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AP-1023
Copy # 6
5 August 1964

THE J MISSION

METHODS OF SYSTEM APPLICATION AND POTENTIAL CAPABILITIES

PROGRAM 241

August 1964

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1.0 INTRODUCTION

This document is one of a sequel of documents to AP-1011, System Operational Capability, which was issued March 1964. This preceding document AP-1011 provided a summary of (1) the applicable physics of the sun/earth/satellite/camera system and, (2) the performance and programming capabilities for up to 30 day missions.

It is the intent of this document to describe the various ways that the J system can be used in achieving quantity and value of data, and to quantitatively compare the yield of the area search and reconnaissance information for each of these ways.

It is to be recognized that the J system can be utilized for purposes other than emphasized in this document, (e.g. storage in orbit until target requirements are assigned, a single quick-reaction response, etc.). There are also ways of planning missions in order to obtain data of maximum quality which are still to be described. Subsequent addenda are to be issued in the near future covering these information areas.

The quantitative evaluation presented herein makes use of a weather/target/operations model which produces an Index of Yield. This Index is a comparative measure of the efficiency of film usage. The higher the Index value, the higher is the yield of information per square foot of film operationally available on orbit.

A Phase I study that has preceded this documentation delved into the mission concept, the system problems, and the constraints in relation to maximizing the mission information yield potential. As a result of this Phase I study, means were determined for minimizing such problems and constraints. A general summary of these results are given herein, in Section 6.0, as the changes that would be required in the current system and procedures in order to use these various methods of system application.

In addition, this document presents, in Section 5.4.7, an example of how equivalent or greater information yield can be attained by trading off mission configuration for system procedures.

2.0 CAPABILITIES SOUGHT

Operational flexibility is the capability that is sought in order that the information yield of the J mission can be increased to the maximum practical value.

Yield of information is measureable by an index number that represents the total film square-footage which is cloud-free and is over ground areas of greatest information density and interest. Thus the system must be able to select only those operations which have acceptable predicted cloud cover over specific areas of maximum value.

The operational flexibility sought must therefore be able to provide:

1. Launch in coincidence with predicted weather spans.

2. Reaction on orbit to quickly and efficiently select payload operations in coincidence with favorable predicted local weather conditions.

3. Required orbit parameters at injection and maintainance of such parameters during the useful life on orbit so as to produce operations of the highest quality (See AP-1011).

4. A pattern of ground tracks, and maintain such a pattern during the useful life on orbit so that the greatest percentage of area of maximum value is repetitively covered during a mission.

5. Power conservation and synchronism of the stored programs with instantaneous spaceposition so as to allow extended useful orbit life for achieving coincidence of overfly over valuable area with an optimal weather condition.

3.0 CURRENT OPERATION CONCEPTS AVAILABLE

In the logical development of the area search and reconnaissance concept from the previous single capsule M system to the two capsule, single D/R cycle J system, the final development steps to realize full system potential are still to be accomplished. However, the current system configuration allows the following operation concepts:

3.1 The vehicle is active and stabilized from injection until first recovery initiation. The normal span of time is 4 days for approximately 40 payload mission-operations.

3.2 The vehicle can be maintained active and stabilized for a subsequent 4 days and 40 more payload mission-operations. The J mission is therefore accomplished in a continuous 8 day, 80 operation run ending with initiation of the second recovery.

3.3 The vehicle can be placed in a pitch-tumbling mode and deactivated immediately after initiation of the first recovery. Power consumption during the deactive phase is in the order of 130 watt hours per day. The number of deactivated days will depend on the next predicted favorable 4 day weather span. The maximum number of deactivated days possible is a performance function, see AP-1011, and the adequacy of the orbit parameters and the ground cover pattern.

3.4 Reactivation must be accomplished at the same station at which deactivation was preprogrammed and executed. (See Figures 1 & 2)

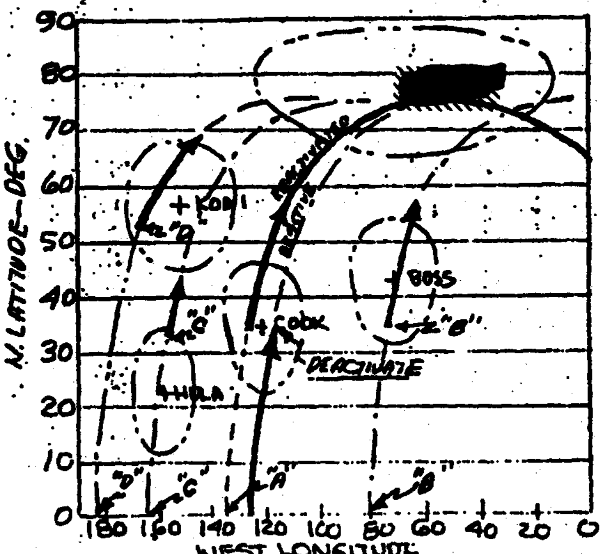
3.5 Payload operation programming is optimized to permit deactivation after completion of day 3.

3.6 For successive orbits not contacted by a ground station unique control is limited to 4 or less. These successive uncontacted orbits range from one for orbit plane inclination of 90° to five for 65° or 115°.

3.7 Prestored payload operations can not be changed, added to, or deleted except for system "off" or "intermix." Intermix is the unique control referred to in item 3.6 and is the current method for selecting which orbits will have payload operating, which one program will be executed, and whether the interval to the next command contact shall be stereo or mono. (See Figure 3).

FIGURE 1

D/R AT DIFFERENT STATIONS



"A" - AFTER A DEACTIVE PERIOD, REACTIVATE RESUMES THE PROGRAMMING LATITUDE CONTINUITY (D&R BOTH AT COOK). HOWEVER, SOME LONGITUDE DIFFERENCE OCCURS. THE A/P PROGRAMMING ARRAY PROVIDES SELECTIONS TO MATCH FIXED-CONTINUOUS PROGRAMS, SUCH AS STATION CONTACTS, DO NOT HAVE THIS FLEXIBILITY.

"B" - AFTER DEACTIVATION AT COOK, REACTIVATION CAN BE MADE AT BOSS AT THE PROPER LATITUDE, BUT THE LONGITUDE DIFFERENCE PUTS PROGRAMS ABOUT TWO ORBITS OUT OF PHASE.

"C" & "D" - REACTIVATION AT KODI OR HULA WOULD RESULT IN CONSIDERABLE MISMATCH OF PROGRAMMING IN BOTH LONGITUDE & LATITUDE.

CONSTRAINT

INABILITY TO SLEW THE PROGRAMMER TAPE ON ORBIT TO A SUBCYCLE THAT APPROXIMATELY MATCHES THE LONGITUDE TRAVERSE AT REACTIVATE PREVENTS USE OF MULTIPLE STATION COMMAND FOR D/R. (REACTIVATION MAY BE DEFERRED TO DAY OF BEST LONGITUDE MATCH)

FIGURE 2 - REACTIVATION - REACTION TIME

ORBIT SEQUENCE	i: 75° POTENTIAL CAMERA OPS	STATION COMMAND CONTACT & DIRECTION OF FLT	
X_9	[redacted]	COOK↑ [redacted]	REACTIVATE AT COOK. PROGRAMMER STARTS. S-BAND BEACON WARMUP. AT [redacted] - ADJUST & RESET TIME. RECONSTRUCT V/H RAMP
X_{10}		KODI↑ HULA↑ [redacted]	VEHICLE HAS RESTABILIZED. TOUCH UP THE PROGRAMMER AS REQUIRED. TARGET PROGRAMMING SET UP AS REQUIRED.
X_{11}		KODI↑ HULA↑ [redacted]	TOUCH UP, RESET, OR SELECT AS REQUIRED
X_{12}		[redacted]	
X_{13}		BOSS↓ [redacted]	[redacted]
X_{14}		BOSS↓	
X_{15}		—	
X_{16}		KODI↓ COOK↓	
X_1		KODI↓	
X_2		HULA↓	[redacted]
X_3		NO STATION COMMAND CONTACTS	
X_4			
X_5			
X_6			
X_7			
X_8			

CONSTRAINT
BUNDLE OF SEQUENTIALLY UNCONTACTED ORBITS

35°N ASC.
6 HRS. SPAN
20°N ASC.
13½ HRS SPAN
75°N DESC.

CONSTRAINT
[redacted]
PROGRAMMER MUST RESTART AT APPROX. THE SAME LATITUDE & LONGITUDE

CONSTRAINT
LONG REACTIVATED PERIOD UNTIL THE PAYLOAD OPERATIONS
[redacted]

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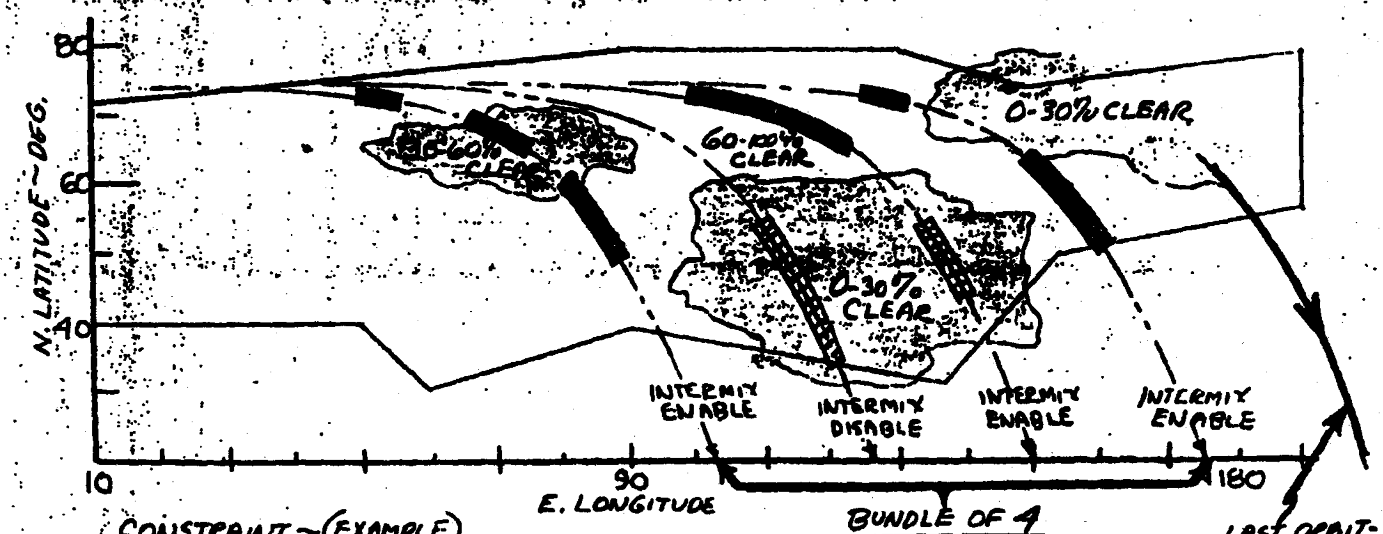
FIGURE 3 ~ INTERMIX SELECTION

THE CURRENT PATTERN OF STATION CONTACTS CAUSES A "BUNDLE" OF SEQUENTIALLY UNCONTACTED ORBITS WHOSE NUMBER VARIES WITH INCLINATION FOR CURRENT MISSION PERIODS.

FOR $i = 60°$	BUNDLE = 5 AVG.	[redacted]
$i = 70°$	BUNDLE = 4 AVG	
$i = 80°$	BUNDLE = 3 AVG	
$i = 90°$	AVG. ONE ORBIT	



LAST ORBIT-COMMAND CONTACT. INTERMIX SELECTED & THE PROGRAM & MODE

CONSTRAINT ~ (EXAMPLE)

SINGLE PROGRAM MUST BE USED FOR 4 ORBITS - OPTIMUM FOR DARK SWATHS SHOWN

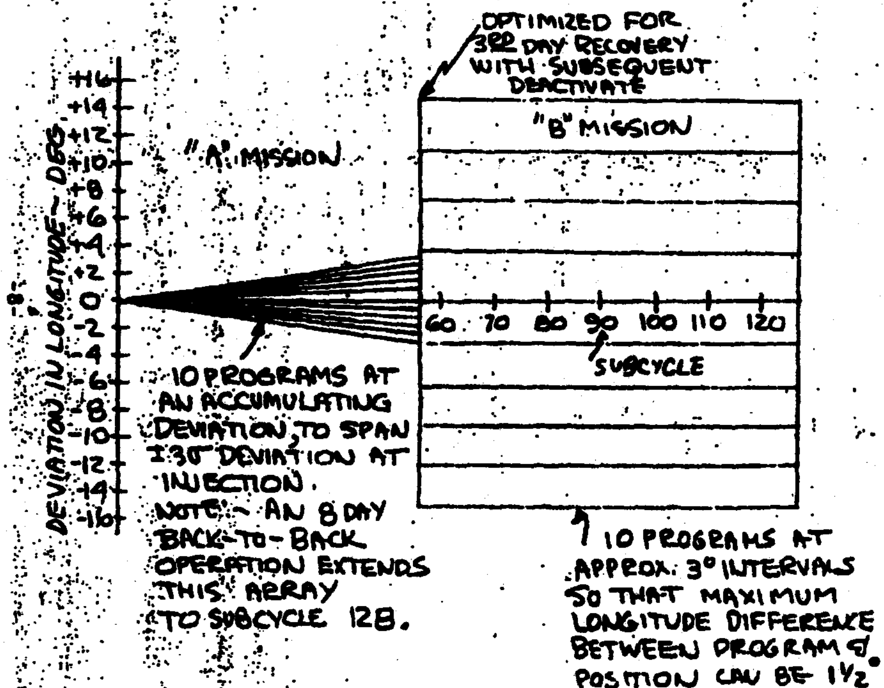
SINGLE MODE MUST BE USED FOR 4 ORBITS

AN OPERATION ON 2ND ORBIT IS MADE, THOUGH NOT DESIRED

3.8 **The programming of the first three days of operations is based on possible $\pm$ 30' period dispersions at injection. Ten stored programs are arrayed, including special programming for Vulnerability and Indicator targets (See Figure 4).**

3.9 **The subsequent programming uses 10 programs arrayed within $\pm$ 15° in longitude about the preprogrammed reactivation longitude. Program array is therefore used to provide longitudinal synchronization. (See Figure 4).**

FIGURE 4
PAYLOAD PROGRAM ARRAYS



1. TARGET PROGRAM DISTRIBUTION
   50-60% ARE ONE OPERATION/ORBIT
   30-40% ARE TWO OPERATIONS/ORBIT
   10-20% ARE THREE OPERATIONS/ORBIT

2. FOR THE "A" MISSION, THE TEN PROGRAMS PROVIDE FOR A SELECTION OF ANY COMBINATION OF THREE OPERATIONS

   CONSTRAINT

   1. REDUCTION OF AVAILABLE NUMBER OF PROGRAMS REDUCES COMBINATION CAPACITY
   2. EXPANSION OF AREA OF INTEREST WILL INCREASE NO. OF OPERATIONS/ORBIT & REDUCE SELECTIVITY FOR WEATHER MATCH

3. FOR A D/R MISSION THE "B" MISSION IS ARRAYED FOR APPROXIMATE LONGITUDE SYNCHRONIZATION

   CONSTRAINT

   USE OF PROGRAM ARRAY FOR LONGITUDINAL SYNCHRONIZATION REDUCES SELECTIVITY FOR WEATHER MATCH. FUTURE EFFICIENCY WILL BE REDUCED.

4.0 METHODS OF SYSTEM APPLICATION

4.1 Basic Requirements To Be Met

4.1.1 Cover

To be useful, a satellite must pass over an area of value. Orbital parameters must therefore be initially achieved, and subsequently controlled, to allow one or more passes over the maximum percentage of area of value within a minimum number of days.

4.1.2 Acquisition

Command and control capability must efficiently match the longitude and latitude spans of area-of-value on any orbit to the complete exclusion of any undesired operation. Each operation and the mode (stereo or mono) must therefore be individually selectable.

4.1.3 Observation

The vehicle must have payload operational capability with cover coincident with the most favorable local weather conditions over areas of value. Observation therefore requires an extended useful time on orbit and the necessary reaction time to operate.

4.2 Operations Strategies

There are four basic strategies that can be applied singly or in any combination and permutation, and the system must be capable of accomplishing any of the four in accord with what is the most practical for the conditions encountered. These are illustrated in Figure 5.

These four basic strategies are; (of which the first two are within the capabilities of the system as currently configured):

1. Eight days continuous operation (back to back)

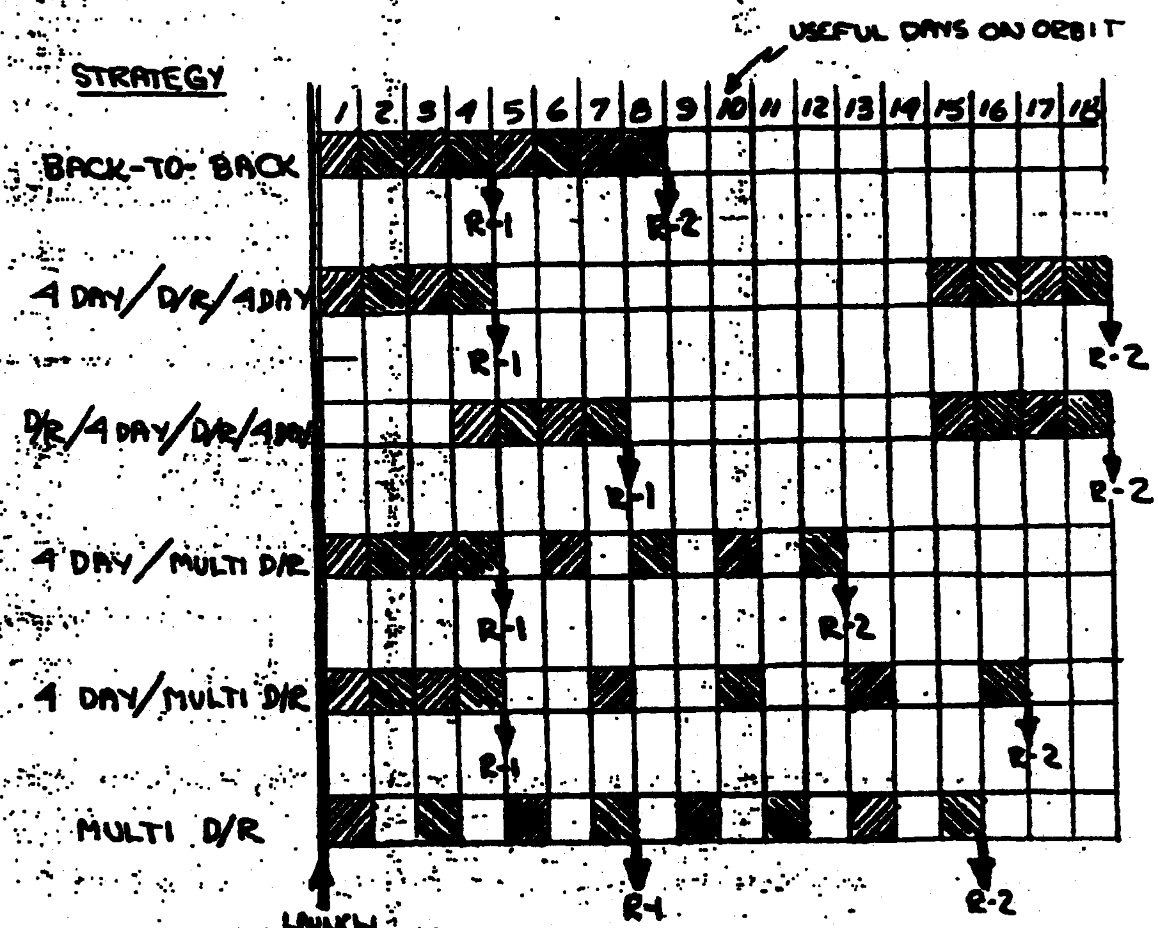
2. Single Cycle Deactivate/Reactivate

3. Two Cycle Deactivate/Reactivate (Deactivate after injection)

4. Multiple Cycle Deactivate/Reactivate

FIGURE 5

OPERATIONS STRATEGIES



NOTES:- 1. NUMBER OF USEFUL DAYS ON ORBIT & TIMES OF RECOVERIES R-1 AND R-2 ARE DESIGN POINTS, NOT EVALUATED MAXIMUMS OR MINIMUMS.

2. FOR MULTI D/R, AN ACTIVE DAY CAN BE A PARTIAL OF NOT LESS THAN 4 ORBITS FOR PAYLOAD OPERATIONS.

The conditions which govern the choice of strategy are time of year and weather conditions. Winter time eliminates the possibility of photographing the northern latitudes due to the lack of sun illumination. This reduces the number of payload operations available from which selections can be made to maximize information yield for a given square footage of film carried. [redacted] reducing the number of payload operations available from which such selection can be made. Summer time has neither limitation providing that orbits are properly tailored and controlled.

Weather conditions govern the strategy at any time between pre-launch to on-orbit. As will be shown, timely reaction can optimize the total yield of information, if the launch and a favorable weather span are coincident.

If a highly favorable span of 4 days is matched by the launch, a high yield will result for the first 40 operations. If the condition persists, a continuous 8 day operation would be carried out rather than gambling on a future condition that may not afford a much greater yield. If the condition does not persist, deactivation would follow first recovery with subsequent 40 operations in a continuous reactivated period or by multiple D/R. This subsequent mode would be determined by whether future predictions show a reasonable fixed pattern or a fluctuating pattern.

If launch can not be coincident with a favorable span of 4 days then the vehicle could be put into a deactivated mode with a 4 day operation for the first 40 operations at a favorable time, or all subsequent 80 operations can be accomplished by multiple D/R when persistence of a favorable pattern does not occur.

As will be shown by the weather model, the average percent clear sky over the entire gross area of interest does not vary much (7%) between all four seasons, but some climatic regions show considerable seasonal difference. Climatic regions whose areas are very dense with valuable information will therefore yield radically different quantities of information if the cloud cover varies considerably seasonally.

5.0 GAINS FROM SYSTEM APPLICATIONS

5.1 Index of Yield

An index of the yield of information was created in order to quantitatively establish the comparative gains from the methods of J system application. In principle it is a summation of numbers that are the product of the percent clear sky at the time of a payload operation and the information value of the area. These values of interest range from one to 22 and are primarily representative of the density of information within a given area.

It is recognized that a true interest value would fluctuate with current events, and a value of "one" on one mission can rise to a value of "1,000" on the next mission. However, the evaluation of system use is aimed at area search and reconnaissance, rather than tactical use. It is therefore representative of information density.

This Index of Yield reflects the fact that a substantially greater yield of information is obtainable from a high density area with a small percentage of clear sky than from a low density area with a large percentage clear sky. Repetitive photography over these high density areas is considered as desirable as long as the time interval between sequential covers is long enough to assure statistical independence of the local weather conditions across the swath width.

The index of yield is the sum total of the values for 40 operations selected during any 4 day period, 80 operations during an 8 day period, or 80 operations accomplished by multiple D/R during x useful days on orbit.

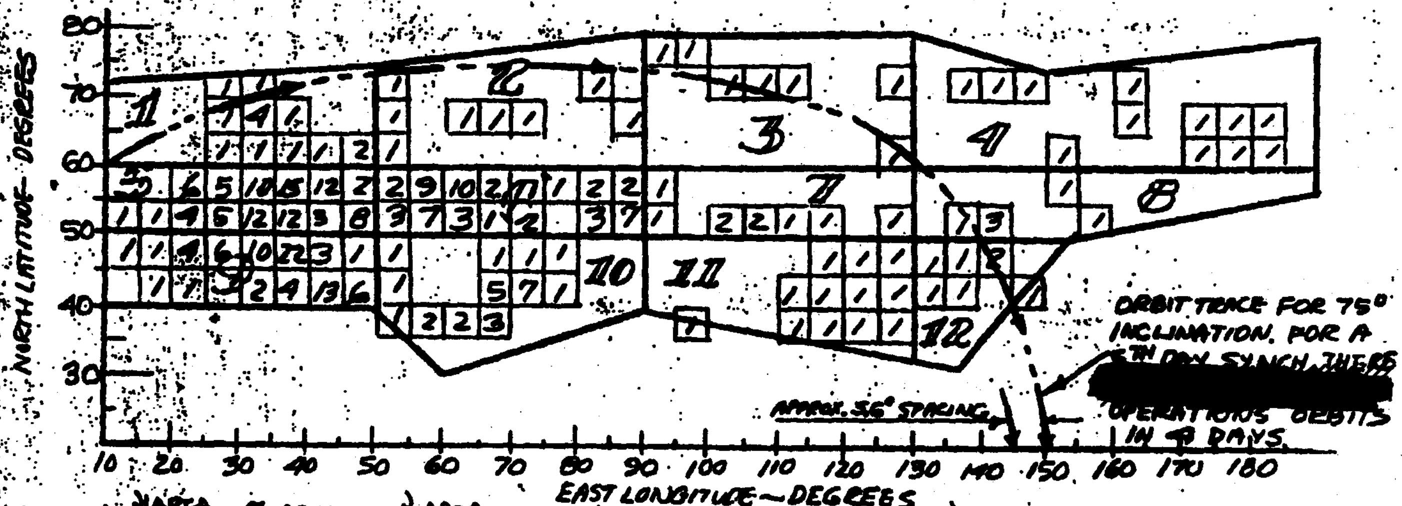
5.2 Weather/Target/Operations

A weather model has been derived at LMSC based on raw data supplied by the USAF Climatic Center of daily observations at noon for the period 1957 through 1960. As shown in Figure 6, the area of interest is devided into 12 climatic regions. These areas differ in the climatic conditions throughout the 4 seasons and in total area contained. However, the entire area in each region is not of interest on every mission. To reflect a weighting as to contained interest, specific 5° x 5° areas were given comparative information values reflecting density of information. As shown in the table of Figure 6, the result is that from 21% to 94% of the region areas are valued at "one" or more.

FIGURE 6

WEATHER/TARGET/OPERATIONS MODEL

1. A DEFINED AREA OF INTEREST IS DIVIDED INTO 12 SEPARATE CLIMATIC REGIONS.
2. WITHIN EACH CLIMATIC REGION ARE DEFINED 5°x5° SPECIFIC AREAS WEIGHTED AS TO CONTAINED INTEREST.



REGION	AREA IN REGION	% AREA OF INTEREST	REGION	AREA IN REGION	% AREA OF INTEREST	REGION	AREA IN REGION	% AREA OF INTEREST	REGION	AREA IN REGION	% AREA OF INTEREST
1	620,000	42%	2	740,000	29%	3	990,000	22%	4	1,150,000	30%
5	840,000	88%	6	859,000	94%	7	870,000	44%	8	920,000	19%
9	1,240,000	88%	10	1,820,000	46%	11	1,230,000	50%	12	[illegible]	[illegible]

An overlay of the orbit traces for a 75° inclination for 4 days at [redacted]

For each operating orbit there is a total of the information values (numbers in the 5° x 5° blocks that the orbit crosses) for each of the climatic regions.

For each season of the year there is a statistical probability of percent clear sky. As shown in Figure 7, three values of clear sky are given:

A = 0-30% clear sky (15% avg.)
B = 30-60% clear sky (45% avg.)
C = 60-100% clear sky (80% avg.)

Figure 7 tabulates the average number of days per month as the frequency of occurance. Making a random selection based on these statistics, a model was chosen for a 30 day period for summer, Figure 8, and winter, Figure 9. This model gave a percent clear sky value for each of 30 days for each climatic region. This percent clear sky value multiplied by the summation information value for each pass, gave an index of yield.

[redacted] represented the index of yield. For an 8 day period the highest values for 80 operations were selected. For multiple D/R, the highest 80 operations were selected out of the total for from 8 to 30 days.

5.3 <u>Test of Model</u>

The validity of the model was tested by comparing the simulated operations against 162 and 241 Program statistics:

5.3.1 <u>Operations per Orbit</u>

Statistics show that the distribution of operations were as follows:

50-60% were one operation per orbit
30-40% were two operations per orbit
10-20% were three operations per orbit

FIGURE 7

AVERAGE NUMBER OF DAYS PER MONTH WITH VARIOUS CLEAR SKIES — AT NOON.

CLIMATIC REGION	DEC/JAN/FEB			MAR/APR/MAY			JUN/JUL/AUG.			SEP/OCT/NOV		
	A	B	C	A	B	C	A	B	C	A	B	C
1	25.4	4.4	0.2	22.7	6.7	1.6	23.7	5.8	0.5	27.4	2.5	0.1
2	16.6	10.5	0.9	18.2	10.2	2.6	21.9	7.6	1.5	26.7	3.3	0.3
3	9.4	14.5	5.1	13.8	12.7	4.5	21.5	7.3	2.2	21.6	7.4	1.0
4	11.5	14.9	3.6	15.9	12.8	2.3	24.9	5.9	0.2	22.3	7.6	0.1
5	28.1	1.8	0.1	21.9	7.8	1.3	25.8	4.7	0.5	26.1	3.7	0.2
6	20.0	8.8	1.2	19.8	9.2	2.0	21.8	8.1	1.1	22.9	5.9	1.2
7	11.7	14.8	3.5	19.3	10.5	1.2	21.4	9.1	0.5	20.8	8.8	0.4
8	16.0	11.9	2.1	21.0	8.7	1.3	26.1	4.7	0.2	20.4	9.3	0.3
9	24.2	5.8	0.0	22.5	7.8	0.7	8.2	17.2	5.6	14.6	13.7	1.7
10	10.3	15.0	4.7	14.4	12.4	4.2	1.1	12.3	17.6	2.0	11.1	16.9
11	2.3	9.2	18.5	11.0	13.7	6.3	10.6	17.1	3.3	0.6	14.1	15.3
12	11.6	14.1	4.3	19.8	8.8	2.4	25.4	5.4	0.2	11.2	14.0	4.8

LEGEND:
A = 0-30% CLEAR
B = 30-60% CLEAR
C = 60-100% CLEAR

NOTE:-
FOR DEC/JAN/FEB, THE CLIMATIC REGIONS 1,2,3 & 4 HAVE NO ILLUMINATION & FOR REGIONS 5,6,7, & 8, ONLY THE LATITUDE SPAN OF 50° TO 55°N IS CONSIDERED IN WEATHER EVALUATION.

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FIGURE 8

PERCENT CLOUD CLEAR - SUMMER (JUN/JUL/AUG)

DAY OF MONTH SPAN

CLIMATIC REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	B	C	B	A	A	B	A	A	A	A	A	A	A	A	A	B	A	A	A	A	A	A	B	A	B	A	A	A	A	A
2	A	A	B	B	A	A	B	A	A	C	A	A	A	A	A	A	A	A	A	B	B	A	A	B	B	C	A	A	A	A
3	C	A	B	A	C	A	A	B	B	A	A	A	A	B	A	A	A	A	A	B	B	A	A	A	A	A	A	B	A	A
4	A	A	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A	A	A	A	B	A	A	A	A	A	A	B	A
5	A	A	A	A	B	B	B	A	A	A	A	A	A	A	B	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
6	A	A	A	B	A	A	A	B	A	B	A	A	A	B	A	A	A	A	A	B	A	B	A	A	A	A	A	C	B	B
7	A	B	A	A	A	B	B	B	A	A	A	A	A	C	B	A	A	A	B	A	A	B	A	B	A	A	A	A	B	A
8	A	A	A	A	A	A	A	A	A	B	A	A	A	A	A	A	A	B	A	B	A	A	A	A	B	A	A	B	A	A
9	C	A	B	B	A	C	B	B	C	A	A	B	B	B	A	C	B	A	B	B	B	C	B	B	B	C	B	B	A	B
10	C	B	B	C	B	A	C	C	B	B	B	B	C	B	C	C	B	B	C	C	C	C	C	C	C	C	B	B	C	C
11	A	A	B	B	A	B	A	B	A	B	B	B	B	C	B	A	B	C	B	C	B	A	B	C	B	A	B	A	A	B
12	A	A	A	A	B	A	A	B	A	B	A	A	A	A	A	B	A	A	A	A	A	A	B	A	A	A	A	A	A	A

LEGEND:

A = 0.15 CLOUD-CLEAR AVG

B = 0.45 CLOUD-CLEAR AVG.

C = 0.80 CLOUD-CLEAR AVG.

FIGURE 9

PERCENT CLOUD CLEAR-WINTER (DEC/JAN/FEB)

CLIMATIC REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
5	A	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
6	A	A	A	B	B	A	A	A	A	A	B	A	B	A	A	A	A	A	A	A	A	B	A	B	A	B	A	A	B	A
7	B	B	B	A	A	A	B	B	A	C	A	A	A	A	B	A	B	A	A	A	B	B	A	C	B	A	B	A	B	B
8	A	A	B	A	A	C	A	B	B	B	B	B	B	A	B	A	A	B	A	B	A	A	A	A	B	A	A	A	A	B
9	A	A	A	A	A	A	A	A	A	A	A	B	A	A	A	B	B	B	A	A	A	A	B	A	A	B	A	A	A	A
10	B	A	B	B	B	B	B	C	B	C	C	B	B	A	B	C	B	C	A	B	B	A	B	C	B	B	B	C	B	A
11	C	B	B	B	B	C	C	B	C	C	A	B	C	A	C	B	B	B	C	C	B	C	C	C	C	C	C	B	C	B
12	B	C	A	A	B	A	A	B	B	A	A	A	A	A	B	B	B	A	A	B	A	B	C	A	B	B	B	B	B	B

DAY OF A MONTH SPAN

LEGEND:
A = 0.15 CLOUD-CLEAR AVG.
B = 0.45 CLOUD-CLEAR AVG.
C = 0.80 CLOUD-CLEAR AVG.

Simulated operations, using the model, show:

	Spring	Summer
one operation	61%	52%
two operations	36%	36%
three operations	3%	12%

5.3.2 <u>Operations per Day</u>

Choosing the highest index of information yield over a 30 day span resulted in 8 to 13 operations per day with an average of 10 per day.

5.3.3 <u>Average Cloud Clear Percentage</u>

The randomly chosen 30 day model (Figure 8) shows an average of 30% cloud clear over the entire 12 climatic regions as against the statistical average of 34.3% for summer, over a 30 day period.

5.4 <u>Comparison of Information Yield</u>

Using the Index of Yield, a comparison has been made of the information yield for the various strategies, between summer and winter operations, and between a descending node only operation and an ascending and descending one.

Fundamental to the comparison is the determination of the day-to-day variance. This is illustrated by Figure 10 for summer. The descending node only shows a persistence of the 4th day of [redacted] day cycle over a 30 day period.

The difference in the daily yield between summer and winter is illustrated by Figure 11. Of particular interest, beside the greater yield in summer, is the random variance of the yields of each of the 4 days of the 4 day cycle over a 30 day period in winter reflecting to some extent the decrease in valuable areas available for observation due to lack of illumination.

The 4 day active period is the basic, or standard, strategy and its yield is the sum of 40 operations with more or less than 10 performed each day selected as to the highest predicted yield. This 4 day, 40 operations represents the first capsule capacity, and two such periods make up the 8 day back-to-back, or the single cycle D/R.

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5.4.3 Strategy - 4 Day Continuous

[redacted]

The significance here is that of coincidence of 4 days operations with a favorable weather phase. The comparison here is one of comparing Indices for different days of launch during a 30 day period. Proper coincidence to match prediction can provide a high gain. Coincidence is attainable with a timely launch, or by deactivating after launch to defer the start of the 4 day interval.

In winter the sensitivity to launch timing is not as great as in summer for nominal weather conditions.

5.4.4 Strategy - 8 Day Continuous

Persistence of a favorable weather phase would demand the continuance of active operations. The prediction would be for better than nominal conditions persisting over areas of high value so that the deferrment of the second 4 day operation would not yield enough more gain to warrant the risk.

Since selections of the 80 operations are made over twice the the time interval that 40 operations are selected, weather conditions will be averaging out and variations in the value of the Index will not be as great percentage-wise. Figure 12 [redacted]

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DENIED IN
FULL

[redacted]

5.4.5 Strategy - Single Cycle D/R

The fundamental here is the attainment of a high value for the first 40 operations by launch timing (favorable weather forecast) otherwise the total Index for 80 operations is initially and irretrieveably biased downward. As plotted [redacted] day total was initially used. Each 4 day Index total, starting with an 8 day back-to-back, was added as a function of time of deactivation (zero to 22 days). Winter again shows considerably less sensitivity to day of launch than summer since there is so little selectivity for the 80 operations.

Two significant things can be seen. First, a winter operation yields, on the average, the same for an 8 day continuous as it does for a single cycle D/R. In summer, the single cycle D/R can yield significantly more as a strategy used when the favorable first 4 day phase does not persist to allow a continuous 8 day operation. This yield increases when [redacted] "eye-ball" evaluation of values attainable over a 30 day span indicates that, on the average, satisfactory yields are attainable for the 80 operations within about a 15 day span of useful life on orbit for nominal conditions for this one strategy.

5.4.6 Strategy - Multiple D/R

The ultimate gains achieveable are through the strategy of multiple deactivation and reactivation and target selectivity (Section 6.0). In this strategy the vehicle, to conserve power and extend its useful time on orbit, is activated only for intervals when cover of a valuable area and a favorable local weather condition coincide. This interval would be for not less than 4 total orbits.

In Figures 12, 13, 17 and 18, the step function for the multiple D/R Index is the calculated numerical maximum possible by selecting the highest 80 values out of the total available in x days. Near-linearity of increase is the characteristic of this maximum possible. However, the practical achieveable, or most probable, is non-linear and is estimated to be as shown. Human decision and forecasting confidence limits the probability of correct decision for maximizing the yield of information to the 50 to 60% point in 30 days. However, good decision-making is possible for the first 12 to 15 days. Inspection of the numerical values and their selective rejection led to this evaluation and the construction of the "most probable" value curve.

On the average it appears that significant yield are attainable up to about 20 useful days on orbit beyond which additional significant gains represent a lower confidence and a greater risk. This, at best, is an estimate.

5.4.7 Trade Off - Example Of

It is obvious that the yield of information is optimized by both selection of the best strategy and by tailoring the orbit during the seasons when such tailoring is possible. However, all the characteristics of such an optimization may not be attractive. Of interest, therefore, is the possibility of achieving a lower than maximum value of yield in trade for a specific consideration.

The greatest interest is in reliability. The intent here would therefore be to trade some of the yield for a greater confidence in mission success. The desire would be to cut the number of days on orbit to a minimum and to apply the least complex operational procedures.

[redacted]

1. [redacted]

2. An 8 day back-to-back operation is made, coinciding launch with a favorable 8-day weather phase.

3. An efficient operations select system is used.

4. A single cycle D/R capability, a programmer slew controller, and 2 retro rockets for orbit control are available, to be used if required.

This 8 day back-to-back operation described has the following potentials:

1. [redacted]

2. [redacted]

3. [redacted]

The simpler 8 day back-to-back strategy gives up in trade the following yields:

1. [redacted]

2. [redacted]

The trade values determined herein are based on a system capable of efficient operations selection.

6.0 MEANS FOR REALIZING MISSION YIELD POTENTIAL

The means under discussion in this document relate to minimal changes to current hardwares and procedures only. The determination of these means was arrived at through detailed studies now documented in an 8-1/2 x 11 briefing aid "Current Command System Improvement". June 1964 (Special Handling). This briefing aid was derived after a thorough Phase I operations research and system analysis aimed at establishing the mission concepts. the current system capabilities. problems and constraints. the definition of system and mission potentials. and the approaches to problem solutions.

6.1 Operations Selectivity System

This is. in principle. a means to in-flight store. by RTC. the selection of payload operations by deleting prestored operations for which undesirable weather predictions are made or. to eliminate redundant operations for a verified good weather condition on a previous operation over the same area.

The selection storage capacity should be for 6 operations for 5 consecutive orbits (bundle of consecutive uncontacted orbits at $i = 60^\circ$). The selection system should be flexible to allow a greater number of operations for a smaller number of consecutive orbits (up to the 30 total for one orbit) so that. for tactical use. a single stored program can be run in long continuity or in small select segments; or. current long continuous payload operations can be segmented if desired. The system is to be fail-safe in that failure or shut off of the select system results in execution of all the stored operations.

This system. changing the current payload logic. can first of all gain 6 to 13% in efficiency of film use by preventing unnecessary operations. Additional information yields have already been presented. This select system is fundamental to attaining such yields.

6.2 Payload Operations Programming

A single and considerably universal payload program can be prestored on the programmer tape from which the recommended select system can make its in-flight selections. Three more programs would be added to take care, individually. of Indicator. Vulnerability. and Tactical area targets. The four programs would replace the current ten programs. This philosophy of programming and selection should reduce the programming sensitivity to launch delays.

6.3 Programmer Slew Control

To achieve the information yields which the system is capable of providing, it is necessary to add a control to use the current programmer capability to slew the programmer tape at 20 times normal speed. This slew will allow the synchronization of the stored payload programs (and station contact operations and other payloads) with the longitude, and latitude, where large deviations result from injection deviations, orbit decay, multiple station D/R command and multiple D/R operations.

Adding this control eliminates the need for building the means of longitudinal synchronization into the payload program arrays (See Figure 4).

6.4 Orbit Control

For extended periods on orbit (up to 30 days), a means of orbit control is needed to maintain the ground tracks within a reasonable pattern envelope so that cover occurs over the greatest percentage of the areas of greatest value. Considering that the 5th day synchronous pattern is the most applicable, means such as simple rocket firings by RTC command, based on operational ephemeris determinations, will maintain synchronism within a desired envelope.

6.5 Launch Reaction

The analyses have indicated that considerable change in yield can occur during a 24 hour interval. The ability to launch and deactivate until an oncoming acceptable weather phase occurs is a gain, but it can not retrieve a good phase that occurred in the past.

6.6 Multiple Station D/R Command

This capability requires the use of the control for the slew of the programmer tape. Multiple station D/R takes constraints off of D/R operations and the reaction time from a deactivated to an activated mode (3 hours) except through the bundle of uncontacted orbits due to the station locations.

6.7 Multiple D/R

The first development of multiple D/R should be a two-cycle D/R capability in order to allow the start of any operations to be deferred until any number of days after injection into orbit. The use of the control of programmer tape slew is very desirable.

The second development would be for an ability to call up the vehicle to an active status for periods as short as 4 orbits. Since the current deactivated mode is one of pitch-tumbling, a means of maintaining attitude control continuously for upto 30 days is needed.

6.8 Attitude Control

One of the principal uses of attitude control during the entire useful time on orbit would be for minimizing the drag decay of the orbit. In a pitch-tumbling mode the orbit deteriorates at a rate three times that of a stable vehicle. The resulting changes in synchronism detrimental to information yield would occur in fewer days resulting in shorter useful times on orbit and would require orbit control. For the long useful times on orbit, greater expenditures of energy would be required for orbit control.

Operations are considerably simplified if attitude control is maintained when several D/R cycles are used.