CHAPTER V

OVERALL ASSESSMENT

The response to the Davis Committee in the form of a proposed modification to Vehicle No. 2733 was dominated by the short development span required by a 1 December 1967 launch. Urgency was stressed on the mission of searching for the [redacted] The proposed modification is responsive to this specific requirement. No attempt was made initially to evaluate the impact on such things as the general search requirement and the effect on funding of new systems which might be defined. In short, the proposal was specifically tailored to one set of conditions and limits vehicle capabilities to an [redacted] It is an example of sub-optimization. The mission as defined is enhanced as shown in Chapter IV but subsequent evaluations which considered all related factors raise serious doubt as to the desirability of the proposed modification.

Total impact on SIGINT missions in general and on the [redacted] specifically is as follows: 50X1

Favorable

(1) [redacted] The modified vehicle has a 95% probability of illumination in 25-32 days by a 1% on-time emitter compared to 50 days for the unmodified version. Either version has an expected life between three to six months.

(2) The proposal is responsive to the Davis Committee requirement for a late 1967 launch.

Unfavorable

(1) Overall mission capability is [redacted] search to one area.

(2) At the higher altitude the direction finding (D/F) capability of the Multigroup Digital Payload is essentially lost.

(3) The extensive modifications required on a crash basis introduces reliability uncertainties not applicable to the unmodified vehicle which will be the third in its series.

(4) The proposed modification delays launch of Vehicle 2733 by at least two months. Since the Multigroup vehicle has a good ABM/AES signal search capability the potential gain inherent in the proposed modification is offset by its later employment.

(5) The schedule has no allowance for contingencies and is sensitive to unforeseen developmental and test problems.

(6) The funding of this proposal (11.7 million dollars) can adversely affect development of new programs derived from current competitive studies.

More deta il on overall program impact is enhanced in the following chapter. To answer the question concerning "the advisability of proceeding with this proposal since to do so would probably withdraw funds from any program which might result from the current competitive studies" some overlap is necessary. Considering the 11.7 million dollar cost of the proposal along with schedule and reliability considerations, the proposal is not considered cost effective.

CHAPTER VI

IMPACT ON MULTIGROUP PROGRAM

In optimizing the 2733 Multigroup Vehicle for ABM/AES signal search, the ground rules on which this proposal is based essentially limit this vehicle to an [redacted] 50X1

The normal 2733 mission of [redacted] over the Sino-Soviet land mass is essentially eliminated in the elliptical orbit alternate mission for the following reasons:

(1) The proposed gimbal logic and command system for antenna aiming are extremely limited in their capability and allow the selection of only one point target between read-out station contacts.

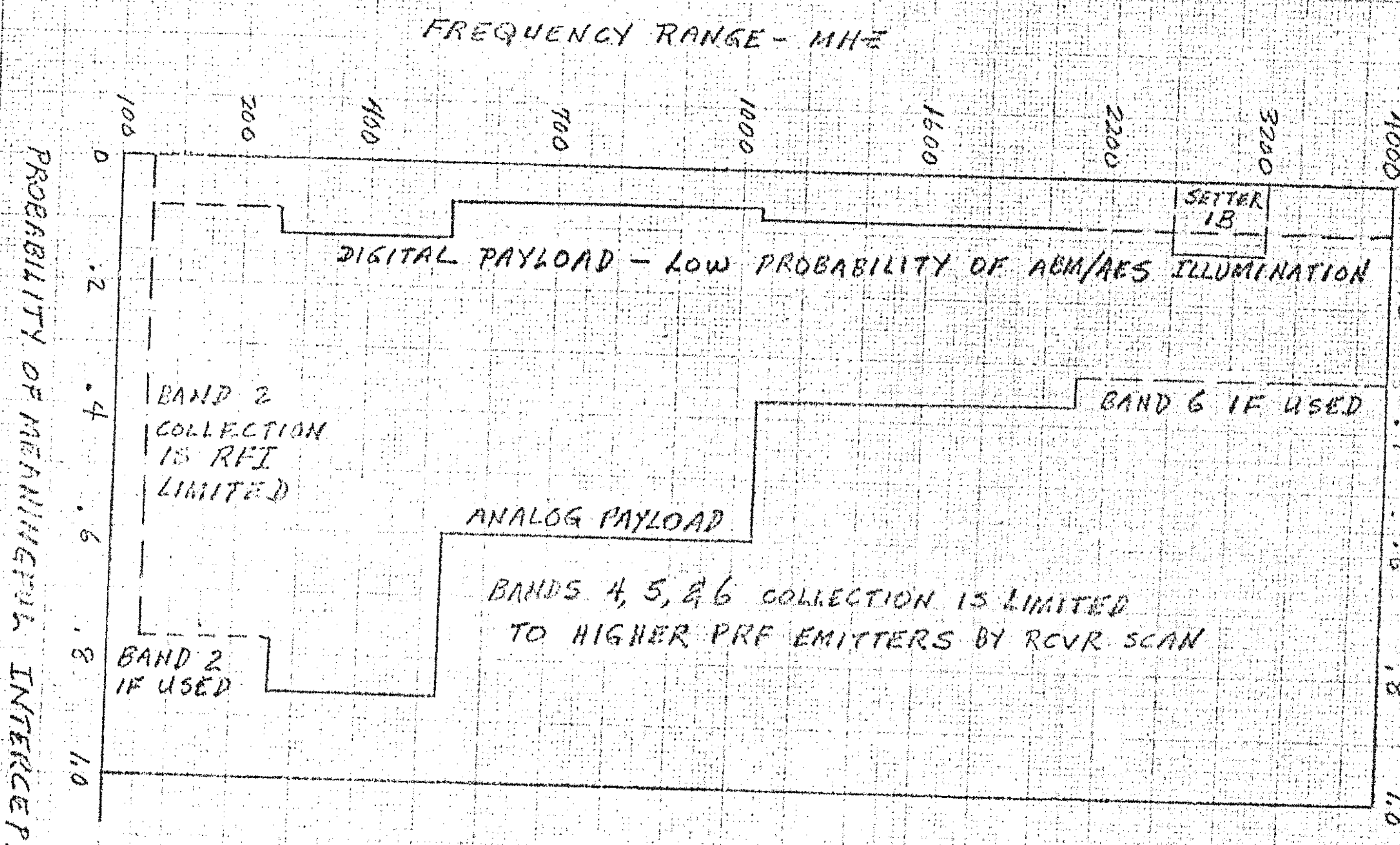
(2) Because of the increased slant range, the Agena gravity gradient oscillations induced by the elliptical orbit, and the off-nadir aiming to the point target, the geoposition capability of the digital ROB system will virtually cease to exist.

(3) Because of the footprint of the aimed antenna, near the horizon, will be fifty times larger than the normal 150 NM EOB collection circle, inter-leaving in the digital collection will greatly increase. The four-pulse Multigroup digital words will be unintelligible in a large number of cases (each of the four-pulses may be from a different emitter).

(4) Removal of the Setter 1B payload required by the proposed modification eliminates the excellent ROB data which has enhanced Strategiv Air Command ROB compilation.

With the exception of the ABM/AES P-11's, the Davis Committee evaluation showed that the Multigroup systems were the major contributors to the ABM/AES search mission. The 2733 intercept probability spectrum is shown in the following chart. The analog payload has a 97% probability of illumination over its first two months. Hence, the probability for the elliptical orbit is only 3% better than shown. The improved probability of either system with wide-pulse recognizers or a reduced scan rate in the PRF limited higher bands would swamp the other differences between them in terms of improving the probability of ABM/AES intercept.

50X1



2733 EFFECTIVENESS AGAINST 1% ON-TIME ABM/AES SIGNAL AS COMPUTED FOR DAVIS COMMITTEE

(5 PULSES ON EACH OF 3 FREQUENCY INTERCEPTS, SLOW SCAN)

16

CHAPTER VII

ESTIMATE OF COST

Latest estimate of cost was provided to WHIG in TWX CHARGE 6366 dated 23 March 1967. Following is a repeat of this information:

LMSC	Reconfiguration of 2733	$ 5.0M
	Integration of Rescheduled 2734	3.0
PAYLOAD	Changes on 2733	1.0
SOFTWARE	Changes for 2733	.5
AGENA	Hardware: No change	0
	Launch Services: Rescheduled 2733	.3
ATLAS	Hardware (Allocate from 206-1)	0
	Launch Services & Pad Mod	1.9
		$11.7M Total

The $11.7 million dollars assumes allocation of a 206-1 Atlas Booster and consists of $7.0 million in FY 67 and $4.7 million in FY 68.

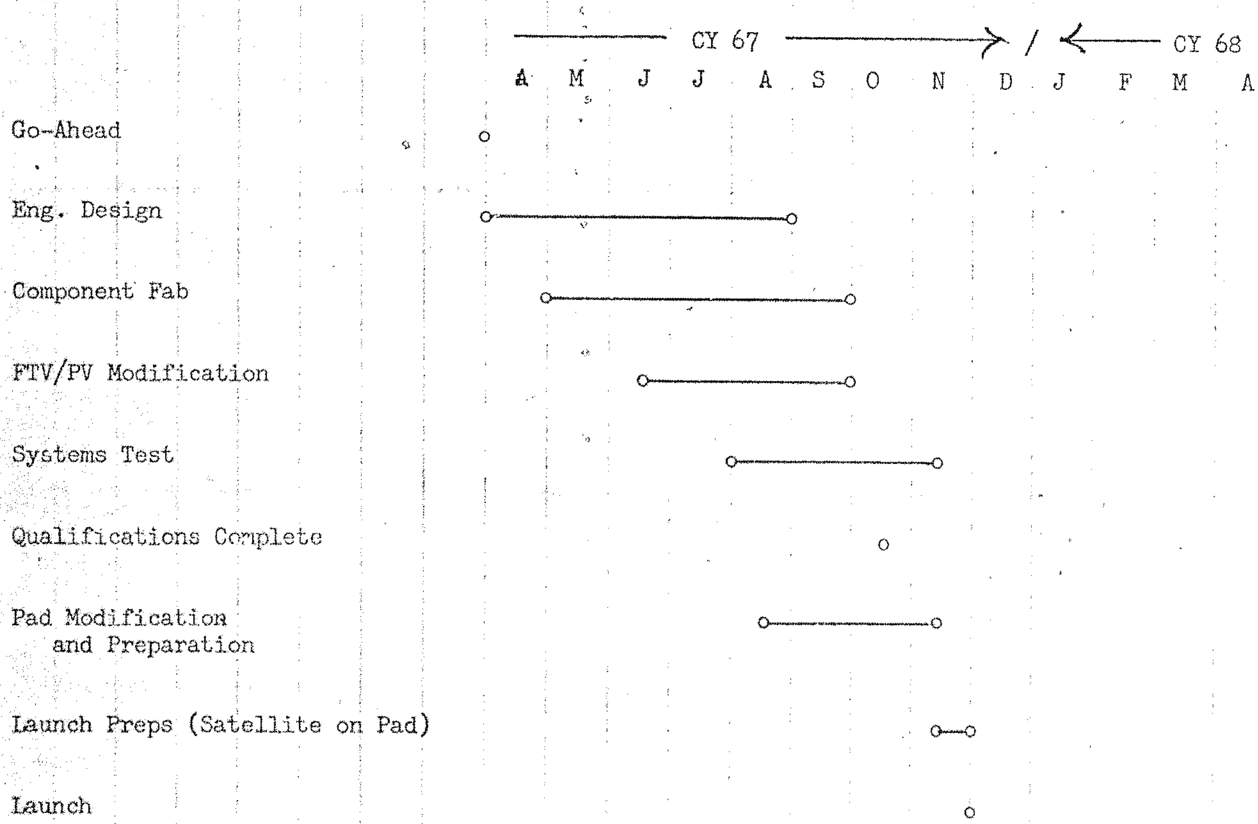
CHAPTER VIII

SCHEDULE

A schedule of activities necessary to support a launch date of 1 December 1967 is provided on the next page. This date is especially significant in the selection of a system approach which could meet the requirements as defined by the Davis Committee. Definition of changes required was begun in mid-February just seven months from the scheduled launch date of 2733. The new launch date allows an additional two and one-half months for development and qualification of the extensive modification necessary. Because of the short lead time, there is no allowance for contingencies. Anydevelopment or test problems will result in schedule slippage. The following developmental items are considered critical.

a. Antenna Drives and Control Electronics. The variable rates required during a single pass over a pre-determined geoposition will be approximated by a small group of vehicle-stored constant rates in pitch and a fixed offset (no rate) in roll.

b. Closed-loop CMG Torquer Control System. Program 770 vehicles, in a circular orbit, require a constant gimbal torque current; the elliptical orbit will require a variable current that will depend on horizon-sensor feedback. Present planning is to incorporate a back-up open loop mode (i.e., return to constant torque) that sacrifices pointing accuracy to achieve higher reliability.


CY 67
CY 68
A M J J A S O N D J F M A
Go-Ahead
Eng. Design
Component Fab
FTV/PV Modification
Systems Test
Qualifications Complete
Pad Modification and Preparation
Launch Preps (Satellite on Pad)
Launch

Modification to the 2733 vehicle consists of the following changes:

Removals

- Multigroup antenna deck
- Lo-band antenna
- Setter payload
- WECO/BTL radio guidance system

Equipments to be modified

- Multigroup payload
- Structure and antenna booms
- Stored and real time command systems; including Fairchild timer modification to increased period
- Ascent guidance system
- Telemetry system
- Solar array panel assemblys

New equipments to be added

- Recognizer capability on all bands
- Redundant analog recorder (DSU)
- Antennas (3)
- Antenna drive motors, steering electronics, and command system
- Closed-loop CMG torquer controls
- Additional pyro J-box and circuitry

A picture of the modified payload vehicle is provided on the next page.

Satellite Capabilities. The Atlas booster permits selection of an elliptical orbit, 835 x 2100 NM, with an inclination of 116.5°. The orbital period is 144 minutes. This orbit and the directivity of antennas will increase the look or available time on target to approximately five hours per day as compared to one hour for the low orbit. Payload life will be comparable to 2731 which has exceeded 90 days as of the date of this paper. Reliability is expected to be degraded somewhat because of the complexity of the change and the short development and test span. A more detailed description of the capabilities of the modified 2733 vehicle is contained in Chapter 4.

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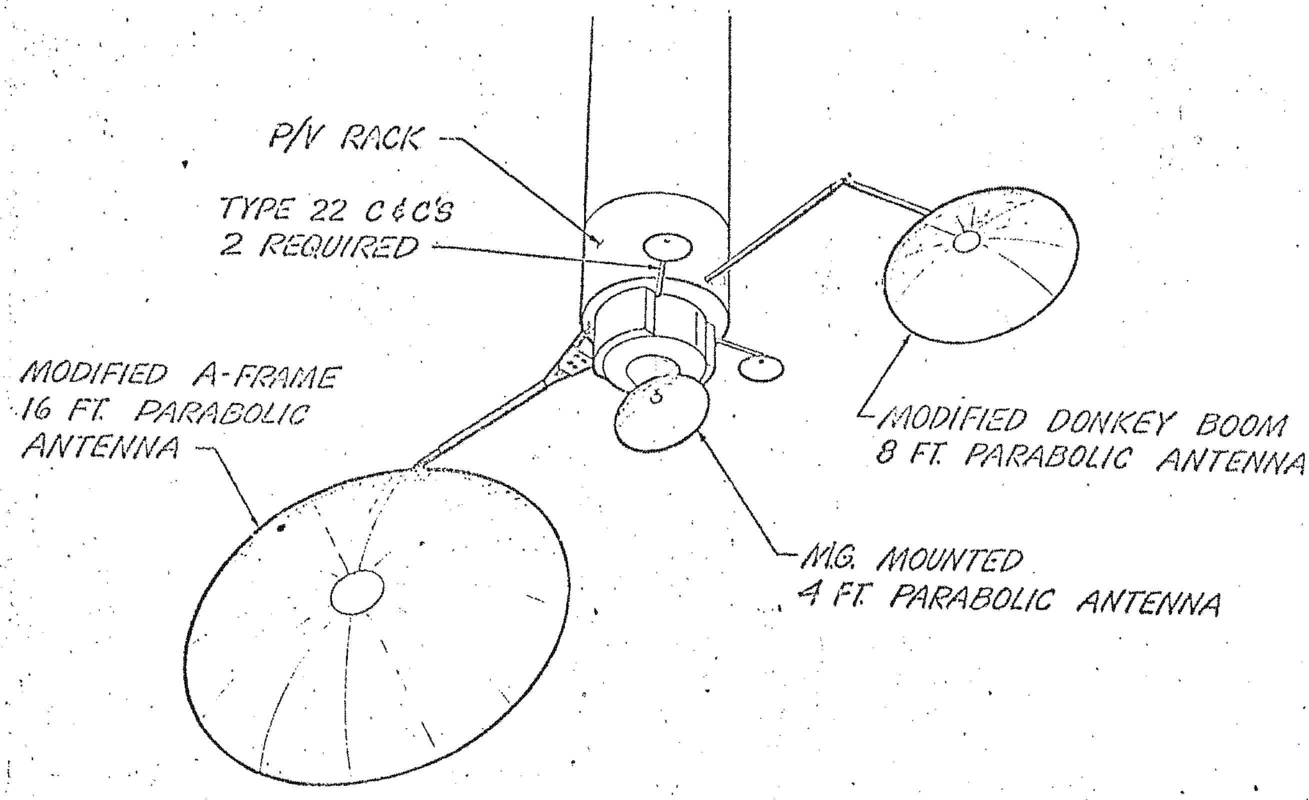
SECRET-SPECIAL HANDLING

PV 233 PROPOSED CONFIGURATION



50X1

AF 18(600)-2761
AA15335 CY1
3-9-67

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CHAPTER III

PROCESSIBILITY OF PAYLOAD DATA

The proposed mission would affect several aspects of data processing, both at the pre-processing stage by LMSC and processing by NSA.

Pre-Detection Analog Data

No essential change to methods of processing the data would be required. It is estimated that an additional 58 man-months of effort would be needed at LMSC to support 4 hours per day of read-out time. Additional costs for equipment, spares, and tapes to support the 4 hour per day read-out time would amount to 392 thousand dollars.

Digital Data

Modifications to LMSC computer programs would require about 12 man-months of effort. These programs would include provision of vehicle attitude, antenna pointing, and geopositioning data to NSA. It is assumed that major modifications to the ELKHART computer programs would be required. The positional errors of the data to be provided NSA will be based on circular error probabilities (CEP's) of about 200 to 250 miles. The high probability of having interleaved data also poses a serious problem in the ability to uniquely identify signals, at least until a learning process through analysis of the data is made. The digital data portion of the payload thus becomes of questionable value in view of positional errors and identifiability of targets.

CHAPTER IV

ADVANTAGES AND DISADVANTAGES

Increasing the probability of intercepting ABM/AES signals from [redacted] the sole criterion for this analysis of the proposed modifications to the 2733 Multigroup Vehicle. Advantages and disadvantages are based on a comparison of a normal 270 NM, 75° inclination orbit with an elliptical 835 x 2100 NM, 116.5° inclination orbit. For the purpose of this comparison, it is assumed that the intercept of at least five pulses on each of three frequency scans with $S/N \simeq 15$ db will result in signal identification. Since neither of these orbits provides continuous coverage of the target area, it is also assumed that the desired signal is on randomly for 1% of the time as a basis for computing the probability of active target contact. 50X1

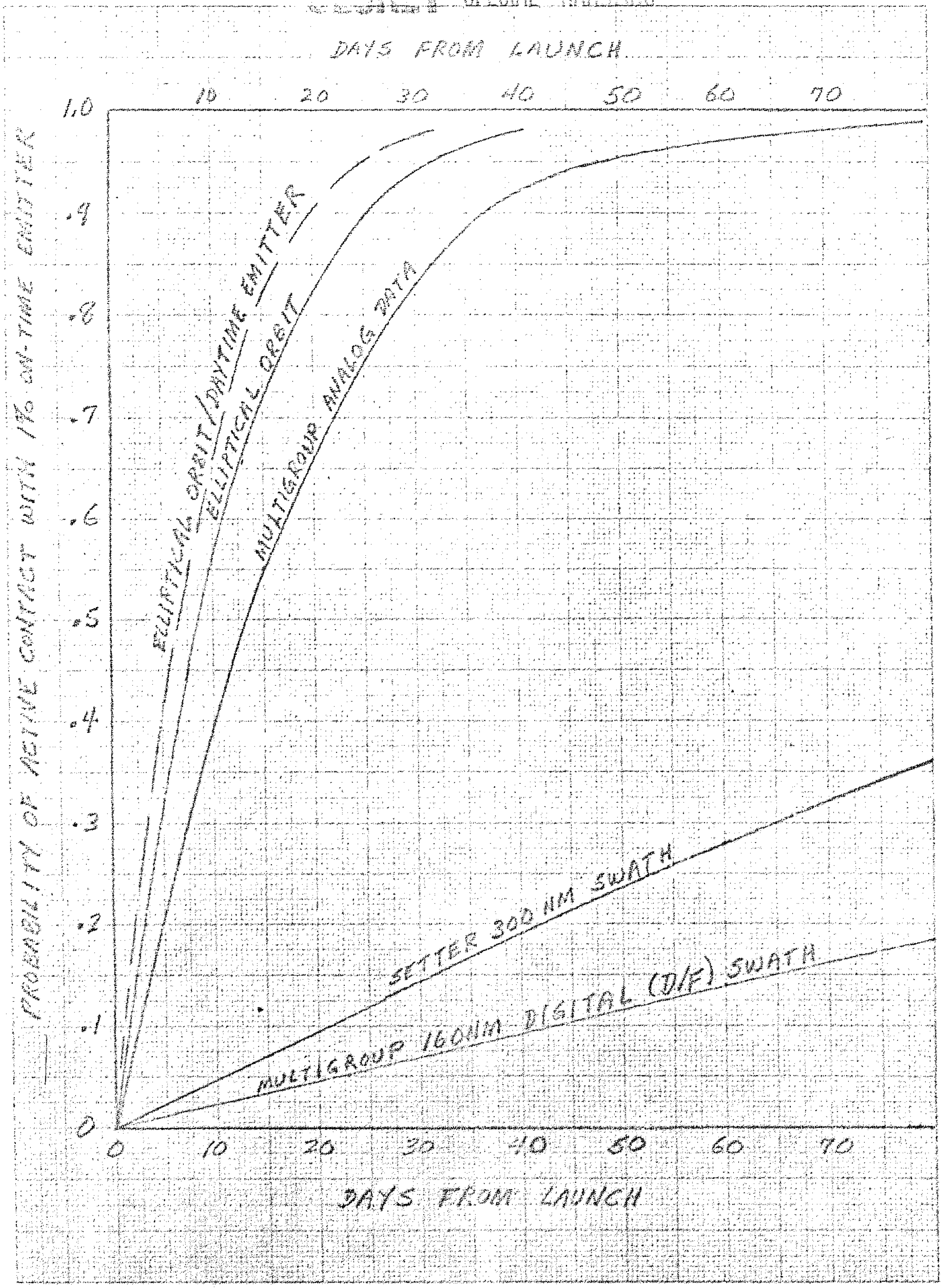
The horizon swath of the 270 NM orbit will contact the target location on six of its 15 revs each day for a total contact time of roughly 50 minutes per day. The equivalent number of independent looks per day to an emitter which is on for more than one horizon pass time but less than one 94 minute orbital period is

$$\text{Looks/Day} = 6\left[1+50/1440\right] = 6.2$$

The comparable figure for the elliptical orbit which makes contact on 8 of its 10 revs per day for a total contact time of 295 minutes per day is

$$\text{Looks/Day} = 8\left[1+\frac{295}{1440}\right] = 9.6$$

Using standard statistical techniques, we can relate the number of looks per day to a probability of illumination as a function of time. This function is shown in the following graph. Since the elliptical orbit is nearly sun synchronous, its coverage can be centered around daytime coverage; but, since it makes contact on eight out of its 10 revs each day, this is not a big advantage. The plot shows the probability gain due to this if we assume daytime emitter operation. It can be shown that, since the low altitude orbit will spread its samples throughout the day over each 30 day period (90° nodal rotation), it does not suffer a penalty (on average) due to the assumption of daytime operation.



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The curves show that the elliptical orbit has a 2:1 advantage over the normal Multigroup orbit against [redacted] but that either system has almost unity probability of intercepting the 1% on-time emitter during its nominal two months' life. As long as the emitter on-time is low, the probability of ABM/AES intercept in the low altitude digital payloads is low. However, these intercepts will produce a 10-100 NM emitter position estimate if they occur. The geoposition accuracy from the elliptical orbit is 200-2000 NM depending on the intercept, geometry and frequency.

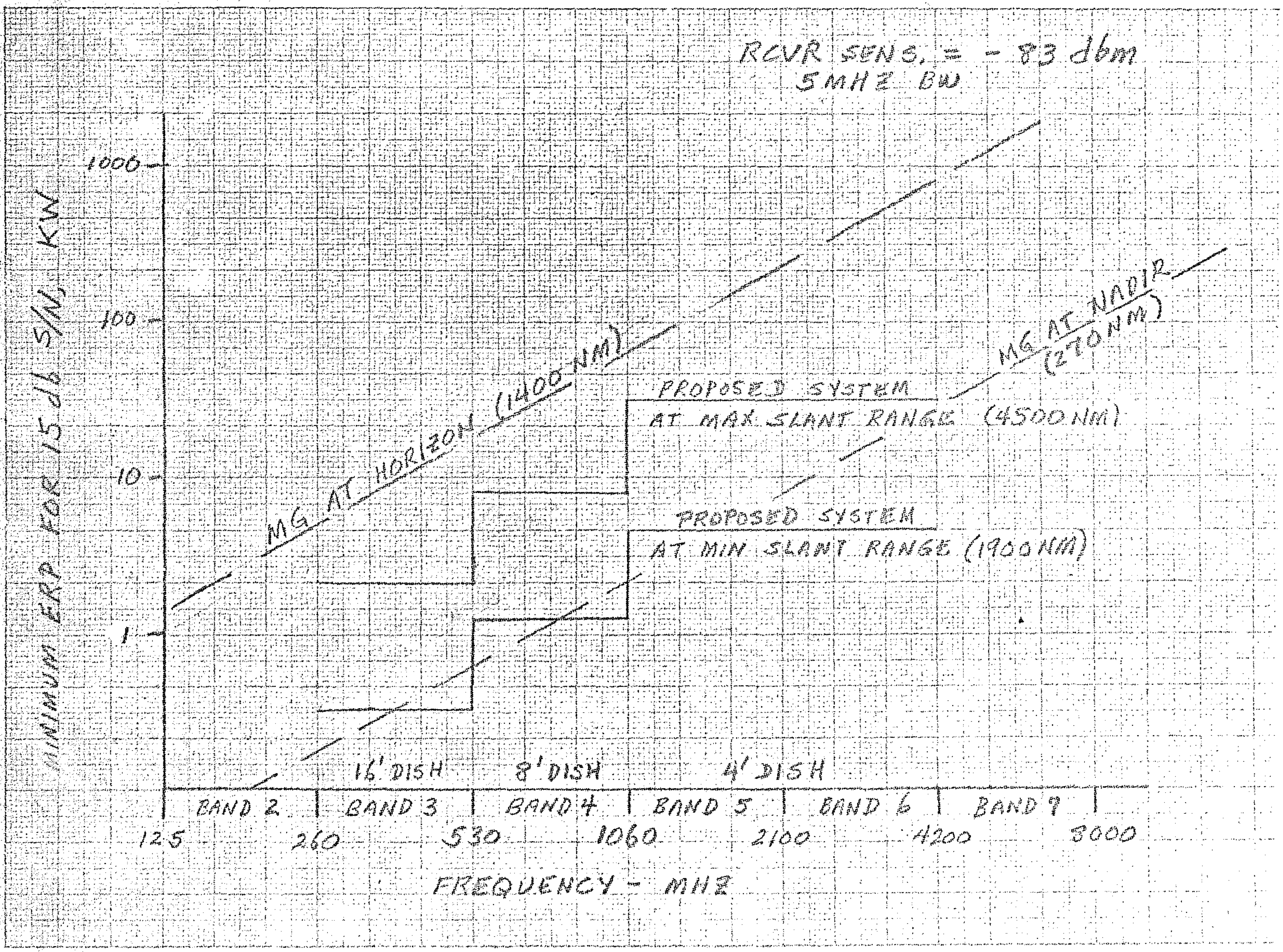
The circular and elliptical orbits are nearly equivalent in their ability to intercept the emitter frequency, PW and PRI. The elliptical has an advantage in analog data processing in that the amount of clutter on the tape will tend to be less. But the four-pulse digital words for the elliptical orbit will reflect inter-leaving and be uninterpretable much more often than for the circular orbit, vertical antenna orientation.

The only remaining evaluation parameter is the minimum power which the payload can intercept. This is compared in the following chart. It can be seen that the systems are very nearly equivalent in their ability to collect weak signals.

Thus, it appears that the only significant argument in favor of the elliptical orbit is its 2:1 advantage in probability of [redacted] 50X1
This must be traded off against the following considerations:

(1) Because of command limitations, the elliptical system can only be targeted at one area per orbit rev. Hence, if all other target areas have a combined probability of ABM/AES emissions equal to that of [redacted] taken alone, then the low altitude system (which covers these alternate sites) immediately regains the above illumination disadvantage.

(2) If the emitter is on for even 1% of the time, neither system is illumination limited. Hence, the above 2:1 advantage means that, although either system will intercept the signal, the elliptical orbit system will obtain twice as many intercepts in a given period of time.


RCVR SENS. = -83 dbm
5MHZ BW
MINIMUM ERP FOR 15 db S/N, KW
1000
100
10
1
MG AT HORIZON (1400 NM)
MG AT NADIR (270 NM)
PROPOSED SYSTEM
AT MAX SLANT RANGE (4500 NM)
PROPOSED SYSTEM
AT MIN SLANT RANGE (1900 NM)
16' DISH
8' DISH
4' DISH
BAND 2
BAND 3
BAND 4
BAND 5
BAND 6
BAND 7
125
260
530
1060
2100
4200
8000
FREQUENCY - MHZ

50X1

(3) The four-pulse digital (EOB) words will not be sufficient to identify the collection within the large footprint of the elliptical orbit in many cases. The low orbit EOB footprint is a 150 NM diameter circle about nadir. The elliptical orbit at apogee has a 600 x 2200 NM footprint at the horizon and represents a 50:1 increase over the low-orbit EOB footprint.

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BYE-66529-67

DEPARTMENT OF THE AIR FORCE
DIRECTORATE OF SPECIAL PROJECTS (OSAF)
AF UNIT POST OFFICE, LOS ANGELES, CALIFORNIA 90045

REPLY TO ATTN OF: SP-1

31 March 1967

SUBJECT: Modification to Multigroup Payload Vehicle Number 2733

TO: Dr. Flax, D/NRO

1. The attached report is provided in response to TWX WHIG 6280 dated 22 March 1967. This message requested a short paper to serve as a basis for DNRO review of a proposed modification to the third program 770 Multigroup Vehicle No. 2733 (Mission 7163) to increase the probability of intercepting the [redacted] radar [redacted] The proposed modification to this vehicle was generated by my staff in response to a 16 February 1967 request from the Davis Committee for definition of a crash ABM program which could support a launch date of 1 December 1967. The Chairman of the Committee, Mr. Harry Davis, was provided a brief system description on 17 February 1967 which was incorporated in the committee report.

2. The system description briefed to you by Col Bradburn on 20 March 1967 was based on a fixed set of ground rules, dominated by the 1 December 1967 launch date. The briefing was silent on the question of the impact of such a change on overall Program 770 mission requirements and did not include trade-off studies. The proposed modification limits the capabilities of Vehicle No. 2733 to an [redacted] 50X1

a. Advantages

(1) The probability of intercepting the ABM/AES signal [redacted] is increased because of the increased look times. The modified vehicle has a 95% probability of illumination in 25-32 days by a 1% on-time emitter compared to 50 days for the unmodified version (see chart, attached paper). Either version has an expected life between three to six months.

(2) The proposal is responsive to the Davis Committee requirement for a late 1967 launch.

b. Disadvantages

(1) Overall mission capability is reduced by elimination of the Setter IB Payload and restriction of the ABM/AES search to one area.

(2) At the higher altitude the direction finding (D/F) capability of the Multigroup Digital Payload is essentially lost.

(3) The extensive modifications required on a crash basis

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introduces reliability uncertainties not applicable to the unmodified vehicle which will be the third in its series.

(4) The proposed modification delays launch of Vehicle 2733 by at least two months. Since the Multigroup vehicle has a good ABM/AES signal search capability, the potential gain inherent in the proposed modification is offset by its later employment.

(5) The schedule has no allowance for contingencies and is sensitive to unforeseen developmental and test problems.

(6) The funding of this proposal (11.7 million dollars) can adversely affect development of new programs derived from current competitive studies.

3. I have concluded that the modification would not actually improve the probability of intercepting ABM signals, and would, instead, represent a loss of overall system capability and reliability. I recommend against further consideration of the proposal.

4. In the meantime I am continuing efforts to define changes to the Multigroup vehicle which are responsive to requirements described by the Davis Committee. Specifically, I have directed the incorporation on Vehicle No. 2732 a special signal detector (SSD) in band 4 which increased the flexibility demonstrated by the band 2 wide pulse recognizer (WPR) of Vehicle No. 2731. In Vehicle No. 2733 I fully expect that introduction of improved signal recognizers and probably a second wide band recorder will further enhance the ABM/AES search capabilities of this vehicle.

1 Atch
Paper on Modification
of Vehicle No. 2733

JOHN L. MARTIN, JR.
Brig Gen, USAF
Director

BYE-66524-67
Cy 1, Atch 1

~~SECRET SPECIAL HANDLING~~

COMMENTS ON PROPOSED MODIFICATION TO MULTIGROUP PAYLOAD VEHICLE NUMBER 2733

A REPORT
PRESENTED IN
RESPONSE TO TWX WHIG 6280
DATED 22 MARCH 1967

BY

COLONEL DAVID D. BRADBURN
MARCH 1967

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CHAPTER I

THE PROBLEM AND SPECIFIC TOPICS

Introduction. A plan to modify a Program 770 Multigroup Vehicle was formulated by the Advanced Development Staff, SAFSP in response to a request from the Davis Committee for definition of a program which would have the mission of ABM/AES signal search, used any available Spacecraft/Payload/Booster combination and would be launched by 1 December 1967. Such a plan was provided the Davis Committee on 17 February 1967 and briefed to the DNRO on 20 March 1967.

I. THE PROBLEM

Statement of the problem. Additional information is required by the DNRO to serve as a basis for a decision whether to pursue or terminate the proposal to modify Multigroup Vehicle No. 2733.

II. SPECIFIC TOPICS

DNRO Message. WHIG 6280 dated 22 March 1967 specified the following topics to be included in a short paper:

"1. Technical description of the modifications and of the resultant satellite capabilities.

2. An evaluation of the processability of the data to be obtained and or any new problems which they might present to NSA.

3. An analysis of the advantages and disadvantages of the proposal, 'What does it buy us?'

4. An assessment of the advisability of proceeding with this proposal since to do so would probably withdraw funds from any program which might result from the current competitive studies.

5. An evaluation of the impact to the overall program of withdrawing the multigroup vehicle from its original mission.

6. An estimate of cost refined and supported to the extent possible at this time.

7. A complete schedule with an evaluation of most likely causes of slippage."

III. ORGANIZATION OF THE REPORT

Each chapter covers the information requested by specific topics in the same order as supplied in WHIG 6280.

CHAPTER II

TECHNICAL DESCRIPTION

Primary mission of the modified 2733 vehicle is to search for [redacted] Increasing the probability of intercept requires increased look times. Detected signals will be recorded in a predetected video form on the wide band (DSU) recorder. A second recorder is added to extend predicted recorder life and to improve reliability. An Atlas booster is required to achieve the higher energy orbit associated with look time requirements. At the higher altitudes the present low gain Multigroup antennas do not have sufficient gain or directivity. New high gain, narrow beam antennas covering the frequency range 260 - 4200 MHz would be provided: 50X1

<u>Band 3</u>

It is planned to use a 16-foot unfurlable parabolic dish mounted on the existing low-band boom. LMSC will also design the feed for the dish which will operate in a sum and difference mode taking advantage of the two receiver channels that are available. The phase information which is obtained in the VIM detection system will not be calibrated prior to launch, but will provide some additional location information. This dish will cover a frequency range of 260 - 530 MHz to operate with the MG receiver. LMSC will also provide a multicoupler on the PL antenna deck to provide RF energy for the special purpose Wide Pulse Recognizer in the 153.6 - 162.5 MHz frequency range. This boom will again be deployed in the trailing axis flight.

<u>Band 4</u>

An eight-foot dish covering the 530 - 1060 MHz range will also operate in the sum and difference mode. This unfurlable dish will be stowed on the Granary boom and deployed on the leading vehicle axis.

<u>Bands 5, 6</u>

A four-foot dish will be stowed and deployed on the PL antenna deck and will cover the 1060 - 4200 MHz range. The dish will be fed to operate in the sum and difference mode. Coax switches will be provided to switch between bands 5 and 6.

Antennas (General)

The above antennas are steerable to limits of ± 35° in pitch and ± 15° in roll. This capability coupled with the steering modes planned by LMSC permits target tracking through about 50% of the total time the target is within line-of-sight. The steering will be accomplished via programming from the Fairchild timer. AIL will supply the coax switches, hybrids, couplers, and control box for all bands. These are already available except for band 6 hybrids which will be developed, qualified, and delivered to LMSC for test.

A compatibility test plan will be prepared by AIL describing the type and amount of testing to give a confidence level not only in compatibility, but in performance and coverage circle prediction on orbit. This will be a joint effort between LMSC and AIL.

The FTV 2733 payload will have the capabilities planned for 2733 except for location accuracy. The predicted half-power beamwidths for bands 3 through 5 range from 8° at the high end of each band to 17.5° at the low end. In band 6 the beamwidth ranges from 8° at the low end to 4° at the high end.

The payload will have a wide pulse recognizer for each band plus a separate WPR with its own front end to operate between 153.6 - 162.5 MHz. It will receive RF energy from the 16-foot dish and multicoupler.

The WPR built for 2731 can be used in any band. The PW threshold can be selected on the ground to match the environment of each band. The frequency threshold can be disabled if desired for given bands. In band 4 it may be desirable to set the range for 800 to 870 Mc. Based on EOB bands 3 and 4, PW threshold can be set for a 20 sec threshold. Band 5 should have a 10 sec threshold. Band 6 threshold should be 7 - 8 sec. To conserve tape the DSU should be programmed to record only WPR alarms for a fixed part of the mission. Upon alarm, the DSU will be commanded on for a present time of 100 seconds. Steady-state recording should be available for the remainder of the mission.