AD 360919

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

NOTICE:

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 and 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

Copy No. 14

CONFIDENTIAL

360919

HUMAN FACTOR PROBLEMS IN ANTI-SUBMARINE WARFARE

Technical Memorandum 206-15

FEASIBILITY STUDY AND SUGGESTED PROGRAM FOR
COLLECTING RECORDED AQS-10 DETECTION AND CLASSIFICATION MATERIALS (U)

360919

HUMAN FACTORS RESEARCH, INCORPORATED
1112 Crenshaw Boulevard • Los Angeles 19, California • WEbster 3-7356

CONFIDENTIAL

CONFIDENTIAL

(21) Report on

HUMAN FACTOR PROBLEMS IN ANTI-SUBMARINE WARFARE [U].

(9) Technical Memo[redacted]

(6) FEASIBILITY STUDY AND SUGGESTED PROGRAM FOR COLLECTING RECORDED AQS-10 DETECTION AND CLASSIFICATION MATERIALS (U). (8)

(14) Rept. no. TM-206-15

(10) by Raymond A. Gavin,

Prepared for

Personnel and Training Branch
Psychological Sciences Division
Office of Naval Research
Department of the Navy

by

(5) Human Factors Research, Inc[redacted]
Los Angeles, [redacted], Calif[redacted]

(11) Apr [redacted]62,
(15) Contract Nonr-2649(00),
(16) Proj. NR-153-199

(12) 16p.

CONFIDENTIAL

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

FEASIBILITY STUDY AND SUGGESTED PROGRAM FOR COLLECTING RECORDED AQS-10 DETECTION AND CLASSIFICATION MATERIALS

Human Factors Research, Incorporated

Technical Memorandum No. 206-15

I. BACKGROUND

Previous work by HFR has clearly indicated the benefits, both for systems operation and personnel training, of obtaining faithful dynamic recordings of the target information displayed by active sonar equipment. To date, effective research and training materials have been generated through recordings made of SQS-10, SQS-4, and SQS-29 sonars; work on the SQS-23 is in progress. Among the important results of these efforts has been the development of seven 30-minute filmed exercises in target classification, a 60-item doppler test, and a complete training material kit for use with the HHIP*, all of which are regularly employed throughout both Atlantic and Pacific Fleet ASW training activities.

When it became evident that the AQS-10 would present new target information display problems and that the HSS-2 aircraft would probably provide an adequate platform for a data recording system, HFR personnel felt it would be desirable to determine the feasibility of using a similar approach to the problem of collecting target data from this airborne sonar system.

Preliminary studies were planned in a joint effort with USNEL personnel who were working on related AQS-10 problems. However, when fleet delivery of the AQS-10 commenced before the equipment became available at NEL, a decision was made to design and fabricate a data collection system that would be suitable for use within the

* Hand-Held Information Processor.

operational environment. Such a system was developed by M. L. Seltzer of the HFR staff. A series of preliminary tests were then conducted within the environment of the operational flight trainer. These tests indicated that further refinements to the recording system were desirable. A number of these refinements were accomplished and a further series of tests were made in an HS-10 aircraft during the period 14-16 March.

The target data collected represented less than a finished product in a number of ways. However, HFR personnel were satisfied that the approach to the problem was sound and that the technical feasibility of collecting useful data in this manner has been firmly established.

To insure that recorded materials will be obtained that will permit effective operator training, as well as lend themselves to the proper studies of operator detection and classification performance, it is imperative that a systematic data recording plan be initiated at an early date. More detailed results of the feasibility studies, and a recommended data recording plan, are presented in the following sections.

II. DESCRIPTION OF TESTING PHASE

Photography

Because of the weight and space restrictions a decision was made to employ single system motion picture photography using an Auricon sound-on-film camera.

Since a circular area, approximately eight inches in diameter was to be filmed, wide angle high speed lenses were investigated, and it was determined that by using a 12mm F1.2 Elgeet lens the focal distance would not exceed 15 inches.

The photographic platform shown in Figure 1 was then designed to hold this particular configuration of photographic equipment, i.e., an Auricon Pro-600 camera with the film plane limitedly variable around a point 15 inches from the scope face.

To minimize differential movement between the camera and the scope it was decided to mount the platform directly to the AQS-10 sonar using the lifting handle at the top, the flange surrounding the scope, and the long bolts at the base as hold-down points.

Lighting

To obtain the type of scope lighting necessary for photographic purposes, i.e., to pre-excite the scope phosphor to a base density of one, a 4-watt UV lamp was integrally mounted on the top of the brass barrel between the camera and the scope. Since the bearing ring was already illuminated at a low level, it was hoped that this level could be increased to the desired value by some simple modification of the sonar system.

Operator Control

To provide the operator with enough information to control the equipment, a viewing port was provided in the left side of the barrel. It was also necessary to extend the bearing control knob from its normal position to a point on the underside of the platform carriage.

Trial in the Flight Trainer

Upon installing the equipment in the Operational Flight Trainer, it became obvious the UV lamp was too intense. The reflector was removed and the bulb shielded with masking tape to provide a level of intensity which appeared subjectively correct.

One roll each of Eastman Tri-X and Eastman Double-X film were exposed using various lens openings ranging from 1.2 (wide open) with the Double-X, down to 2.0 (two stops down) with the Tri-X film.

Equipment Modification

Before proceeding with further tests, it was necessary to provide the UV lamp with a powerstat for control of UV intensity, to install UV filter lenses in the operator viewing port, to build a pulse generator (Figure 2) for obtaining a synchronizing signal on the magnetic tape and to fabricate a bearing ring illumination system (Figure 3) since the inherent lighting proved to be both inadequate for photography and difficult to modify.

Trial in the Helicopter

Three 2-hour flights were made, using the HSS-2 aircraft as the sonar equipment platform, and approximately three 400-foot reels of film were obtained. This film was routinely processed by a commercial film laboratory to complete the test of this approach to the problem. Based on findings from the trainer tests, Eastman Double-X film was used with the F1.2 - 12mm Elgeet lens. A lens opening of F1.6 and a focal distance of 16 inches were used as standard settings.

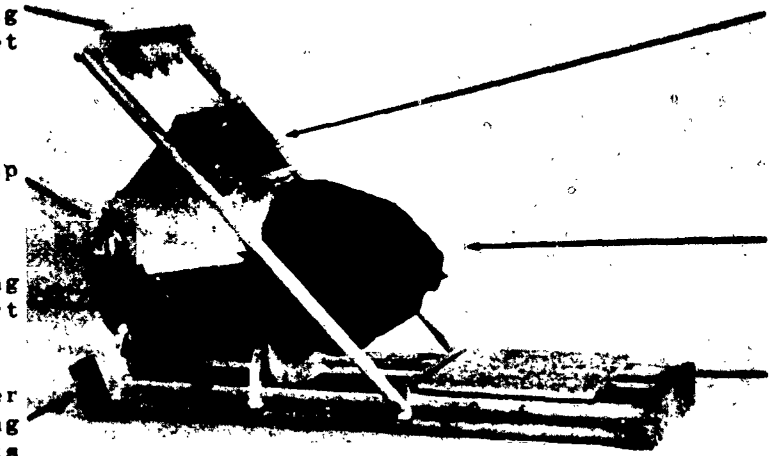

Figure 1. Photographic platform

Figure 2. Pulse generator

Figure 3. Bearing ring illumination system

Recording Personnel

One sonar operator participated in each flight which enabled two HFR staff members to act as the recording team. One of these served as the recording supervisor with primary responsibility for all equipment requirements, e.g., monitoring the power inverter frequency and the record amplification for both camera and the tape recorder. The second member acted as operations coordinator with responsibility for assisting the operator in obtaining best information for filming, maintaining liaison with the aircraft commander, recording corollary information such as B/T, transducer depth, target range and bearing, target nature if known and finally for monitoring film footage and reloading camera magazines.

III. RESULTS OF TESTING PHASE

Flight Trainer Tests

The film obtained from the Operational Flight Trainer produced the following results:

1. The photographic platform could be easily attached to the AQS-10 sonar console and motion pictures of the scope display thus obtained.

2. Both Eastman Tri-X and Double-X were sufficiently fast film to faithfully capture the dynamic sonar returns from the AQS-10 scope display.

3. Operation of the AQS-10 sonar was not seriously hampered by the addition of the photographic equipment and could be easily accomplished with a small amount of assistance to the operator by recording personnel.

4. Focusing of the camera using a small prism mounted in the film gate was extremely difficult and proper focus was not achieved.

5. The built-in bearing ring illumination was inadequate for photographic purposes.

6. UV lighting was bothersome to the operator over prolonged periods of operation.

7. Sound recording at normal recommended levels was inadequate for faithfully reproducing the wide range of amplitude encountered in AQS-10 sonar returns.

Equipment and Procedural Changes

In view of these results which are illustrated in the sequence of scope pictures comprising Figure 4, the following decisions and design changes were made in preparation for the actual flight testing:

1. Double-X film and lens setting F1.6 would be used.

2. Critical focus would be carefully determined before installation and a standard setting used thereafter.

3. A powerstat would be provided for control of UV light intensity.

4. UV filter lenses would be mounted in the operator viewing port.

5. A special bearing ring illumination system would be fabricated on a standard AQS-10 face plate.

6. Recording levels would be set so as to sacrifice maximum fidelity, by overdriving, during the initial period of reverberation burst in order to obtain optimum sound quality in the part of the return containing the target echo.

Tests in the Helicopter

The film obtained in the actual operational environment of the HSS-2 aircraft produced the following results:

1. Good bearing ring illumination could be obtained (Figure 5). Due to lack of testing opportunity it was decided to operate this system at 14 volts (although a maximum of 28 volts was available) to prevent possible interference with scope returns. As a result the bearing ring was overly dim in the photographic returns. This shortcoming is known to be capable of correction in future data collection.

2. Excellent scope photographs were obtained with sharp focus and scope detail faithfully reproduced (Figure 6).

3. The aircraft provided an adequate platform for the task. Weight and space requirements for the recording team posed no operational problem.

4. A good sound track was obtained on at least one reel of film.

5. The utility circuit did not provide enough power to drive all the recording equipment. The first flight was aborted because of this problem after a circuit breaker let go. Subsequent use of a 20-amp fire control circuit completely eliminated this problem.

6. Obtaining a reliable sound track via the single system sound-on-film approach appeared impractical since the sound track was lost on two of the three reels of film.

Figure 4. Examples of Sonar Trainer returns under various control settings.

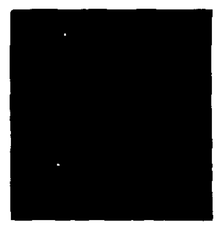

Figure 5. Bearing ring, installed on AQS-10, as photographed on motion picture film.

Target Simulator | Destroyer | Surface Sub | Submerged Sub

Figure 6. Examples of actual AQS-10 sonar returns.

For this and other reasons discussed later in this memorandum, a double system is recommended for future work.

7. Vibration of the aircraft during hover created a minor problem during the third flight. This introduced a small amount of noticeable movement in the film but did not in any way impair the fidelity of recording. Since the aircraft was probably 10 to 20 feet closer to the water during transducer dips on this flight than on previous flights, this variable can undoubtedly be controlled satisfactorily.

8. It was noted on the film that when the operator looked away from the viewing port a considerable amount of ambient light entered the assembly and faded a portion of the scope. This can be overcome by having the operator work within a blackout covering but should more properly be handled by controlling the amount of ambient light coming into the sonar compartment, since this undoubtedly is also a problem during normal operation of the AQS-10 sonar.

After carefully weighing the limits of this modest testing program, it seems reasonable to conclude that the approach is technically feasible and that recorded materials suitable for both research and training can be obtained by exploiting the approach described.

IV. RECOMMENDED PLAN FOR A DATA COLLECTION PROGRAM

Because of the pressing need for operator training materials, there exists a danger that a number of different and unrelated efforts to obtain data, via a variety of techniques and exercise sources, might commence in the very near future. However, some rather basic questions concerning equipment performance under a variety of conditions are still to be answered, due to the limited experience of fleet operators with the equipment. Therefore, a well coordinated and planned approach to target data collection, using the best techniques available, appears desirable and necessary if maximum utilization of this equipment is to be realized.

To illustrate, the following brief outlines indicate some of the major points to be considered in organizing a data collection program, in planning a data collection cruise, and in instrumenting the aircraft for data collection purposes.

A. <u>Major Determination to be Made from the Data Sample:</u>

1. <u>System performance</u> under relatively controlled conditions with the following major variables:

<u>Submarine Target</u>

1) Depth of water, at least 2 areas
2) Depth of target, at least 2 depths
3) Target speeds, at least 2 speeds
4) Target aspect, all 8 major aspects
5) Depth of transducer, at least 3 depths

<u>Non-Submarine Target</u>

1) Depth of water
2) Depth of transducer
3) Kinds of targets
4) Widest possible geographical range

2. <u>Analysis of information</u> presented to operator:

1) AUDIO

a) Frequency (Doppler))
b) Quality) ICS vs. Non-ICS
c) Intensity)

2) SCOPE

a) Intensity of Return)
b) Duration of Return) Normal vs. Expanded
c) Orientation of Return)

3) GRAPHIC (Potential only)

Potential improvement in information and/or performance using a graphic display.

3. <u>Analysis of training requirements</u>:

1) Utilization of equipment controls to obtain maximum information from the system.

2) Target detection under marginal sonar conditions.

3) How to analyze displayed information for target classification.

4) Auxiliary Requirements

a) Communication with pilots to maximize team performance
b) A/C control to maximize system performance

B. <u>Hypothetical Data Collection Plan</u>: <u>One Week Period</u>

1. Equipment and Personnel Requirements:

2 A/C with AQS-10 peaked by Bendix Personnel

4 Pilots

2 Sonarmen

2 Recording Teams

1 set of recording equipment capable of being moved from one A/C to the other in less than one hour.

Services of target submarine, using pre-arranged courses, speeds and depths.

2. Schedule:

Monday

Sub in Area A (shallow MM 15-500 fathom mean)

0830-1130 A/C No.1; S/M at 100 ft 3 KTS 2 hrs 6 KTS 1 hr
1330-1630 A/C No.2; S/M at 300 ft 3 KTS 2 hrs 6 KTS 1 hr

Tuesday

Sub in Area B (Deep 119-1000 fathom mean)

0830-1130 A/C No.1; S/M at 100 ft 3 KTS 2 hrs 6 KTS 1 hr
1330-1630 A/C No.2; S/M at 300 ft 3 KTS 2 hrs 6 KTS 1 hr
1800-2000 A/C Enroute Pt. Arguello or Vandenberg (if feasible)

Wednesday

Non-sub data collection in the vicinity of Point Conception A/C out of Pt. Arguello or Vandenberg (if feasible)

0830-1130 A/C No.1; Collect in HH 6 & 11 on 500 fathom curve
1330-1630 A/C No.2; Collect in HH 12 & 19 on 500 fathom curve
1800-2000 A/C Enroute Alameda

Thursday

Additional non-sub data collection in the vicinity of Point Conception or Monterey Bay as necessary.

Specific areas based on HFR findings during surface cruise.

Friday

Non-sub data collection in waters adjacent NAS Ream.

NOTE: Relatively long flights with completely programmed collection procedures are indicated mainly on the basis of results obtained during surface collection operations.

C. Recommended Equipment for Recording Data:

1. Photography

1) 16mm Mitchell Camera

a) C-mount adapted and 235° shutter opening
b) Lens equivalent to 12mm F1.2 Elgeet
c) 400-foot magazines
d) 115-VAC synchronous motor powered by inverter

2. Sound

1) Two-channel Magnasync Recorder

a) Powered by inverter
b) Synchronized with film by means of hand key
c) Sonar audio only on channel A
d) Audio plus ICS on channel B

2) AN/URHG Recorder for commentary information from operation coordinator.

3) Power

28-volt inverter capable of supplying approximately 500 watts of power at 115V 60~ AC for camera and magnasync.

4) Auxiliary

a) Photographic platform
b) Illuminated bearing ring
c) Pulse generator to enable audio recording to drive devices similar to TRR for graphic display studies
d) Sonar compartment blackout materials
e) Data collection plans, plots and corollary information recording forms

NOTE: Double system motion picture photography is recommended for a number of reasons:

Among those are:

1. Reliable control over audio information.

2. Complete freedom in editing recorded data for various purposes such as training films versus research materials.

3. Addition of commentary to sound track which might be desired in training films.

4. 16mm Mitchell Camera more readily available at Navy photographic facilities.

5. Critical focus is very reliably and simply achieved with this equipment.

6. Double sprocket drive gives greater insurance against vibration problems.

7. Slight increase in weight poses no forseeable problem.

This memorandum, which was hastily prepared in view of the pressing nature of the problem, is intended to suggest a potential plan of approach and some of the considerations that should precede any data collection program.

It is recognized that an immediate need exists for training materials and it should be stated that the approach outlined could be executed in a relatively short period of time. It is likely that training materials could be made available within three to six months after successful data collection is completed.

V. SPECIAL FILM REPORT, AQS-10 SONAR

HFR personnel have prepared a 12-minute motion picture to illustrate the findings of the previously described feasibility exercise in collecting AQS-10 data aboard the HSS-2 aircraft. The film consists of four runs on a submerged submarine target under varying conditions of range, bearing, and transducer depth. Following these sequences there appears a short SQS-4 sonar classification item followed by a set of corresponding graphic recorder traces. This is included to provide an example of a finished product in terms of a training film.

The four AQS-10 sequences are described below:

Run I.

Sub bearing: 270°
Initial range: 1800 yards
Transducer depth: 125 ft.
Destroyer at 350°, range 1000 yards

Run II.

Sub bearing: 315°
Initial range: 3200 yards
Transducer depth: 125 ft.

Run III.

Sub bearing: 210°
Initial range: 1500 yards
Transducer depth: 130 ft.
Two destroyers at about 360°, ranges 2000 and 2500 yards

Run IV.

Sub bearing: 240°
Initial range: 1200 yards
Transducer depth: 80 ft.
Destroyer at about 360°, range 1000 yards