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UNITED STATES INTELLIGENCE BOARD

SIGINT COMMITTEE

SIGINT OVERHEAD RECONNAISSANCE SUBCOMMITTEE

MEMORANDUM FOR ALL MEMBERS OF THE SIGINT OVERHEAD RECONNAISSANCE SUBCOMMITTEE

SUBJECT: Mission Descriptions of SIGINT Missions 7163 - MULTIGROUP III and 7232 - SETTER 1B

Mission Descriptions of SIGINT Missions 7163 - MULTIGROUP III and 7232 - SETTER 1B have been provided to SORS by the NRO and are forwarded for your information.

[redacted] 50X1

EXECUTIVE SECRETARY

Attachment:
a/s

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GROUP 1
Excluded from automatic downgrading and declassification

MISSION 7163
(MULTI-GROUP III)

OBJECTIVE:

To locate ground emitters by intercepting ground signal emissions, analyzing and recording certain critical characteristics of these data while on orbit. This payload contains a digital recorder and a 6 mc analog data storage unit (DSU) for recording electronic emissions. The DSU will permit fine grain measurement of specific signals of interest. These data are retrieved by transmission in digital and wideband analog form via the data links upon command.

SYSTEM DESCRIPTION:

This payload is an electronic reconnaissance system that intercepts pulsed electronic emissions from ground radiations. Analog video signals from the receivers are recorded on wideband recording system. Digital data expressing frequency, time, and operating mode information, are compiled periodically and recorded on an AR-400 tape recorder. Emitter parameters, such as frequency, pulse repetition frequency, pulse width and pulse amplitude are also recorded. The signals recorded on the wide-band system (DSU) will be read out, or transmitted, to a ground station via a wide-band UHF data link. The digital word recorded on AR-400 tape recorder will be read out, or transmitted, to a ground station via a narrowband VHF data link.

Major Components: The Multi-Group payload consists of the following eight major components:

1. Antenna
2. Receiver(s)
3. Payload Control
4. Data Handler
5. Tape Recorder(s)
6. Vernier Location Module
7. Wide Pulse Recognizer
8. Predetection Module

1. Antennas. Two log-spiral antennas and an individual horn arrangement are used to cover the four frequency bands. One log-spiral covers Bands 3 and is an unfurlable structure of mylar and aluminum. It is stored in a hermetically sealed canister and mounted on the end of a 15 foot boom. The boom is extended after the vehicle is in orbit and the antenna is inflated shortly thereafter.

The other log spiral antenna is a fixed cone covering Bands 4 and 5 which is exposed for use after nose cone separation.

The Band 6 signal antenna is a conical horn fed by a cavity backed archimedian spiral. Another spiral without the horn is used for the inhibit antenna.

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The antenna radiation patterns develop a coverage cone by the difference between the amplitude of the signals received by the signal and inhibit antenna pair. The size of the coverage cone angle is mainly influenced by (1) the signal and inhibit channel gain settings, (2) the payload altitude and ground speed, and (3) is set to be consistent with the scanning rates of the receiver. A cone angle of 30 degrees at 275 N.Mi. orbital altitude produces a circular coverage area of 150 N.Mi. diameter.

2. Receivers: The frequency range of the multigroup payload is divided into four receiver bands: Band 3 - 253-553 MHz, Band 4 - 522-1065 MHz, Band 5 - 1048-2106 MHz and Band 6 - 2055-4225 MHz. Each band utilizes a complete receiver consisting of an RF front end, an IF/video section, and an amplitude comparator.

Sum and difference mode signals from the antenna forming the signal and inhibit channels, respectively, are amplified, mixed, amplified again, detected and routed to an amplitude comparator. The amplitude comparator examines these signals for relative amplitude difference, and determines whether they came from an emitter within the desired circle of coverage. If so, an accept pulse is generated within the comparator and sent to the Data Handler (DH) and the signal is processed. An inband detector inhibits the generation of an accept pulse for an off-channel response (those signals appearing from detuned signals outside the IF passband). A discriminator receives the limited IF output from the signal log IF amplifier and delivers a discriminator video output to the payload control (PLC).

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3. Payload Control (PLC): The payload control component receives interface commands and converts them into a form that provides the controls for payload operation. It provides:

a. Storage, interpretation, or distribution of nearly all interface commands as necessary to control the payload in its various modes of operation.

b. Recorder controls for the digital recorder.

c. Protection to the analog recorder by proper voltage control to prevent destruction of the tape.

d. Receiver scan voltage generation with back-up capability (the back-up generator does not provide a quadrant select capability).

e. Payload sequencing and scan controls. The bays are sequenced 1, 2, 3, 4, 1, 2, 3, 4, regardless of which receivers are located in the bays. Any bay disabled will not be included in the sequence, and no delay will be encountered in scanning through a disabled bay. Any disabled quadrant or quadrants cannot be by-passed, however, without some delay. (64 usec each quadrant).

4. Data Handler (DH): The data handler receives, measures, digitizes, and stores the electrical description of the electromagnetic signal detected by the payload. The following information is processed:

a. Pulse Repetition Interval (PRI). The PRI circuit receives the accept pulses from the receiver, digitzes and stores the internval between them and determines the basic time for which the data handler operates on an input signal before generating a data word.

b. Pulse Width (PW). The PW circuit receives, digitizes, and stores the PW information contained in the accept gate input to the data handler. This circuit digitizes PW's form 0.25 usec to 379.75 usec.

c. Pulse Amplitude (PA). The PA circuit digitizes and stores signal channel PA information from the receivers. This circuit digitizes PA's over a range of 52 db.

d. Pulse Amplitude Difference (PAD). The PAD circuit measures, digitizes, and stores the PAD between the signal and inhibit amplitude gate inputs. The PAD compares and subtracts the inhibit pulse amplitude from the signal pulse amplitude when the pulses are coincident. If the inhibit amplitude gate width is greater than the signal amplitude gate width, the PAD circuit inputs are blanked since no accept pulses will be received by the data handler under this condition.

e. Band Code, Frequency, and Time are other characteristics that are processed through the data handler.

The data handler also originates the record actuate signal through a record control circuit to the tape recorders after the electrical characteristics of the intercept have been analyzed and digitized in the data handler.

This record control circuit synchronizes the proper operation for start-stop words when either recorder is turned ON or OFF and steers all forms of digital words to the proper recorder.

5. Tape Recorders: The digital tape recorder records digital information in a start-stop fashion on magnetic tape and, on command, plays back this information continuously in either a forward or reverse direction. The tape recorder stores the processed digital data from the DH during an intercept. During readout, the stored data are read out to the DH for reprocessing. The following is a summary of the digital tape recorder characteristics:

Number of tracks	Four (two for information and two for synchronization)
Steady-state recording speed	22.5 ips

Steady-state readout speed	22.5 ips
Start time	6.8 ± 0.4 milliseconds
Record time	9.6 ± 0.5 milliseconds
Time beyond word	3.3 ± 0.3 milliseconds
Bit density	444 bits per inch (nominal)
Tape capacity	Sufficient for 6200 recorded words minimum

The digital recorder is switchable to the SETTER payload by read time commands.

Two analog recorders are provided, one as backup. The Analog Recorder records analog and digital information and operates in a steady state condition. On command, playback is obtained continuously in a reverse direction, with the last recorded information being readout first.

Analog tape recorder characteristics:

Recording time ≈ 40 min.
1:1 readin/readout 6 MC pre-detection
Number of channels - 1 video and 1 digital

6. Vernier Location Module (VLM). The VLM is an add-on module that provides azimuthal location of emitters within the cone of coverage. It is designed to operate with the antennas for Bands 3, 4, and 5. As a component, the VLM is concerned only with measuring the electrical phase difference angle between certain combinations of the conical spiral antenna windings so as to yield azimuthal location information. It samples the signal and inhibit channels in the receiver and measures the phase difference over a 360° range to within ± 40°. The azimuth angle of incoming signals shall be coded in 5 bits. The VLM will be ON and operational whenever the payload is ON during readin and calibrate.

7. Wide Pulse Recognizer (WPR). The WPR is an add-on module that provides recognition of an emitter pulse greater than 75 usec with a signal channel input power greater than - 65 dbm. The WPR is independent and is a separate receiver. Since the WPR receiver works independently there is no stop scan associated with the WPR operation. All the bands continue to scan and receive data in the normal scan mode. The digital track of the DSU will contain marker words for the bands that are turned on, and the WPR alarm bit will be a one, indicating DSU video is a valid WPR intercept. The DSU will either start up from the off condition or pull tape from a standby condition for the duration of the WPR signal. If the DSU is already in steady state actuate when the wide pulse signal generates an alarm, the pre-D track of the DSU will be switched to the WPR receiver. The WPR operation will cease after a 15 second delay from loss of an intercept. The WPR will be enabled ON and OFF by real-time commands.

8. Special Special Detector (SSD) The SSD is an add-on module which is mounted in the Payload Vehicle. This module is somewhat similar to the one on 7162 in that it is not a separate receiver like the WPR. The SSD obtains its inputs from the high-level signal channel video output of the multigroup payload receivers. This is a considerable expansion of capability as compared with the previous SSD which was operated in conjunction with only Band 4. There are numerous design and timing changes which create considerable difference in operation between the two units.

The SSD operates in all bands and for specific frequency ranges in certain of these bands. The table below shows the significant parameter ranges for each band. There is an amplitude threshold requirements for each band which has to be satisfied to produce an alarm.

SSD TECHNICAL REQUIREMENTS

Band No.	Amplitude Threshold (dbm)	PW - 1 (usec)	PW - 2 (usec)	Frequency Window (MHz)
3	65 ± 3	10	30	260-400, 460-530
4	65 ± 3	5	60	530-1060
5	70 ± 3	10	30	1060-2100
6	70 ± 3	1.3	5.6	3100-4200

The pulse width comparator in the 7163 SSD is quite different from that of 7162 in that there are two selectable pulse width standards for each band. Each pulse width circuit has a wide and narrow choice which can be selected by real time command and involves simply a component change for each comparator circuit.

The pulse width comparison circuit for each band compares the signal channel high level video output of a particular receiver with the selected standard pulse for that receiver. This comparison is made only after the intercept meets the amplitude and frequency criteria.

To prevent CW signals from causing false alarms, a three pulse verification circuit is under consideration for inclusion in the SSD. At least three pulses must occur within a prescribed time period in order to produce an alarm.

Any pulse in any band that is being scanned which meets the proper amplitude threshold, frequency window, and pulse width selection requirements (and has been verified), will cause an SSD alarm to occur.

9. <u>SSD Operation With No WPR Signal Present</u>: This SSD alarm does many things which will be discussed below. First of all, and most important, an SSD alarm will cause the normal accept pulses generated in the receiver amplitude comparators to be blanked in the data handler. This causes all normal data inside the field of view to be inhibited. The pulses which are causing the SSD to alarm will generate what is known as a ΔPW (delta Pulse Width) gate. This new ΔPW gate will now go to the payload Data Handler to be processed in place of the normal Accept Gates. Pulse Repetition Rates (PRF) and Pulse Width (PW) measurements are made from these ΔPW gates. Since ΔPW gates are generated from the signal channel high level video only, they can be from emitters which are either inside or outside the normal coverage area. It should be noted that pulse amplitude (PA) and pulse amplitude difference (PAD) measurements of SSD alarm signals will be inaccurate. PA and PAD measurements are normally generated from amplitude gates from both the signal and inhibit channel video pulses. Amplitude gates arising from SSD video pulses are initiated in the receiver amplitude comparators at the beginning of these pulses but the measurement of their width in the Data Handler is not initiated until the beginning of the ΔPW gate.

A ΔPW gate causes the following sequence of events:

1. Inhibits normal Accept Gates and thereby enables processing of SSD signals which originate outside the coverage circle. Also, the data handler will write words only on those intercepts which are "filtered" by the SSD and thus all unwanted non-SSD interleaved pulses are inhibited.

2. Signals the data handler to switch to lock-on mode, thus providing ten data words to the digital recorder every ten to twelve seconds.

3. Signals the payload control unit to stop receiver scan.

4. Signals a time delay circuit to start the DSU after a 2 second delay. The 2 second delay has been incorporated to allow the DSU to recover from any OFF command which may have been sent previously. The DSU will actuate and pull tape to record either the pre-detected or detected video payload output after another 42 second delay (provided, it was in an OFF state) or will actuate and pull tape after the 2 second delay if it was already in the standby state.

5. Starts a 66 $\pm$ 6 second timer. At the completion of the time-out plus the time required for the data handler to complete a lock-on sequence (an additional 1 to 12 seconds), the following events take place:

a) The SSD circuitry signals the receiver in operation to scan half a pass band.

b) Unblanks the alarm gate to check if an SSD alarm signal is still present.

If an alarm signal is still present the process above is repeated and the DSU remains ON. The re-start of the timer is so rapid that, depending on the time between time-out and re-initiate, the second and subsequent SSD stop scan times could be as short as 30 seconds because of timer characteristics. Whenever the timer times out, the receiver moves over half a pass band and the alarm gate unblanks again. Once the receiver has been tuned past the alarming signal, a 120 millisecond time delay is allowed to fire. The trailing edge of this pulse in turn fires the DSU OFF time delay which turns off the DSU.

10. <u>SSD Operation with the WPR:</u> If a WPR signal is present prior to intercepting an SSD alarm, it would be controlling the DSU and the DSU video track would be switched to the WPR output. At the time of an SSD alarm, the priority circuitry in the SSD would take over the DSU in exactly the same manner as in 7162. Operation of the SSD would be the same as previously described.

If the WPR signal were still present or an Analog Read-In were programmed ON, the DSU would <u>not</u> be turned OFF at the completion of the tuning through an SSD alarm signal, and the payload would revert back to WPR operation or Analog Read-In.

During SSD operation, signals inside the normal circle of coverage will be tagged and those outside the circle will not be tagged since the tagging function takes place within the amplitude comparator. However, digital words will be written on SSD intercepts whether they are inside or outside the coverage circle.

11. <u>Predetection Module (PDM):</u> The predetection module is an add-on module that processes and shapes received signals for analog recording before detection. It is designed to operate within all the receiver bands, PW's and PRI's. The PDM receives power and combined IF pulse signals from the VLM. However, the PDM and VLM may be operated separately or simultaneously because of their interconnection with the PLC.

The PDM will be turned ON and OFF by real-time command.

<u>PAYLOAD CHARACTERISTICS</u>

	RECEIVER BANDS			
ITEM	3	4	5	6
Frequency range (Mc Spec. limits)	253-553	522-1065	1048-2106	2055-4225
Bandwidth (Mc)	4.0	2.0	5.0	2.0

Scan time (Normal) (Sec) (no intercepts)	4.1	4.1	4.1	8.192
Scan time (Alt. rate)(Sec)	16.4	16.4	16.4	16.4
PRF, minimum (PPS) (verified)	10	10	10	10
PRF, maximum	10,000	10,000	10,000	10,000
Minimum PW (usec)	0.5	0.3	0.3	0.5
Maximum PW (msec)	4.0	3.8	3.8	3.8
Sensitivity (dbm) without antenna gain	-75	-83	-83	-85
Antenna gain	0	-2.0	-3.0	-2.5
Ground coverage area (diameter)	150 nmi with a cone angle of 30 degrees ± 15 at 275 nmi orbital altitude			

OPERATIONAL CONCEPT:

The Agena will be launched by a Thorad booster to a nominal 275 n mi 75° inclination circular orbit with a mission lifetime of 30-60 days. The digital recorder will be programmed on from border to border, the analog recorder and payload modes will be pre-programmed for operation over specific locations according to SORS guidelines. All data will be dumped and recorded at ZI facilities. The digital material will be sent electronically to the processors and the analog data will be forwarded by courier. Location accuracies will be ± 35 n mi for one intercept and less for multiple intercept.

The basic operating functions of the payload are readin, calibrate, and readout. A simplified explanation of these operating conditions is given below.

Readin: With respect to receiver operation, the basic reading mode of operation is scan. A payload command for the basic operating mode turns on power to the DH and PLC and starts the programmed receivers in their scanning sequence. Any combination of receivers can be selected for operation. A scan generator in the PLC programs each enabled receiver on as its turn comes in the sequence. All receivers are scanned from low to high frequency, and the receivers are scanned from Bay 1 through Bay 4.

Signal and inhibit antenna outputs are fed into separate receiving channels having the same gain characteristics. An amplitude comparison is performed on the outputs of these two channels. When the amplitude of the signal channel exceeds that of the inhibit channel by the desired amount, an identifying tag (accept gate) is generated that locates the signal (if the amplitude of the signal channel is not greater than the inhibit channel, a tag is not generated and the signal is not processed).

Upon receipt of a signal from the coverage area, an accept gate is generated within the receiver, initiating DH operation. The DH signals the PLC to stop the receiver scan for up to three more accept gates. At least two accept gates are required to generate a data word, although four are required for a complete word. If a second gate is not received within the maximum PRI for the band, the DH is reset, scan resumes, and in the normal scan mode, no data word is produced. When the fourth accept gate is received, the DH will have completed 3 PRI, 2 PW, 2 PA, PAD, frequency and time measurements, and will transfer the data word to the recorders. The DH then initiates the actuate signals to the recorder that is programmed on. The timing at this point is a function of the mode programmed and the recorder being used. In the normal scan mode, the scan remains stopped only long enough to obtain up to four accept gates and generate a data word.

Four different types of 96-bit digital words are generated: (1) the data word just mentioned, which is generated for each time verified incoming signal within the coverage area; (2) the start word which is generated when either tape recorder is turned on in a write mode, and the stop word which is generated as each recorder is turned off at the end of a write period; (3) the status word which is generated between the frequency scan of Bay 4 and Bay 1 and (4) the marker word which is generated and permit interpolation of a signal's frequency. If a record signal should be received during the generation of a marker word, the data word will override the marker word.

<u>Calibrate Mode:</u> In the calibrate mode, known signals are transmitted to the payload and the data are transmitted to a tracking station in real time. Program 770 ASTROPHYSICAL RESEARCH VEHICLE's are utilized to transmit signals of known parameters from predetermined sites inside the Vandenberg area of tracking coverage to the payload.

<u>Readout:</u> In the readout mode, the stored digital data and pertinent payload monitor points information are transmitted to the station. When the payload receives the digital readout command, the DIGITAL tape recorder reads out the data in reverse order to the DH. The DH reprocesses the data for transmission by the command and control subsystem. Transmission is automatically stopped when front-of-tape is reached.

The analog recorder records on one side of the tape while the tape moves in one direction, and on the other side while the tape moves in the opposite direction. When the Analog Readout ON command is given, the recorder will read out in the reverse direction from which it reads in, with the last recorded information being read out first.

MISSION 7232

(SETTER IB)

OBJECTIVE: The SETTER IB payload is an electronic reconnaissance system which locates ground-based S-Band emitters by making relative phase measurements on the received RF signal. The SETTER IB is capable of working in dense signal environments using emitter frequency and geoposition as parameters for sorting the pulse trains. The payload processes and records the intercept information in digital form and converts the recorded information into a form suitable for transmission to the ground

SYSTEM: SETTER IB is integrally mounted with the prime payload (in this case Mission 7163) on a fully stabilized AGENA vehicle. It is a 6 channel, 90 dbm sensitivity system using six circular horn antennas arranged in an interferometric array feeding six superheterodyne receivers each tuned in 256 steps 2604.5 to 3216 MC with 2.4 mc bandwidth. The dwell time on each step is 26. msec or 52 msec. During this time the 120 x 340 mi field of view is scanned and the radio frequency, pulse width and repetition interval of received pulses are digitized and stored. The SETTER data is recorded and dumped on the same type of 10,000 bit/sec equipment as is the Mission 7163 data. One 182 bit words is used for each intercept; 6550 intercepts can be stored and the total dump time is only 165 sec. The SETTER IB payload has three fundamental functional modes of operation: a reconnaissance mode (read-in), and two real-time modes (readout, and calibrate and record).

Read-In

The readin or reconnaissance mode may be further subdivided into 5 operational modes: The normal mode and 3 alternate modes. In the normal mode, 4 successive pulses may be analyzed from the same emitter, but only 2 are needed to confirm the intercept and print descriptive 182 bit digital word onto the associated AR-400 tape recorder. All basic intercept parameters, together with other necessary data, are recorded in the data word. In any operational mode, 2 start-stop words are generated at both the beginning and the end of an observation period. These words contain system time, vehicle attitude, and payload operational configuration. Also, 2 time attitude words are generated once every 16 seconds during an observation period. The 3 alternate modes are provided to permit continued limited system performance in the event of certain malfunctions. All modes are discussed below:

Normal Mode. The normal mode utilizes a Space Window concept of sorting phase (geoposition) information of emitter signals for the logic decision to process or reject. The normal mode permits de-interleaving during a single dwell period. All of the following inhibit-confirm parameters are also analyzed in the normal mode of read-in:

a. Within phase field-of-view (FOV)

b. Real and not a spurious signal

c. Amplitude within dynamic range

d. PW FW min (0.4 usec)

e. Within Frequency process band

Alternate Mode I. This command shall disable the buffer storage memory and the Space Window memory.

Alternate Mode II. This command shall disable the following confirm/inhibit functions:

(a) Tmin Inhibit
(b) Tmax Inhibit
(c) A/R Inhibit

Alternate Mode III. This command shall disable the following confirm/inhibit functions:

(a) Min. PW Inhibit
(b) Phase Field of View Inhibit

Readout

In the readout mode, the data which was stored in NR Z-Mark form is readout through the IBU to the data link in 3 level RZ code. The digital tape recorder is the same type as that used with the 7163 payload and may be switched to Mission 7163 by real time command.

Calibrate and Record

In the calibrate and record mode, known signals are transmitted to the payload and the digital dataare transmitted to a tracking station in real-time at the same time the data are recorded. Program 770 Astro Physical Research Vehicle's are utilized to transmit signals of known parameters from predetermined sites inside the Vandenberg area of tracking coverage to the payload.

Location accuracy of SETTER is ± 7.5 n mi on a single intercept with even increased confidence and minimized system errors possible from multiple hits. Rf measurement accuracy is ± 2.0 mcs pulse width resolution accuracy is ±15% from 0.4 to 0.6 usec and ±10% from .6 usec on, pulse repetition interval is measured to ±.3% and pulse amplitude is measured ±2.5 db over a 40 db dynamic range.

SETTER IB is an advanced all-solid state system using electronically tuned frequency synthesized stripline receivers and a magnetic core data handler.

EXPECTED LIFETIME: 30-60 days.

SCHEDULED LAUNCH DATE: Winter 1967-68.

SETTER IB PAYLOAD CHARACTERISTICS

Frequency coverage	2604 ± 1 Mc to 3200 ± 1 Mc
Scan time (entire freq. range)	7.2 sec or 13.8 sec (max dwell at each 1 MC step)
Dwell time (time at one discrete frequency)	26 MS or 52 MS
Dynamic range (referenced to antenna input)	40 db
Pulse repetition interval	
PRI min	40usec
PRI max.	26 millisec
Pulse width (PW)	
PW min	0.4 usec
PW max	3.3336 usec to CW
Absolute pulse amplitude	Encoded in a 2.5 db increments, ± 5 db (bottom increment)
Space coverage	A rectangle approximately 120 n.m. wide and 340 n.m. long (at 275 n.m. alt.) (The width dimension is along the flight path)
DF Accuracy	CPE of 1.5° ($\frac{1}{2}$ angle) cone about the line of sight to the emitter (payload only) (Equiv. to 0.6745).