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12 October 1961

MEMORANDUM FOR THE RECORD

SUBJECT: NSA Processing of Project GRAB Data

I. GRAB-IIA. Automatic Processing

1. An operational system for routine processing, analysis, and reporting of GRAB-II intelligence has been designed and tested, and is now operating. Routine end-product reporting of this material is now possible. Difficulties are still being experienced in obtaining accurate and complete analog-to-digital conversion; however, a system of quality control has been instituted and should eventually eliminate most of this problem. Locations can be derived in only a small number of cases.

2. The automatic system consists of four basic parts. These are:

- a. Analog-to-digital conversion
- b. Burst Selection
- c. Scan Sorting
- d. Location Finding

3. The analog-to-digital conversion is performed on AUDICO, a special-purpose machine which converts the analog signals on magnetic tape to a formatted IBM 727 tape which can be used directly as input for an IBM 704 computer. A threshold is pre-set by the AUDICO operator, and each time a pulse rises above this threshold, the elapsed time since the last previous pulse is recorded. Time is measured by a clock controlled by the 60kc tone which has been recorded on another track of the input tape, thus eliminating tape speed variations as disruptive elements in the system. The critical part of this operation is the manual adjustment of the threshold and the incoming signal level. As the AUDICO operators gain experience, it is believed that a more effective job can be done in this area.

4. The Burst Selection program, which runs on the IBM 704 computer, reads the AUDICO output tape, groups individual pulses into unique bursts, and eliminates noise pulses, where possible. After a burst has been formed, its PRF and mid-point (in time) are calculated, and

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this information, plus the number of pulses found in the burst, is written on magnetic tape. Time resolution with this system is on the order of 0.01 second for the starting time for each tape, and 0.2 milliseconds for time of each pulse relative to the starting time.

5. The Scan Sorting program uses the output of the Burst Selection program to form series of bursts which have emanated from individual emitters. The Scan Sorting program currently attempts to identify only regularly rotating radars [redacted], and will not identify [redacted] etc., although these are being studied. After four bursts are found which are at nearly the same scan rate, the series is extended in both directions (with allowances for missing bursts and some irregularity in scan rate) as far as is possible. Upon completion of this step, all bursts between the ones found are examined in order to determine if the true scan rate should be an integral multiple of the rate found first. If, for example, a number of bursts are found which fall almost exactly half way between pairs of the bursts found originally, then the true scan rate should be twice the original rate, and the extra bursts are included in the series. The Scan Sorting program writes out all series found, with the average PRF, average scan period, and the variance of each, along with the time, PRF, and number of pulses for each burst in the series.

6. No method has yet been found for reliably locating more than a very small portion of the radars encountered in GRAB-II material. Given a relatively rapidly-rotating, fixed-rotation-rate emitter which is intercepted over a fairly long period of time, the following technique appears to give an approximate location, accurate within 100-500 N.M. radius:

a. A number of different angles (above the horizon) are assumed for acquisition and loss, and circles are calculated for each. The emitter is then tentatively located at the intersection of these.

b. Since the location, speed, direction, and altitude of the vehicle and the rotation rate of the emitter are known, it is possible to calculate the exact times at which each illumination should occur, if the radar is located at any of the assumed points. These times are compared with those actually observed, and the location which best fits the data is chosen.

c. From this location, by a least squares method, other locations are attempted which better fit the observations, until such time as ten iterations have produced no useful result, or until the last iteration caused the assumed position of the radar to change by less than three miles. Since, however, in the vast majority of the actual intercepts, either (a) the emitter has a fairly slow rotation rate, (b) the rotation rate is not stable, (c) the period of intercept is too short, or (d) a number of bursts are missing; this technique,

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since it depends upon a large volume of fairly smooth data, does not work.

B. Tape Duplicating

1. Equipment has been ordered which will enable C13 to take over this task from NHL. Personnel in C13 are familiar with the details of the dubbing system and can begin to perform the dubbing process as soon as the equipment arrives and is placed in operating condition.

C. End Product

1. See 3/0-S/CMRUK/R3-61, published on 19 September 1961.

II. GRAB-I

A. Automatic Processing:

1. The Burst-Selection and Scan-Sorting programs which have been written and are operating on GRAB-II will probably work equally well on GRAB-I material. A program for locating emitters fairly accurately is operational and will be used on these emitters in the GRAB-I data. The analog-to-digital conversion of GRAB-I data is much more difficult than for GRAB-II, since the recorders used were of low quality and there is no timing tone which can be used directly to run the AUDICO clock.

2. A system for performing the analog-to-digital conversion through AUDICO has been worked out and is in the testing stage. This system builds the 1kc EECO timer tone up to 15kc, and attempts to use this as the clock rate. In order to get the best information available, both from the timing tone and from the data track, the input tapes are run backwards at twice real time speed.

3. A routine to convert the AUDICO counts produced in this manner into the format used by the Burst Selection program has been written and is operational. Preliminary testing of the entire system has indicated that a small D.C. error is occurring, which has the effect of producing PRF's which are low by approximately 5 pps. This problem is currently under study.

B. Semi-Automatic Processing

1. A routine to convert the output of the Bausch and Lomb film processing to a format usable by the Scan Sorting program is nearly complete.

2. A routine to convert the Gerber paper tape format to the same format is also nearly complete. Work on these two routines has

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been performed under a lower priority than the automatic processing system enjoys.

C. Manual Processing

1. For playback, a magnetometer at 7 $\frac{1}{2}$ ips, using the 1000 cps component of the HECO time signal for hand nerve control, is employed. If another type of recorder is used, and if extremely accurate real time measurement is required, a small correction should be applied to all time measurements to compensate for the difference in hand spacing of the two channels.

2. Both the data and time signals are fed to the vertical axes of different traces of a Tektronix 575 or equivalent oscilloscope. In order to provide time coding as well as a 1000 cps reference for launch and launch calibration, the HECO time signal is played into two time-shared traces with filtering to concentrate 1000 cps on trace #3 and 100 cps on trace #4. Two parallel 500 variable filters are used, high pass for trace #3 and high pass - low pass for trace #4, both adjusted for optimum signal. The data signal is patched to trace #1 of the scope without filtering. No horizontal sweep is used in the oscilloscope, pulse separation being achieved by the horizontal passage of the film past the scope.

3. The photography is performed with a BIEBER 321A camera at a film speed of 10 ips and F2.3 aperture. Linagraph Pan film and standard developing procedure with close quality control have been found to produce strip film of adequate quality. Major difficulties proved to be local noise at some recording sites and defective or missing time code signals. Precise beam focus on the oscilloscope is important to produce a fine trace on the film. Care must be taken to maintain the three traces in correct vertical alignment to maintain timing accuracy.

4. Film has been received for six orbits. With the exception of seven film strips on which the timing signal was either absent or illegible, all of these have been manually processed, and individual bursts, with HF, time, and number of pulses for each, have been logged.

of the location 5. WGL devised a system wherein an operator makes measurements of the marks on the 0 to 1 record, and the location of calibration marks which assess paper stretch or shrinkage, analyzer calibration, and speed control of the original tapes, and automatically punches this information on paper tape. The computer program for the processing of this tape is a two part affair. The first part checks the paper tape for format errors, and if none are found combines the measurements of the signal and calibration marks to produce a listing of the time of occurrence and HF of each signal burst, and if desired a listing of each HF observed and the number of times it occurred during the pass. This information is designed to be compared against the output of "burst-sort" program which is an automatic processing system, and from this end is my

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paper tape in IBM 704 format. The second part of the program compares the listing in memory against PRF ranges which are an input to this part of the program, and produces as its output the times of occurrence of bursts falling within the ranges. These times of occurrence are divided by ten seconds, the integral quotient being used to control the y position of a digital point plotter, the remainder controlling the x position. These outputs, together with overlap and calibration cause the plotter to produce a chart analagous to that produced by a QRC-26, although with a greatly enhanced signal to noise ratio. Repetitive bursts can be visually located on the chart and can be compared with the output of "scan-sort" programs required in automatic systems.

6. The first five QRC-26 records from the Gerber process have been read out. A number of additional QRC-26 records have just been received, and work has commenced on these.

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Please return this receipt to [redacted] for, Naval Security Group (Attn: G52),
Room 1210, 3801 Nebraska Ave., N. W., Washington 25, D. C.

1. The following documents have been received by this office:

a. [redacted] memo G52/000393-61/jmc of 30 Oct 1961 (Copy #4)

2. Above material hand carried by [redacted] to Mr. H.O. LORENZEN, NRL.

BYE-057362-99

mention of
[redacted] on p. 2
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Project Director, Project GRAB

G52/000393-61/jmc

30 October 1961

Processing problems with GRAB data; amplification of (U)

- Ref:
- (a) Project GRAB Processing Suggestions by dated 6 Dec 1960 (Copy #2 attached as Tab 1)
 - (b) Further Processing Suggestions from TOG (with NSA answers), dated 3 April 1961 (Copy #6 attached as Tab 2)
 - (c) STIC Member, TOG memo Subj: Suggestions for extracting maximum utility from GRAB II, dated 27 Sep 1961 (Copy #9 attached as Tab 3)
 - (d) STIC-ONI memo for and Mr. DEELEY (NSA) of 30 August 1961
 - (e) TOG Report on Project CANES Initial Intelligence Results dated 1 March 1961
 - (f) NSA ltr 3/0 S/CMRUK/R-1-61 of 20 July 1961
 - (g) NSA ltr 3/0 S/CMRUK/R-3-61 of 19 September 1961

1. Pursuant to request at Navy portion of TOG meeting held 27 October 1961, I am forwarding amplifying comments concerning difficulties encountered in processing GRAB data.

2. Only three final intelligence reports have been produced, references (e), (f) and (g). Reference (e) was a TOG product in which NSA participated, and was based on manual processing of a single mission among 21, combined with a new NRL-ONI "Quick Look" technique and pulse density studies plus intelligent interpretation of the data. Reference (f) consists of V-beam locations determined by NSA with ONI assistance in interpretation of results. This labor was the result of interesting computer techniques, but was achieved on only a single one of the GRAB I missions (V-beam only), and again was based on the same single mission previously manually-processed. This result might not have been achieved had it not been for the input and competition provided by SAC processing of GRAB I data on a selective but timely basis. Reference (g) is the latest summary incorporating data on GRAB II based on some manual, some semi-automatic and some automatic processing; plus further analysis of GRAB I, based on contributions from ONI, SAC and NSA. The report was a stimulating exercise in joint reporting.

3. No further "end-product" has been produced. It was informally understood that, after reference (g), NSA would produce such material from both

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GRAB I and GRAB II on a weekly basis. We doubt if any product will be coming soon. The NSA manual-processors are entirely involved in analyzing Air Force input, which is more difficult to analyze. The automatic output at NSA is stalled due to difficulty in obtaining qualified operators for the AUDICO equipment.

4. Both NRL and ONI have informally made suggestions and have provided manpower assistance repeatedly. Examples of these formal written suggestions are references (a) through (d) respectively, the first three of which are attached. These recommendations have only been partially followed, and no response whatsoever is evident from reference (c).

5. Individual persons in NSA have made tremendous contributions. In particular, [] (In manual processing), [] (In general guidance and interpretation), and Mr. DEELEY and Mr. STRUVE (in general management). Navy members of the TOG are pleased with references (e), (f) and (g). NSA has in their machine work, accomplished a tremendous breakthrough in reduction of the analogue data automatically to hard copy in a small sampling of GRAB II take, which is really a milestone in ELINT processing.

6. However, the task group that Mr. DEELEY had available in mid-1961 is no longer available to GRAB. The turnover in mathematicians working on computer programming has been severe. Furthermore, reorganization within NSA and a general lack of ELINT appreciation outside of C15 has inhibited results further.

7. No current manual processing of interesting portions of the data is under way, such as investigation of missions such as those when TITOV returned to earth, during missile shots, or during atomic tests to search for new sets or changed environment.

8. It is not believed that a really solid effort has been made to screen the approximately 130 missions to see if new signal types are in use. This failure is evident despite the high community priority to look for ABM radar systems, which could well be in these bands of GRAB II data.

9. No effort has been made to test a broad geographic-time-versus extent of activity to provide possible early warning capability. See, for example, paragraph 1(g) of reference (c).

10. NSA has abandoned any efforts to locate scanning radars other than []. Both NRL and ONI feel such despair is premature. NSA has made some very interesting suggestions as to future techniques with two balls with similar coverage, which involve serious rocketry and tracking problems. Yet, at the same time, such data input as obtained from [] with a direct ELINT pickup of the signal on one tape channel

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as compared with the concurrent pickup from the satellite has not been utilized fully. Test signals such as the Greenland radar, and the new 3.9-second scan radar first detected by this satellite have not been tested seriously. Furthermore, it is believed the less dense portions of the data provide substantial hope on unique emitters such as the Marconi radar in  (See reference (c), para 1(f)).

11. Regardless of emitter location success, which is equally applicable to other current collection systems, we believe the data has important intelligence applications. We wish other approaches would be tried and that data reduction at a minimum similar to that being used on current Air Force take be applied to Project GRAB.

12. These comments do not reflect upon the many faithful and diligent NSA workers who have in many cases, worked unrewarded overtime on the task. We admit the problem is difficult. Nevertheless, we must all do more or consider abandoning the GRAB project entirely.

13. Recommendations:

a. The Navy attempt with its own personnel to obtain some data from GRAB, with assistance of one GERBER reader from NSA.

b. NRL with ONI together with NSA data input, attempt other approaches at emitter location on existing data.

c. Clearance on an urgent basis be provided for  (when she comes aboard ONI or sooner).

d. Assignment of  to NRL be made on an urgent basis, to work as a trouble shooter. We understand he is slated for eventual assignment to NSA/C15. His background of some years ago on U-2 data processing and his long ELINT experience qualify him admirably for the task.

e. Other recommendations forwarded separately should also be followed.

Copy to:
NRL (Mr. H. O. LORENZEN)
Chairman, TCG

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