ROUTE SHEET

NDW-NRL-5511/1552 (Rev. 5-54)

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CODE	DATE	INITIALS	*PURPOSE	REMARKS
5614	5/15/69	[illegible]	I	
5610	15 May	JF	I	
5170	15 May	[illegible]	I	
5600	16 May	[illegible]	I	
5000	5/16/69	WRF	I	
5000	5/16	[illegible]		
4000				
1000		[illegible]	4	
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NDW-NRL.-5511/1552 (Rev. 5-54)

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From: Director, Naval Research Laboratory
Washington, D.C. 20390
To: Director, Program "C" (CAPT MOFFIT)

Subj: Proposed Concept for Mission 7107

Ref: (a) NRL ltr to Dir NRO of 7 Feb 1967, (BYE-26904-67)
(b) WHIG Msg 011239Z CITE WHIG 8916
(c) SORS 9./75 Draft of 1 Apr 1969, (TCS-1640-69)
(d) NRL ltr to Dir Program "C" of 9 May 1969, (BYE-51901-69)

ONRL TK-00056-69

Encl: (1) Technical Discussion; Subj: Proposed [redacted] Techniques

1. Introduction:

This concept proposal for Mission 7107 is an up-date of reference (a) submitted in February 1967 and represents the latest guidance provided by references (b) and (c). It is also the major element which defines the effort which was described, in terms of cost and schedule, in the summary of the NRL financial program for Mission 7107 given in reference (d). There are several areas where a significant change is proposed in this concept for Mission 7107. This concept reflects primarily the requirements for overhead ELINT data collection and processing which have been recommended to the USIB by SORS, reference (c)

2. Operational Objectives and Priorities Proposed for Mission 7107:

The operational objective of reference (b) and (c) apply to Mission 7107, since they are projected through 1974 and reflect the requirements for the collection of ELINT data by overhead means leading to the early detection of (1) existing and future major weapons systems in the denied Soviet and CHICOM areas and (2) the advancements in technology which may

be applied to future weapon or space systems in any area of the world where crisis situations may develop.

In conformance with the capabilities demonstrated in earlier POPPY missions, Mission 7107 will provide data to support the following intelligence priorities:

(1) Timely discovery of the existance of previously unknown emitter sub-systems.

(2) Technical assessment of these new sub-systems to ascertain the performance function, capabilities and limitations as they are deployed into a major overall weapon system.

(3) Electronic Order of Battle (EOB) surveillance capability for timely periodic determination of location of known emitter sub-systems with sampling by geographic area sufficient to disclose a measure of the activity level as well as the interrelationships and usage patterns of these sub-systems relative to the overall weapon system.

(4) In addition to these areas of demonstrated past POPPY capability there is an area of proposed endeavor which is being advocated as an extension to the present POPPY "Alert" capability. POPPY can provide a vastly superior long lived missile launch detection capability by coupling the standard ELINT collection capability

3. Historic Philosophy of POPPY Continued for Mission 7107:

POPPY emitter location analysis techniques such as [redacted] and the selective location-analysis possible at these sites with digital data systems, will continue to be a major operational goal. In addition the further development of a geographic-location data sort will be continued so that those emitters which are associated by location can be identified at a early time, even though these signals may span the entire spectrum of radar use. The basic ability of POPPY to simultaneously cover the major portions of the radar spectrum will be capitalized upon in the operational endeavor to provide the early discovery of new and unusual signals and additionally to provide the data from which an early technical assessment may be made.

Previous POPPY missions have provided a wide variety of parametric measurement capability such as the ability to measure both [redacted] duration across the entire frequency spectrum. At specific frequencies there have been command options which will describe the manner and degree of emitter frequency agility as well as the ability to detect the presence of a [redacted] These options will be included in Mission 7107 as specific direction is provided.

In addition to the above areas of operational endeavor which will be retained in the concept for Mission 7107, there are also many other basic attributes of POPPY which will also be inherent in the design; (1) Long lifetime in orbit (18 to 36 months anticipated); (2) High probability of intercept inherent since no scanning of azimuth or frequency will be used; (3) High data confidence inherent since no image or spurious signal components are generated in POPPY; (4) Spacecraft attitude and station keeping control will be provided for each of the four spacecraft; (5) Spacecraft collection systems will be designed wide open in both frequency and azimuth, so that the main-beam of the emitter signals will be intercepted any time the spacecraft is illuminated by the emitter. Thus the antenna scan characteristics of the emitter will be preserved to a high degree of accuracy in the POPPY data.

4. Operational Philosophy:

"Target-of-opportunity" tasking of the POPPY spacecraft can be attained in near real time against a specific target emitter of the highest priority by the overseas interrogation

(command) station when such a target emitter is recognized thus greatly enhancing the impact of POPPY against the highest priority signals. For example during an orbit tasked for "General Search" across a wide frequency range, the real-time recognition of the intercept of one of about 6 or 8 of the highest priority signals would allow the spacecraft to immediately be re-tasked by the site to capitialize on this "Target of opportunity". The manner of re-tasking would be dependent upon the particular target signal and its specific intelligence requirements as well as capabilities of the particular POPPY spacecraft. In general, those parametric measurements which are available could be tasked for all frequency bands containing sub-system emitters which have known or suspected association with this target of opportunity. The versatility of the system is great but entirely dependent upon the ingenuity used in the planning stages for definition of this "emergency tasking" proceedure to make full utilization of this inherent POPPY capability.

Stored commands will be contained in an on-board memory system in the Mission 7107 spacecraft so that the commands may be loaded into the memory at a domestic ground station in [redacted] A typical stored command memory system of 3200 bits has been studied as an example. It, for instance, would be capable of the following type of operation:

> It would have 50 individually programable "Time Words", these "Time Words" are selectable to one-second of resolution within the total duration of 14 hours. At each of these "Time Words" a "Task-Group" would be commanded on. A Task-Group is also individually programable and by definition is any practical or desirable combination of ELINT collection bands with their appropriate parametric measurement, sensitivity or [redacted] options. This type of stored command system is very flexible. It essentially allows any combination of collection bands to be turned on and off at any time, within the overall total storage period of the system. The detailed design of the system will be "firmed up" after appropriate dialogue with the tasking community.

The stored command program can be interrupted for "dedicated" tasking against targets of opportunity as they are detected

and after a period of five or ten minutes the stored program will take over, automatically picking up the correct point in the time cycle. This provision for stored commands will provide far greater command versatility thus taking advantage of geographic coverage potential of POPPY as well as the ability to change tasking at points in the orbit remote from the three POPPY command sites. Another significant advantage of this ability to store commands is the additional security provided the command system by reducing the exposure of the signal characteristics. In addition to the aforementioned advantages made possible by the use of stored commands there is also another advantage of extending the time available for collection and recording of data at the sites which would otherwise be occupied with the operational tasking effort.

Spacecraft evaluation will be performed routinely throughout the operational lifetime of Mission 7107 and not as in the past when only at the beginning of the Mission is a thorough engineering evaluation performed. This endeavor has become increasingly necessary as the quality of the overseas data collection systems has improved rapidly to the point where the overall system accuracy is now far more dependent upon the time delays inherent in the spacecraft systems. These must be calibrated regularly in order to assure the highest accuracy and confidence potential for Mission 7107.

It is proposed that missile launch detection

5. ELINT Specification Proposed for Mission 7107:

NRL has provided in TABLE I, the proposed ELINT collection coverage for Mission 7107. This coverage is consistent with the guidance provided in reference (b) and (c) as well as retaining and enhancing the past POPPY concepts and the philosophies outlined earlier in this paper. The major change in ELINT collection capability proposed in this concept is an extension of the frequency coverage both upward to above 35 GHz and downward to 50 MHz; this is attained at no sacrifice in either (1) the Dual-Ball duplicate frequency coverage or (2) the continuity of coverage over the entire radar frequency spectrum.

This ELINT collection concept depends upon simultaneous intercept capability being possible in all portions of the radar spectrum; so that when a "new or unusual" signal is intercepted it may be evaluated not only by geographic location but its technical parameters may also be compared in real time coincidence with signals from major weapon systems emitters which are intercepted simultaneously. Thus the technical assessment of the unknown signal depends upon the ability to view it through a background of known signals so the assessment will disclose (1) new technological developments at the earliest possible time, and (2) the function, capabilities and limitations of these "new or unusual" signals as they are related to one of the major weapon systems.

At present it is considered imperative that the four spacecraft of Mission 7107 be parked in orbit close enough to each other to permit simultaneous comparative assessments on various signals over the entire radar frequency spectrum and not just that portion of the spectrum of coverage offered by one pair of 7107 spacecraft.

Note in TABLE I the parametric measurement options which are proposed; these can be altered rather easily now but final design is requested before 1 July 1969.

6. Spacecraft Design:

General - Mission 7107 will employ four spacecraft, all equipped with 3-axis gravity gradient stabilization systems and station keeping. This combination will enhance the [redacted] and permit the use of directional collection antennas. However the basic spacecraft for Mission 7107 will most likely not be the "multiface" design which was used on Mission 7105 and 7106. The main reason a change is probably required is because the "multiface" spacecraft does not provide sufficient electrical power, nor does it provide sufficient usable volume to house the electronics for Mission 7107.

Basic criteria for new spacecraft - The following items are the basic features which should be incorporated in the new spacecraft design: (1) Increased electrical power - be capable of generating 30 to 40 watts from nearly omni-directional solar flux without using articulated solar paddles. This is a factor of approximately 3 times as much power as "multiface" generates. This power will be required due to the increased tasking capability inherent in the stored command system, more electronics in the payload, greater use of regulators which decrease efficiency but increases the stability of the electrical systems. (2) Increased usable volume - this criteria, although certainly related to the above criteria, is essentially an independent requirement. To meet the requirement of "usable volume" the space must be accessible and thermally and mechanically stable. Such space is at a real premium in the "multiface" and 2 to 3 times as much of this type of space is required for Mission 7107. (3) Suitable antenna ground plane - due to the tremendous number of ELINT bands covered in one POPPY spacecraft antenna design is most difficult. A spacecraft of suitable size, shape and surface contours will greatly simplify and improve the antenna characteristics. (4) Compatible with launch vehicle - the launch vehicle for Mission 7107 will be the Thorad-Agena. Studies are being conducted to insure maximum compatibility with the Agena while, at the same time, other vehicles such as the Titan III-D are being examined.

MISSION 7107 ELINT COVERAGE PROPOSAL

	7107 ALPHA	7107 BRAVO	7107 CHARLIE	7107 DELTA
1	50 to 81 MHz	73 to 100 MHz		
2	155 - 165	155 - 165	100 - 125 MHz	100 - 125 MHz
3	165 - 200	165 - 200	200 - 350	200 - 350
4	**350 - 450	**350 - 450	450 - 550	450 - 550
5	810 - 930	810 - 930	550 - 860	550 - 860
6	1080 - 1210	1080 - 1210	860 - 1080	860 - 1080
7	1210 - 1400	1210 - 1400	1400 - 2070	1400 - 2070
8	*2580 - 2680	*2580 - 2680	*2070 - 2580	*2070 - 2580
9	*2680 - 2930	*2680 - 2930	3600 - 4000	3600 - 4000
10	*2930 - 3120	*2930 - 3120	6720 - 7900	6720 - 7900
11	*3120 - 3300	*3120 - 3300	9100 - 9340	9100 - 9340
12	3300 - 3600	3300 - 3600	9340 - 9400	9340 - 9400
13	3900 - 4850	3900 - 4850		
14	4850 - 5300	4850 - 5200	9400 - 9600	9400 - 9600
15	5200 - 5850	5200 - 5850	9600 - 10,500	9600 - 10,500
16	5850 - 6720	5850 - 6720	10.5 - 12.0 GHz	12.0 - 13.0 GHz
17	7900 - 8600	7900 - 8600	13.0 - 14.0	14.0 - 14.5
18	8600 - 9100	8600 - 9100	34.5 - 35.0	35.3 - 35.8
19	14.5 - 15.1 GHz	14.5 - 15.1 GHz		
20	34.9 - 35.3	15.0 - 18.0		

OPTIONS:

Pulse width - all bands up to 15 GHz in all spacecraft
Signal Amplitude - all bands up to 15 GHz in all spacecraft

[ ] option where desired.

TABLE I

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[redacted] has suggested that the Titan III-D might be used to replace the Agena on [redacted] Should this come to pass we would certainly want a spacecraft which could be adapted to the new vehicle. The Agena, however, has been a most satisfactory vehicle, and because of the profound effect a new vehicle could have on the entire POPPY mission and concept we feel a great deal more study of this question is required.

Spacecraft Design - while the spacecraft design is far from complete, several concepts all addressing themselves to the previously mentioned criteria, have been considered. The concept which seems to meet all the criteria best is one of four "drum shaped" payloads stacked one on top of the other. This arrangement has the following attributes: (1) efficient use of the volume in a vehicles nose fairing; (2) a relatively simple structure to fabricate; (3) structurely quite sturdy; (4) a great deal of "usable volume"; (5) good omni-directional solar collection; (6) both curved and flat surfaces to accommodate a variety of collection antenna designs.

Two of the areas requiring special attention are the adequacy of the combined structure to pass the launch vibration environment and the controlled separation of all payloads. While there may be several steps in the evolution on this basic structure concept it will most likely form the basis for Mission 7107.

7. Orbit Parameters:

The orbit parameters required for Mission 7107 are essentially the same as for Mission 7106. Specifically they are:

Altitude:	500 ± 25 n.m.
Inclination:	70 ± 1 degree prograde
Eccentricity:	less than 0.003
Trajectory:	Such that, in the event there is a failure of the second burn of the Agena that an orbit of approximately 500 n.m. apogee and 135 n.m. perigee results. While this would not permit gravity gradient stabilization it would at least provide reasonable orbit lifetime

Launch window: Will be based on minimizing ground station conflicts with other POPPY payloads already in orbit.

8. Summary:

The POPPY concept for Mission 7107 has been prepared by the NRL team, using the most recent guidance and requirements provided by references (b) and (c). NRL has solicited and received information in support of this concept from all elements of the POPPY community. Additional detailed design goals will need finalization after NRL has received authorization to proceed.

This concept has not sacrificed those proven attributes of the POPPY system such as (1) long-life; (2) wide frequency and geographic coverage; [redacted] (4) world wide capability; (5) high probability of signal intercept; (6) wide variety of parametric measurement options available; and (7) high confidence data with no artifacts.

In addition to these demonstrated areas of POPPY philosophy which will be retained there are other areas where improvement and innovation is being proposed: (1) Extension of the frequency coverage both upward and downward; (2) Intensified evaluation of the characteristics of the ELINT systems aboard the spacecraft throughout the mission will result in a reduction of instrumental error and thus an improvement in the location accuracy anticipated; (3) Use of stored command capability will result in improved versatility of tasking and control of the mission; (4) The new spacecraft structure will permit many technical improvements by increasing both the usable volume and the available electrical power; (5) The proposal of [redacted]

The major elements of the intelligence collection goals are in support of the (1) timely discovery and technical [redacted]

and CHICOM denied areas and in any other area of the world where crisis may develop. Significant opportunity exists in this concept to utilize this mission operationally [redacted]

NRL will continue to be responsive to the changes in the operational requirements; however, as the effort progresses these changes will be increasingly costly in schedule. Therefore it is essential that the best and most complete guidance be provided at the outset of this effort. Delay in finalization of this concept and authorization to proceed until after 1 July 1969 will result in the loss of at least 3 1/2 or possibly 4 months of prime long lead time for critical pace-setting procurements and development which cannot start again until after the conclusion of the launch and evaluation exercise for Mission 7106 anticipated about early October 1969.

The magnitude of effort required to implement this concept for Mission 7107 is greater in many areas than any previous POPPY effort thus far attempted. However the 24 month development cycle can be attained only if we are permitted to get a "running start" by having authorization to proceed before 1 July 1969.

[redacted]