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ACOUSTIC MEASUREMENTS ON EDO 120-INCH LUCITE SONAR DOME, (U)
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UNDERWATER SOUND REFERENCE LABORATORY REPORT

ACOUSTIC MEASUREMENTS ON
EDO 120-INCH LUCITE SONAR DOME

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⑥ **ACOUSTIC MEASUREMENTS ON
EDO 120-INCH LUCITE SONAR DOME**

⑩ by
Charles K. Brown

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⑭ USRL ~~CONFIDENTIAL~~ 26
⑪ 6 November 1952

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ABSTRACT

↳ The results obtained from acoustic measurements on an Edo 120-inch lucite sonar dome that the dome causes serious distortion of the main beam and undesirable side lobes in the directivity of an enclosed transducer.

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ACOUSTIC MEASUREMENTS ON EDO 120-INCH LUCITE SONAR DOME

INTRODUCTION

The USRL was requested by the Bureau of Ships¹ to make a series of measurements to determine the receiving and transmitting losses and beam distortion introduced when a 120-inch lucite sonar dome, manufactured by the Edo Corporation under contract NObsr-42120, is used with a transducer which may be trained and tilted.

Calibration measurements for the Edo 120-inch lucite dome began at the USRL on 6 February 1951. Prior to this date the Naval Research Laboratory had reported:² "The lucite dome introduces severe distortion at the higher frequencies, but even at the lower frequencies, secondary lobes of high magnitude at oblique angles would make the dome unusable." This fact was also apparent from USRL measurements before they were completed on 16 February 1951.

On 9 February 1951, while measurements were in progress, the USRL was requested by the Bureau of Ships³ to make further measurements using a type QH8a transducer. Prior to this time, however, the QH8a equipment had been dismantled and the re-rigging of this equipment would have involved considerable time and effort, so these measurements were deferred. The USRL was informed some time later that the lucite dome project was being cancelled and no further consideration was given this series of measurements.

The USRL was informed by telephone on 14 November 1951 that the Bureau of Ships was interested in only the data which was available at that time, and that this data could be submitted as an informal report with no conclusions being necessary. Accordingly, no priority was given the preparation

1. BuShips restr ltr S68-(9)(846) serial 6295(848) of 15 Dec 1949
2. NRL ltr report C-4000-78A/50 (4014) hw "Interim Report on Sonar Dome Development - NRL Problem 40S07-04R - Acoustic measurements of the 120-inch Edo Aircraft Company Lucite Dome"
3. BuShips restr ltr S67/13-2(848) serial 848-61 of 9 Feb 1951

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of the report and it has been withheld while more urgent data were processed. The data are submitted here with only the necessary explanations.

EQUIPMENT

The transducer used in the dome was a USRL-developed ADP-crystal instrument designated D3 number 1. The case was so designed that the orientation of the transducer with respect to the dome could be changed easily.

The dome is made of clear $\frac{1}{2}$ -inch-thick lucite, strengthened with ribs of the same material. It is 120 inches long and approximately 24 inches wide at the widest point, and is shaped in accordance with a David Taylor Model Basin formula for streamlined bodies known as EPB (Ellipse, Parabola, Hyperbola).

Fig. 1 shows a sketch of the dome and transducer with an explanation of the terms used in designating the different orientations.

MEASUREMENTS

All measurements were made with the dome rigged in an upright position similar to the position it would maintain in operation. The type D3 transducer was used in the dome as a transmitter in all measurements, and a type XQB transducer was used as the receiver.

In order to determine the transmission loss through the dome as a function of frequency, the dome was rotated through an azimuth angle of 90° and the sound pressure was then measured outside the dome through the frequency range 2 to 50 kc. This measurement was repeated with the dome removed. The difference between these two measurements was the loss through the dome at 90° azimuth.

Three types of directivity measurements were made in order to determine the effect that the dome would have on the operation of a transducer enclosed in the dome:

Control Patterns - these patterns were made in each case with the dome removed, and are to be compared with the dome patterns so that the effect of the dome may be seen more readily.

Dome Rotation Patterns - these patterns were made for various azimuth and tilt angles with the transducer stationary and the dome rotating, thereby giving the relative transmission loss through the dome as a function of azimuth angles.

Dome Field Patterns - the transducer was fixed at some orientation with respect to the dome and both were rotated as a unit, thereby giving the

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transducer pattern as it appears through the dome. The distortion introduced by the dome may be determined by comparing these patterns with the control pattern for that particular orientation.

The relative orientation of dome and transducer is described on each pattern presented in this report in terms of "azimuth" and "tilt" angles. These terms are explained with the aid of a sketch in Fig. 1.

Note that the patterns that result from the rigging arrangement used actually depict the directivity in a conical surface, except for tilt angles of 0° .

RESULTS

The dome loss measurements made at an azimuth angle of 90° show very little loss up to a frequency of about 25 kc, and only one- to two-db loss from 25 through 50 kc. These measurements were made with the dome transducer transmitting.

Additional dome loss measurements in the form of Dome Rotation Patterns are shown in Figs. 2, 3, and 4, from which relative dome loss for all azimuth angles at frequencies of 15, 24, and 45 kc can be determined. These patterns show that the loss at angles other than 90° azimuth is far from negligible.

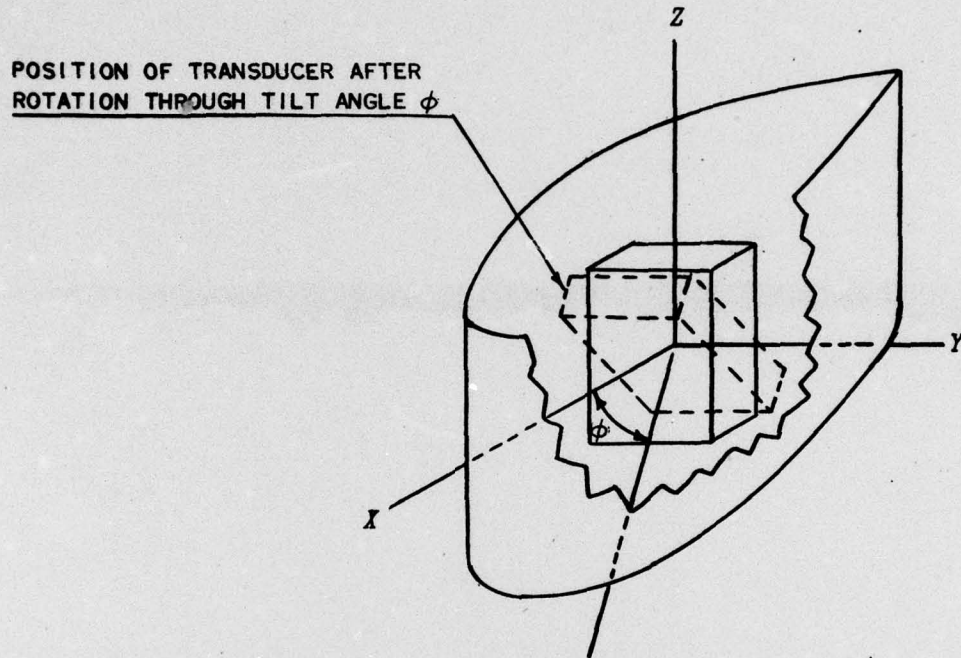
The dome field patterns in Figs. 5 through 25 show the effects of the dome on the directivity of the enclosed transducer for various azimuth and tilt angles at frequencies of 15, 24, and 45 kc. A control pattern or a pattern for the transducer and rigging alone is shown in each Figure. When this control pattern is compared with any other pattern in one particular Figure, the effects of the dome may be seen.

CONCLUSIONS

Since there is no longer any great interest in the project, no detailed analysis has been made of the data presented here; however, a casual inspection will show that the dome introduces very high side lobes and distorts the main beam of the transducer to such an extent that it would very likely be unsatisfactory for operational use.

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The dome and transducer may be placed in a coordinate system as shown above. The coordinate system is to remain fixed and the dome and transducer orientations will be given with respect to this system. For measurements where the dome or transducer or both are rotated, the orientations given are those existing at the beginning of rotation.

The term "Azimuth Angle" refers to the dome only and is the angle through which the dome is rotated about the Z axis in a counter-clockwise direction, or from X into Y .

The term "Tilt Angle" refers to the transducer only and is the angle through which the transducer is rotated about the Y axis so that the axis of the main beam is directed down from the horizontal.

In all measurements, the receiving transducer is positioned so that it is on the acoustic axis of the dome transducer; that is, it is lowered in the water and tilted upward from the horizontal by the amount of the tilt angle. As the tilt angle increases, the depth of the receiving transducer must also increase. The Z axis is the axis of rotation in all cases.

Fig. 1. Orientation of dome and transducer

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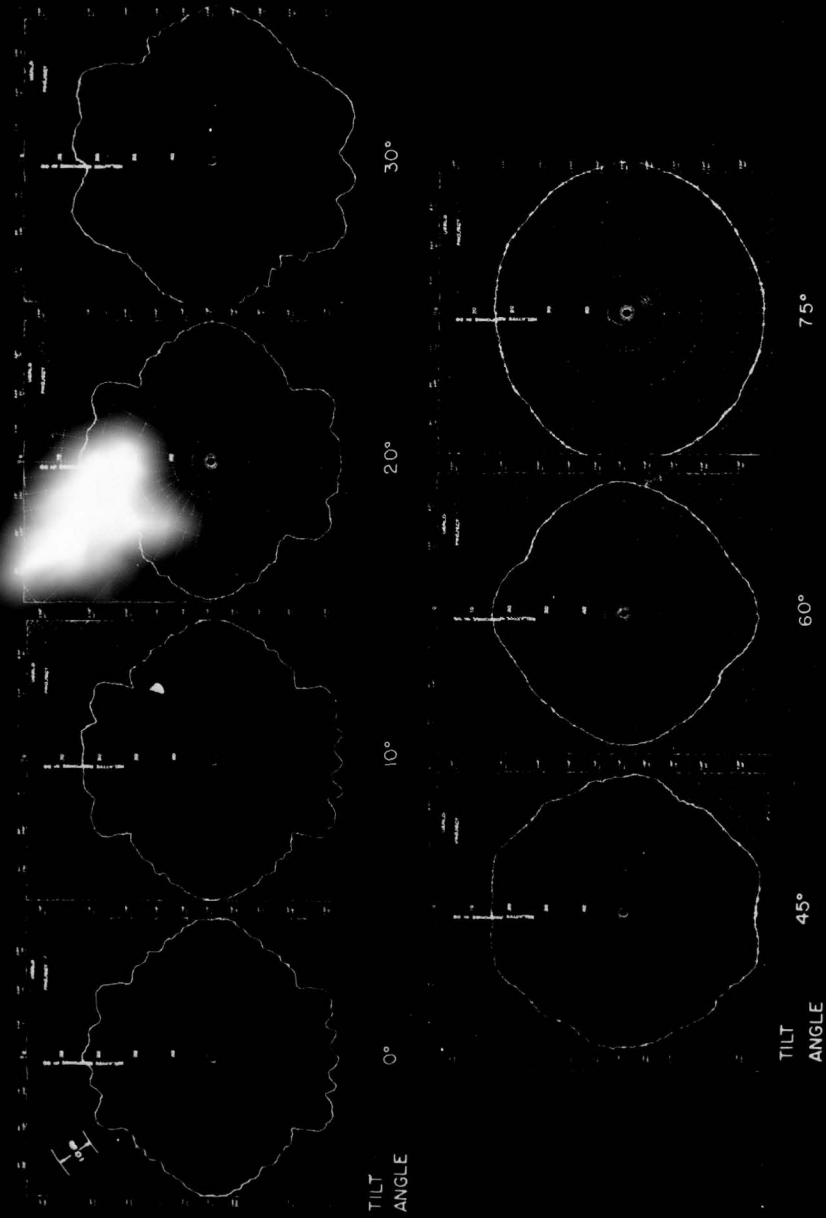


FIG. 2 DOME ROTATION PATTERNS AT 15 KILOCYCLES PER SECOND
RELATIVE TRANSMISSION LOSS FOR VARIOUS TILT ANGLES OF
EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

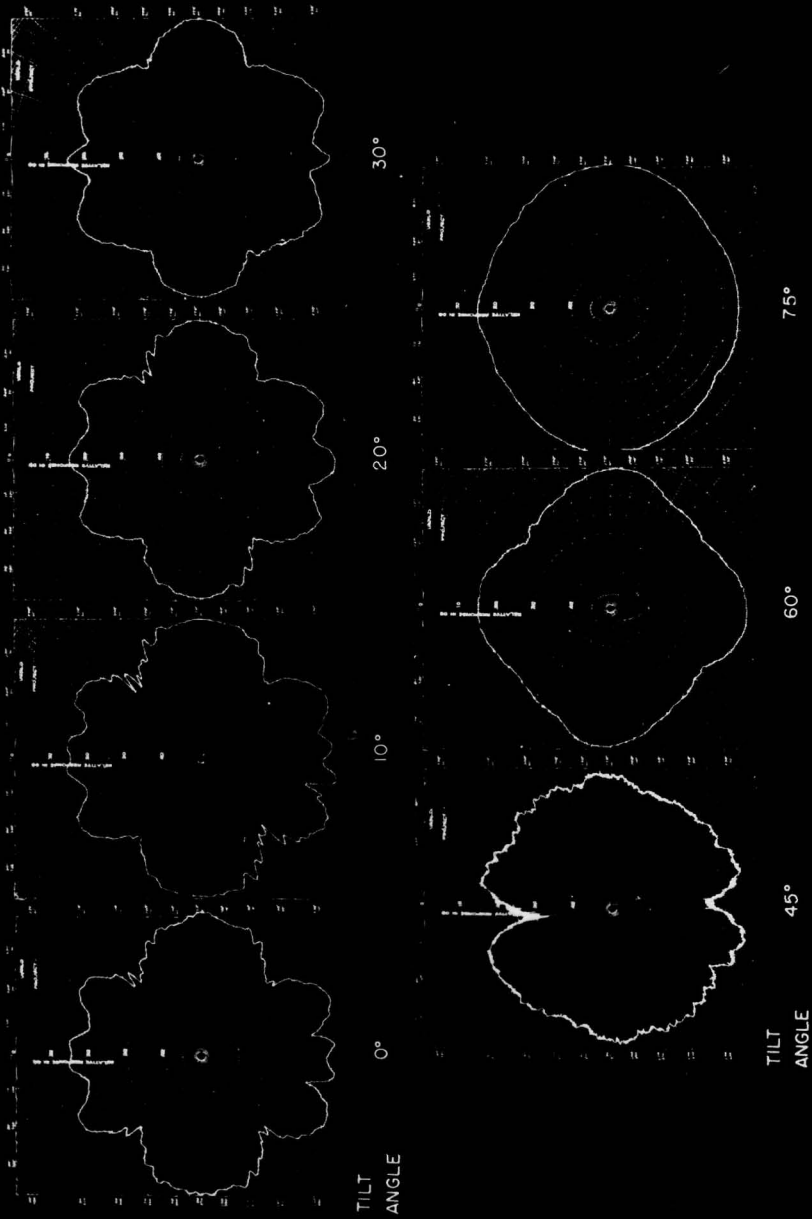


FIG. 3 DOME ROTATION PATTERNS AT 24 KILOCYCLES PER SECOND
RELATIVE TRANSMISSION LOSS FOR VARIOUS TILT ANGLES OF
EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

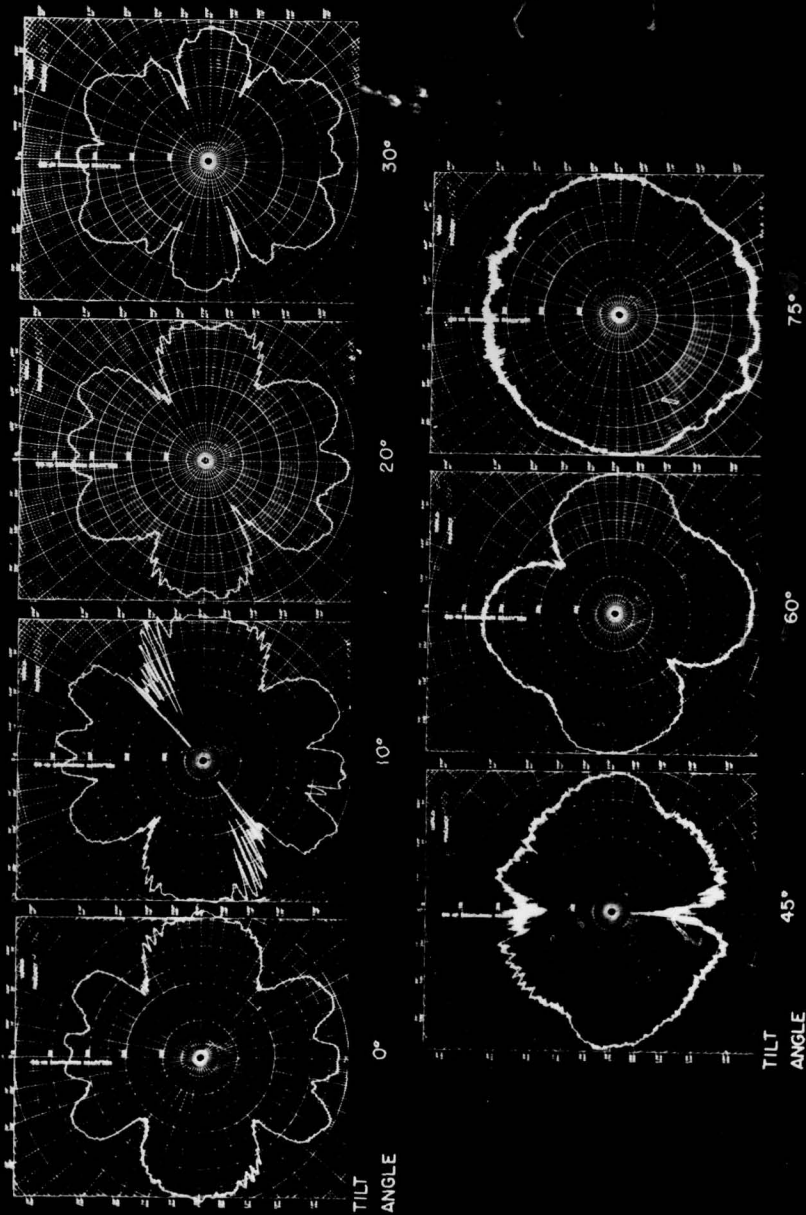


FIG. 4 DOME ROTATION PATTERNS AT 45 KILOCYCLES PER SECOND
RELATIVE TRANSMISSION LOSS FOR VARIOUS TILT ANGLES OF
EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

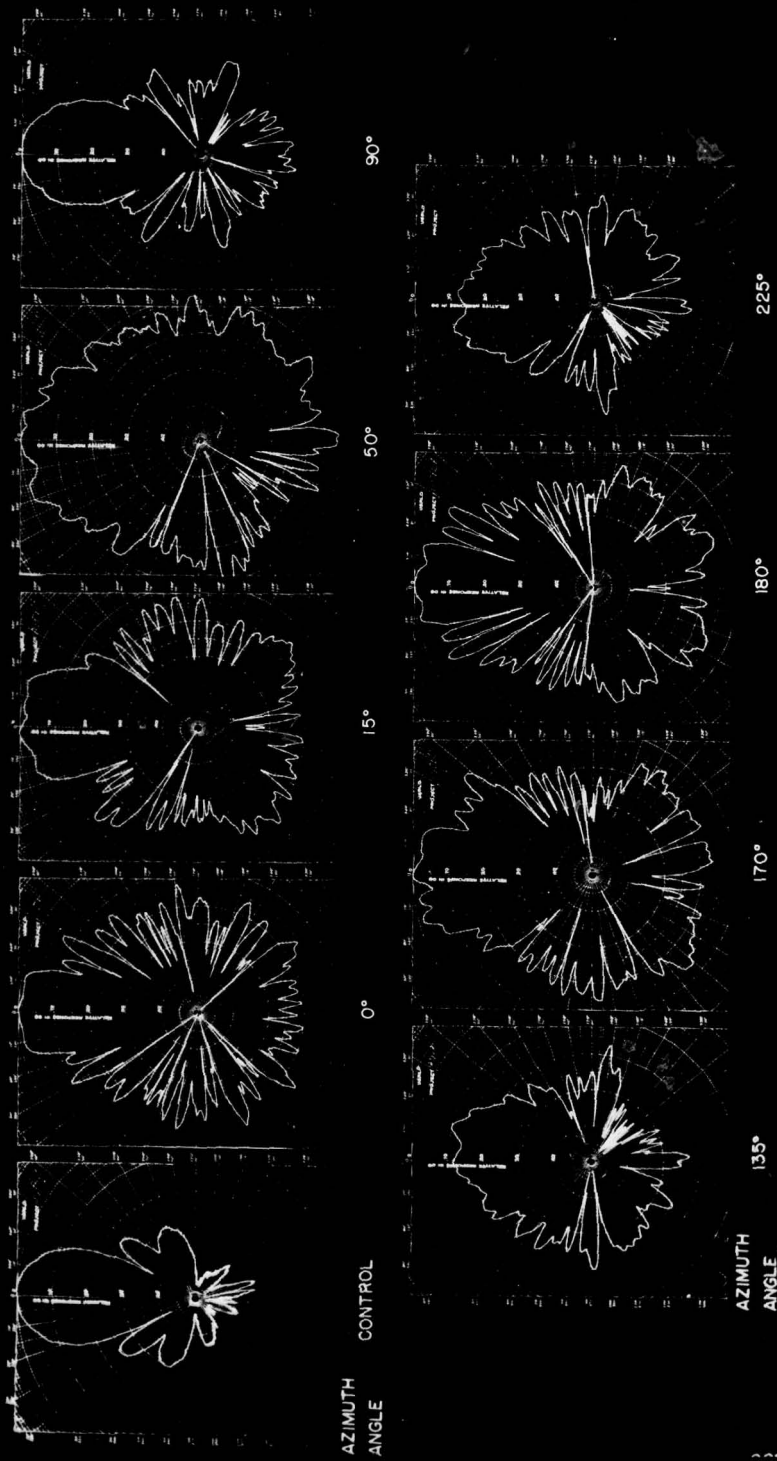


FIG. 5 DOME FIELD PATTERNS AT 15 KC AND 0° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

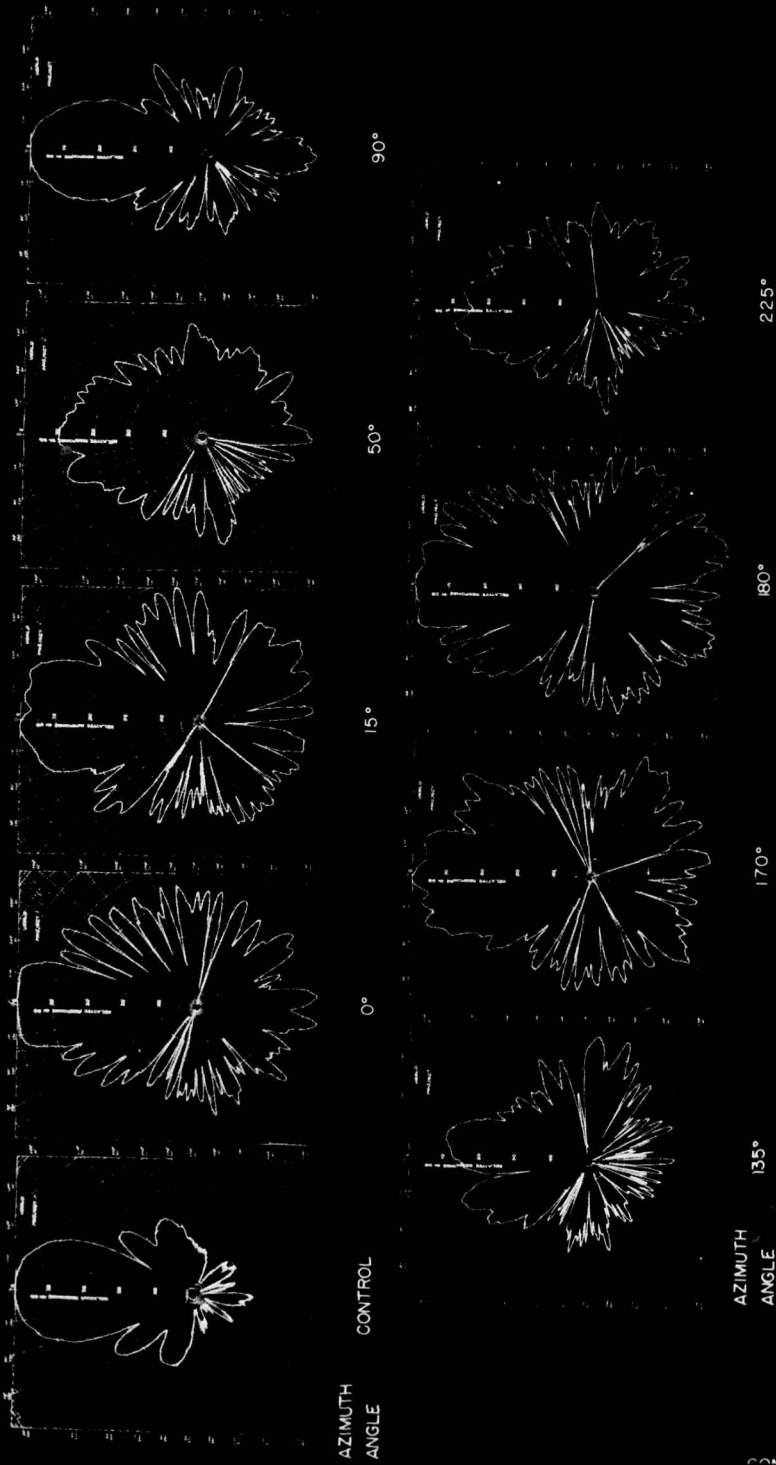


FIG. 6 DOME FIELD PATTERNS AT 15 KC AND 10° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

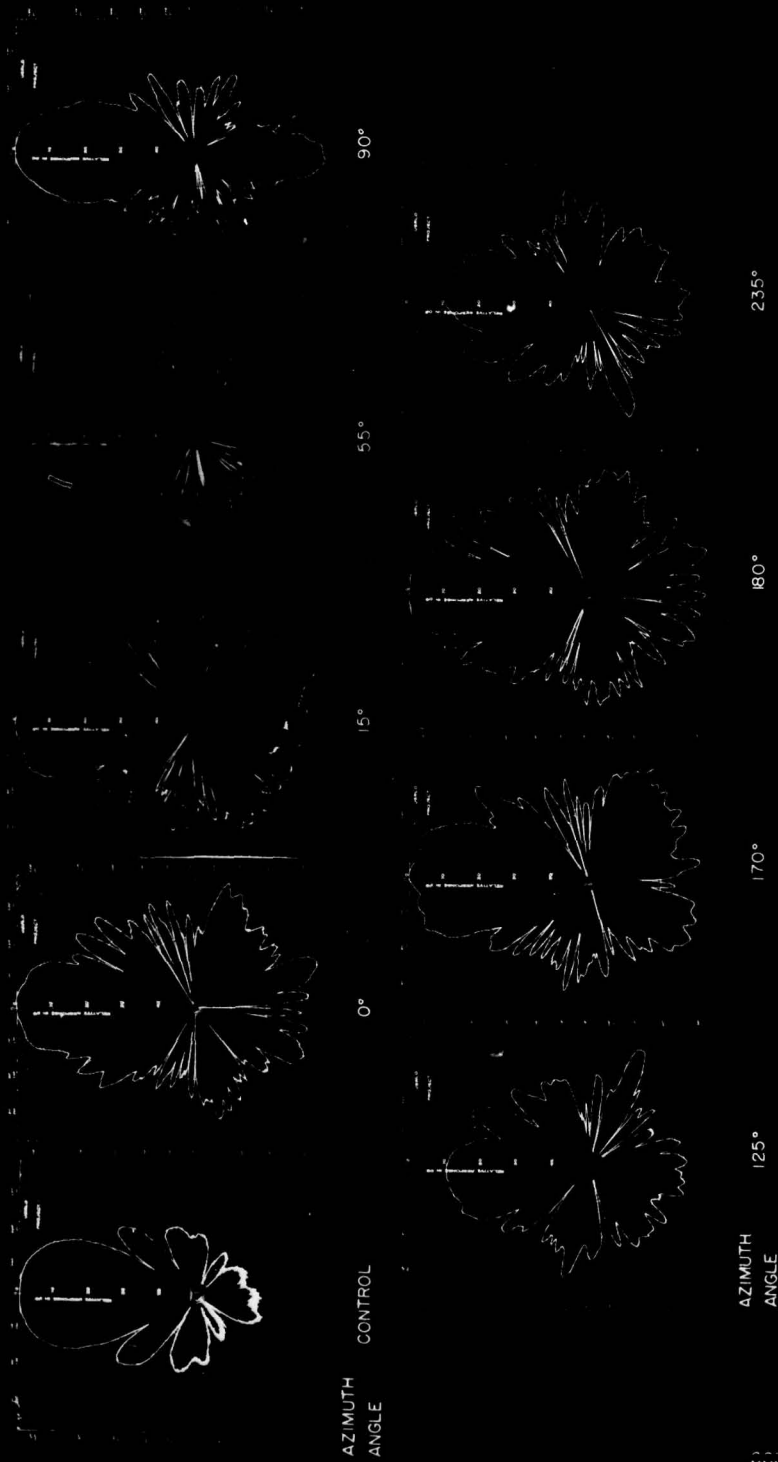


FIG 7 DOME FIELD PATTERNS AT 15 KC AND 20° TILT ANGLE

BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

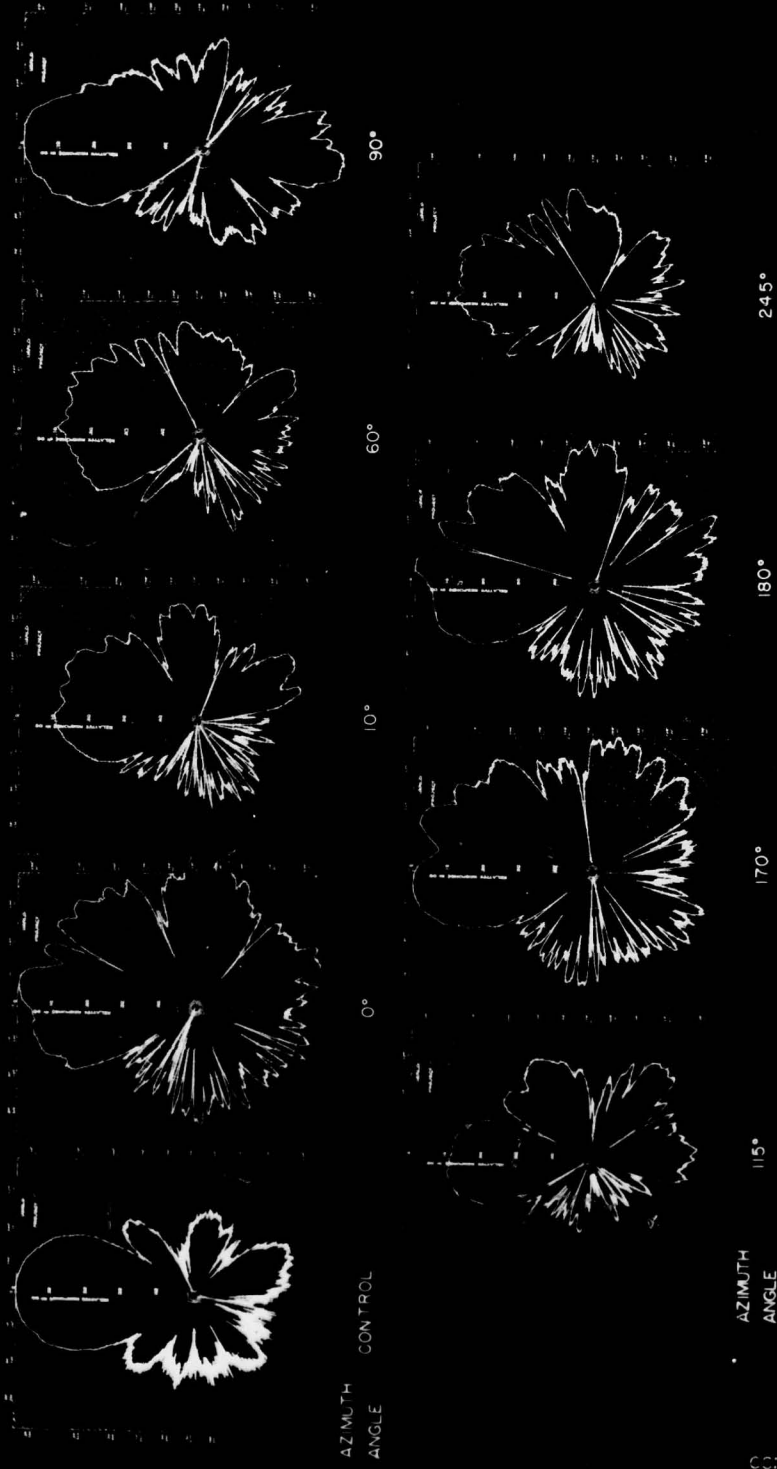


FIG. 8 DOME FIELD PATTERNS AT 15 KG AND 30° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME



FIG. 9 DOME FIELD PATTERNS AT 15 KC AND 45° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME



FIG 10 DOME FIELD PATTERNS AT 15 KC AND 60° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME



FIG. 11 DOME FIELD PATTERNS AT 15 KC AND 75° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

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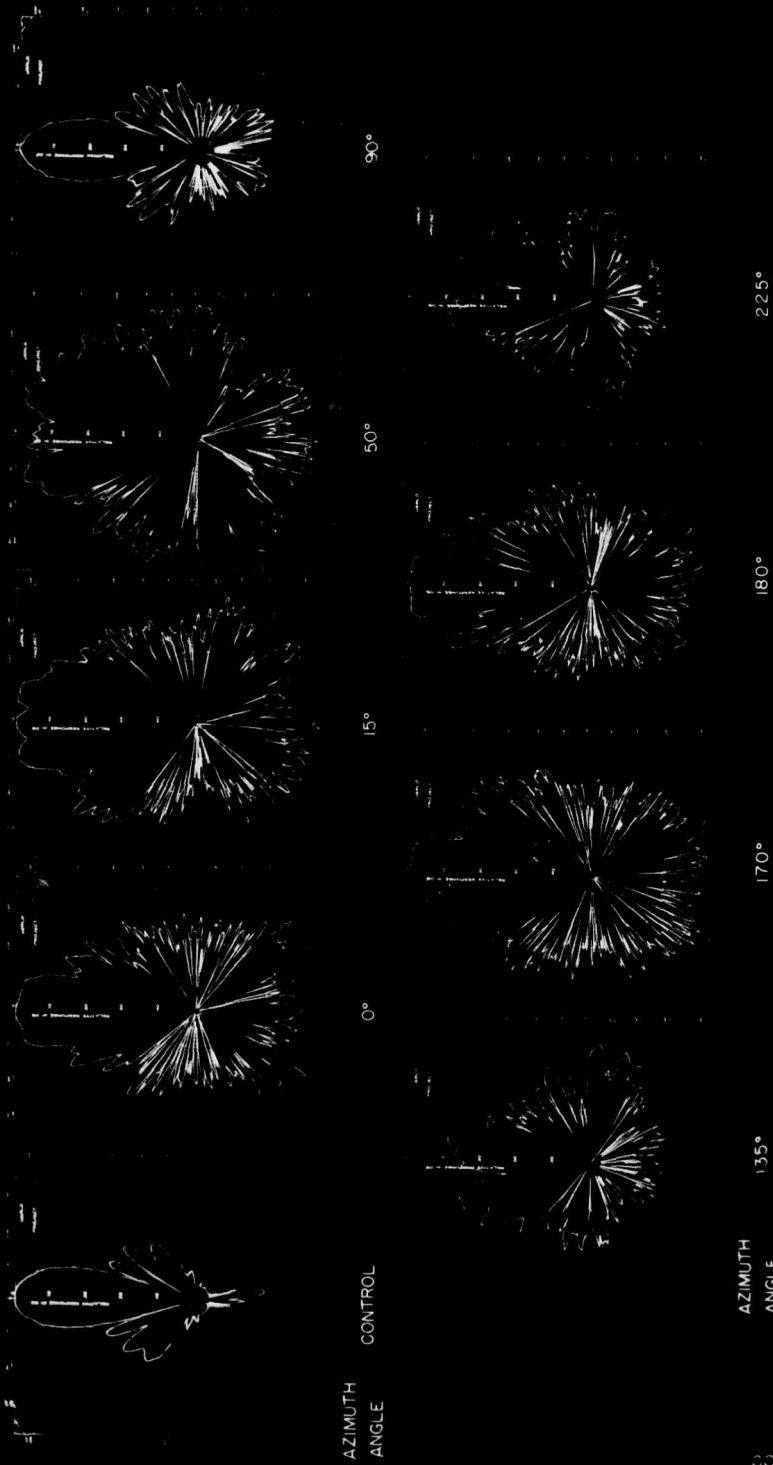


FIG. 12 DOME FIELD PATTERNS AT 24 KC AND 0° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

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ANGLE

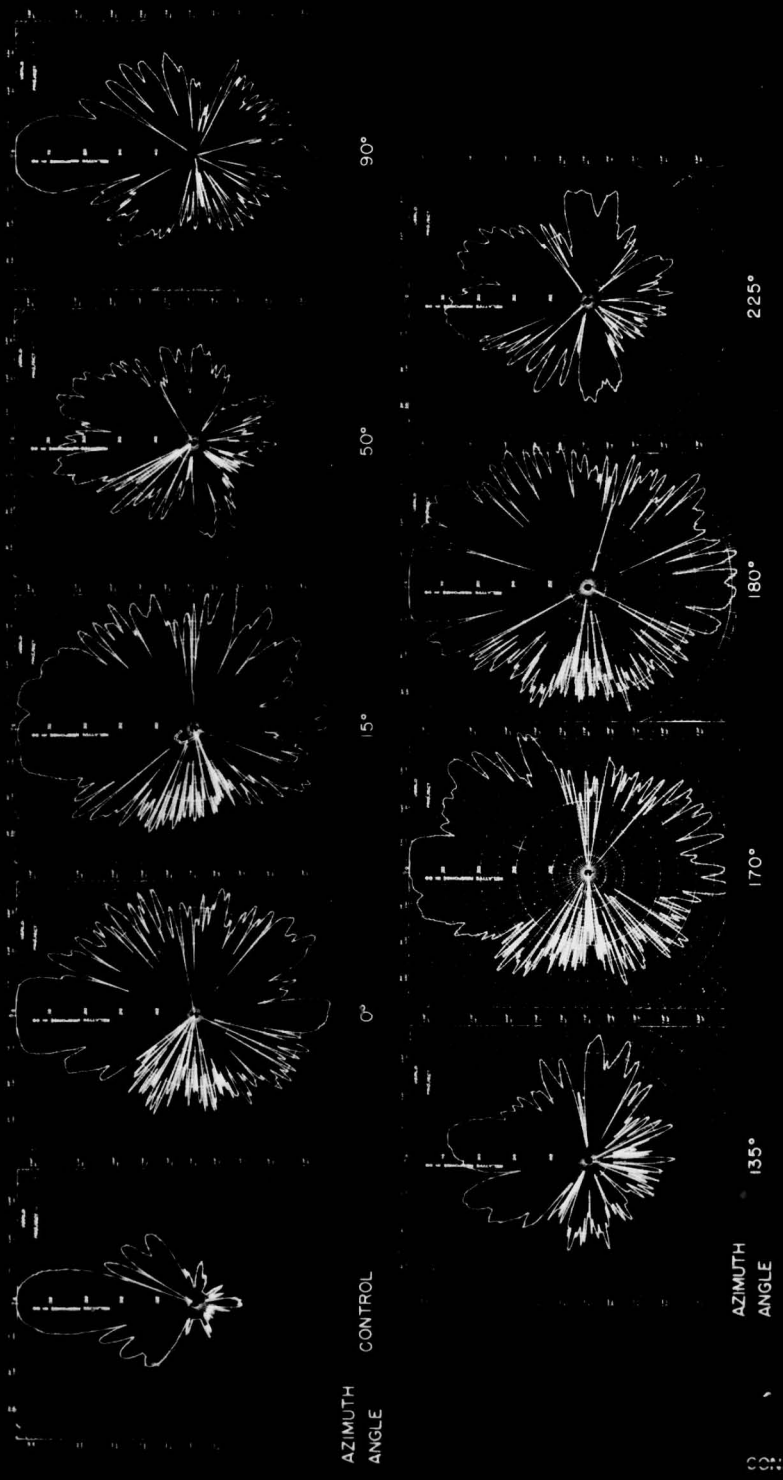


FIG. 13 DOME FIELD PATTERNS AT 24 KC AND 10° TILT ANGLE

BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

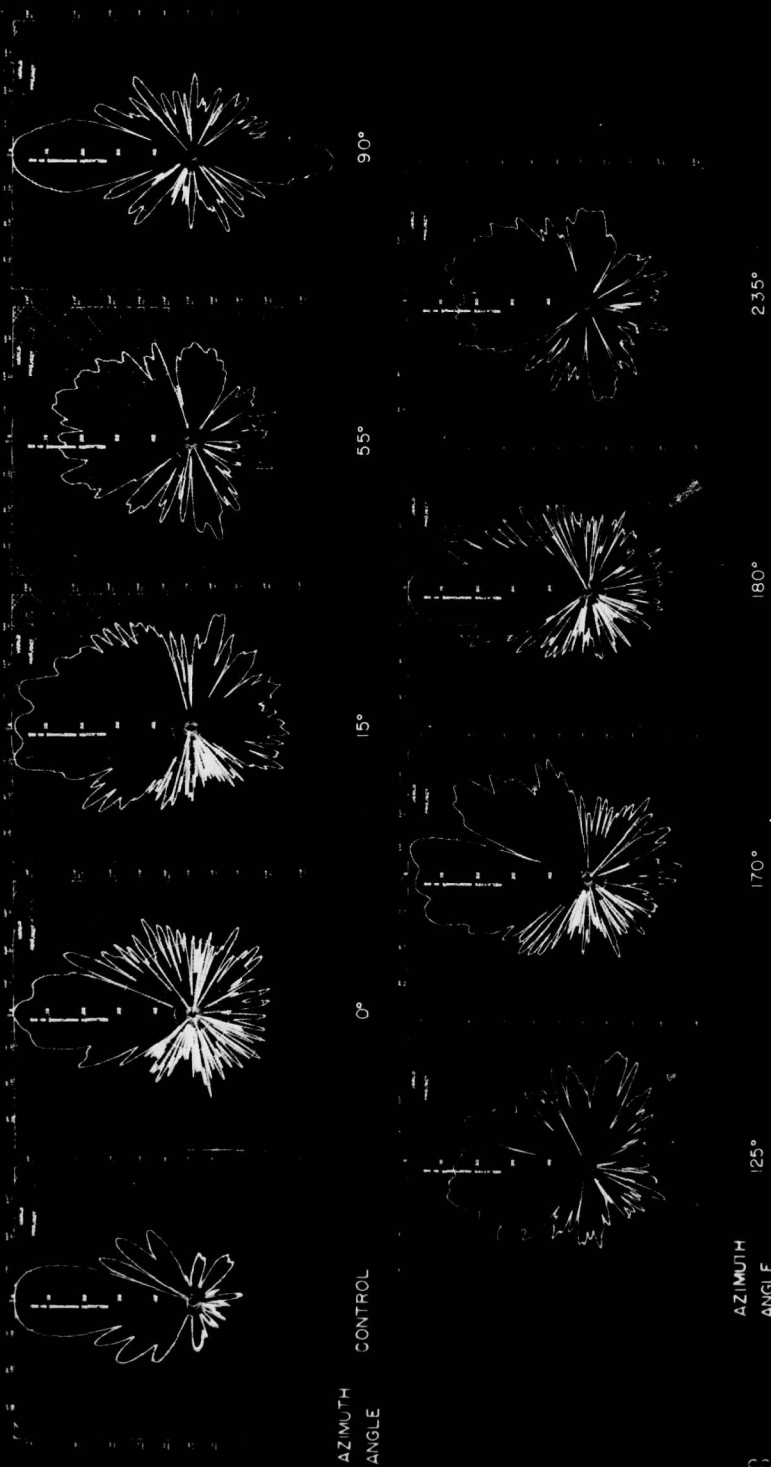


FIG. 14 DOME FIELD PATTERNS AT 24 KC AND 20° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

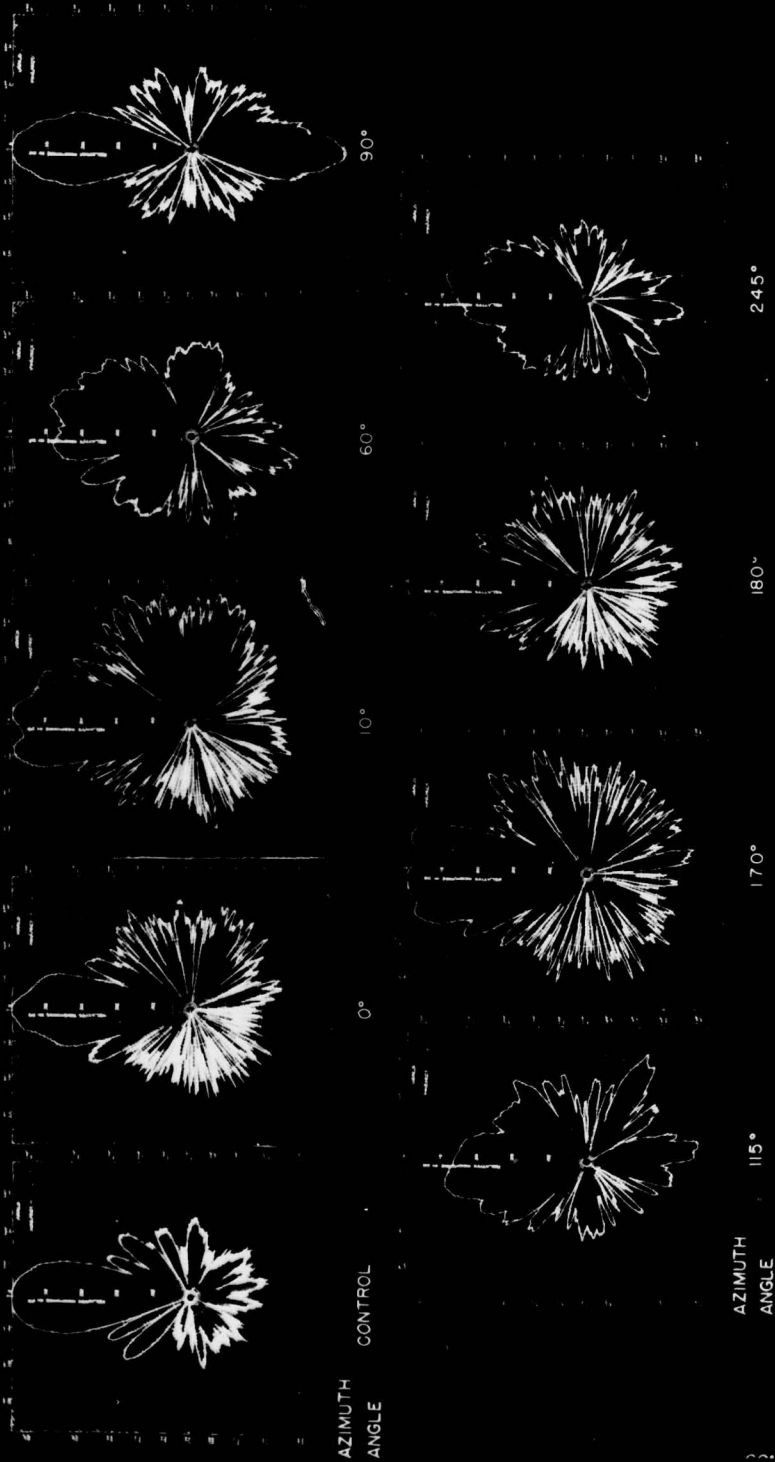


FIG. 15 DOME FIELD PATTERNS AT 24 KC AND 30° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

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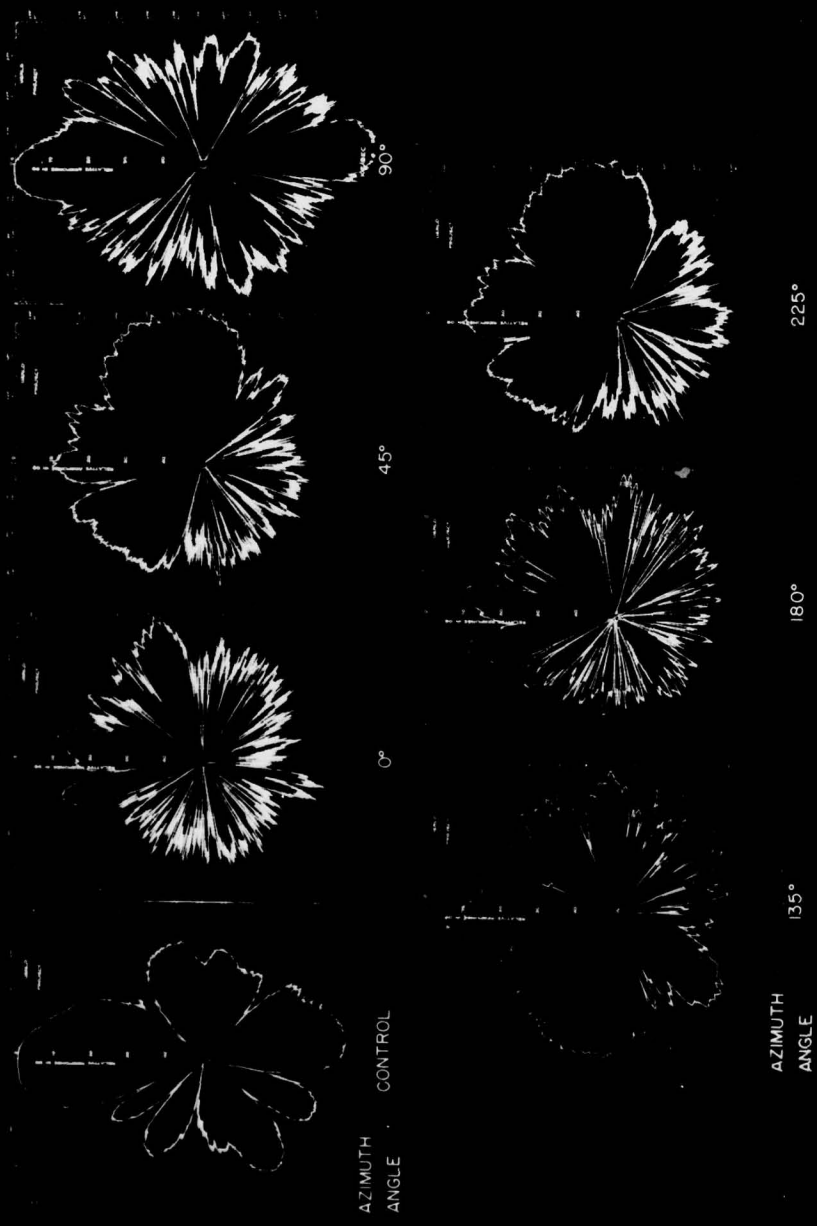


FIG. 16 DOME FIELD PATTERNS AT 24 KC AND 45° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

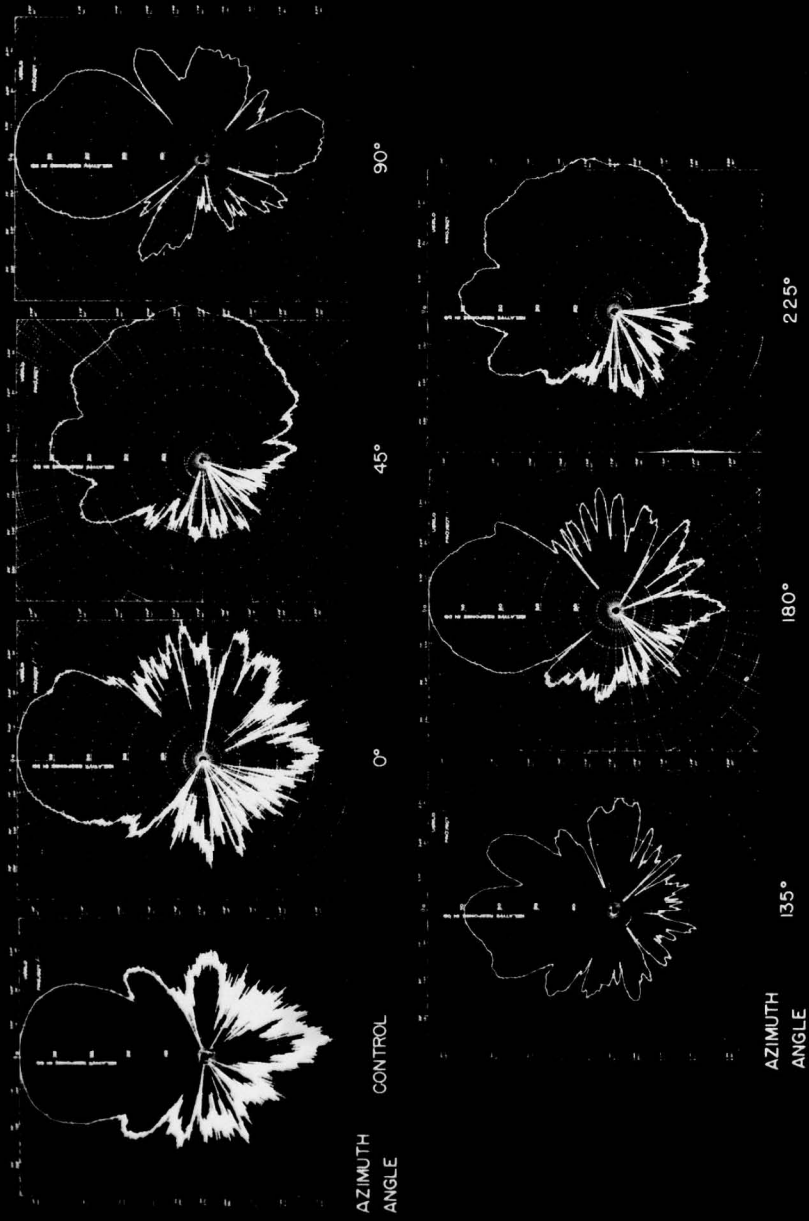


FIG. 17 DOME FIELD PATTERNS AT 24 KC AND 60° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME



FIG. 18 DOME FIELD PATTERNS AT 24 KC AND 75° TILT ANGLE
BEAM DISTORTION, SPECULAR AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

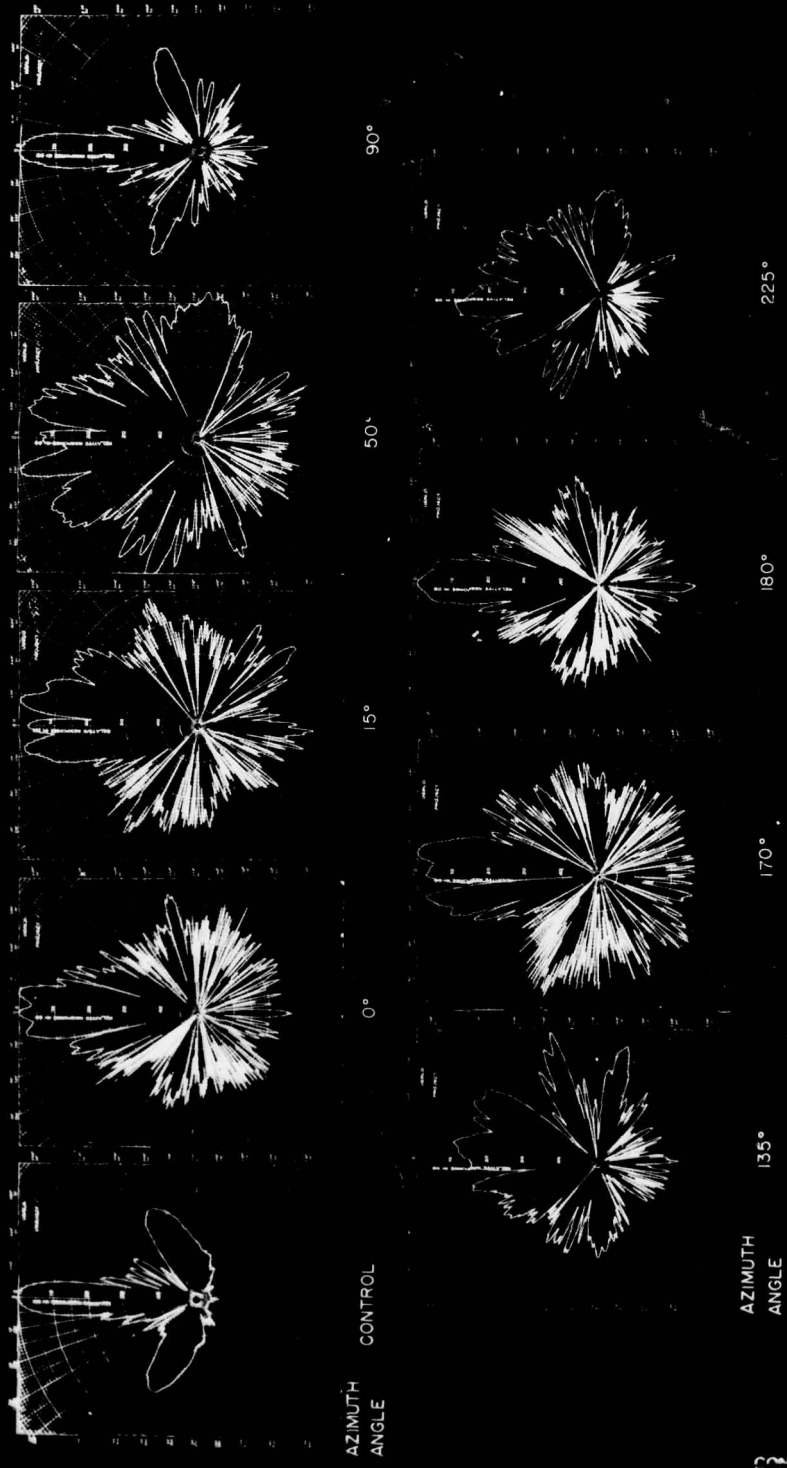


FIG. 19 DOME FIELD PATTERNS AT 45 KC AND 0° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

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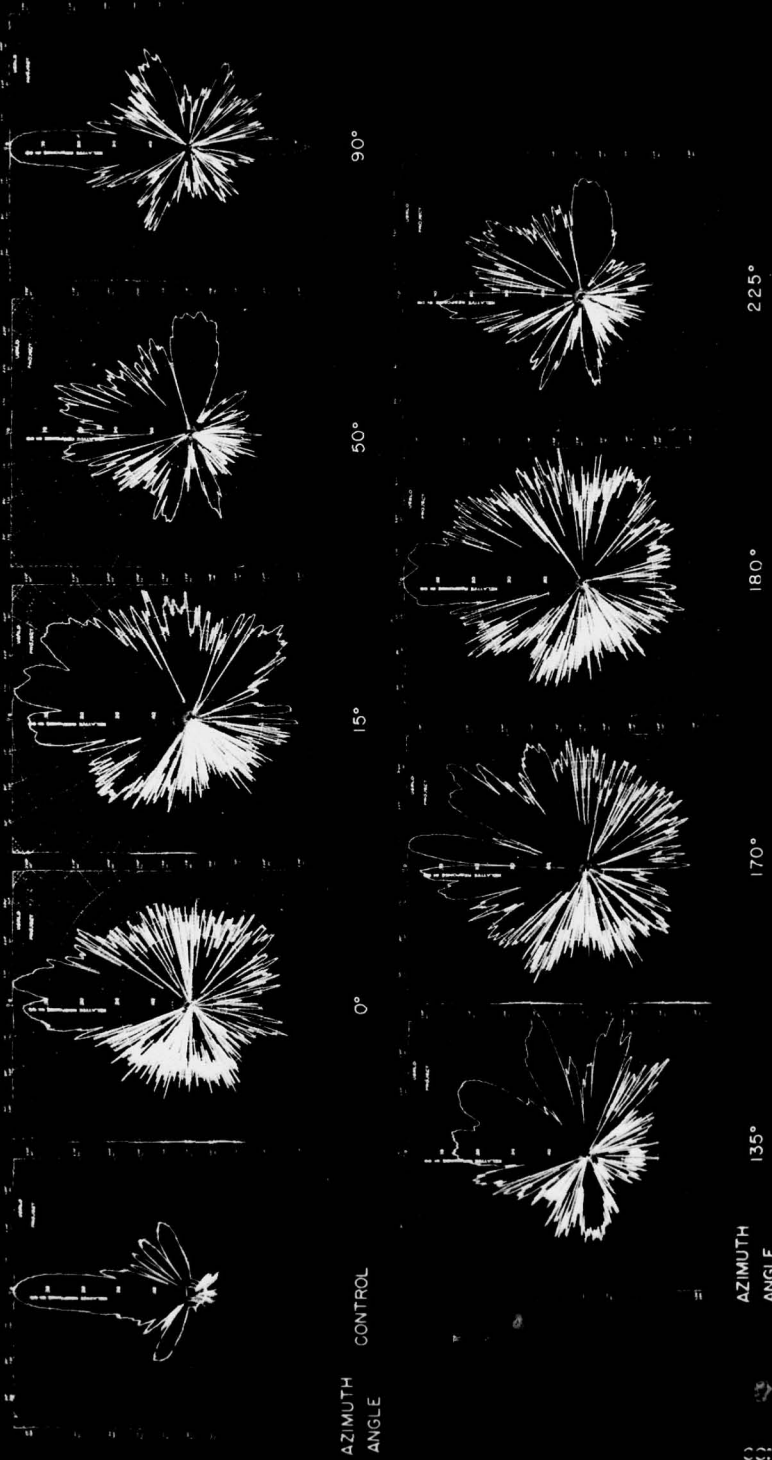


FIG. 20 DOME FIELD PATTERNS AT 45 KC AND 10° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

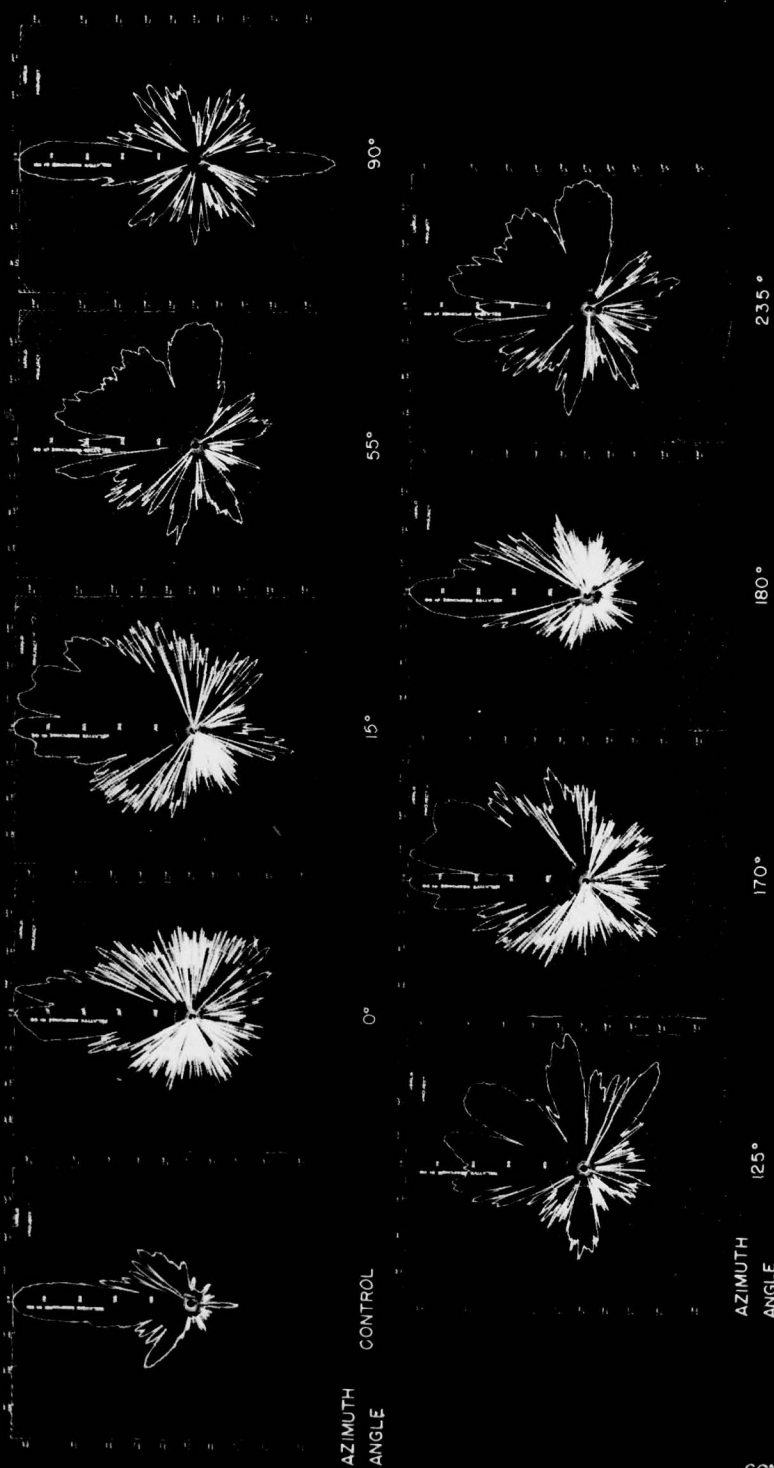


FIG. 21 DOME FIELD PATTERNS AT 45 KC AND 20° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

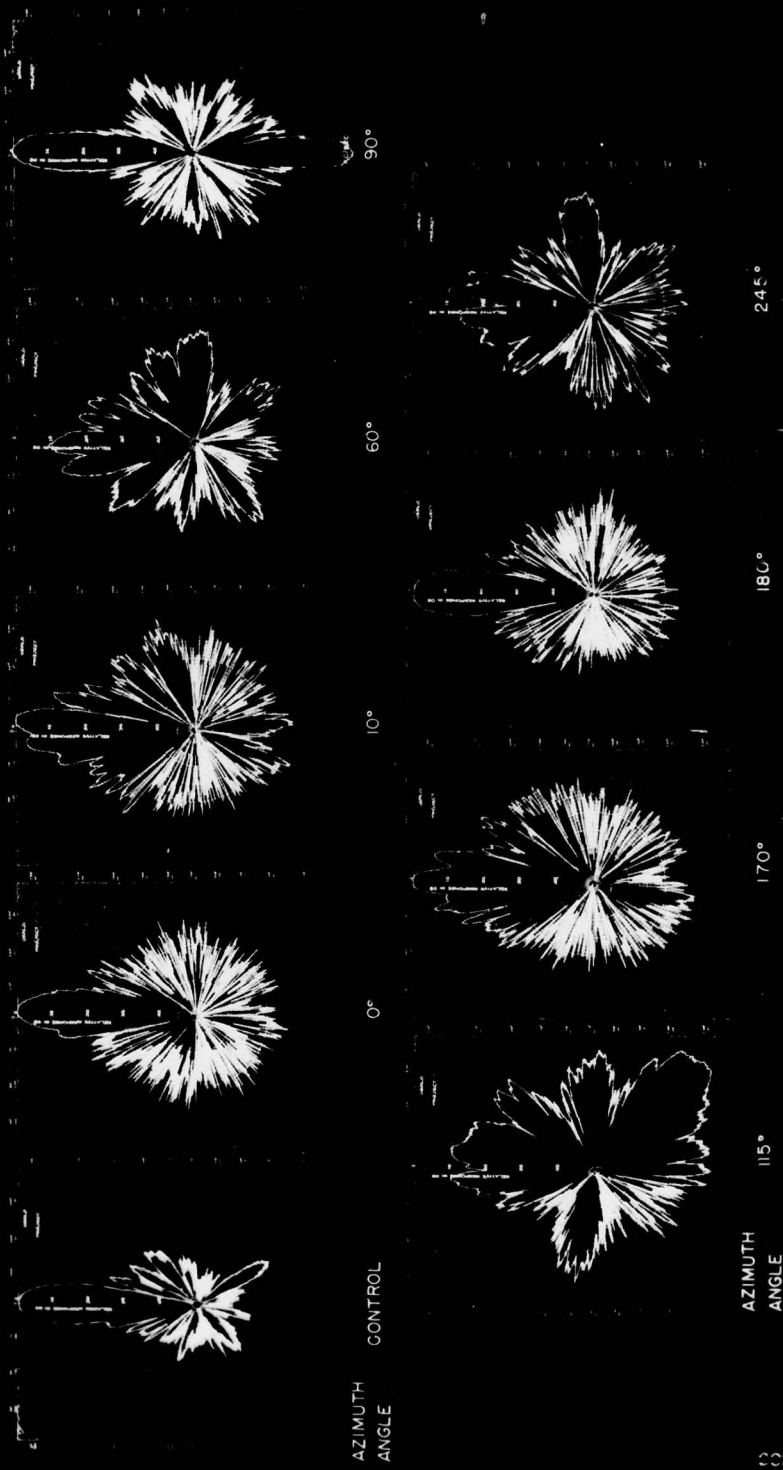


FIG. 22 DOME FIELD PATTERNS AT 45 KC AND 30° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

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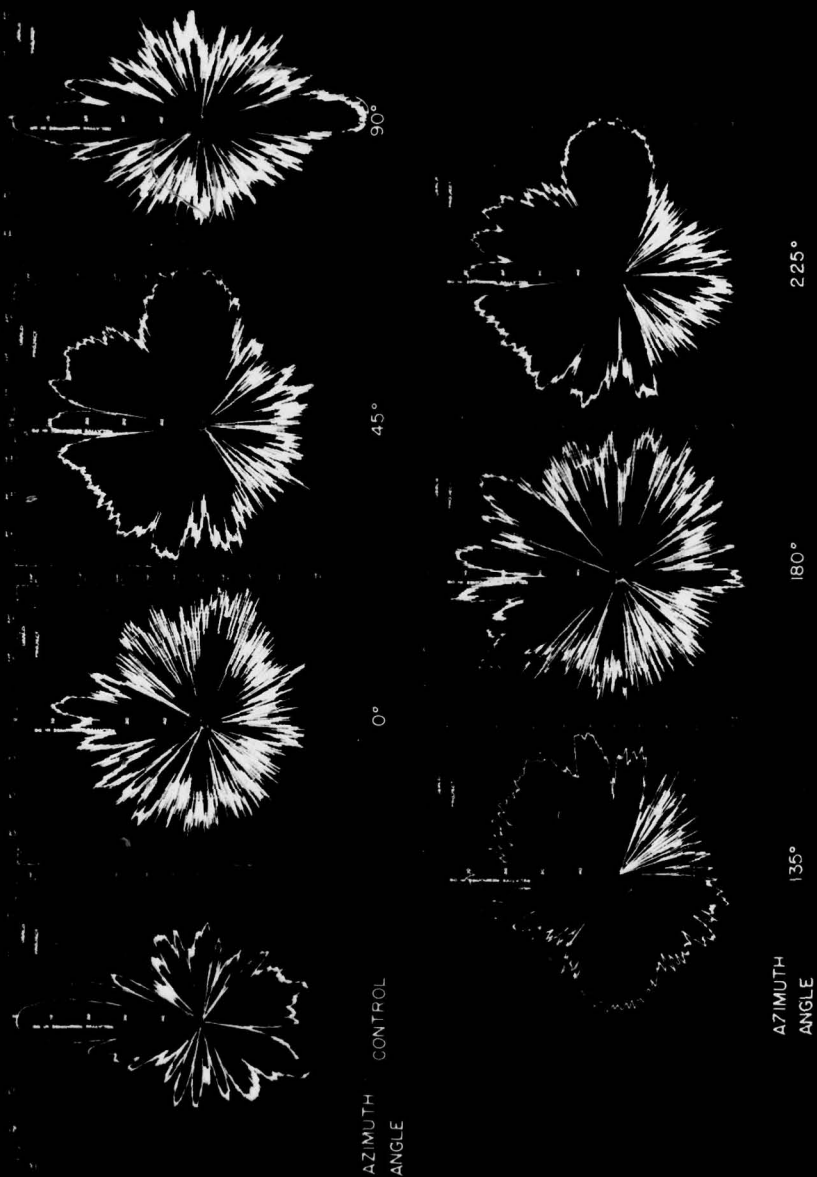


FIG 23 DOME FIELD PATTERNS AT 45KC AND 45° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

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FIG. 24 DOME FIELD PATTERNS AT 45 KC AND 60° TILT ANGLE
BEAM DISTORTION, SPECULAR, AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

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FIG 25 DOME FIELD PATTERNS AT 45 KC AND 75° TILT ANGLE
BEAM DISTORTION, SPECULAR AND SCATTERED REFLECTIONS FOR VARIOUS
AZIMUTH ANGLES OF EDO AIRCRAFT COMPANY 120-INCH LUCITE SONAR DOME

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