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~~TOP SECRET~~ EARP OP Handle via BYEMAN Control System

~~TOP SECRET~~ - HANDLE VIA BYEMAN CONTROL SYSTEM

From: Director, Naval Research Laboratory, Washington, D.C. 20390
To: Commander, Naval Intelligence Command 33

Subj: Preliminary Technical Description of Mission 7106

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PRELIMINARY TECHNICAL DESCRIPTION MISSION 7106

I. DESCRIPTION OF THE BASIC FUNCTIONS -

A. Four satellites are under development by the U. S. Naval Research Laboratory for launch into orbit from the Pacific Test Range in early 1969, for use in the Program-C (POPPY) SIGINT collection effort of MISSION 7106. The satellites will be known by their respective assigned nomenclature, 7106A (Alpha), 7106B (Bravo), 7106C (Charlie), and 7106D (Delta).

B. These four satellites with their 82 primary collection systems are designed to fulfill two basic requirements:

(1) to perform General Search Surveillance of the electromagnetic spectrum from 153 to 15,100MHZ, against pulsed type radar emissions.

(2) To enhance the Electronic Order of Battle (EOB) emittor locations data of the Sino-Soviet-Bloc radar emittors.

C. Each collection system is designed to cover a specific portion of the frequency spectrum. There are at least twenty unique SIGINT collection bands in each of the four satellites, any combination of them can be utilized operationally at one time.

II. OVERALL OPERATIONAL DESCRIPTION --

A. The basic POPPY type collection system uses the simple, reliable crystal-video type receiver, designed for low power consumption and hence have regularly demonstrated an operational life time in excess of one year. Any combination of the collection systems in each satellite may be commanded "On" and at the end of timed cycle of either 50 or 20 minutes, the data collection and re-transmission systems are automatically turned "Off" or RESET by an on-board Timer. Various modes of this timer incorporated in Mission 7106 are as

follows:

(1) Delayed "TURN-ON" permitting up to 140 minutes (in 10 minute increments) delay after the payload is interrogated or commanded.

(2) A short "TURN-ON" is provided for 20 minute timed operation to allow the Domestic Calibration and Engineering Evaluation to be expedited.

B. Payload System: When pulsed signals from a radar illuminate the satellite with sufficient signal strength, the signal is intercepted, stretched in time duration to either [redacted] (hence-forth referred to as [redacted] respectively). The stretched pulse is then re-transmitted on a pulse-for-pulse basis by one of the two Data-Link transponding systems contained in each of the satellites. The radar's pulse repetition rate (PRF) and scan rate characteristics are preserved in the re-transmitted data. The data collection frequency is defined by characteristics of the band-pass filters used in each of the SIGINT Collection Systems.

C. Ground Data System: The pulse data from the satellite transponding (Data-Link) systems will be received and recorded along with precise ground station timing information at [redacted] ground sites situated around the periphery of the Sino-Soviet-Bloc. At [redacted] the data will be converted from analogue to digital form in real time, (prior to data

being recorded) so that a minimum of time distortion of the data results. These [redacted] will be equipped to monitor all four satellites at the same time with one of the ground based receiving antenna systems taking the data from two satellites at a time while the other receiving antenna monitors the other two satellites of Mission 7106. Similarly, at the other [redacted] which will receive and record the data in analog form from two satellites on one magnetic tape, while the data from the other two satellites will simultaneously be recorded on the other tape recorder.

[redacted]

III. PAYLOAD CHARACTERISTICS - - -

A. The four satellites are designed to be launched in a sequence such that order of arrival over the ground data station will be the Delta Payload followed by Bravo, then Charlie and Alpha [redacted]

[redacted]

On-Board "microthrusters" will be employed to maintain these separations. 3-Axis Gravity Gradient type stabilization systems will be employed in order that the effects of these thrusters will be predictable. Additional Payload and orbital characteristics are provided in Table #1 below:

TABLE #1

ITEM OR CHARACTERISTIC	7106 A	7106 B	7106 C	7106 D
Weight lbs in orbit (est.)	270	270	270	270
Size	27 Inch Diameter 12 Sided Multiface			
Orbital Inclination (est.)	70°	70°	70°	70°
Telemetry Frequency (Chan A.) MHZ	137.950	137.800	137.440	13741
Radiated Power (Milliwatts)				
Chan A (TM) est. (Modulated)	68	Undergoing Test		
Chan B. (DL-1) est. (CW)	384	Greater than 333		
Chan C (DL-2) est. (CW)	432	Greater than 333		

Transmitter Receiver Antenna Turnstile Array at + 36° Lat.

IV. SATELLITE COLLECTION SYSTEM - - -

A. The collection systems utilized are basically crystal-video receivers with omni-directional antenna systems, and well defined (band-pass type) frequency coverage. With the resultant high probability of intercept, this

collection system is, in the densely populated portions of the spectrum capable of encountering tremendous data density. To assist in reducing this density to a more manageable amount it will be possible to exercise a command-option of using either pair of the opposite-quadrant collection antennas, and thus reducing by 50% the azimuthal coverage and data density. Every collection band in each of the payload except the highest frequency ones in 7106 Charlie and 7106 Delta, are duplicated in at least two of the payloads [redacted] In addition there are ten bands which are duplicated in all four of the payloads. These ten collection bands cover the frequencies of the highest priority signals known at this time.

B. The proposed performance characteristics of the collection systems in each of the satellites are given in TABLE #2, and #3. Unless otherwise noted, identical design goals are maintained for the collection systems duplicated in two satellites [redacted]

C. Bandpass - The bandpass (frequency definition) filters incorporate sensitive crystal detectors, matched to provide maximum flatness over the bandpass. The degree of filtering and skirt selectivity are designed as a function of the frequency range in which the particular filter is used. For example, twenty-one (21) resonant sections are used in Band No. 1 (adjecent to the data transmitter frequencies) compared to seven sections in the X-band range. The frequencies tabulated in the Tables define the bandpass at points 3 db down on the upper and lower band edge. Undoubtedly, depending

upon the signal strength of a received signal (relative to the system sensitivity), this band pass can be slightly wider. For example, Band 1 is expected to have a receiving capability down to approximately 153.5 MHZ, at this frequency the sensitivity response is reduced by 10 db.

D. Receiving Antenna Systems - Various types of antenna elements are used in a number of configurations to provide omni-directional arrays required for the spectrum covered. Bands 1 through 9 use arrays of quarter-wave monipoles arranged symetrically around the Payload North-South polar axis at various satellite latitudes. Combination of the detected video signals results in an omni-directional collection antenna pattern for reception of either vertically or horizonally polarized emissions. Bands 10 and 11 will use horizonal dipole elements spaced in quadrature around the equatorial band of the satellite, for collection of horizonally polarized signals. Opposite antennas are combined (for example through R F hybrids and the two resulting channels, Fore-Aft and Port-Star), are further combined in the video for a composite pattern of 360° Azimuth. Vertical polarization coverage is obtained with a single monopole on the south pole. With this arrangement the selection of polarization is available by commands. Bands 12 through 15 for 7106 Alpha and 7106 Bravo and 12 through 16 in 7106 Charlie and 7106 Delta utilize open-ended waveguide type antenna for horizonal polarization with a southpole monopole for vertical polarization collection. The video combination of all channels produces omni-directional vertical and horizontal polarized collection antenna patterns.

The antenna system for each band above 3600 mc will consist of (4) half-wave dipoles symetrically spaced in quatrature around the equatorial band. Each

dipole is mounted on a ground plane sloping downward (toward the horizon) at an angle of 20°. Each element is rotated about its axis to 30° from the horizontal plane to optimize pick up of both horizontally and vertically polarized signals. Opposite antennas are combine through R F hybrids (for insolation) to form two channels, each followed by a separate R F and video receiving system. These two channels, each with its own oppositely paired dipole antenna system perform independently. The two orthogonal patterns overlay to provide full Azimuth coverage. As a back-up capability, provision is made to select either of the two orthogonal receiving channels (by command). In this back-up mode the Azimuth coverage is limited to approximately half of the total coverage, and thereby it is useful when the signal density is excessive. Band 23 in 7106 C and D (Ku Band) incorporates high gain horn antennas to improve the intercept sensitivity in this range. Two 16 db horn antennas are located on each side of the satellite flight line and combined to give 60° antenna pattern centered at ± 75° in Azimuth relative to the flight line. These elements are mounted at a latitude of -36° to assure coverage of the horizon assuming approximately 10° tolerence in stabilization.

E. R F Preamplifiers - R F preamplification is utilized in all collection bands above the frequency range of 3600 MHZ, to achieve the required sensitivity. Low noise tunnel diode amplifiers with gains from 15 to 40 db are integrated into the filter-detector system, temperature compensated and biased to give the optimum performance. DC-to-DC voltage converters provide the necessary critical regulation of the low voltage to bias the tunnel diode.

R F circulators incorporated in the amplifier are carefully shielded to prevent the interaction with other units in close proximity.

V. PARAMETRIC MEASUREMENT CAPABILITIES

C. System Sensitivity, Option - Several of the collection systems have a selectable option for system sensitivity as shown in Table #3.

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TABLE #2

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7106 A and B

BAND NUMBER	BANDPASS (MHZ)	TRANSMITTER	SENSITIVITY (DBM)	ANTENNA MODES**
1	154-165			153.5 MHZ at -10 DB
2	165-200			
3	200-240			
4	350-450			
5	450-550			
6	550-650			
7	650-820			
8	820-920			
9	920-1080			
10	1800-2100			
11	2100-2580			
12	2580-2680			
13	2680-2930			
14	2930-3120			
15	3120-3300			
16	5250-5850			
17	5850-6700			
18	8600-9340			
19	9340-9500			
20	9500-10,000			

** ALL BANDS HAVE OMNI-DIRECTIONAL AZIMUTH COVERAGE

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TABLE #3

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7106 C and D

BAND NUMBER	BANDPASS (MHZ)	TRANSMITTER	SENSITIVITY (DBM)	ANTENNA MODES**	
1	154-165				153.5 MHZ at -10 DB
2	165-200				
3	240-350				
4	350-450				
5					
6	550-650				High Sens. Option in 7106 C Only
7	835-970				
8	1080-1350				
9	1350-1800				
10	1800-2100				High Sens. Option in 7106 D Only
11	2100-2500				
12					
13	2680-2930				
14	2930-3120				
15	3120-3300				
16	3300-3600				
17	3600-4050				
18	4050-4850				
19	4850-5250				Reduced Sens. Option
20	6700-7300				
21	7300-7900				
22	7900-8600				
23	14.8-15.1 GHZ 14.6-14.9 GHZ				

** ALL BANDS HAVE OMNI-DIRECTIONAL AZIMUTH COVERAGE

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TABLE #4

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NSA SUGGESTED [redacted] BINS FOR MISSION 7106

Alpha/Bravo BINS	[redacted]	Charlie/Delta BINS	[redacted]	COMBINED RESOLUTION	[redacted]
0		0		1-1	
1		1		2-1	
2		2		2-2	
3		3		3-2	
4		4		3-3	
5		5		4-3	
6		6		4-4	
7		7		5-4	
8		8		5-5	
9		9		6-5	
10		10		6-6	
11		11		7-6	
12		12		7-7	
13		13		8-7	
14		14		8-8	
15		15		9-8	
				9-9	
				10-9	
				10-10	
				11-10	
				11-11	
				12-11	
				12-12	
				13-12	
				13-13	
				14-13	
				14-14	

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