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QUARTERLY PROGRESS REPORT NUMBER 4, 1 OCTOBER - 31 DECEMBER 196--ETC(U)
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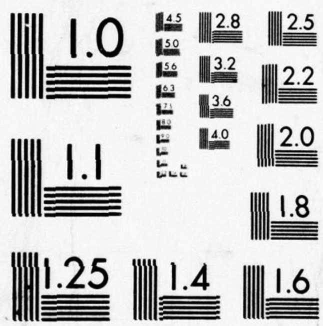

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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DEFENSE RESEARCH LABORATORY

23 January 1969

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QUARTERLY PROGRESS REPORT No. 4 UNDER CONTRACT NObsr-93125 1 October - 31 December 1968

NAVAL SHIP SYSTEMS COMMAND Contract NObsr-93125, Project Serial No. SF1010318, Task 8048

DEFENSE RESEARCH LABORATORY
THE UNIVERSITY OF TEXAS

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QUARTERLY PROGRESS REPORT [redacted] Number 4,
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1 October - 31 December 1968.

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NAVAL SHIP SYSTEMS COMMAND Contract NObsr-93125
Project Serial No. SF1010318, Task 8048

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On 1 October 1968 the title
Defense Research Laboratory
was changed to
Applied Research Laboratories

DEFENSE RESEARCH LABORATORY
THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

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I. INTRODUCTION

Applied Research Laboratories (ARL) was awarded the subject contract, effective 1 January 1965. Work under this contract, primarily concerned with test and evaluation of sonar transducers, has continued to the present time.

Modification 14 to the subject contract, which extended the period of performance through 1 January 1969, initiated the requirement for quarterly progress reports. Formerly, progress was reported orally to NAVSHIPS. This report is the fourth and final quarterly progress report. Current projects will be continued through 1969 under Contract N00024-69-C-1066. This new contract became effective 8 October 1968, and the change in funding was accomplished prior to 31 December 1968. Thus, most of the projects described in this report were partially funded during this quarter under Contract N00024-69-C-1066. This report will serve as an initial progress report for the new contract. The first formal quarterly progress report under contract N00024-69-C-1066 will be issued 31 March 1969, to avoid duplication. Modification 18 to Contract NObsr-93125, dated 7 November 1968, extended the contract until funds are expended so that the STEP Barge Facility can be completed. It is planned that future progress on this work will be reported in N00024-69-C-1066 progress reports, rather than issuing separate reports.

Progress on the various projects under the subject contract will be discussed in the following sections of the report. A list of personnel currently working under the contract is given at the end of this report.

[redacted]

II. STEP BARGE FACILITY

Construction of the STEP Barge is rapidly nearing completion. The principal delay in completion has been electrical wiring of the entire barge. The barge has been equipped with temporary 440 V 3 Ø power for some time. This temporary wiring was done so that the NEFBRACS testing could be done aboard this barge (Chapter III). The permanent wiring of the entire barge is approximately 90 percent complete. As soon as this wiring is fully completed, the barge will be anchored in its permanent location in about 100 ft of water.

The instrumentation hut is fully complete; the floor was installed during the past quarter, as was its electrical wiring, including lights and electric heaters. The latter items were patched into the temporary barge wiring so this hut could be lighted and heated for immediate use. Another item completed during this quarter was the 1 hp motor control unit that will power the rotator.

The Scientific-Atlanta instrumentation for this barge arrived at ARL on 1 November 1968. S-A personnel were at ARL installing this equipment during the period 6-14 November 1968. Only minor problems were encountered with this installation.

Construction of the shore-based transducer handling equipment will begin as soon as possible. Design work has been completed on modification of an existing traveling hoist to be used on the loading platform for the marine railway facility that will be used to transport transducers to the barge.

III. NEARFIELD BEARING AND RANGE ACCURACY CALIBRATION SYSTEM (NEFBRACS)

A. Introduction

During this quarter, the work done on the developmental model of NEFBRACS centered on readying the system for acoustic data acquisition.

A few additional mechanical modifications to the hub and can were completed and checked out. Some new support equipment was designed and constructed to aid in "diving" NEFBRACS and to sustain its underwater operation for greater periods of time.

Preparation for acoustic measurements using NEFBRACS required building a test fixture for shading of the line transducer. Another preparation included the mounting of an AN/SQS-23 stave of TR-208 elements in a horizontal position to approximate the AN/SQS-23 transducer beam pattern.

During November, NEFBRACS was attached to the AN/SQS-23 dome and acoustic data acquired. The data acquisition involved the use of the stave of TR-208 elements, a farfield transducer (F-36), and NEFBRACS. The instrumentation for recording the data was the S-A standardized transducer measurement console installed on the STEP Barge.

Details of the progress during this quarter are given in the following sections.

B. Mechanical

1. Line Transducer Alignment

The developmental model of NEFBRACS was designed so that upon disassembly, the component parts could be easily transported to a test site. Upon reassembly it is necessary to properly align the line transducer, its support structure, and the hub assembly. This alignment is necessary for zeroing bearing readout, for ensuring proper clearance between the support structure and AN/SQS-23 dome, and for positioning the line transducer so that its symmetrical sound field intercepts the AN/SQS-23 transducer in both the vertical and horizontal planes. To simplify the alignment procedure, a transit mounting device was constructed so that all critical measurements can be referenced to the hub and can assembly.

2. Fixed Support for Shading of Line Transducer

In the past, shading of the line transducer was done separately from the NEFBRACS support structure, which had not been fully completed. During this quarter, with NEFBRACS completely assembled and properly aligned, shading of the "line" was accomplished while it was in its actual operational configuration. In order to shade the line a stable underwater attachment point was needed for NEFBRACS. Other criteria, such as accurate probe test depth and distance to the "line" elements, also required a stable mount for NEFBRACS. Consequently, a fixed support for NEFBRACS was designed and built; it is a rigid steel shaft 27 ft long, fixed to the side of the STEP Barge. Attached to the bottom of the shaft is a 1/4 in. thick steel plate rolled to approximate the bottom contour of the AN/SQS-23 dome. NEFBRACS could then be attached to the plate by the same procedure used for the dome attachment. This support shaft provided the rigidity as well as the other requirements for proper shading of the line.

This procedure for shading the line elements will be discussed in one of the following sections.

3. Dome-Mounted TR-208 Stave and Rotator

The proposed NEFBRACS test plan called for mounting a single stave of TR-208 elements in the AN/SQS-23 dome. This stave would enable one to simulate sum and difference beam patterns and, in addition, to approximate the horizontal beam patterns of the full AN/SQS-23 transducer. An existing submersible rotator was used to mount the TR-208 stave. A structure was designed and built to support the rotator and stave so that the center of the stave would exactly coincide with the center of an AN/SQS-23 transducer mounted in the dome. (Fig. 1.) The stave rotator included a remote motor control and synchro readout. The rotator was designed for a total travel of 320 deg. The control box was modified slightly to provide synchro information either to the existing readout or to a polar plotter. Both the rotator cable and the power cable to the TR-208 stave were tied to the mounting frame so as to remain free during the full 320 deg rotation and to remain clear of the elements of the stave. The stave was aligned carefully to give accurate angle readout with respect to the dome.

Power for the stave was supplied by a CML 3 kVA amplifier. A switch was designed to provide three configurations of the TR-208 stave. When the stave was driven at high power (100 V rms drive), all 9 elements were connected in parallel. When the stave was used as a receiver, either all 9 elements were connected in series

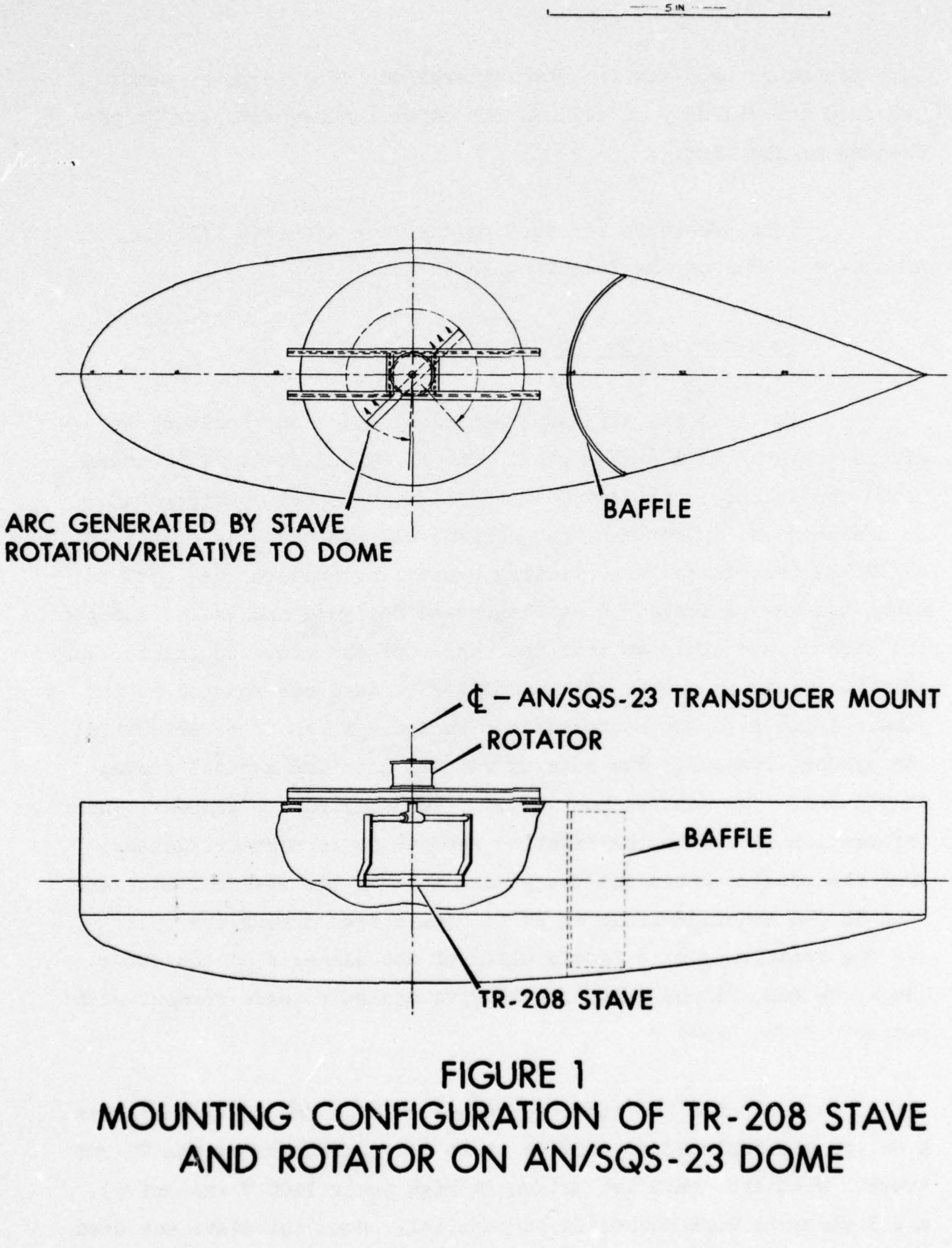

FIGURE 1
MOUNTING CONFIGURATION OF TR-208 STAVE AND ROTATOR ON AN/SQS-23 DOME

(sum mode), or elements 1 through 4 were series wired in opposition to series-wired elements 6 through 9 (difference mode). These configurations were used to simulate the AN/SQS-23 in both the sum and difference receiving modes.

4. NEFBRACS Support Equipment

During the time required for mechanical alignment and shading of the line transducer, modifications and additions to the support equipment were completed and checked. The following paragraphs describe these changes in detail:

a. The three small hand operated winches mounted on the STEP Barge that are used for maneuvering NEFBRACS for dome attachment were converted to remote controlled motor driven winches. A two-speed motor controller was designed and built. The remote diver control box was waterproofed, and lights were mounted for indicating direction of travel and speed. A safety feature incorporated on the remote control box was an "emergency stop" command from surface to diver; also added were "yes," "no," and "repeat" signals from diver to surface personnel, for use in conjunction with a Watercom surface-to-diver communication device.

b. An emergency warning device was built to signal failure of one or more of NEFBRACS' support systems--electric power to the hydraulic pump and air compressor, hydraulic and pneumatic pressure, and NEFBRACS' system electric power. This warning device enabled personnel to leave NEFBRACS attached overnight to the AN/SQS-23 dome, thus eliminating the time required each day for attachment and removal and increasing the amount of time available for acoustic measurements. Any alarm would signal the LTTS security guard who would then relay the alarm via telephone to the NEFBRACS dive crew. No failures occurred, however, during the various test periods of attachment, the longest of which was four days.

C. Shading of NEFBRACS Line Transducer

As mentioned previously, it was necessary to reshade the line transducer when it was attached to the NEFBRACS' line support structure. Prior to shading, NEFBRACS was attached to the bottom of the shaft support; by using the two end acoustic tracking elements, it was possible to position the line in the horizontal plane and parallel to the edge of the STEP Barge. Keeping the line parallel to the edge produced an accurate base line from which to fix the distance from test probe to element. The waterproof shading capacitor junction box, which is normally attached to the hub of NEFBRACS, was brought to the surface and secured to a small floating platform. This modification permitted changing the line shading capacitors while keeping the elements' cable bundle from interfering with the soundfield. Actual shading began with an F-36 projector placed at the precise depth of the line and precisely 9 ft from the particular element being shaded as measured normal to the axis of the line. By using this scheme, the line elements were shaded to within ±1/2 dB of the required values.

D. Acoustic Data

1. There were two sets of measurements made with the single stave of TR-208 elements. The first set of measurements was made in late October to establish "farfield" beam patterns of the stave within the dome. "Farfield" is used here in quotation marks to indicate that the ranges used to record data may not be long enough to be truly in the farfield of the transducer and dome. Test ranges were limited by test geometry, as will be explained following. The second set was a

series of comparative measurements between "farfield" beam patterns and NEFBRACS beam patterns made 22-27 November 1968. Both sets of measurements were made with the AN/SQS-23 dome and STEP Barge in the position and orientation shown in Fig. 2. Note that in the vicinity of the STEP Barge beneath which the dome was suspended, the lake bottom is concave and slopes downward in the direction of a bearing of 90 deg (Br = 090) reference the forward end of the dome.

The first data were acquired by using the data acquisition system mentioned in Quarterly Progress Report No. 3, plus a Brüel and Kjaer polar recorder modified to be driven by the stave rotator synchro. The quality of the measured beam patterns was not considered good, primarily because of normalization difficulties among different beam patterns.

In spite of these difficulties, several things were accomplished at this time:

1. The distance of the dome below the surface was adjusted to minimize the effect of reflections from bottom and surface at large distances (e.g., 80 ft) from the dome. Since the water depth directly beneath the barge was approximately 50 ft and the reflections from the surface were larger than from the bottom, it was decided to lower the dome so that the horizontal stave was located 29 ft below the surface and about 21 ft from the bottom. This location also gave a safety margin to allow for some of the nearby barges' extending several feet below the surface. At Br = 090, the water depth increased and bottom reflection ceased to be a problem.

2. During the first set of measurements, the received waveform was displayed on an oscilloscope and the stave was driven

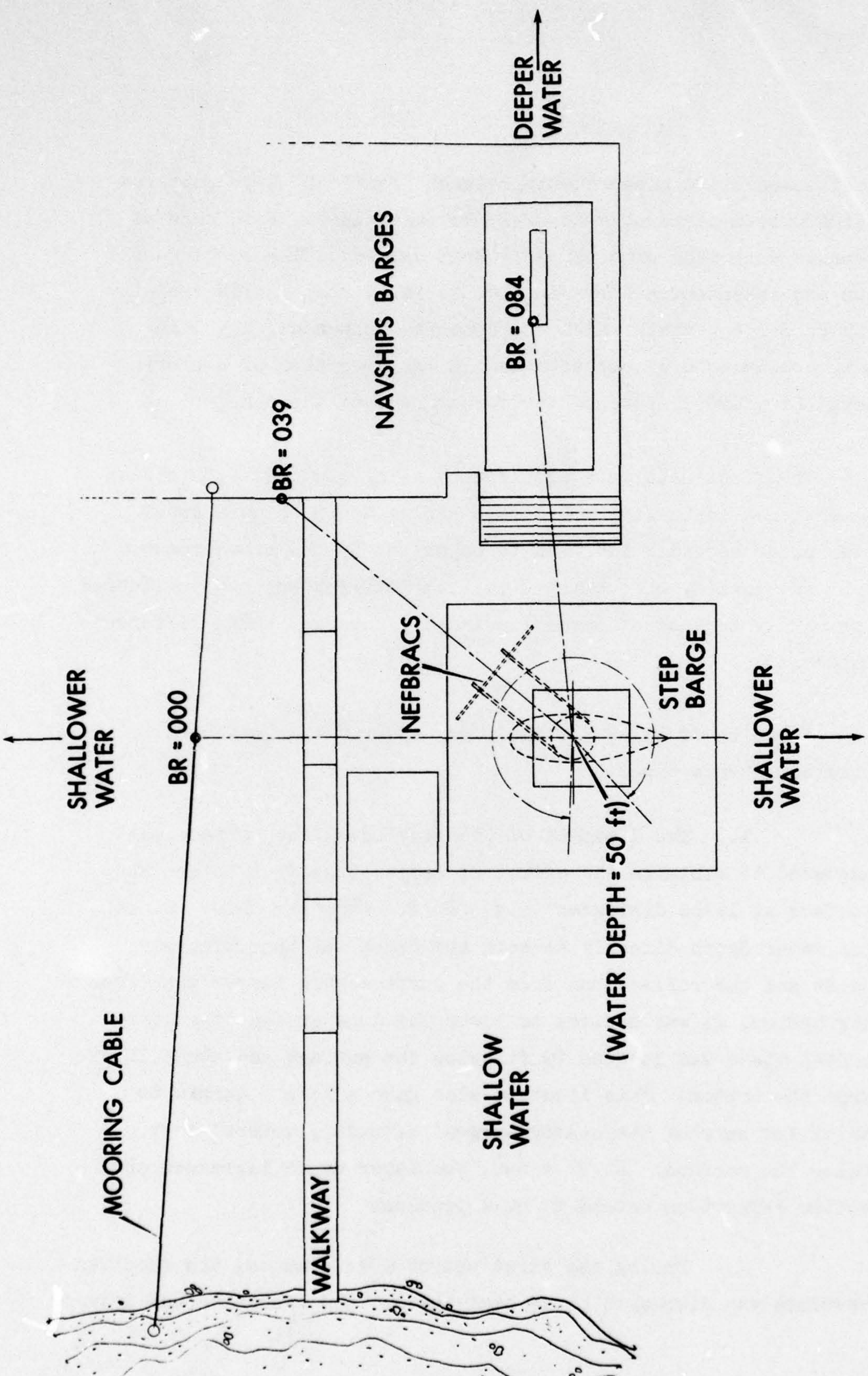

FIGURE 2
NEFBRACS AND DOME CONFIGURATION
AT LAKE TRAVIS STATION

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with short pulses (1.0 msec or less). A hydrophone was placed 24 ft from the center of the dome at Br = 085. There were as many as three reflections, after the direct-path pulse, that could be explained only as internal dome reflections. Also, some of the internal reflections were larger in magnitude than the direct-path pulse. For example, when the main lobe of the stave was turned towards the baffle in the dome with a minor lobe turned towards the hydrophone, the direct-path pulse had a relative amplitude of 0.053, followed 1.6 msec later by a pulse of amplitude 0.257. However, any reflection from surface or bottom could have occurred only 4.0 msec or more after the direct-path pulse. Thus, when considering long pulses from a transducer installed in the dome, such internal reflections would have to be taken into account. For the second set of measurements, long pulses were used to include these internal reflections. Figure 4 is one example.

To further clarify the measurement geometry, Fig. 3 (located in an envelope inside the back cover of this report) can be used to overlay Fig. 4. The overlay shows the outline of the dome and shows an arrow (at 084 relative bearing) that points in the direction of the "farfield" probe (the "measurement direction"). It is important to remember that during these measurements the dome and "farfield" probe (or NEFBRACS) remained fixed; only the stave of TR-208 elements inside the dome was rotated.

If one places Fig. 3 upon Fig. 4 with the center points aligned and the arrow on Fig. 3 pointing to the major lobe of the beam pattern (at 0 deg on Fig. 4), the exact geometry is depicted at the instant the peak of the major lobe passed the

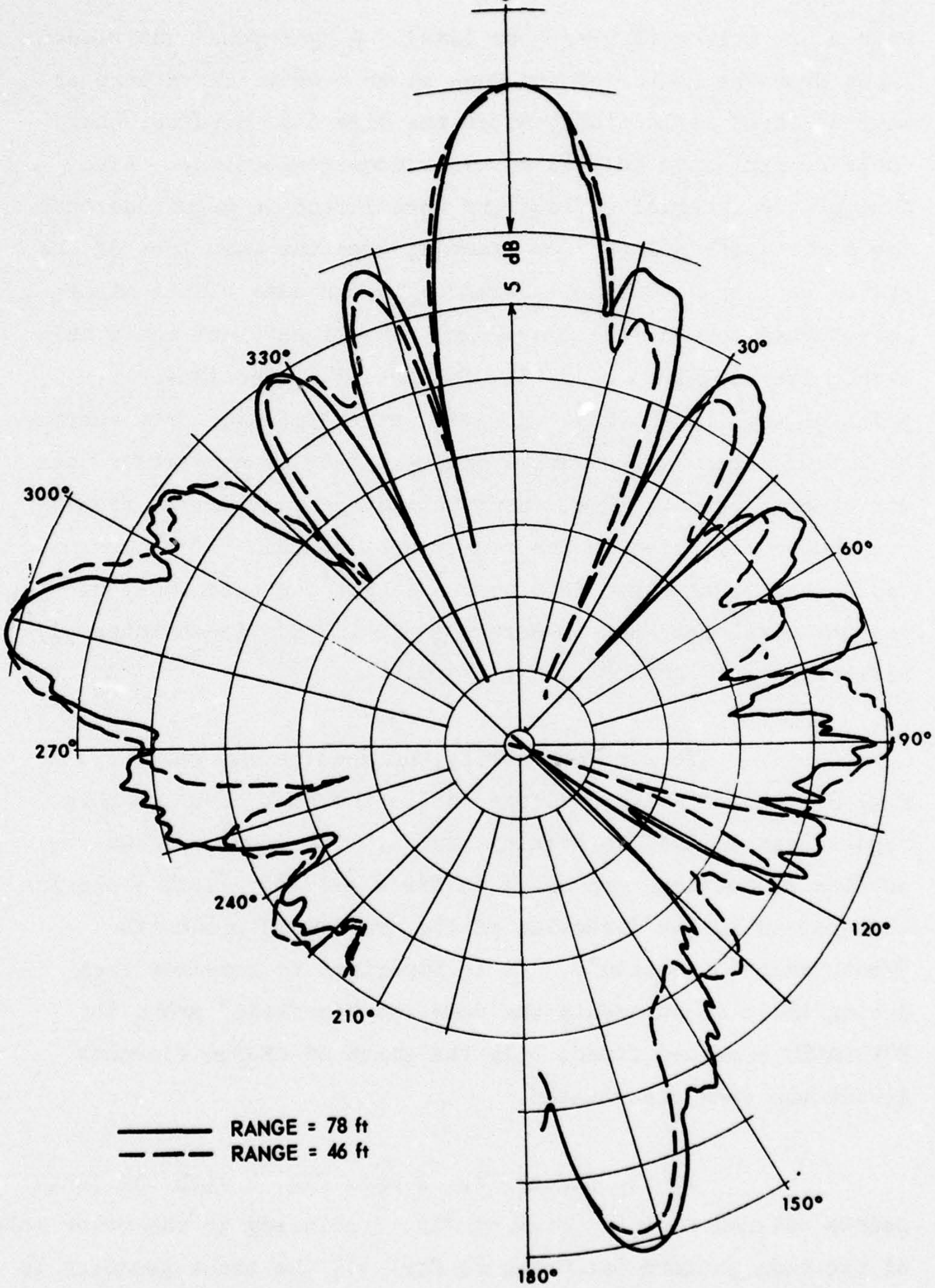

FIGURE 4
COMPARISON OF STAVE TRANSMIT BEAM PATTERNS
AT VARIOUS RANGES AT Br = 084

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2-20-69

measurement direction. The small outline of the transducer shown on Fig. 4 can be seen to point in this direction.

A striking indication of these patterns is that the dome is far from transparent. Two large spurious sidelobes exist at 165 deg and 285 deg. If the overlay is rotated so that the arrow points to the sidelobe at 285 deg on Fig. 4, the geometry is depicted at the instant this lobe was measured. It can readily be seen that the transducer was not pointing in the measurement direction but was pointed toward the baffle in the after part of the dome in approximately the correct manner to give a specular reflection in the measurement direction. For this reason, this lobe is blamed upon this internal dome reflection.

As the overlay is rotated so that the arrow points to the other spurious side lobe at 165 deg, it can readily be seen why reflected acoustic energy off the opposite side of the dome is construed to be the source of this high side lobe.

This single overlay is included in the report to suggest the general measurement geometry followed in all cases. Some patterns are rotated or otherwise changed to compare various parameters. In each case, the example geometry holds, although on an individual pattern basis.

3. One polar beam pattern taken at this time proved invaluable because it was taken at a short enough delay time so as not to include internal reflections of the dome (Fig. 5), and it emphasizes the effect of the dome on the beam pattern of the stave (Fig. 6). This beam pattern was transferred from Brüel and Kjaer polar paper to the same scale and normalization

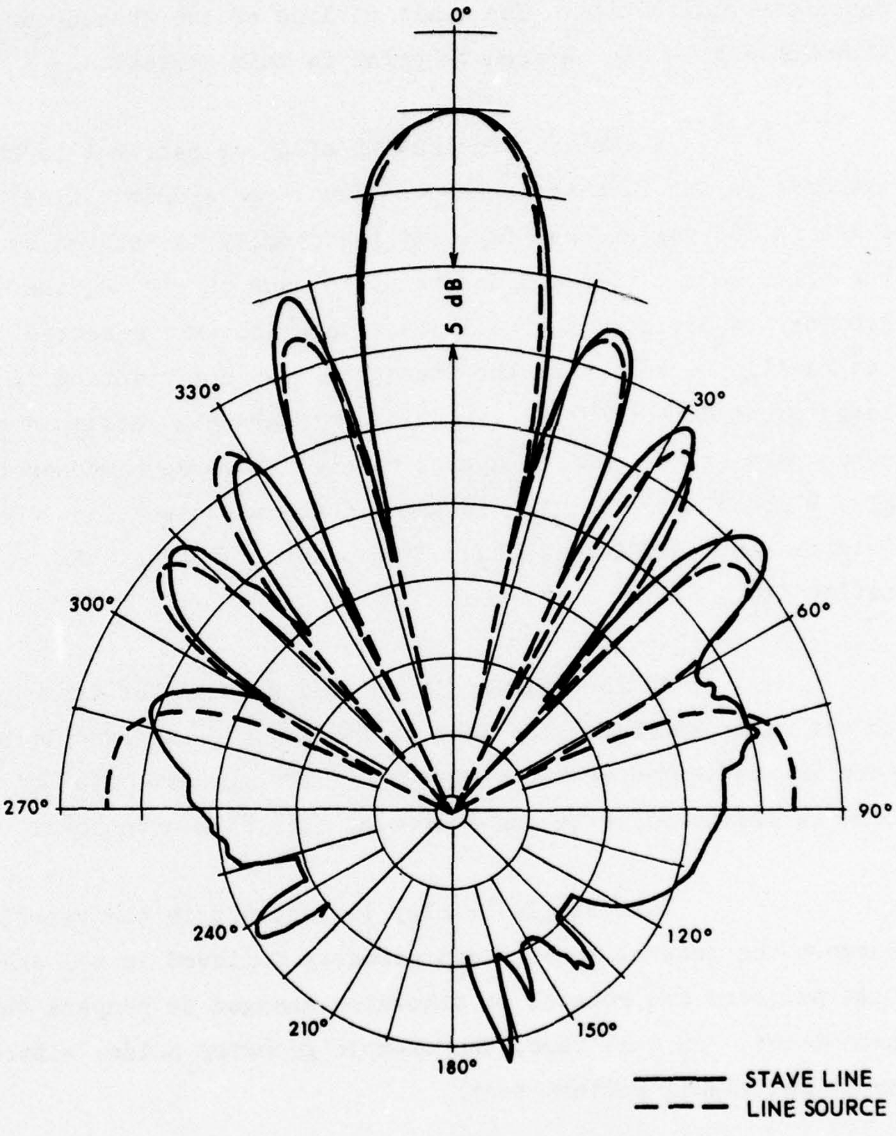

FIGURE 5
COMPARISON OF STAVE TRANSMIT BEAM PATTERN
(BEFORE DOME INTERNAL REFLECTIONS)
AND THEORETICAL LINE SOURCE

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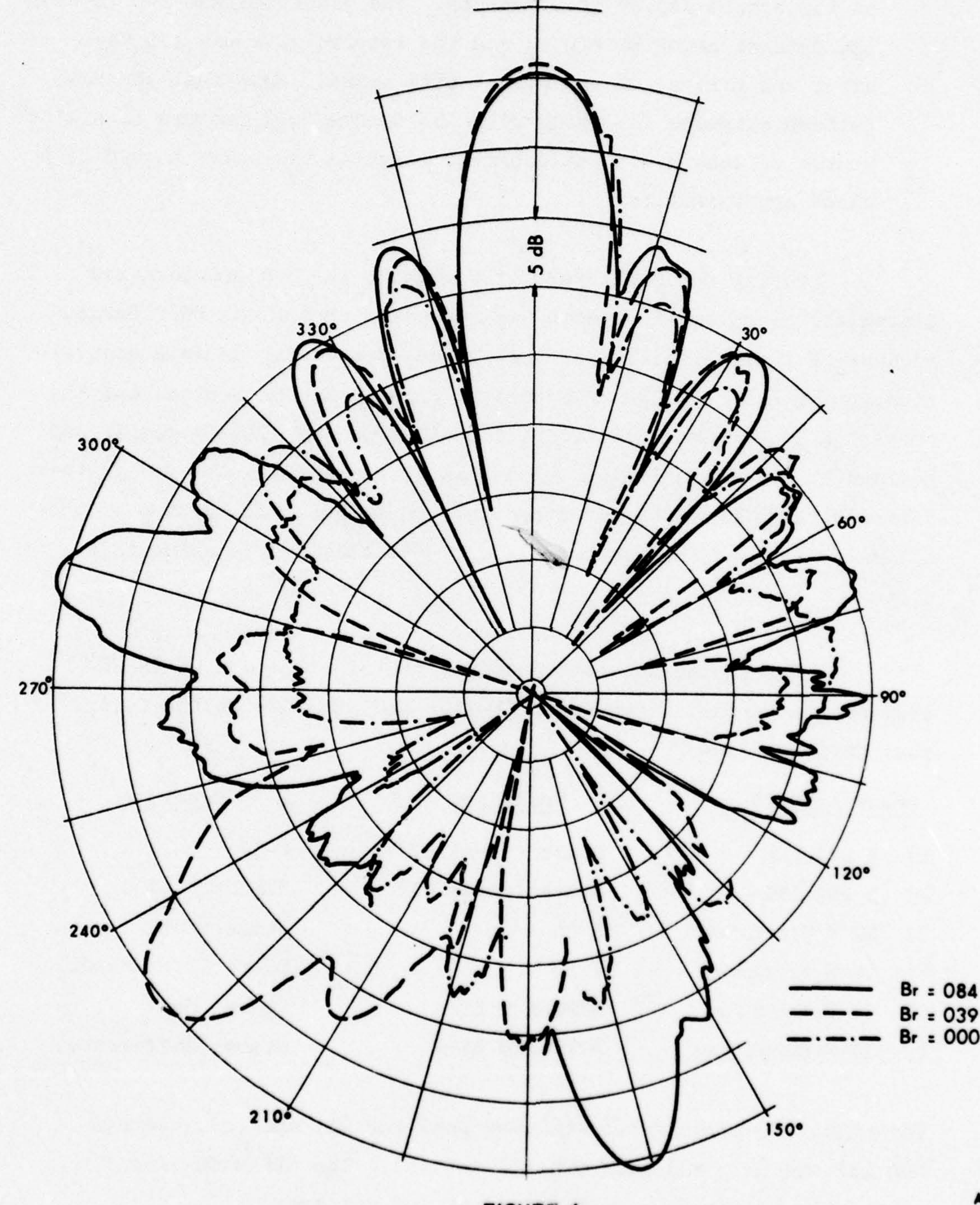

FIGURE 6
COMPARISON OF STAVE TRANSMIT BEAM PATTERNS
AT VARIOUS RELATIVE BEARINGS
WITH RECEIVER IN "FARFIELD"

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HLP - JEW
2-3-69

as the second set of measurements. The projector was 100 ft from the dome at about Br = 078, and the receive gate was 1.0 msec after the arrival of the direct-path pulse. Note that the beam pattern compares favorably with the theoretical pattern of a line source of length 4.5 wavelengths, of which the stave should be a close approximation.

During the early part of November, the S-A standardized transducer measurement console was installed aboard the STEP Barge. Because of the reliability of the system, simplicity of data acquisition, polar and rectangular recorders present in the system, and the three CML 3 kVA power amplifiers installed on the STEP Barge, it was decided that familiarization with this system and its use for further NEFBRACS tests would be advantageous. Thus, both calibration of the NEFBRACS line and the second data set were obtained by using this system.

The second data set involved the single stave of TR-208 elements, a farfield transducer (F-36), and NEFBRACS in the following six configurations:

Power Amplifier	Projector	Receiver
1) 3 kVA CML	Stave (parallel)	F-36
2) 3 kVA CML	Stave (parallel)	NEFBRACS Line
3) 50 W Kronhite	F-36	Stave (Sum)
4) 50 W Kronhite	F-36	Stave (Difference)
5) 50 W Kronhite	NEFBRACS Line	Stave (Sum)
6) 50 W Kronhite	NEFBRACS Line	Stave (Difference)

The signal-to-noise ratio was very good for (1) and (2), average for (3) and (4), and poor for (5) and (6). The NEFBRACS line is relatively insensitive when driven at low voltages.

Since it was not possible to rotate the dome, and since it would have been extremely difficult to obtain farfield beam patterns by moving the probe in the farfield (even if there had been no barges in the way), the beam patterns used for comparison of "farfield" and NEFBRACS consisted of a stationary probe at some distance from the dome and NEFBRACS at the corresponding relative dome bearing while the stave was rotated through its complete 320 deg travel. Thus, besides the six possible configurations, there are the variables of relative dome bearing and of distance of the "farfield" probe from the dome. The distance was varied to observe changes in the beam pattern and to determine if the probe could be considered to be in the farfield.

The polar beam patterns of the second data set were all normalized to -5 dB with the acoustic axis chosen as 0 deg on the polar graph paper. Thus, the angle 0 deg corresponds to each of Br = 000, Br = 039, and Br = 084 at which data was acquired. Since the limit switches on the stave rotator block the region, $228 < Br < 268$, blank portions corresponding to these bearings appear at different angles on the polar plots.

Figure 6 compares the beam patterns of stave-plus-dome at different bearings with a probe at approximately the same distance from the center of the dome. It can be seen that the dome, by its internal reflections, causes beam patterns to be a function of bearing. Note the large -10 dB lobes at 165 deg, 230 deg, and 285 deg on the plot. These lobes are due to internal dome reflections for the probe angles other than Br = 000.

Considering the stave as a theoretical line source, the farfield phase requirement (D^2/λ) would imply a farfield distance of 20 ft for D = 4.5 ft (λ = 1 ft at 5 kHz). The farfield amplitude requirement (10D) would imply a distance of 45 ft. Figure 4 demonstrates that the presence of internal dome reflections at Br = 084 requires a somewhat larger distance to obtain farfield beam patterns since there is an appreciable difference between the beam patterns at 46 ft and 78 ft. Even though the water depth increased in this direction (Fig. 2), the presence of surface reflections and the pulse length required to include internal dome reflections limited test distances to 78 ft. During the next quarter, the STEP Barge will be moved to much deeper water so that larger test distances may be used to determine experimentally the farfield boundary.

It was expected that the NEFBRACS and "farfield" beam patterns would differ least at Br = 000 because the width of the dome when viewed from this bearing is minimum. Consequently, the pattern at a distance of 70 ft would be closer to the true farfield pattern of the stave-plus-dome than at other angles. However, the comparison is poor (Fig. 7). Since the horizontal stave has a large vertical beamwidth (about 120 deg), the NEFBRACS line may have received reflections from the bottom of the dome, because at this bearing the dome extends more than half the distance to the NEFBRACS line. With a full SQS-23 transducer array in the dome, the comparison might be better since the active staves of the transducer would be closer to the forward end and the vertical beamwidth would be much narrower. Support for this conjecture is found in the comparison at Br = 039 (Fig. 8). The dome at this bearing extends less than half the distance to the NEFBRACS line and the beam patterns compare well. The NEFBRACS and "farfield" beam pattern comparison at Br = 084 (Fig. 9) agree fairly well except around 280 deg on the plot. It is thought that the measured "farfield" beam pattern at Br = 084 is not truly farfield, as was pointed out previously (also see Fig. 4), so that future tests will be necessary.

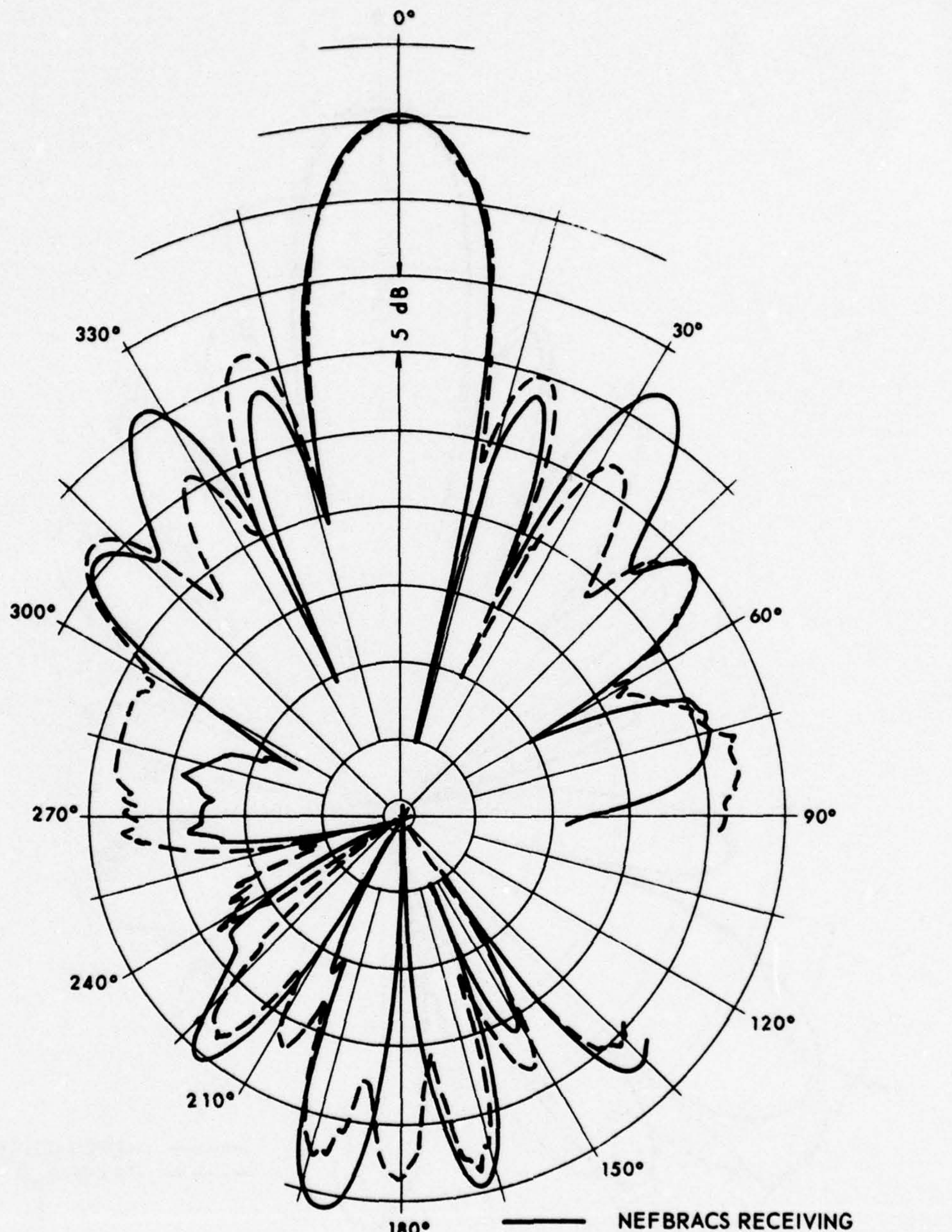

FIGURE 7
COMPARISON OF STAVE TRANSMIT BEAM PATTERNS
AT Br = 000

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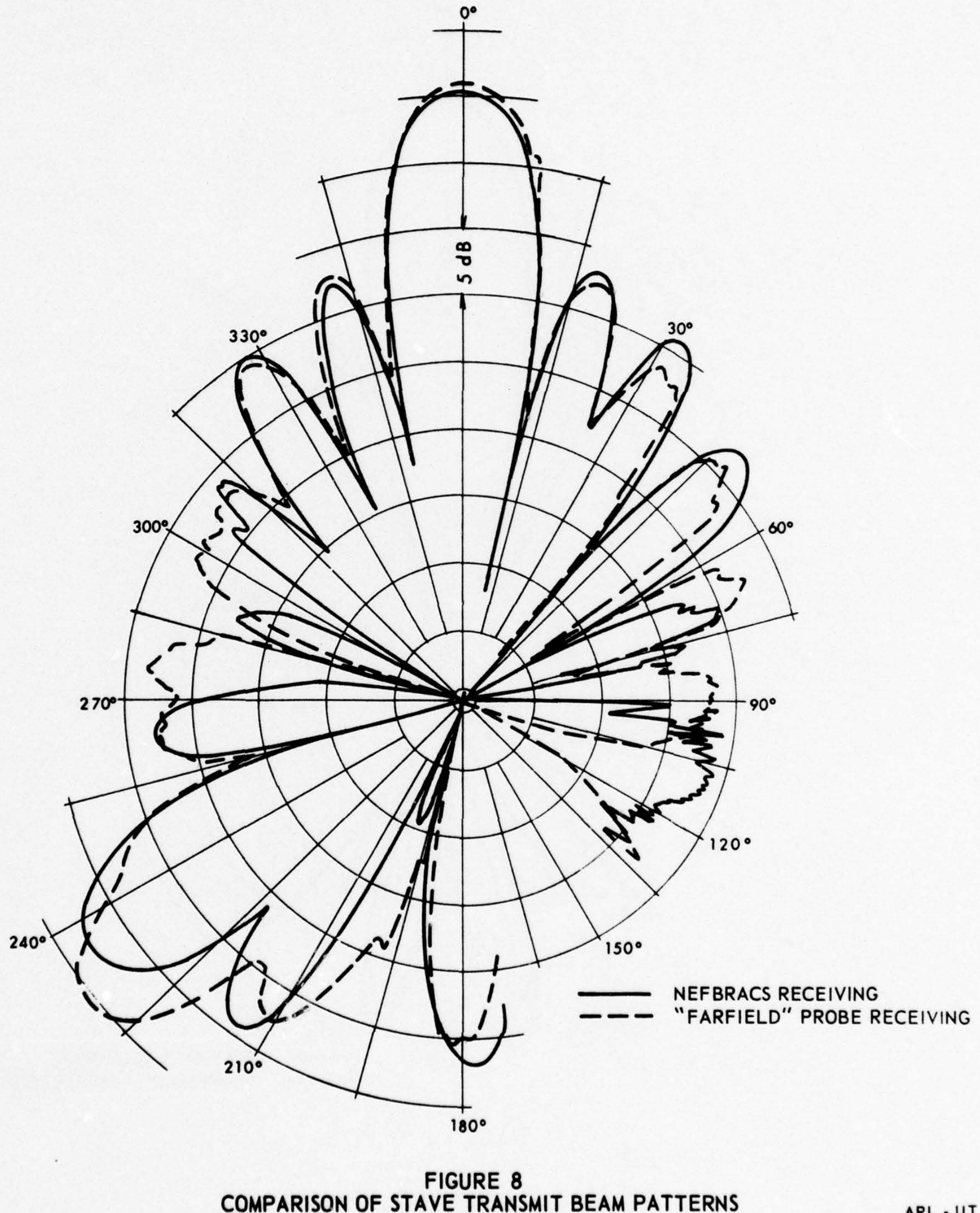

FIGURE 8
COMPARISON OF STAVE TRANSMIT BEAM PATTERNS
AT Br = 039

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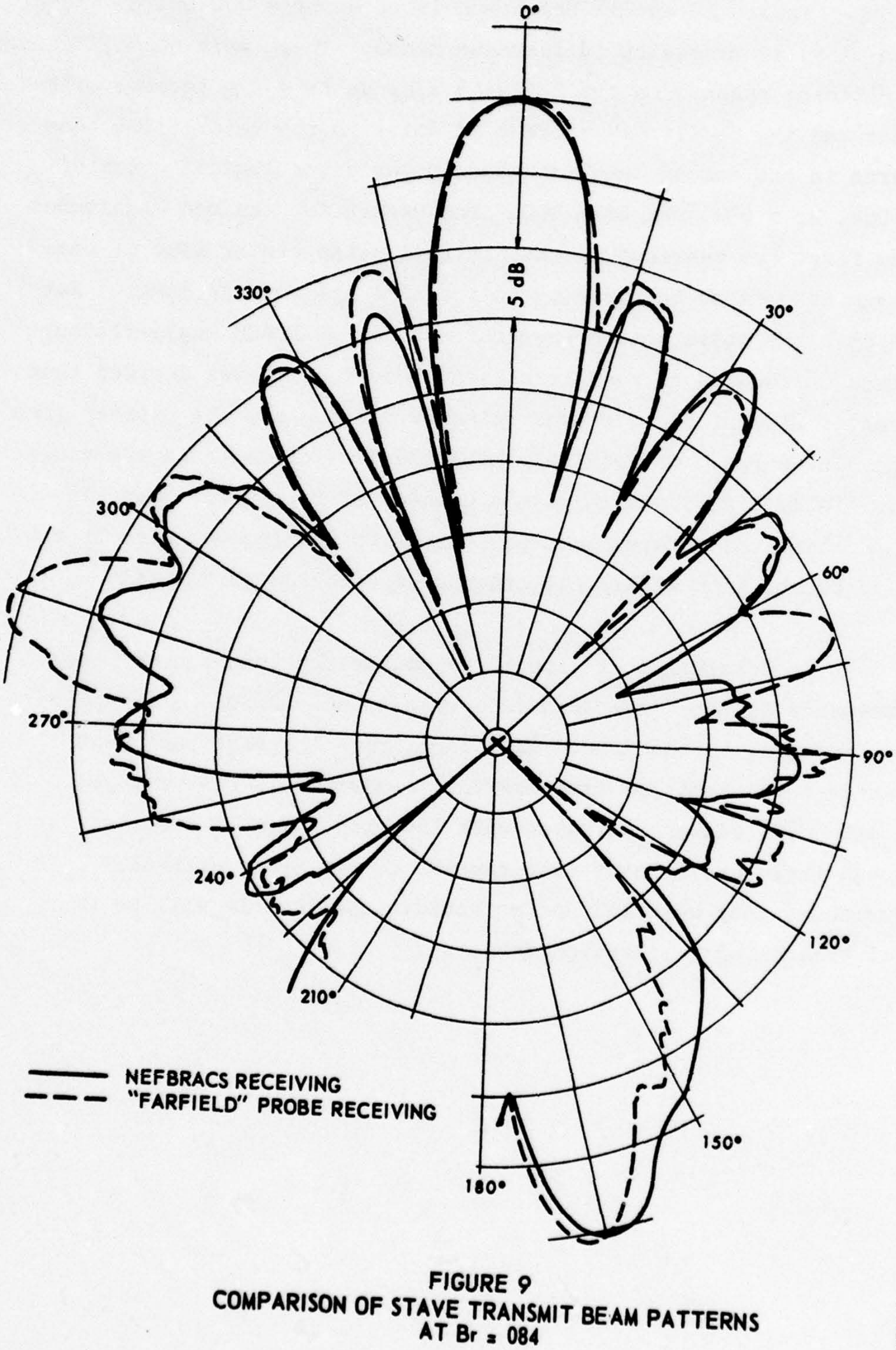

FIGURE 9
COMPARISON OF STAVE TRANSMIT BEAM PATTERNS
AT Br = 084

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HLP - JEW
2-3-69

Figures 10 and 11 are comparisons at Br = 000 and Br = 084 of the stave in receiving (difference mode). There were no "difference" beam patterns taken with the NEFBRACS line at Br = 039 because of bad weather and the resultant increase of noise in the water. The beam patterns in the second data set were in the chronological order of Br = 084, Br = 039, and Br = 000. The reason for the odd magnitudes of the first two bearings is that initially the center line of the dome was assumed to be parallel to the edge of the STEP Barge. But since both the stave rotator readout and the NEFBRACS angle readout had been calibrated to read in relative bearing, it was decided that the center line of the dome was oriented 5.7 deg off the "center line" of the STEP Barge. Consequently, for the last of the runs the probe was initially positioned to give a reading of Br = 000. When the NEFBRACS line was rotated into position, its reading was also Br = 000 and, as can be seen in Fig. 10, the nulls coincide quite well.

In conclusion, it should be emphasized that none of the measurements to date have been made with a full AN/SQS-23 transducer array installed in the dome. This fact, plus the fact that test distances sufficient for true farfield measurements have not yet been attained, causes confusion with interpretation of results. Although these preliminary measurements do not prove NEFBRACS' performance, they certainly offer indications that it will be a useful transducer calibration device.

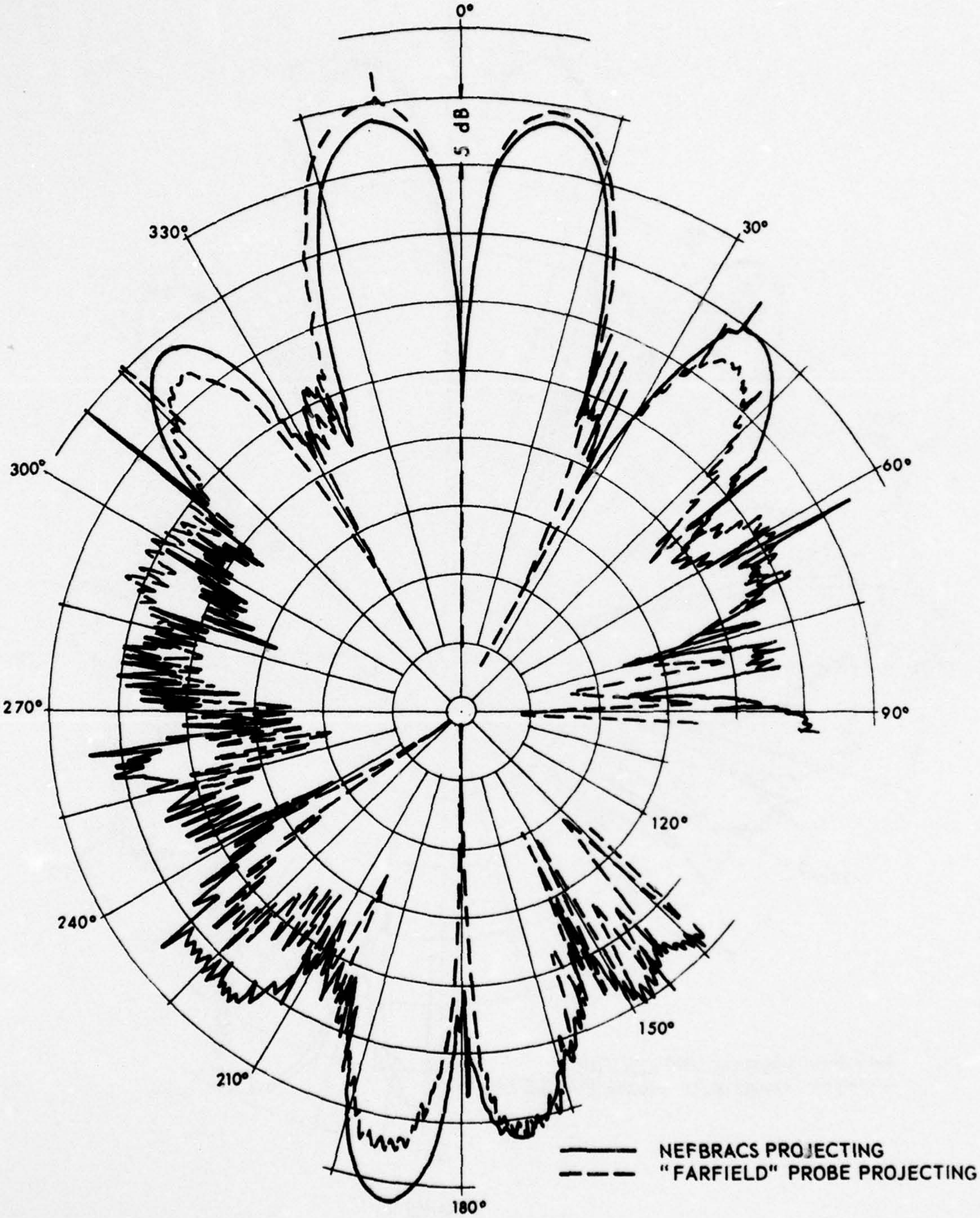

FIGURE 10
COMPARISON OF STAVE RECEIVE (DIFFERENCE)
BEAM PATTERNS AT Br = 000

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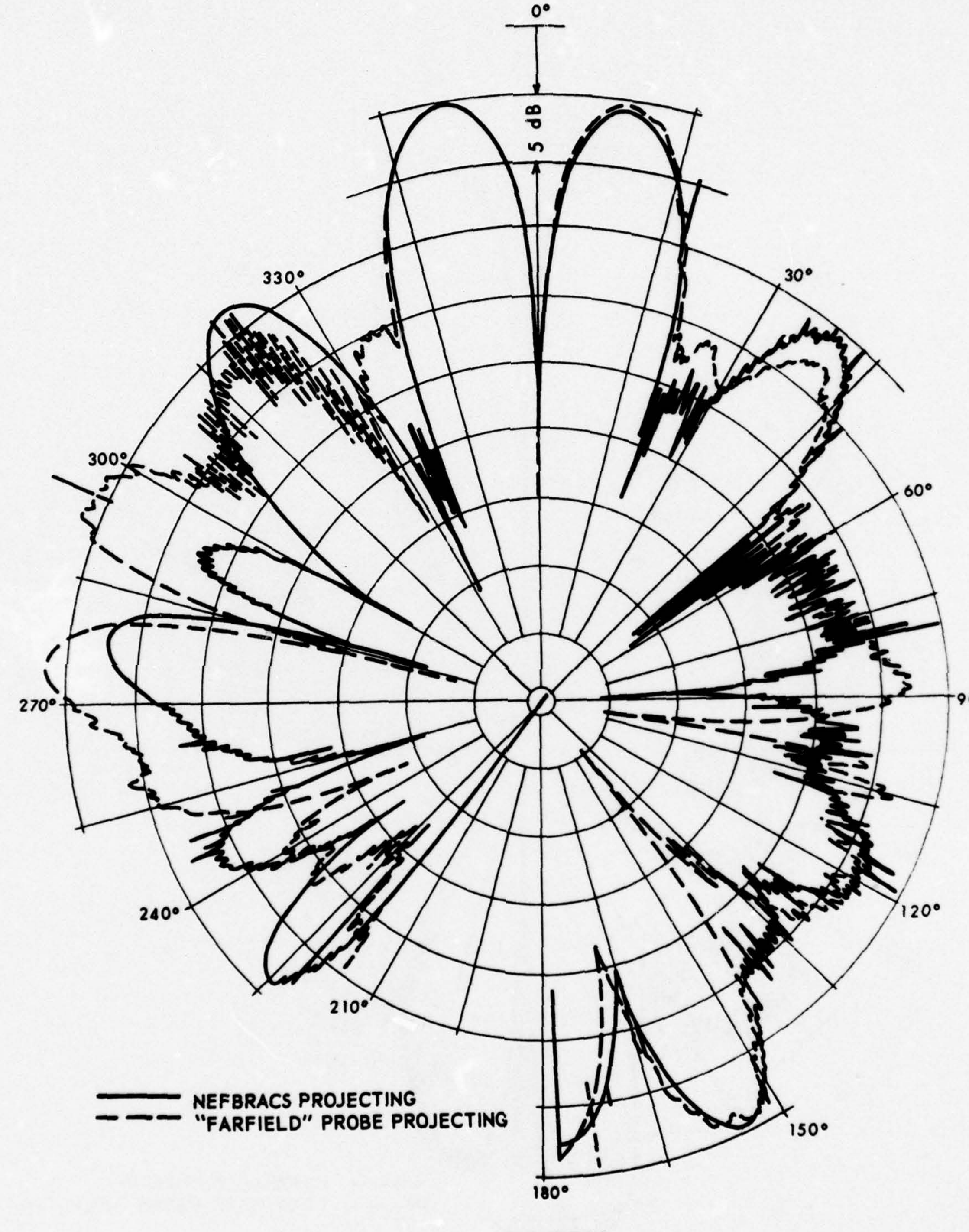

FIGURE 11
COMPARISON OF STAVE RECEIVE (DIFFERENCE)
BEAM PATTERNS AT Br = 084

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HLP - JEW
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IV. HIGH-LEVEL IMPEDANCE STUDY

Early in the quarter ARL's report on this study was published. It was actually dated 24 September 1968 and was designated DRL-TR-68-31, and entitled "Interim Report on the Study of High-Level Pulsed Complex Impedance Measurements for Transducer Evaluations" (U), (CONFIDENTIAL), by D. D. Baker, J. E. Stockton, and J. J. Truchard.

No further impedance measurements on transducer elements were made during this quarter. Six elements are on hand that have not yet been studied. Other elements will be requested of NAVSHIPS shortly. The reason for the delay in further measurements was the impending arrival of the Scientific-Atlanta Pulse Vector Immittance Meter (PVIM). This unit was originally scheduled to arrive at ARL for prototype evaluation in September 1968. The proposed date of this event is 13 January 1969. This unit is scheduled to be evaluated aboard the STEP Barge at LTTS for a two week period. At the same time the programmed scanner and printer will be installed in the console at LTTS. After this two week evaluation period, the prototype PVIM will be shipped back to S-A. ARL's production unit of the PVIM is scheduled to be received in February 1969. After this time, further work on the high-level impedance study will be speeded up tremendously. The PVIM will permit measurements to be made directly rather than making painstaking manual measurements of voltage and current and reducing data to generate impedance.

V. STANDARDIZED TRANSDUCER EVALUATION PROGRAM (STEP) PARTICIPATION

The results of ARL's comparative testing of DT-168 hydrophones were published during the quarter in a technical memorandum (DRL-TM-68-28) dated 4 November 1968, entitled, "Comparative Test Results on DT-168 Hydrophones Repaired at the Naval Shipyard Transducer Repair Facilities" by D. D. Baker and R. L. Batey.

During the period 31 October through 1 November 1968, D. D. Baker and H. C. Evans of NAVSHIPS visited at Scientific-Atlanta in Atlanta, Georgia. This visit was to verify the exact items to be delivered by S-A in 1969, as a part of additional instrumentation for the TRF's. A master list of items was generated during this visit; it was modified somewhat later and was not finalized until December 1968.

VI. SURVEY OF SHIPYARD AND TRANSDUCER REPAIR FACILITY (TRF) SONAR TRANSDUCER TEST CAPABILITIES

A. Introduction

ARL was designated project leader, to be assisted by Stanford Research Institute, in conducting a survey of sonar transducer test capabilities at all Naval shipyards, including the TRF's. Previous surveys at the TRF's had been concerned largely with underwater measurements. During this survey all transducer testing at the TRF's was to be investigated, including all tests normally conducted in air.

B. Outline of Survey

The following information is the outline of this survey, as written on 25 October 1968.

SURVEY OF SHIPYARD AND TRF
SONAR TRANSDUCER TEST CAPABILITIES

I. GOAL:

> To review what is done presently at all Naval shipyards (and perhaps commercial shipyards) in the area of sonar transducer test and evaluation (T&E), so that these procedures may be compared with standards generated by the STEP Committee.

APPROACH:

A. To review all shipyard T&E measurements involved in installation of a transducer--from the time it is uncrated until deployment of the ship upon which it is installed. (The transducer will have come either from one of the TRF's or from a manufacturer.)

   1. Pre-installation tests in air to ensure RFI condition.

   2. Hydrostatic pressure tests.

   3. Post-installation tests in air to ensure correct wiring, etc.

   4. Dockside tests in water to check performance.

   5. At-sea tests (if applicable).

B. To review all shipboard T&E measurements, involving shipyard personnel, that lead to replacement of a transducer (or to the decision not to replace it).

   1. Dockside tests in water to check performance.

   2. Sonar transmitter tests to ensure that the transmitters are not at fault.

II. GOAL:

To review what is done presently at the shipyard transducer repair facilities in the area of T&E, excluding final acceptance testing conducted aboard barges, in tanks, in slips, etc., so that these procedures may be compared with standards generated by the STEP Committee.

APPROACH:

To review all T&E measurements on a used transducer delivered to the TRF for repair or on a new transducer delivered to the TRF for acceptance--from the time the transducer is uncrated until it is delivered to the underwater test facility for final acceptance testing.

1. Tests in air to diagnose faults.

2. In-process tests performed as the transducer is repaired.

3. Tests in air on reassembled units to ensure that all faults have been corrected.

4. Hydrostatic tests on the assembled transducer to check for leakage.

C. General Test Procedures

Prior to this survey, ARL devised general test procedures to correspond to the three separate approaches described in the foregoing outline. These general procedures are included in Appendix A.

D. Survey Visits to East Coast Shipyards

During the period 14-27 November 1968, D. D. Baker of ARL, E. M. Spurlock of SRI, and H. C. Evans of NAVSHIPS visited and surveyed all of the subject facilities on the East Coast of the United States. The facilities visited were Portsmouth Naval Shipyard, Boston Naval Shipyard, Boston TRF, Philadelphia Naval Shipyard, Norfolk Naval Shipyard, and Charleston Naval Shipyard. No attempt was made to report any of the findings of this portion of the survey. It is planned that the West Coast shipyards will be surveyed in January 1969, and that surveying the Pearl Harbor Naval Shipyard will be delayed until February 1969, to coincide with a STEP Committee Meeting at that location.

One might briefly summarize the East Coast survey by saying that many problem areas were encountered. Different yards test transducers in entirely different fashions--a result similar to one of ARL's results of the original TRF survey of 1964. Encountering these problem areas is positive evidence that such a survey is a worthwhile endeavor.

VII. MART PROGRAM PARTICIPATION AND TRANSDUCER DESIGN STUDY

A. Cavitation Position Paper

The primary effort for the MART Program during this quarter was to undertake a comprehensive study and evaluation of sonar cavitation problems. The final product of this review will be a position paper. The goal of this work is to provide a sonar transducer designer with all available information of the subject organized for easy reference.

The work of each contributor in the field will be reported and evaluated. A bibliography will be compiled and will include both open literature references and reports.

Considerable progress has been made toward completion of this work. An estimated 90 percent of the necessary documents have been acquired with the remainder expected soon. In the course of preparing this paper, all known active researchers will be interviewed.

During November 1968, a trip was made by Mr. D. W. Evertson to collect information for this work. The U.S. Navy Underwater Sound Laboratory (USL), New London, Connecticut, was visited 18-19 November 1968. Conferences were held with Mr. Dave Porter and Mr. Gordon Hayes of USL. Also, considerable time was spent in the USL library, which ARL considers the best single bibliographical source for this study. An attempt was made to arrange a visit to Naval Applied Science Laboratory (NASL), Brooklyn, New York. But this trip had to be postponed because of schedule conflicts. On 21 November 1968, a conference was held with Dr. Paul Smith and Mr. Sam Hanish of the U.S. Naval Research Laboratory (NRL), Washington, D. C.

A rough draft of the cavitation position paper should be complete by 1 March 1969.

B. General Transducer Design Study

The ARL sonar transducer design study has continued, but with much lower priority than the work on cavitation. However, progress was made in this area due to continuing exposure to cavitation research, which is closely related to other sonar transducer design problems.

APPENDIX A

Introduction

The following three general transducer test procedures were generated in preparation for the survey described in Section VI.

GENERAL SHIPYARD TRANSDUCER INSTALLATION TEST PROCEDURE

I. Pre-Installation Tests in Air

A. Visual inspection for damage to transducer or cable.

B. Insulation resistance (megohmmeter readings from leads to shield, to case, or to both).

C. dc Resistance (across leads).

D. Phasing (terminal polarity check).

E. Low-level impedance

*F. High-level air test (150% of displacement).

+G. Preamplifier tests, where applicable (gain, linearity, frequency response, and output impedance).

II. Hydrostatic Pressure Tests

A. Repeat tests I.B and C under hydrostatic pressure.

B. Repeat test I.A after removal from the hydrostatic pressure test tank.

III. Post-Installation Tests in Air

A. Visual inspection for damage to transducer or cable.

B. Insulation resistance (megohmmeter readings from leads to shield, to case, or to both).

C. dc Resistance (across leads).

D. Cable insulation resistance.

E. dc resistance and element polarity at the system end of the cable.

F. Low-level impedance.

+G. Preamplifier tests, where applicable (gain, linearity, frequency response, and output impedance).

*projector units only

+hydrophones only

IV. Dockside Tests in Water[1]

A. Insulation resistance (megohmmeter readings from leads to shield, to case, or to both).

B. dc Resistance (across leads).

*C. High-level impedance.

*D. Source level.

+E. Low-level impedance.

F. Element or stave sequence test (drive one unit at low level and receive with the adjacent unit), if applicable.

V. At-Sea Tests[1]

A. Receiving sensitivity.

*B. Source level.

C. RDT and RDR beam patterns, if applicable.

*projector units only

+hydrophones only

[1] If any problems arise with drive voltage or current levels, distortion content, etc., the transmitter performance should be checked into a dummy load.

GENERAL SHIPYARD PRE-DOCKING

SHIPBOARD TRANSDUCER TEST PROCEDURE

I. Dockside Tests in Water

A. Insulation resistance (megohmmeter readings from leads to shield, to case, or to both).

B. dc Resistance (across leads).

*C. High-level impedance.

*D. Source level.

+E. Low-level impedance.

F. Element or stave sequence test (drive one unit at low level and receive with adjacent unit), if applicable.

II. Sonar Transmitter Tests--If any problems arise with drive voltage or current levels, distortion content, etc., the transmitter performance should be checked into a dummy load.

Pre-docking test data shall be forwarded with each transducer to the TRF for use in diagnosing faults.

*projector units only

+hydrophones only

GENERAL TRANSDUCER REPAIR FACILITY NONACOUSTIC TEST PROCEDURE
(from the arrival of a transducer until its
release for final acoustic tests in water)

I. Tests in Air to Diagnose Faults

A. Visual inspection for damage to transducer or cable.

B. Insulation resistance (megohmmeter readings from leads to shield, to case, or to both).

C. dc Resistance (across leads).

D. Phasing (terminal polarity check).

E. Low-level impedance.

*F. High-level air test (150% of displacement).

+G. Preamplifier tests, where applicable (gain, linearity, frequency response, and output impedance).

(If a new transducer passes these tests it is ready for tests of Section IV.)

II. In-Process Tests

A. Ceramic element tests

1. Visual inspection
2. Element sensitivity
3. Element dimensions
4. Element impedance (low-level)
5. Element polarity
6. High-potential tests (60 Hz)(for corona or arcover)

*projector units only

+hydrophones only

B. Magnetostrictive Element Tests

1. Visual inspection

2. Polarity test

3. Impedance

+C. Preamplifier tests (gain, linearity, frequency response, and output impedance)

III. <u>Tests in Air on Reassembled Units</u>

A. Visual inspection for damage to transducer or cable.

B. Insulation resistance (megohmmeter readings from leads to shield, to case, or to both).

C. dc Resistance (across leads).

D. Phasing (terminal polarity check).

E. Low-level impedance.

*F. High-level air test (150% of displacement).

+G. Preamplifier tests, where applicable (gain, linearity, frequency response, and output impedance).

IV. <u>Hydrostatic Tests</u>

A. Repeat tests I.B and C under hydrostatic pressure.

B. Repeat test I.A after removal from the hydrostatic pressure test tank.

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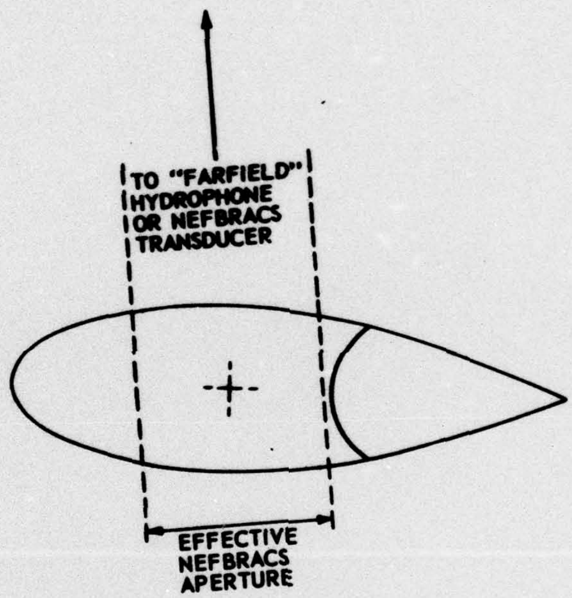

FIGURE 5
OVERLAY OF SONAR DOME TO BE
USED WITH FIGURES 6 AND 7

ARL - UT
AS-69-77
DAS - EJW
1 - 3 - 69