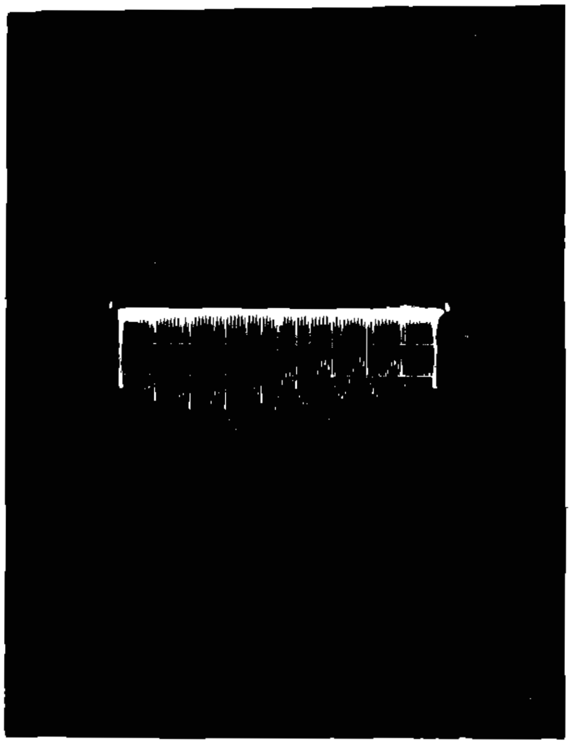
135-CPS COINCIDENCE DETECTOR WAVEFORMS

Task No. 59-436

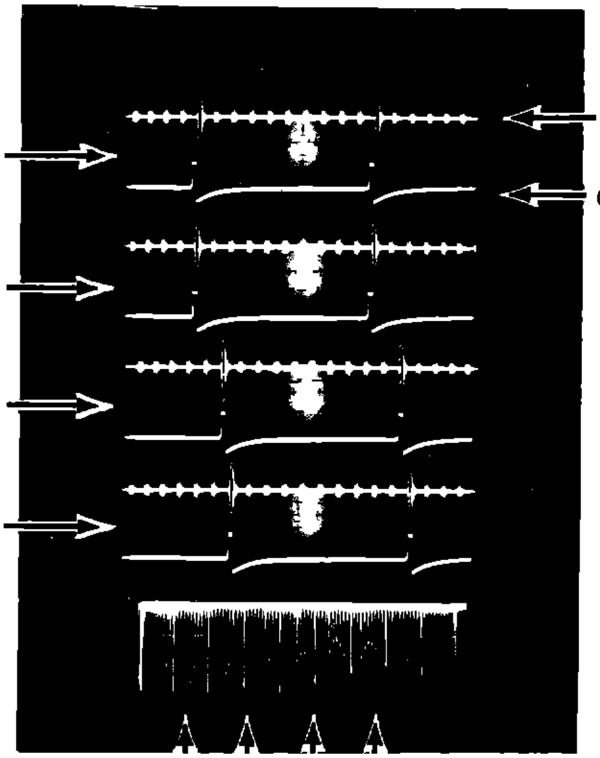
FIG. 1



IDEAL COMPOSITE
MODULATION WAVEFORM

Task No 59-436

FIG. 2



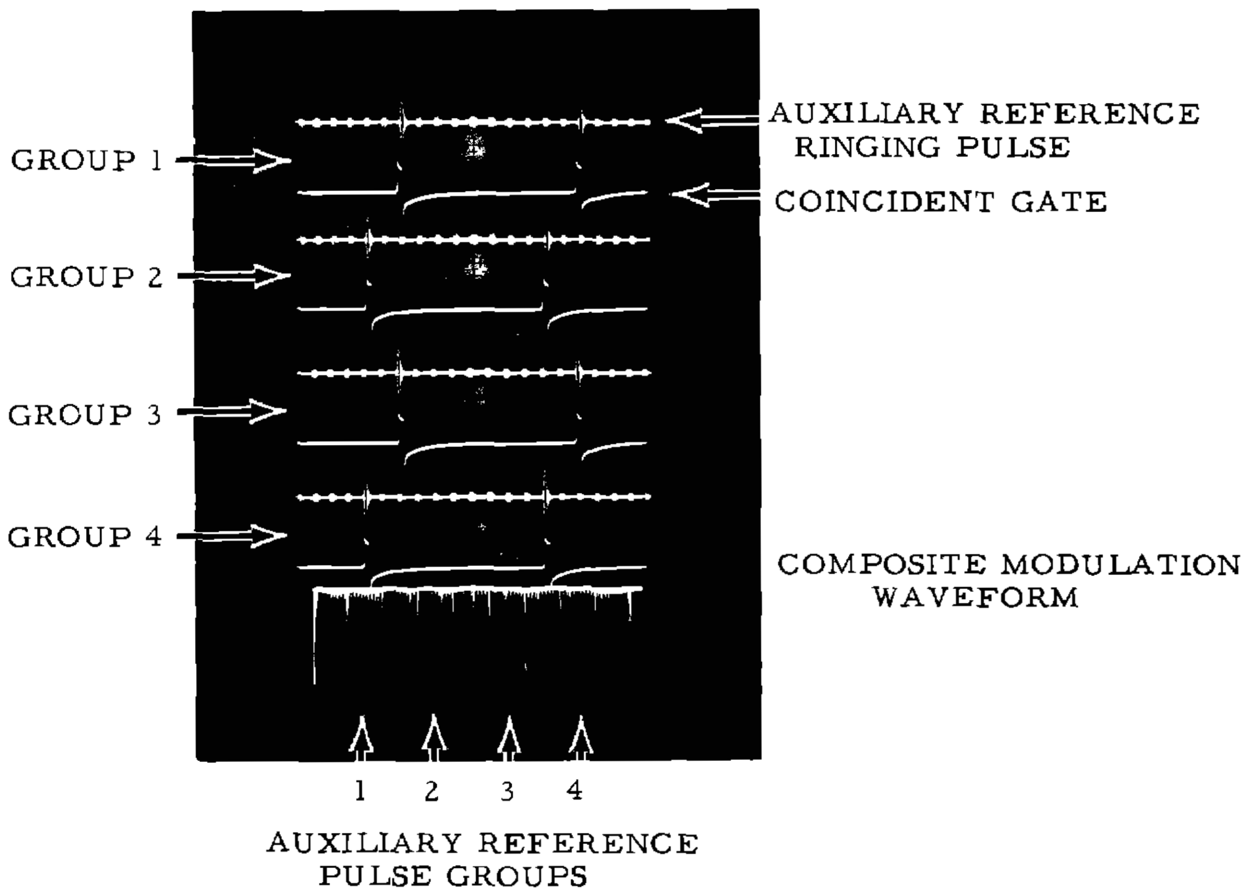
1 THE AUXILIARY REFERENCE RINGING PULSE AND THE COINCIDENT GATES IN GROUPS 1 THROUGH 4 ARE DERIVED FROM THE COMPOSITE MODULATION WAVEFORM.

2. GROUP 1 NOT COINCIDENT, GROUPS 2 THROUGH 4 COINCIDENT.

COMPOSITE SIGNAL SHOWING EFFECT OF EXCESSIVE 135-CPS MODULATION DISTORTION AND PHASE SHIFT

Task No 59-436

FIG. 3



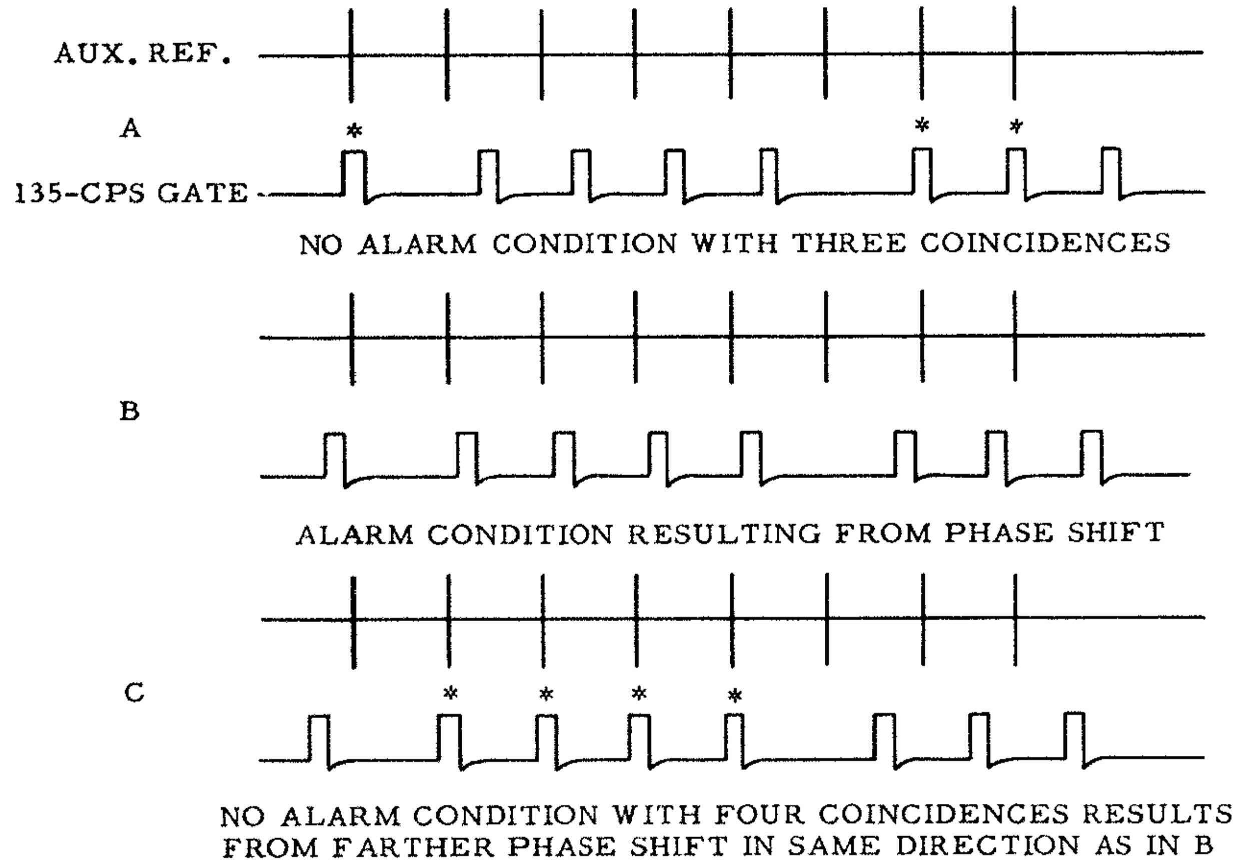
NOTE 1. THE AUXILIARY REFERENCE RINGING PULSES AND THE COINCIDENT GATES IN GROUPS 1 THROUGH 4 ARE DERIVED FROM THE COMPOSITE MODULATION WAVEFORM

2. ALL GROUPS COINCIDENT BUT NOT CENTERED.

COMPOSITE SIGNAL SHOWING EFFECT OF SLIGHT 135-CPS MODULATION DISTORTION

Task No 59-436

FIG. 4



* SYMBOL DENOTES COINCIDENCE OF 135-CPS GATE AND AUXILIARY REFERENCE GROUPS.

NOTES: FIGURES REPRESENT EXTREME 135-CPS GATE DISTORTION WHICH COULD PRESENT TWO SATISFACTORY MONITORING TOLERANCE AREAS TO THE MONITOR WITH AN ALARM CONDITION SEPARATING THEM.

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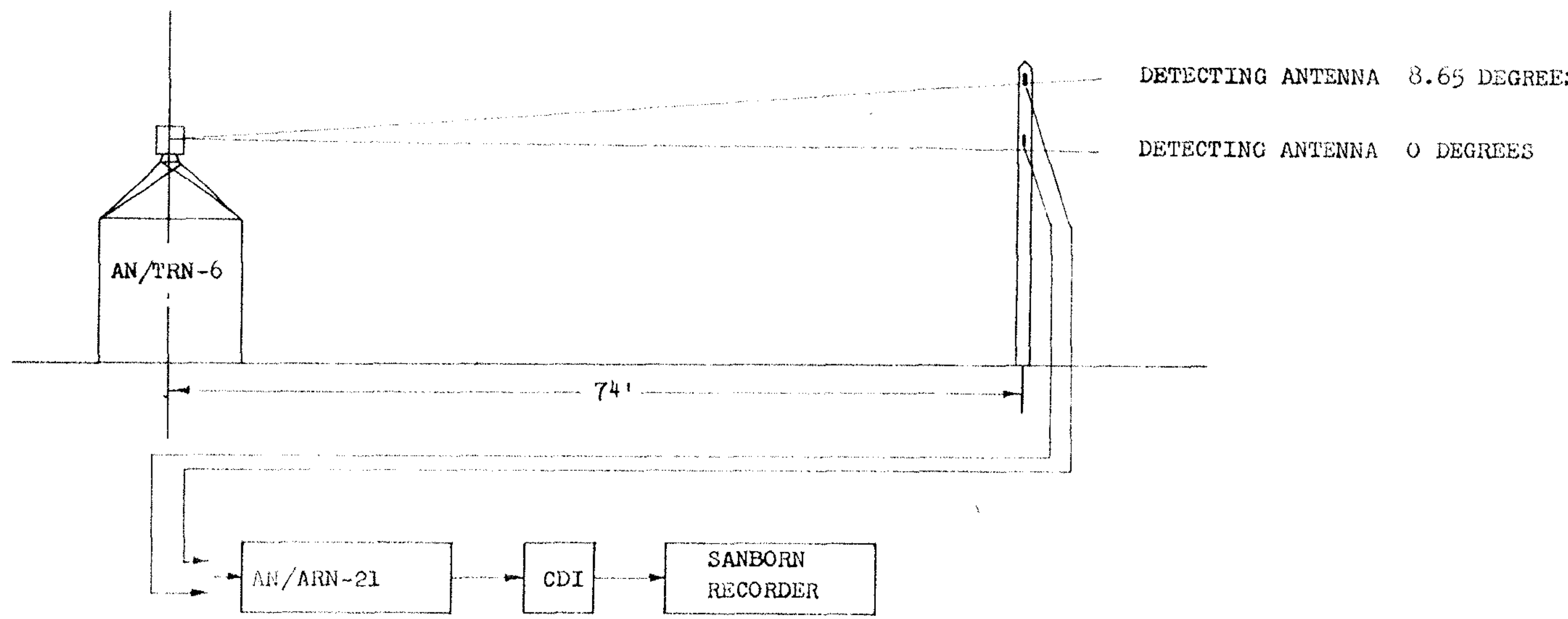
ILLUSTRATION TO SHOW POSSIBLE AMBIGUITY IN 135-CPS BEARING MONITORING

Task No. 59-436

FIG. 5



SITE NO. 1

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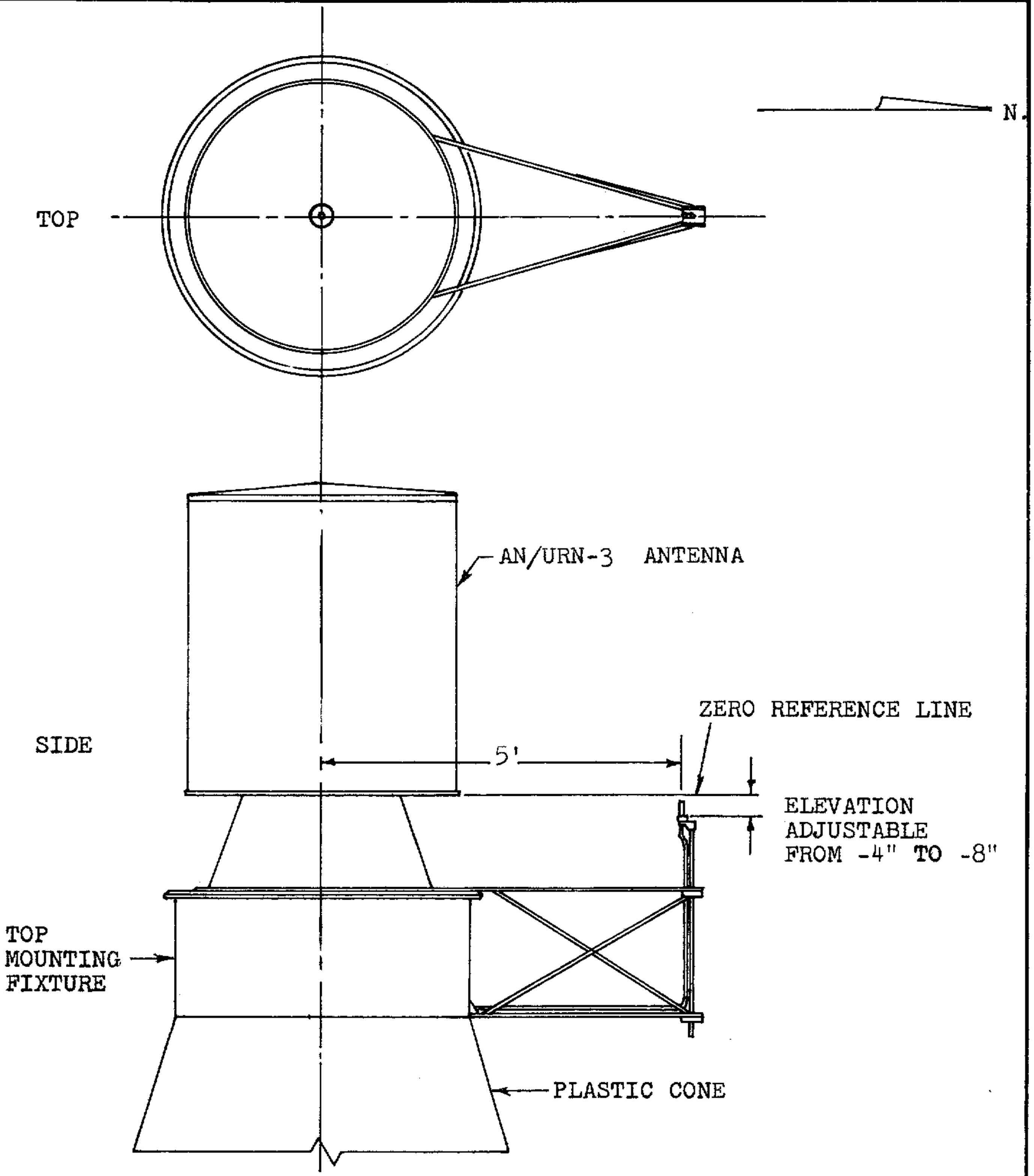
EQUIPMENT ARRANGEMENT FOR GROUND BEARING ERROR MEASUREMENTS

Task No. 59 - 436

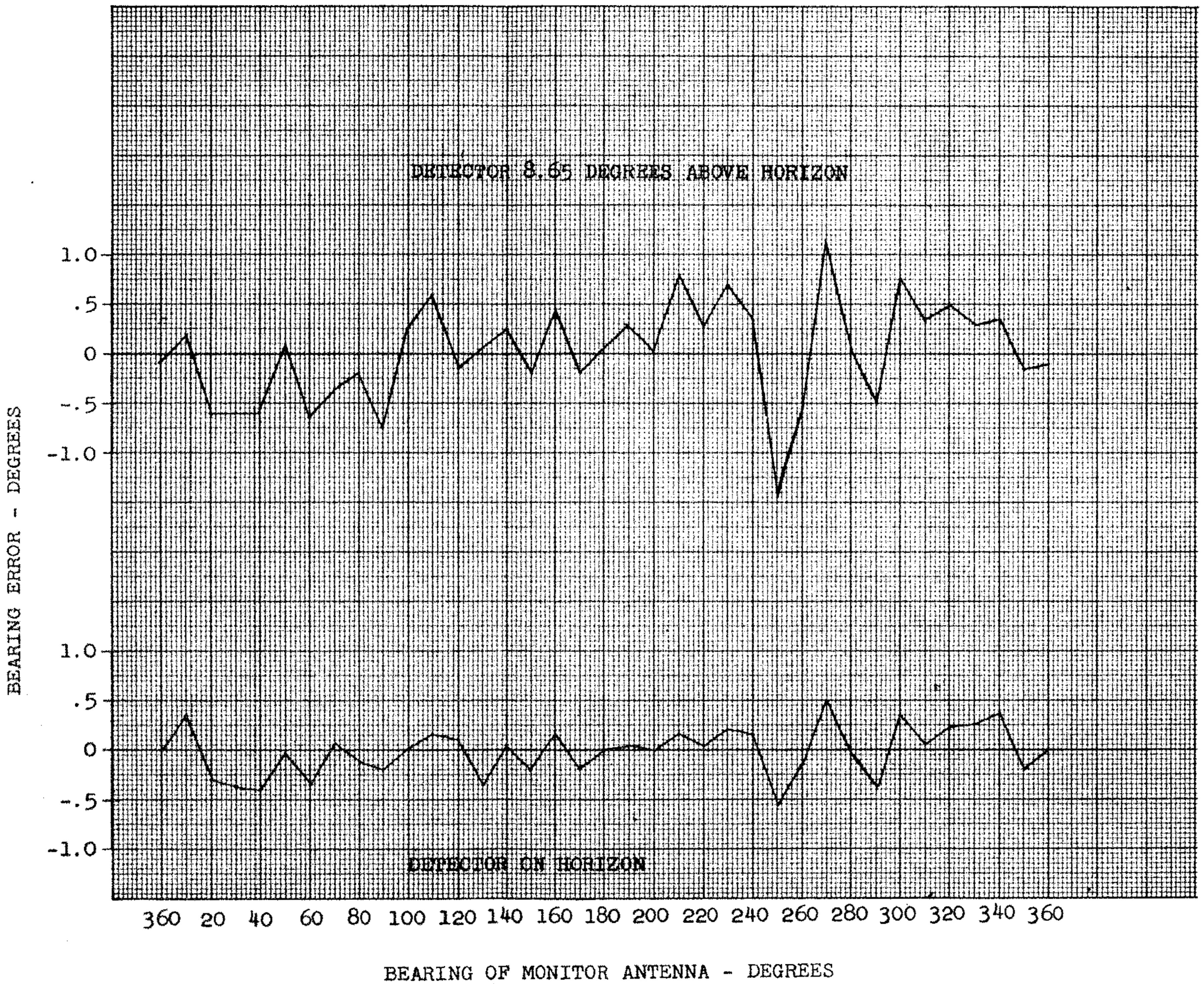
FIG. 6



TACAN MONITOR ANTENNA
ASSEMBLY FOR AN/URN-3 ANTENNA

Task No. 59-436

FIG. 7



NOTES:
TACAN: CHANNEL 50 ANTENNA 4 BAY AN/GRN-9
DISTANCE TO DETECTOR ANTENNA: 74 FEET
ERROR MEASURING EQUIPMENT:
AN/ARN-21 SERIAL CCT 3297

MONITOR ANTENNA POSITION:
RADIUS: 2 FEET 10 INCHES } POINT "A"
ELEVATION: +28.5 INCHES } FIG. 8

DATA TAKEN ON REFERENCE RADIAL
OF 360 DEGREES

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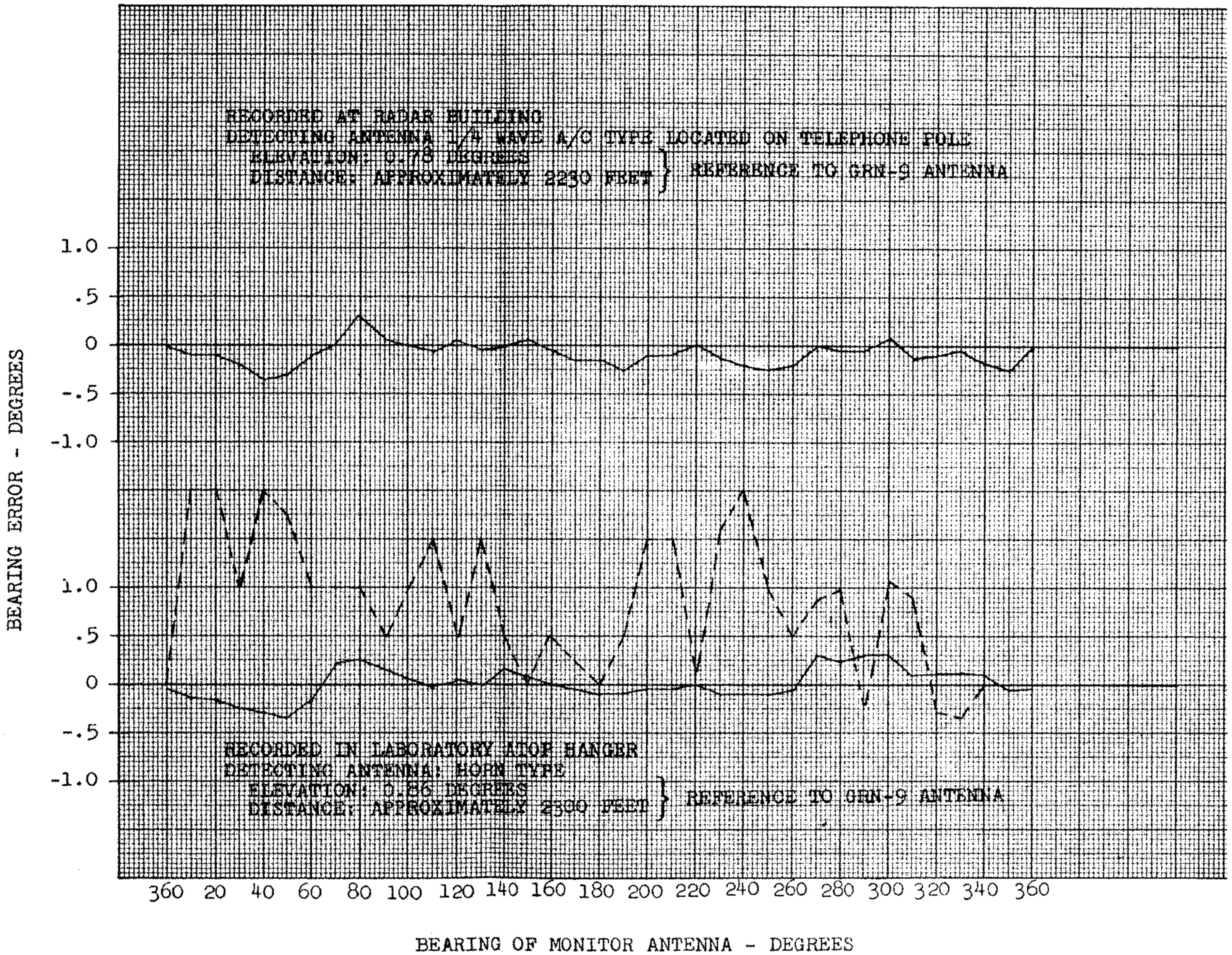
BEARING ERROR AT
SITE NO. 1

Task No. 59-436

FIG. 9



NOTES:
TACAN: CHANNEL 50 ANTENNA 4 BAY AN/GRN-9
ERROR MEASURING EQUIPMENT:
ARN-21 SERIAL CCT 3297

MONITOR ANTENNA POSITION:
RADIUS: 2 FEET 10 INCHES } POINT "B"
ELEVATION: +13.5 INCHES } FIG. 8
——— 135 CPS ERROR
- - - - - 15 CPS ERROR

DATA TAKEN ON REFERENCE RADIAL
OF 360 DEGREES

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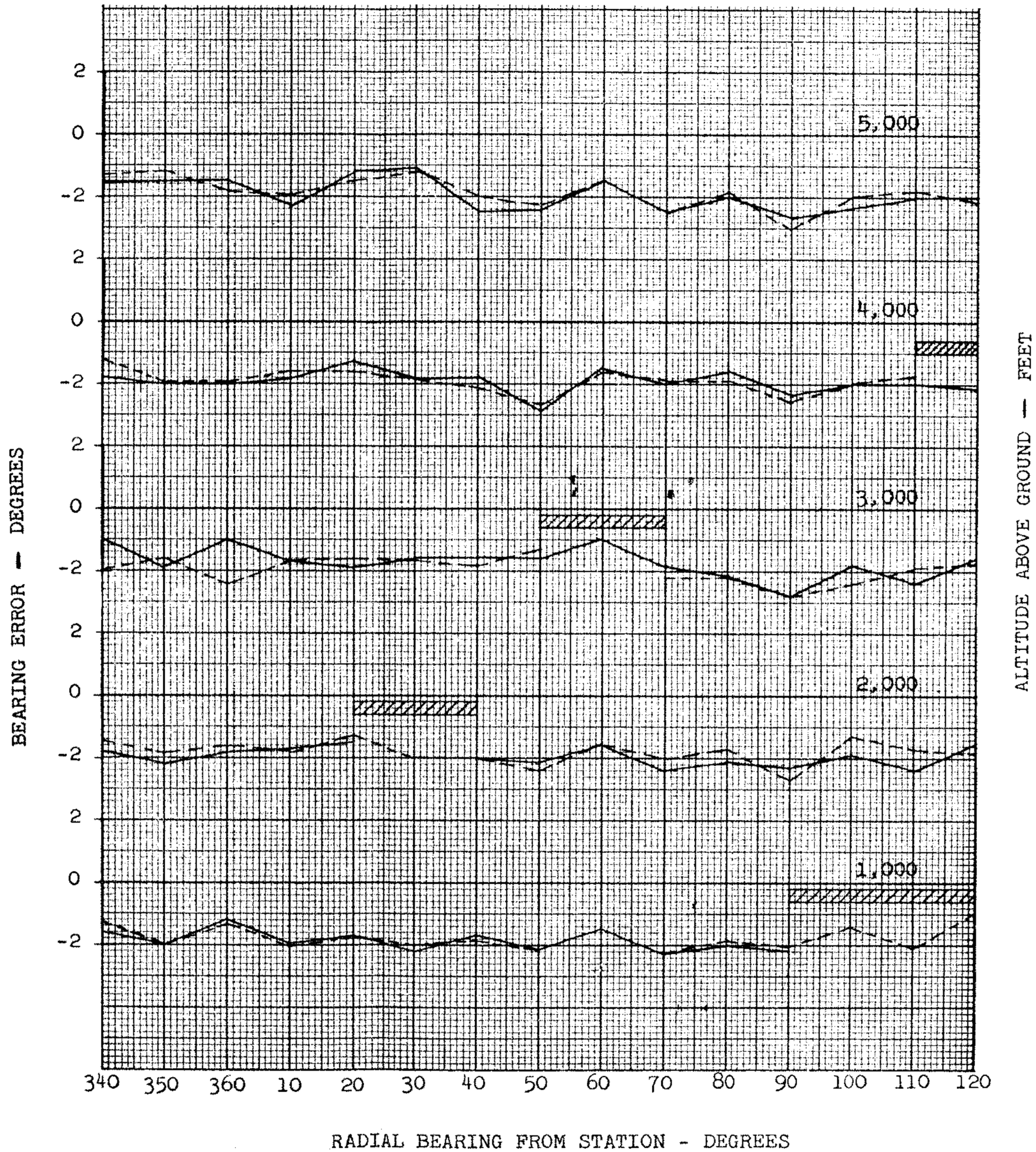
ATLANTIC CITY, N. J.

BEARING ERROR AT SITE NO. 2

Task No. 59-436

FIG. 11



NOTES:
ORBIT: 7.5 N. M.
SITE: NO. 2
ANTENNA: AN/GRN-9
CHANNEL: 50
——— ORBIT NO. 1
- - - - ORBIT NO. 2
▨ BEARING UNLOCKED

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BEARING ERROR AT SITE NO. 2 NO MONITOR ANTENNA

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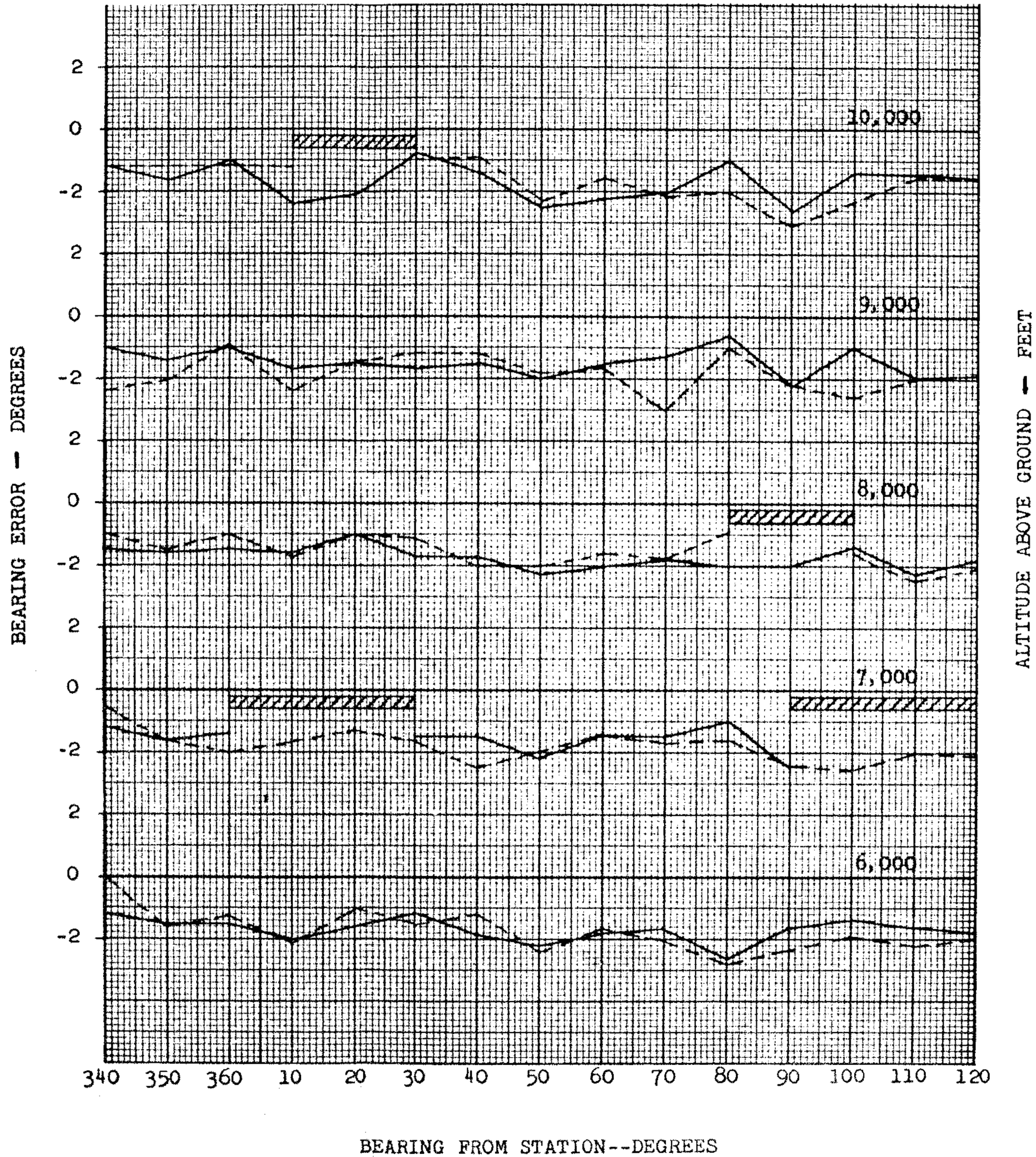
FIG. 12



NOTES:
ORBIT: 7.5 N.M.
SITE: NO. 2
ANTENNA: AN/GRN-9
CHANNEL: 50

——— ORBIT NO. 1
- - - - ORBIT NO. 2
▨ BEARING UNLOCKED

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BEARING ERROR AT SITE NO. 2 NO MONITOR ANTENNA

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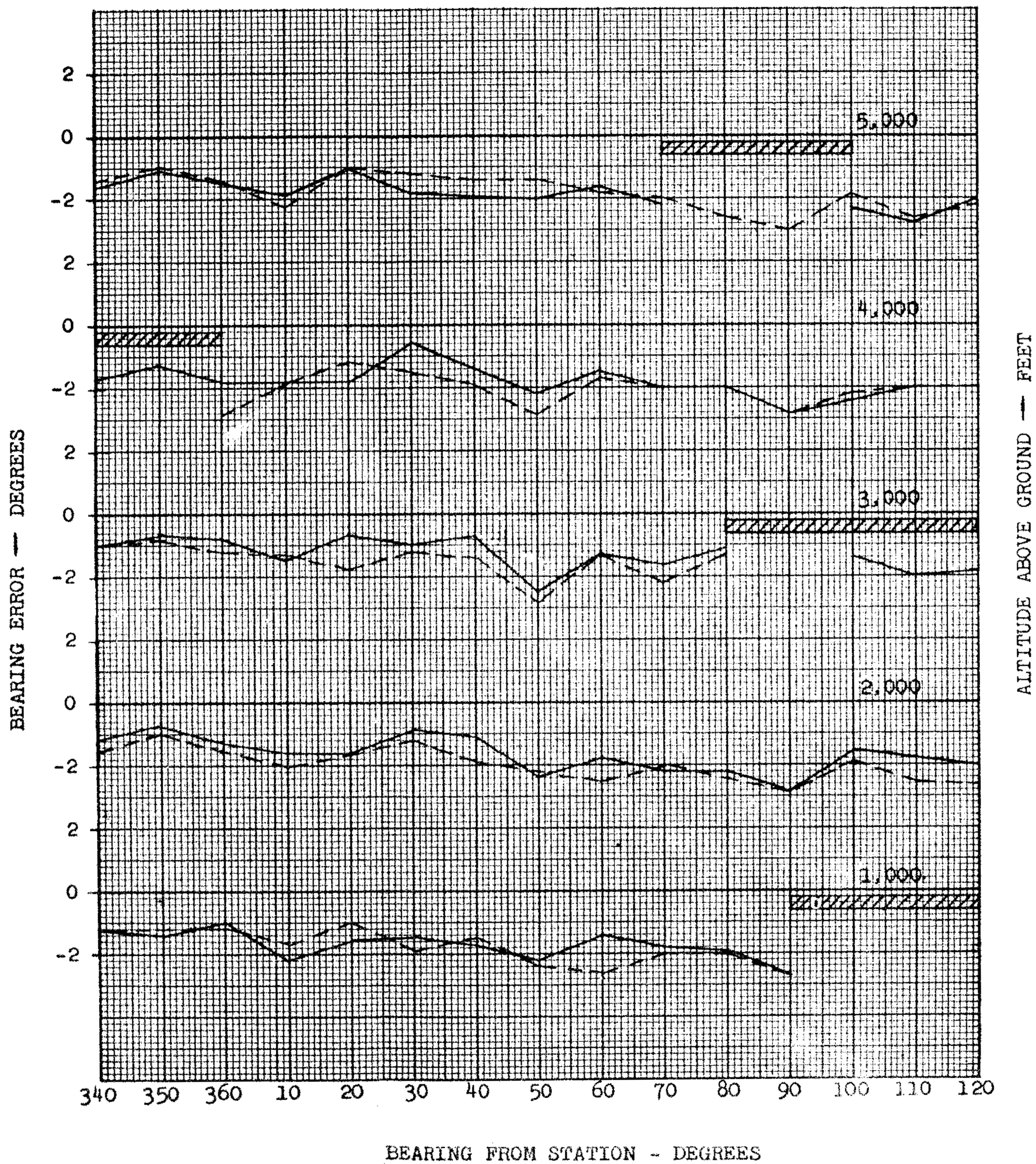
FIG. 13



NOTES:
MONITOR ANTENNA ON
RADIAL 50 DEGREES
RADIUS: 2 FEET 10 INCHES } POSITION
ELEVATION: +13.5 INCHES } "B" FIG. 8
ORBIT: 7.5 N. M.
SITE: NO. 2
ANTENNA: AN/GRN-9
CHANNEL: 50
——— ORBIT NO. 1
- - - - ORBIT NO. 2
▨ BEARING UNLOCKED

AREAS OF UNLOCKING ARE NOT ATTRIBUTED TO MONITOR ANTENNA

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BEARING ERROR AT SITE NO. 2 WITH MONITOR ANTENNA

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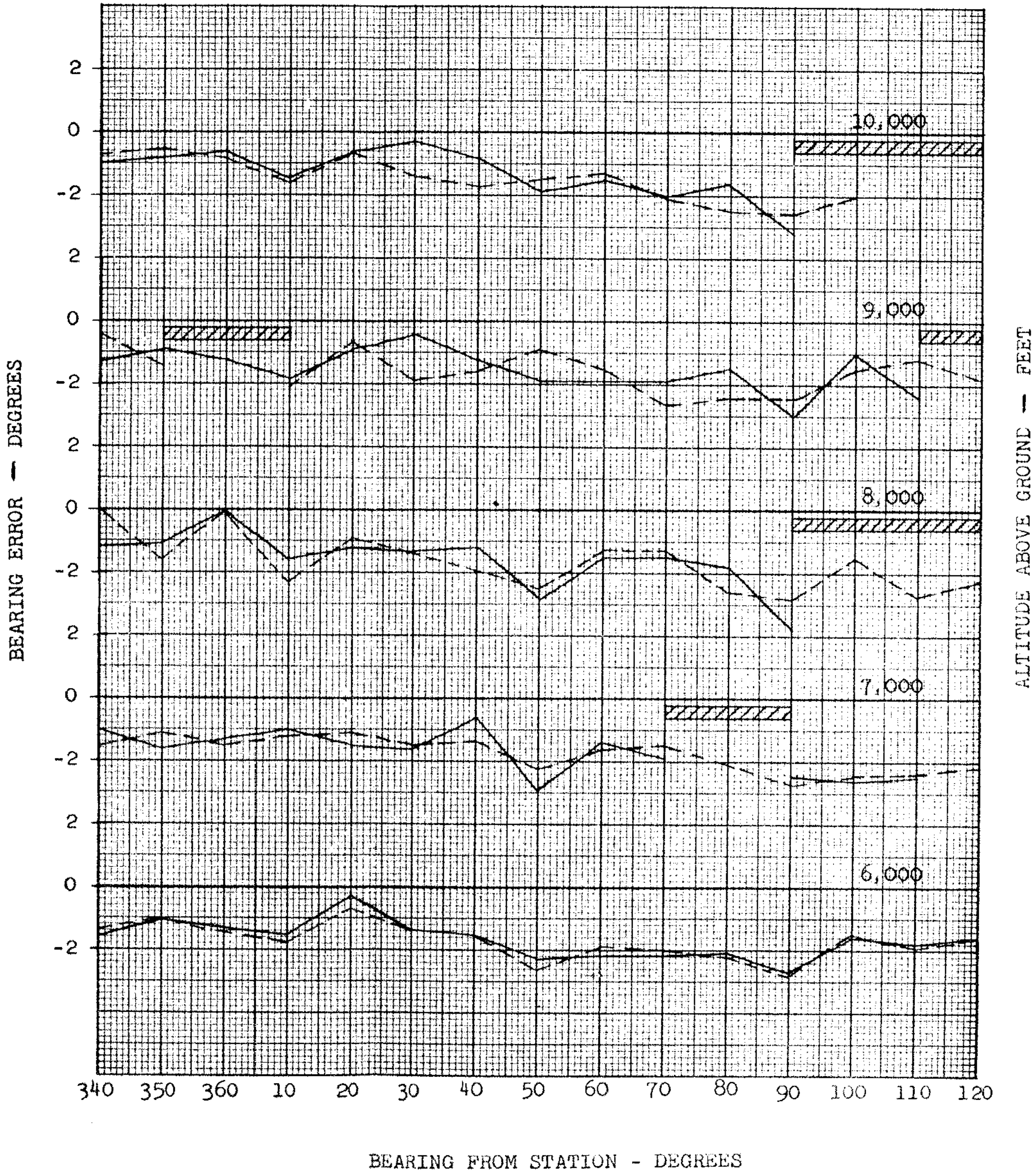
FIG. 14



NOTES:
MONITOR ANTENNA ON
RADIAL 50 DEGREES
RADIUS: 2 FEET 10 INCHES } POSITION "B"
ELEVATION: +13.5 INCHES } FIG. 8
ORBIT: 7.5 N.M.
SITE: NO. 2
ANTENNA: AN/GRN-9
CHANNEL: 50
——— ORBIT NO. 1
- - - - - ORBIT NO. 2
▨▨▨ BEARING UNLOCKED

AREAS OF UNLOCKING ARE NOT ATTRIBUTED TO MONITOR ANTENNA

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BEARING ERROR AT SITE NO. 2 WITH MONITOR ANTENNA

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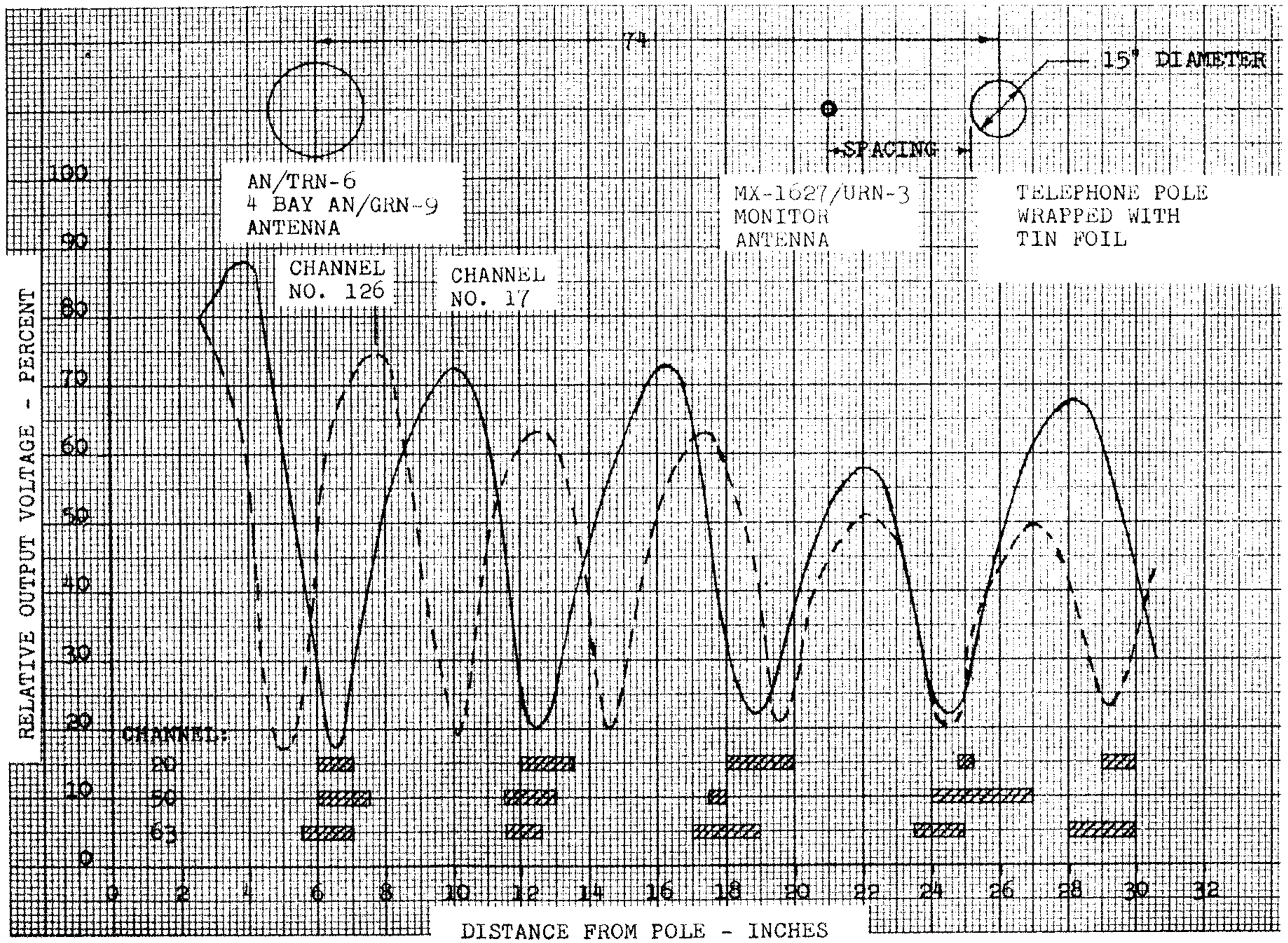
FIG. 15



NOTE:
HATCHED AREAS DENOTE REGIONS CONSIDERED UNSATISFACTORY FOR MONITORING

——— CHANNEL NO. 17 FREQUENCY 978 MC
- - - - CHANNEL NO. 126 FREQUENCY 1213 MC

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EFFECT OF SPACING BETWEEN MONITOR ANTENNA AND MONITORING POLE

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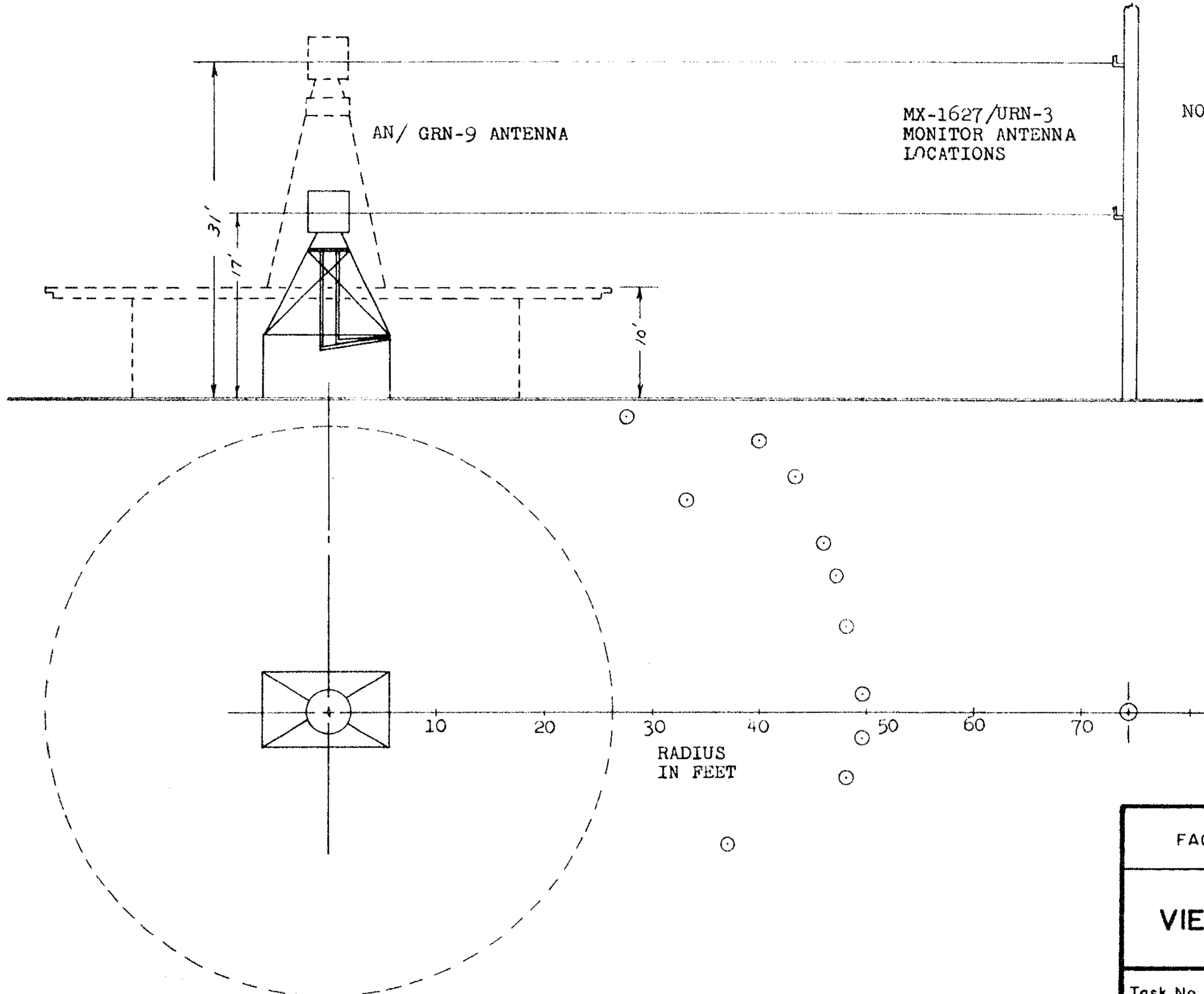
FIG. 16



NOTE:
SOLID LINES INDICATE RELATIVE POSITIONS WITH AN/GRN-9 ANTENNA ON AN/TRN-6 TRAILER.
DASHED LINES INDICATE TYPICAL AN/GRN-9 ANTENNA AT VORTAC INSTALLATIONS.

⊙ DENOTES POSITIONS WHERE 135-cps BEARING DATA IS OUT OF TOLERANCE.

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PLAN AND ELEVATION VIEWS OF TACAN MONITOR TEST INSTALLATION

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FIG. 17