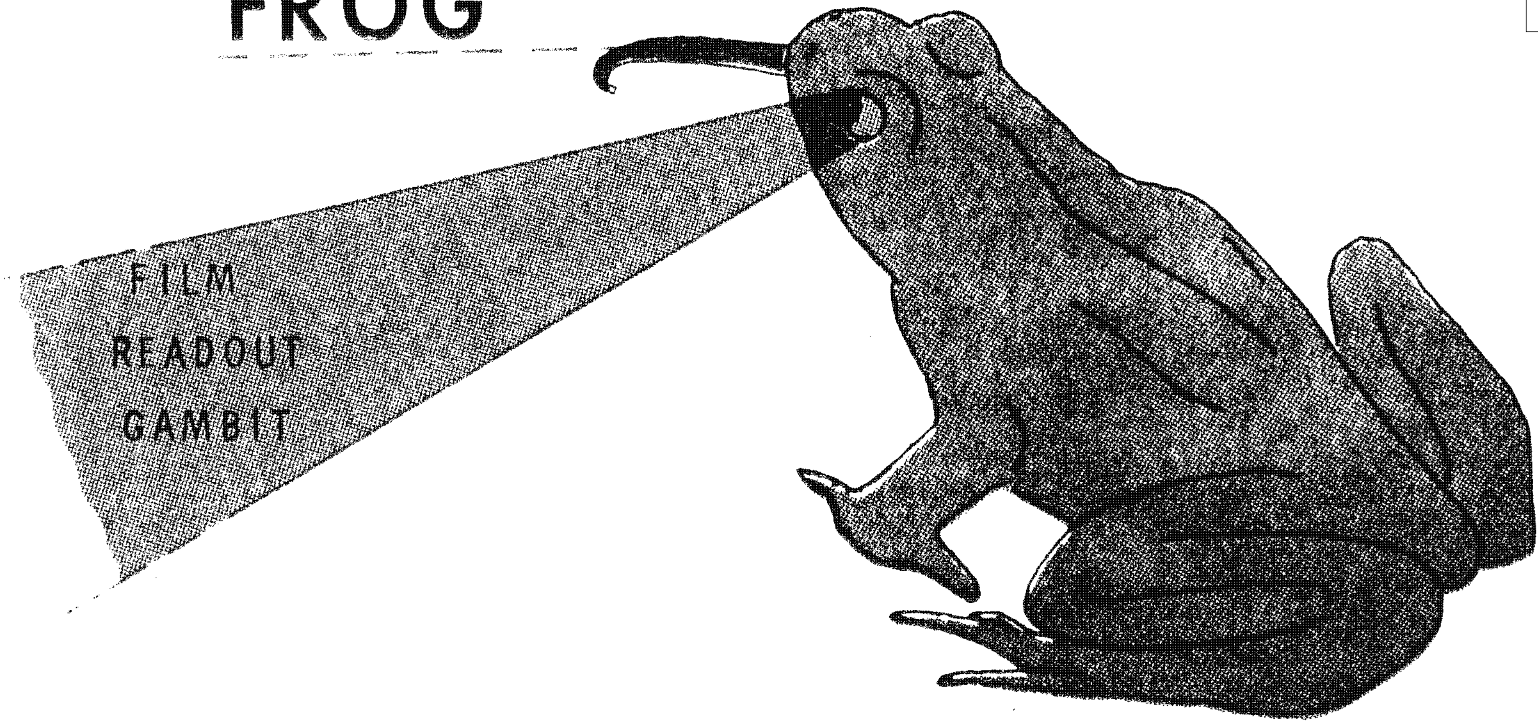
SAFSP

50X1

Cy #5 63

FROG



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Approved for Release: 2021/04/08 C05096524

The FROG vehicle is composed of:

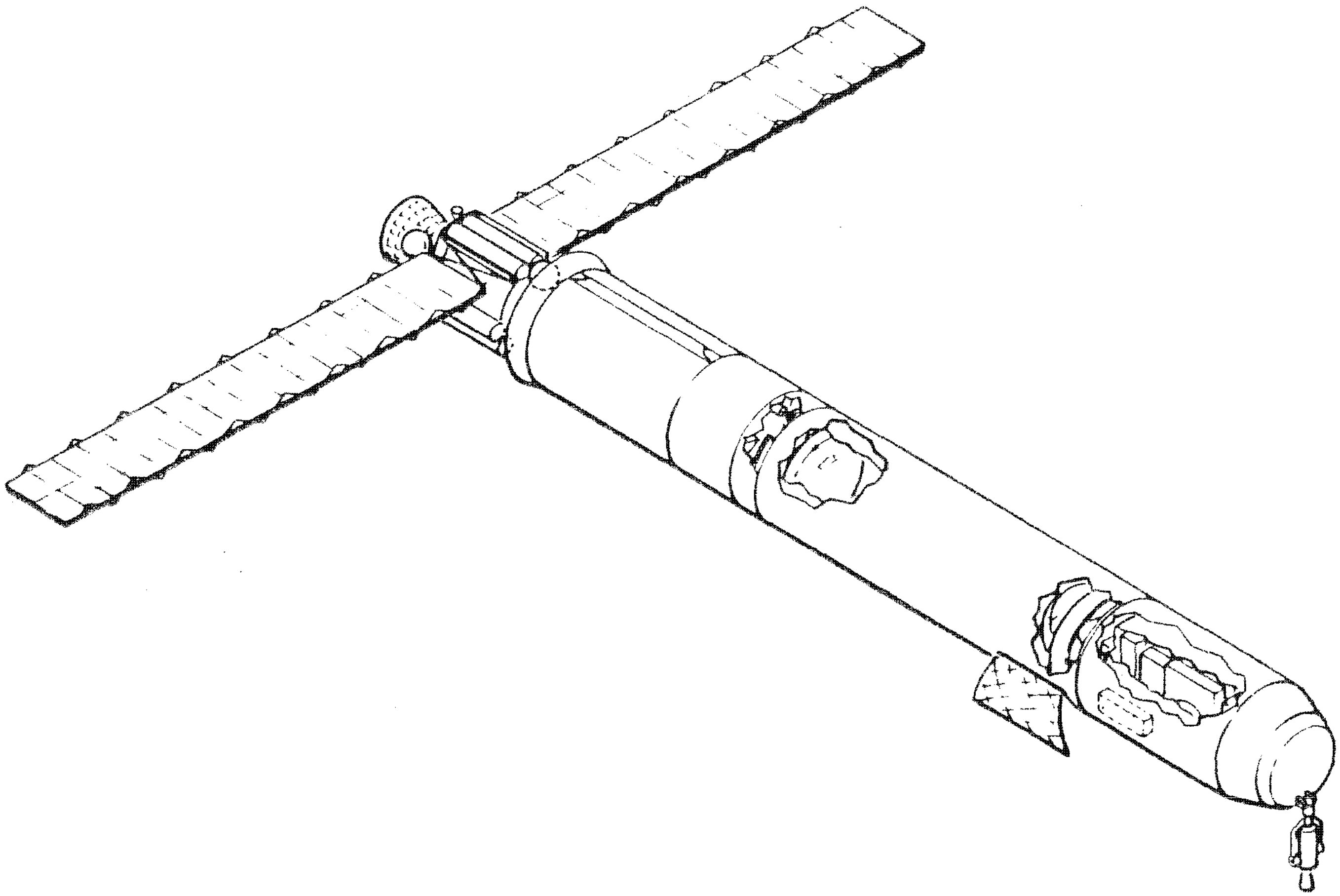
1. A modified Project GAMBIT-AGENA to serve as the orbital control vehicle (OCV).

2. A camera optics module (COM) which utilizes GAMBIT R-5 optics.

3. A film electronic module (FEM) which provides film storage, processing, and readout.

4. A data link module (DLM) which provides two wideband video channels to transmit imagery to ground stations.

The OCV is a GAMBIT vehicle suitably modified to support missions of approximately one year duration. Electrical power is provided by a dual-wing solar array. An integrated secondary propulsion system provides for orbit adjust, orbit maintenance, crisis maneuvers, and deboost of the vehicle. A hot-gas reaction control system together with a modified attitude reference system provides attitude control. A modified Program 770 command programmer together with space ground link system (SGLS) links, decoding devices, and a backup UHF link provide a fully redundant command system. These and other design changes made to the GAMBIT-AGENA are required for longer mission life.



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The configuration that has been selected for the payload meets the following design objectives:

1. The GAMBIT optics assembly is used without significant change.

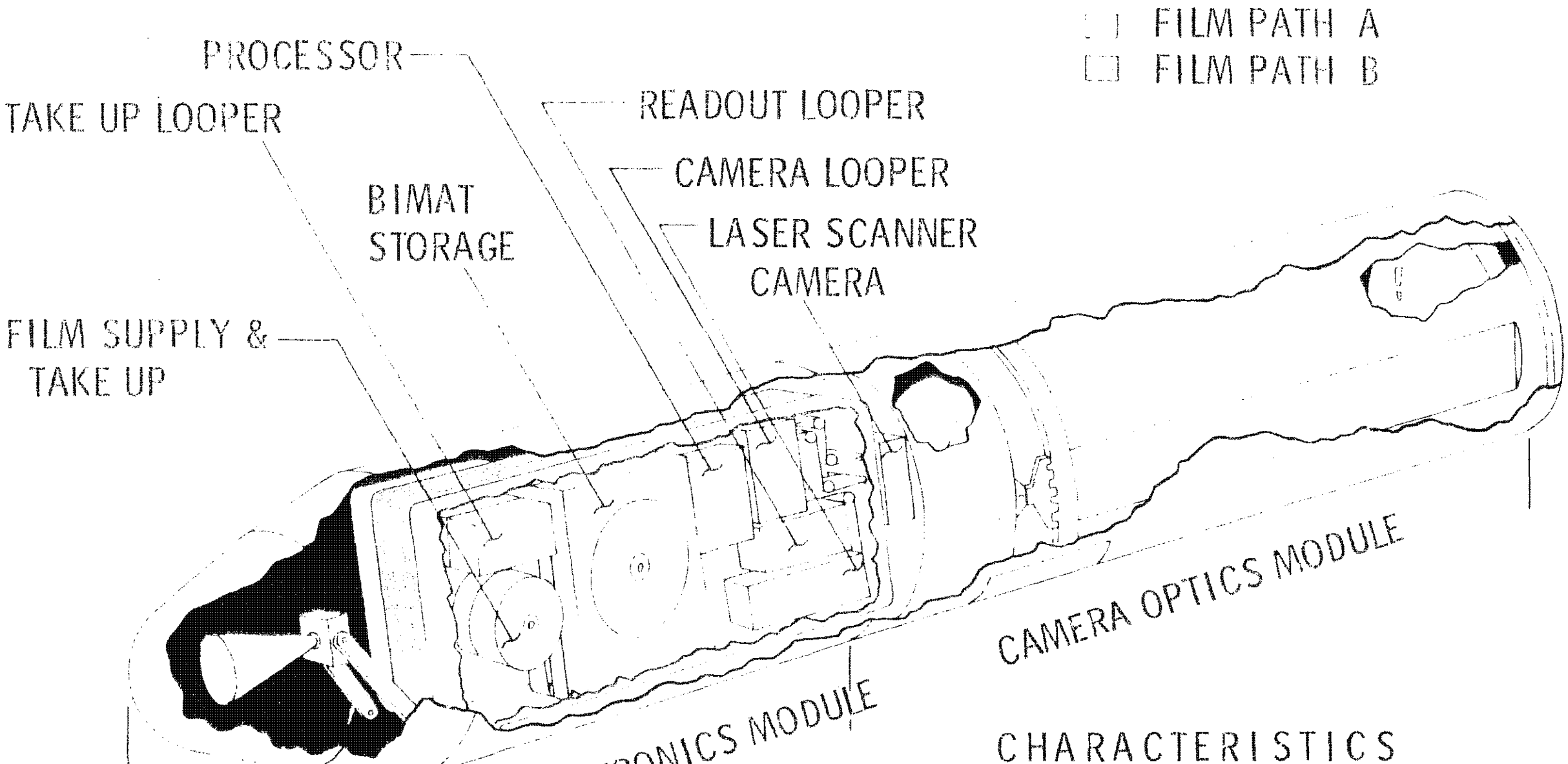
2. Two functionally independent film systems are provided, minimizing the risk of a single point failure.

3. The film supply is sized for a one year nominal mission with 25% contingency for crisis modes.

4. The readout system, processor, and loopers are designed for an output rate of at least 200 frames per day.

The figure shows cut-away views of one of the film paths and portions of the optics and data link. The two film paths are enclosed in a pressure container and maintained at the film vapor pressure. Temperature is controlled selectively within the pressure container. For example, the BIMAT transfer film storage compartment is maintained at 38°F., the processor at 75°F., and the camera and optics near 70°F. At nominal altitude, which is 170 NM, the payload will provide single or overlapping strip photography, each strip covering 3 NM at nadir. Resolution in the ground reconstructed photography for these conditions is predicted to be 2 feet. As with the GAMBIT vehicle, the payload can be operated to provide extended strip, stereo, lateral pair, and lateral triplet coverage in addition to single frame photography.

OPTICS and READOUT MODULE CONFIGURATION CONCEPT



CHARACTERISTICS

OPTICS	175" FOCAL LENGTH f/4, R-5 FORMULA
FILM SUPPLY	15,000 ft. 4" WIDE (EACH PATH)(Approx. 90,000 TARGET FRAMES)
RESOLUTION	2 FEET at 170 nmi (NOMINAL)
COVERAGE	3 nmi STRIP (Ea. SIDE) at 170 nmi.
OUTPUT RATE	SEVEN 4" FRAMES PER SIDE PER MINUTE of READOUT

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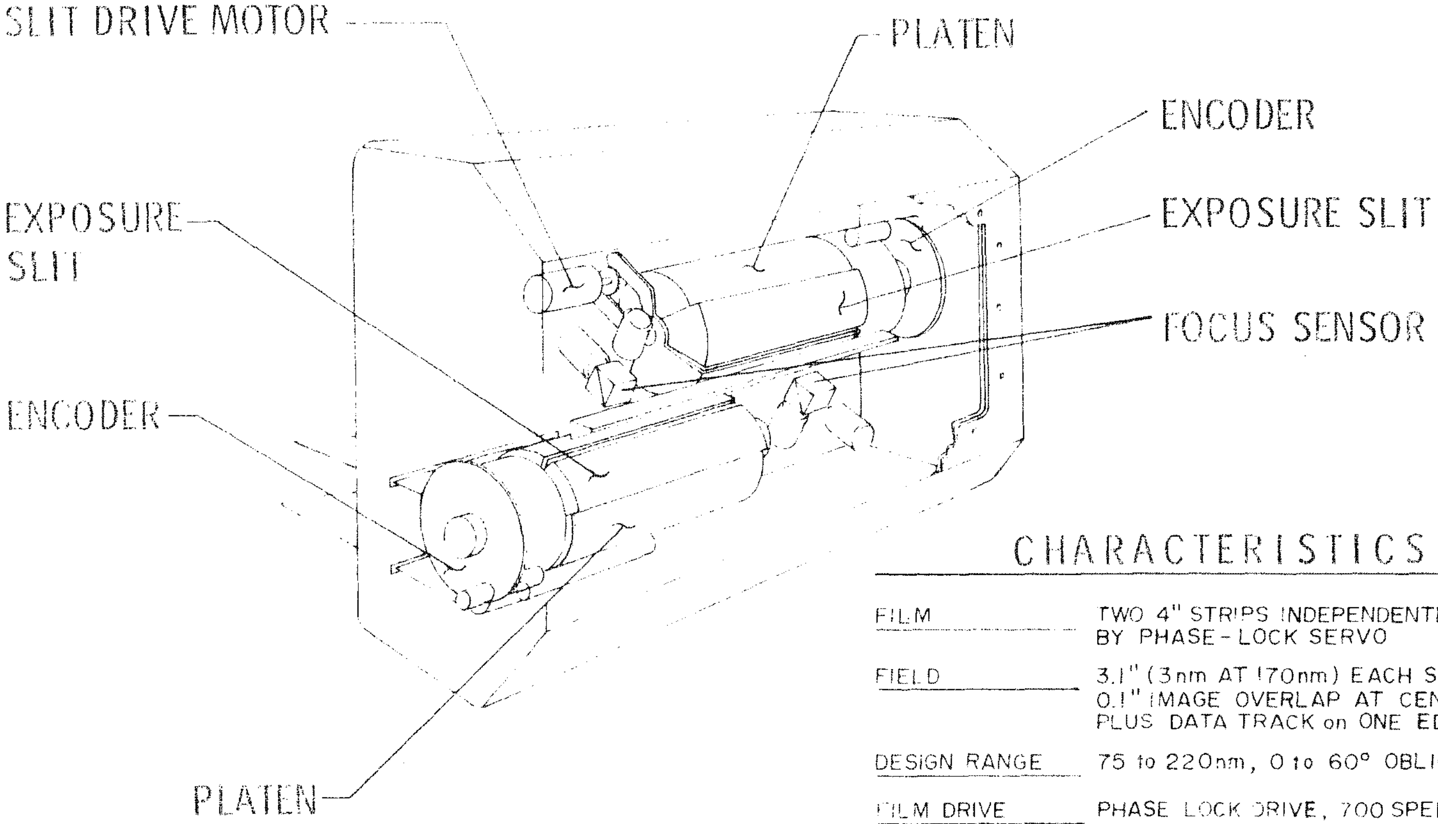
The camera shown in the figure includes two independent sets of camera components. Either platen can be driven singly or the two platens can be driven simultaneously. Each platen is provided with its own focus sensor and control, its own exposure control, and its own film drive. The image field is shared by the two platens through a wedge-shaped mirror. The exposure slits are separated approximately 0.25° in the in-track direction and the film format centerlines are separated approximately 1° cross-track. The camera is designed to operate throughout an altitude range of 75 NM to 220 NM with an obliquity range of up to $\pm 60^{\circ}$. Higher altitudes and smaller obliquity angles which correspond to the same slant-ranges can also be accommodated. The corresponding range of film drive speeds is about seven to one. To provide this range of speeds, a new film drive approach using a torque motor and a phase lock servo has been selected. This film drive method is expected to be smoother and to have less film wastage than the Davis drive used in the present GAMBIT design.

The selected focus sensor approach also differs from that of GAMBIT-CUBED. In the approach shown, each sensor has a pair of detectors which sense image sharpness ahead and behind the film plane. This two-channel approach eliminates the rotating focus shifter disk used on the GAMBIT Program. A self-calibration technique is provided to maintain electronic channel balance.

Exposure is controlled by independently adjustable slits rather than discrete slits. The selected approach eliminates the possibility of failing "closed" and permits the slits to be opened fully to dislodge dirt particles.

CAMERA CONFIGURATION CONCEPT



CHARACTERISTICS

FILM	TWO 4" STRIPS INDEPENDENTLY DRIVEN BY PHASE-LOCK SERVO
FIELD	3.1" (3nm AT 170nm) EACH SIDE 0.1" IMAGE OVERLAP AT CENTER PLUS DATA TRACK on ONE EDGE
DESIGN RANGE	75 to 220nm, 0 to 60° OBLIQUITY
FILM DRIVE	PHASE LOCK DRIVE, 700 SPEED STEPS
FOCUS	TWO INDEPENDENT SOLID STATE FOCUS SENSORS, EACH PLATEN ADJUSTABLE
EXPOSURE	INDEPENDENTLY ADJUSTABLE SLITS

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The weight summary shown is for a FROG vehicle with expendables for approximately one year. The weight contingency shown was calculated on the following basis: 50% for new wiring, 10% for new structure, 20% for new components, 5% for modified structure and components, and 3% for existing structure and components. The total weight shown is equivalent to burn out weight and can be compared directly to booster performance.

The booster performance capability shown on this chart has been developed from dual burn ascent trajectories with constraints nearly the same as GAMBIT. The trajectories were calculated with a -3 sigma performance dispersion propellant reserve of 900 lbs. in the booster and 131 lbs. in the AGENA. To make certain the launch vehicle can lift the system into the required orbit at the necessary inclination angle, the performance capability has been further reduced by 150 lbs., the predicted -3 sigma cold booster dispersion from the nominal capability.

A gain in performance capability of at least 300 lbs. may be realized through the first stage turbine performance improvement currently under analysis by the booster contractor. Fabrication and use of a 75:1 nozzle on the AGENA made of Columbium, material used on the Lunar Orbiter and Apollo Program engine nozzles, could also improve performance by 100 lbs.

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WEIGHT AND BOOSTER PERFORMANCE SUMMARY

OCV	3142
ORM	3948
CONTINGENCY	460
EXPENDABLES	1565
TOTAL	9115

POUNDS

9588 — AGENA NOZZLE EXTENSION (COULD ADD 100 LBS)

9488 — 5% TURBINE SPEED INCREASE (COULD ADD 300 LBS OR MORE)

9188 — TITAN IIIB + AGENA CAPABILITY (MINUS 3 SIGMA)

9115 — TOTAL SATELLITE VEHICLE WEIGHT

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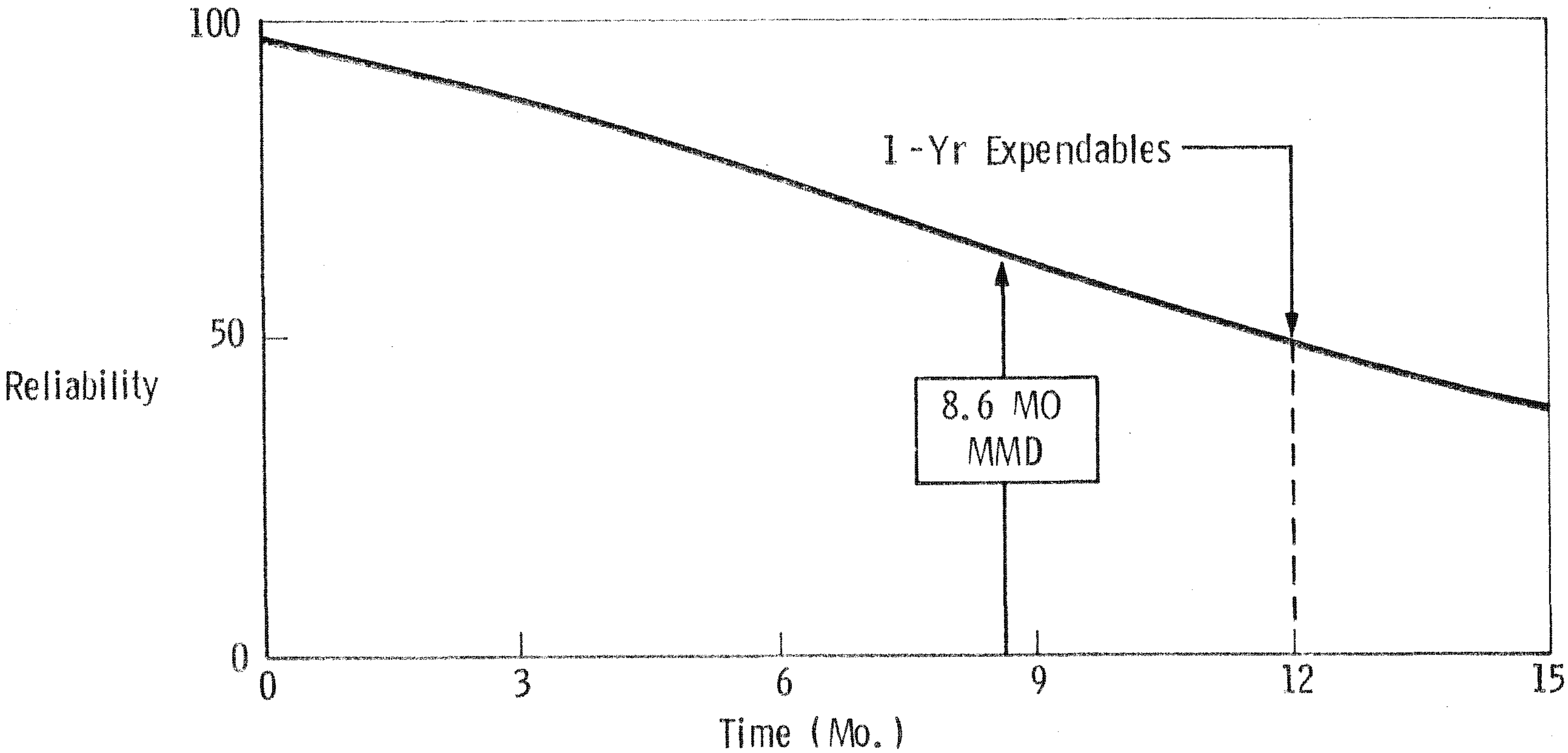
This chart shows the major subsystems of a FROG vehicle versus state of development. Note that no new technology is required.

FILM READOUT SYSTEM DEVELOPMENT STATUS(s)

	NEW TECHNOLOGY	NEW ENGINEERING OF EXISTING TECHNOLOGY	MODIFICATION OF SIMILAR EXISTING DESIGN	EXISTING DESIGN OR MINOR MODIFICATION
OCV				
BASIC P-110 AGENA				X
BOOSTER ADAPTER			X	
SOLAR PANELS			X	
HOT GAS ACS		X		
ROLL JOINT			X	
SECONDARY PROPULSION SYSTEM			X	
COMMAND SYSTEM			X	
ORM				
OPTICS				X
CAMERA			X	
PROCESSOR		X		
SCANNER		X		
DATA LINK				
TRANSMITTER/ MODULATOR			X	
ANTENNA		X		
TRACKER			X	
GROUND				
RECORDER		X		
GROUND STATION				X

This chart shows the predicted reliability of a FROG. Calculations predict a 50% probability that the satellite would be operating at the end of one year. With the expendable limit set at one year, a mean mission duration of 8.6 months can be expected. A launch rate of 2.8 per year will be required to maintain a two-satellite system. It should be noted that as the design progresses all the expendables may exceed one year by a substantial margin, thus increasing the mean mission duration. This would be possible if improved booster performance , or unused contingency now reserved for hardware growth, would allow more expendables to be loaded on the vehicle.

RELIABILITY PROFILE

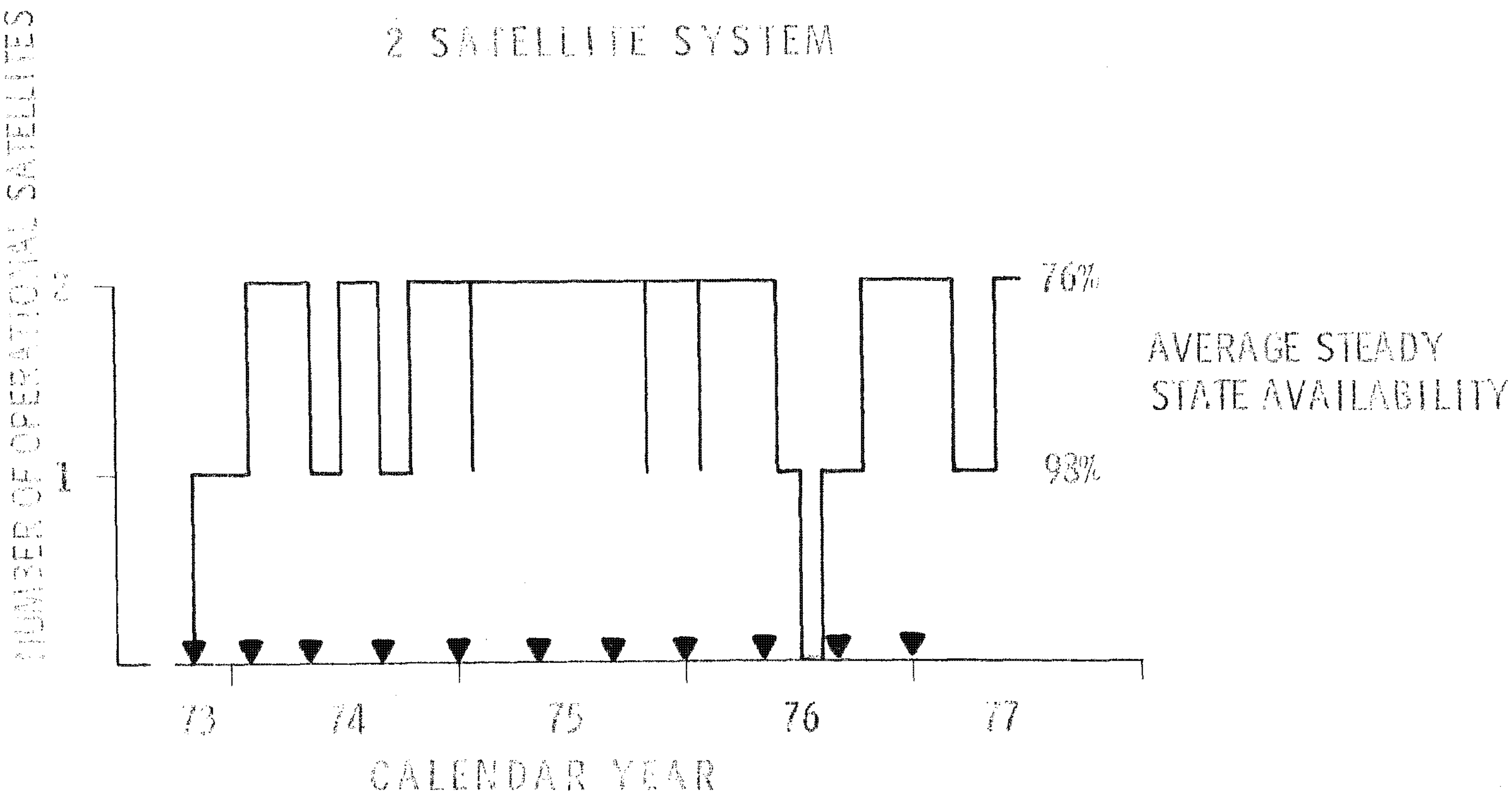


BOOSTER	0.98
ORBITAL CONTROL VEHICLE	0.68
OPTICAL READOUT MODULE	0.75
FILM READOUT SYSTEM	0.50

A typical profile of system availability is shown on this chart. Computer simulations indicate that in the steady state situation two satellites will be operational with a .76 probability and at least one satellite with a .98 probability. This simulation assumes that the predicted reliability is achieved on all of the satellites produced.

The triangles indicate launch availability dates for satellites which occur at zero, three, six, and ten months with subsequent launch possibilities separated by four months. A spare should be available by the third satellite delivery since the calculated average replenishment rate would require a launch every 4.3 months, and the initial build rate will produce a vehicle every three months. If experience shows the average launch interval to be less than four months, the production rate would be adjusted. A delay between failure and replenishment of two months is considered typical. This figure recognizes the possibility of conflict with other programs sharing the launch pad. The delay assumes 15 days to reach the pad, 30 days from pad to launch, and an average of 11-day delay because of pad scheduling conflicts.

2 SATELLITE SYSTEM



▼ DENOTES EARLIEST LAUNCH AVAILABILITY

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This chart shows a schematic diagram of the least complicated and least expensive data recovery option. Exposed film in the satellite is scanned by a laser scanner. The modulated light beam is detected by a photo multiplier tube which produces a video signal. This signal is transmitted to a single SCF ground station at BOSS (New Boston, New Hampshire) using two wideband video channels, one for each film path. Forty MHz of the available fifty MHz in each channel is used for transmitting the video signal, and the remaining bandwidth is used for housekeeping signals. This results in a readout rate of fourteen pictures per minute of station contact time using both channels.

The signal is received on the ground by a wideband data link (WBDL) receiver through the programmed 46-foot antenna at BOSS. The signal is processed and used to modulate the light beam of a laser beam recorder (LBR) which reproduces the image directly on film. The film is then processed and transported by courier to Washington, D. C.

A fully redundant readout station with the same capability would be maintained at COOK (Vandenberg AFB, Calif.). Note that this backup station takes advantage of equipment which must be positioned there for launch checkout to provide a backup readout station at minimum cost.

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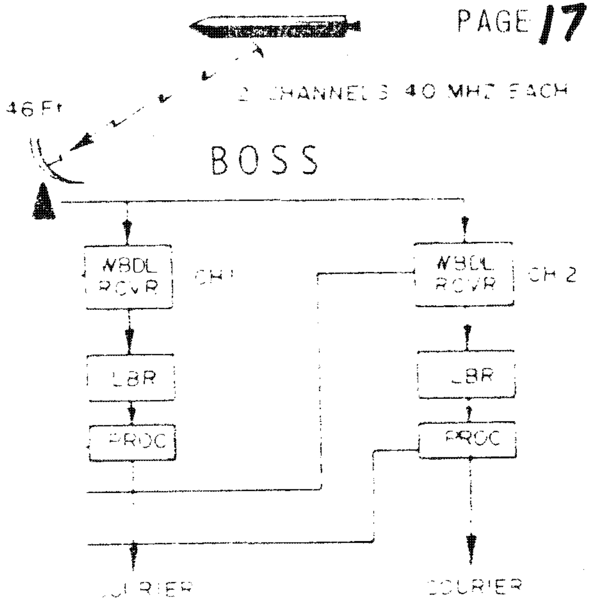

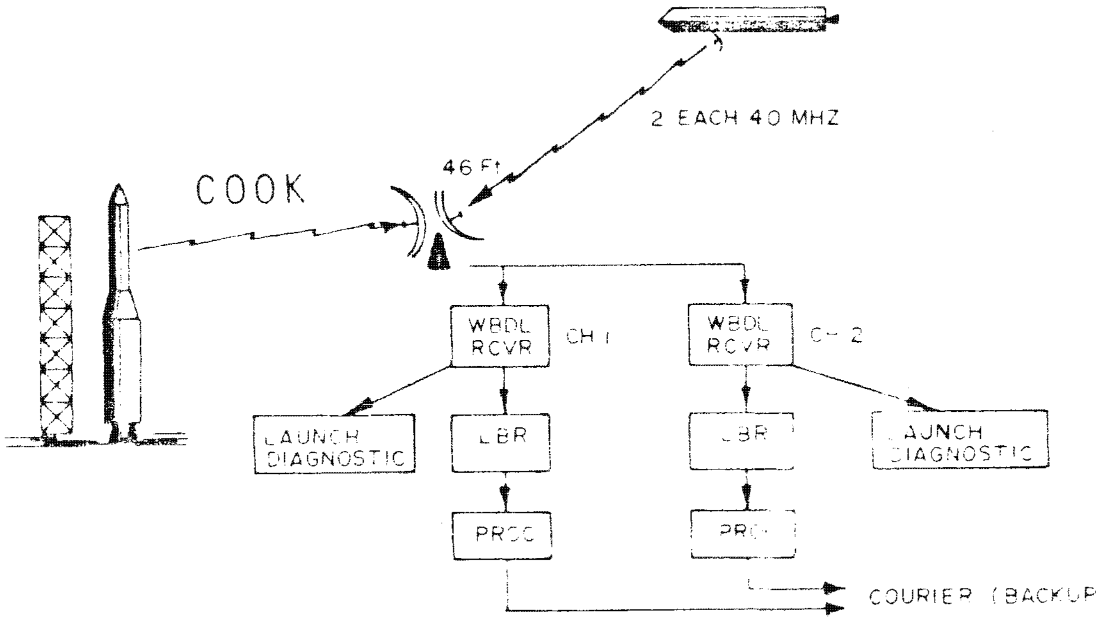

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This chart shows a data recovery option which builds upon the least complicated option shown on the last chart to provide a more rapid return of data to Washington, D. C.

The station at BOSS would be equipped to simultaneously record the image on film and transmit the video signal to [redacted], via the [redacted] communications satellite. This satellite is capable of data rates up to 30 MHz which would limit the retransmitted signal to a single channel passing 5.25 frames per minute of contact time. The second channel could be used to record film at the ground station for later transmission via [redacted] or courier.

A second primary ground station which operates exactly as BOSS could be added at KODI. This would provide for more frequent contacts with the FROG satellite as well as more total contact time to improve both the data return time and the total data capacity.

Note that the ground stations at BOSS and KODI would be additions to existing satellite control facility stations. The [redacted] station would be an addition to the [redacted] Additions to these existing facilities result in very low costs when compared to completely new and independent stations.

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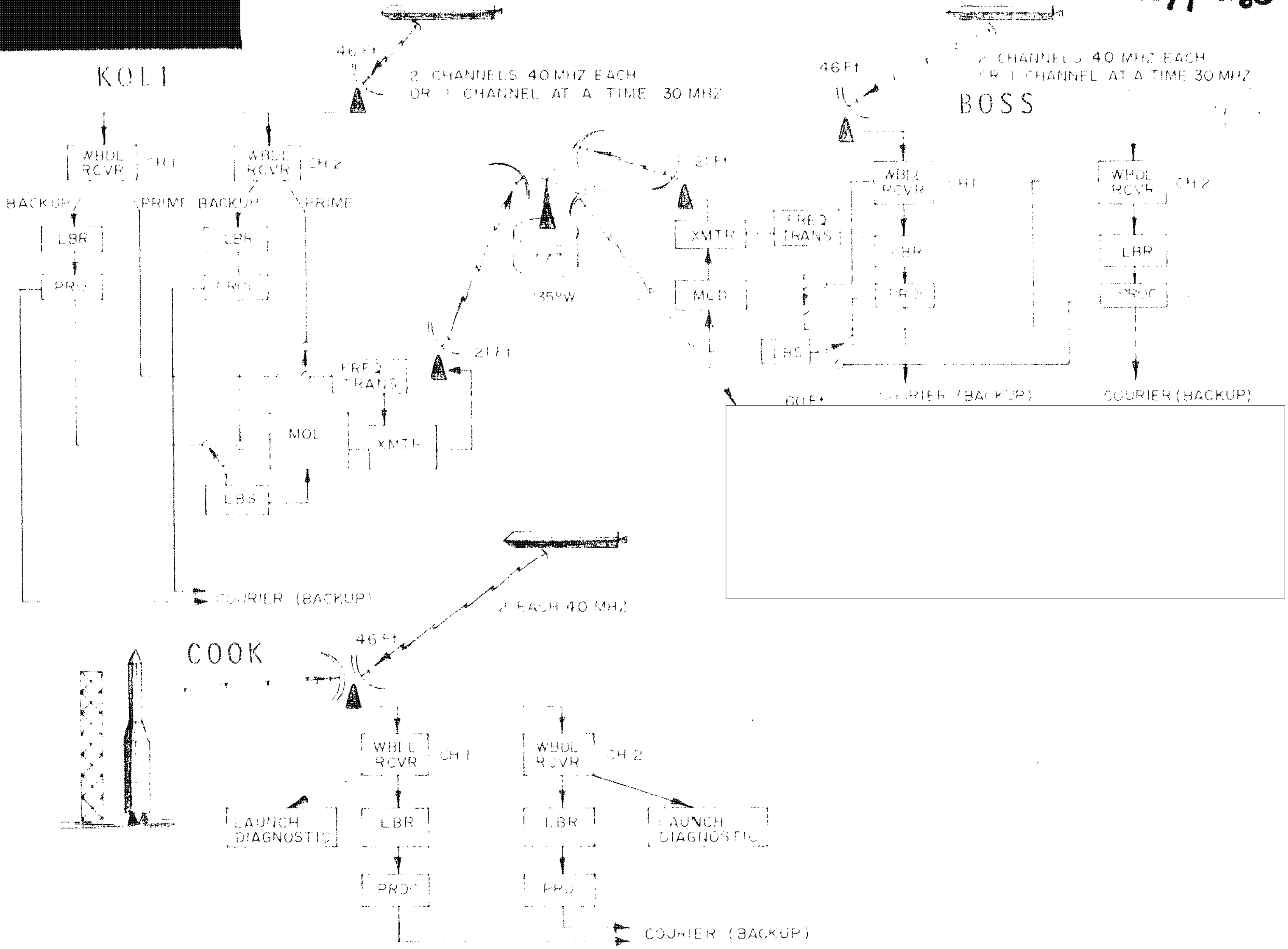
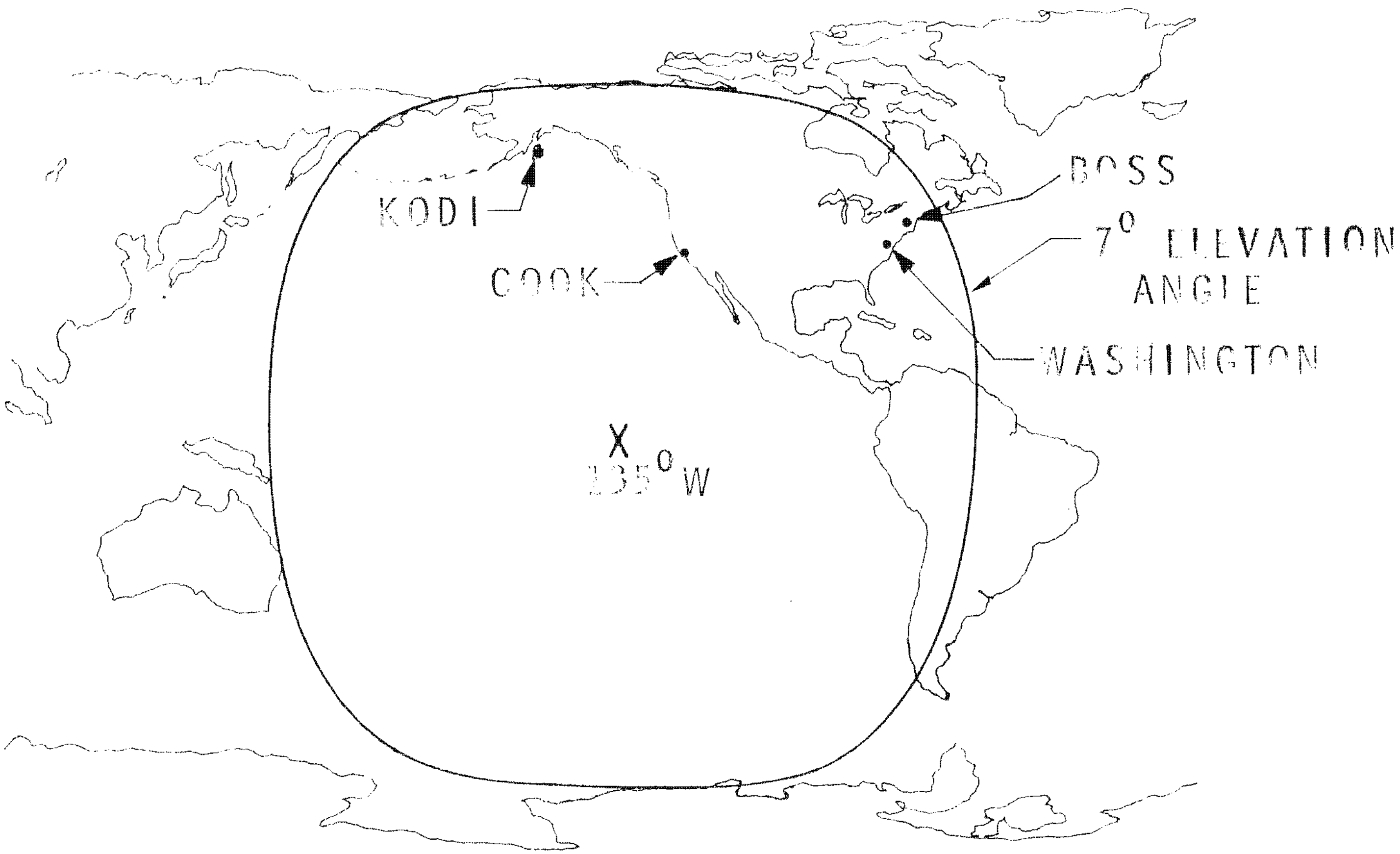
DATA RECOVERY SCHEMATIC



This chart shows the area of coverage a [redacted] satellite located in synchronous orbit at 135° W. The coverage indicated is for 7° elevation angle.

Note that this is the planned position of the third [redacted] satellite. Also note that the area covered includes KODI, BOSS, COOK, and [redacted]

The planned launch of this third [redacted] satellite is in May 1972 which will provide the relay capability well in advance of our needs.


KODI
COOK
BOSS
7° ELEVATION ANGLE
WASHINGTON
X
135° W

Shown here are the average daily contact times that two FROG vehicles would have with several ground station combinations and the maximum number of frames that could be read out during these contact times. If 400 frames per day is the requirement, two vehicles could exceed this requirement using a single ground station at BOSS. If the [redacted] relay were available, about half this requirement could be sent immediately to Washington using the single ground station at BOSS. Using both BOSS and KODI, the total number of frames sent directly to Washington would exceed the requirement.

The satellite design will provide a nominal 200 frames per day per satellite, 100 frames per day from each film path. The design provides for a maximum sustained rate of 400 frames per day per satellite or 800 frames per day with a two-satellite system. Of course the film would be used up in half the time at the maximum sustained rate. Note that BOSS plus KODI provides ample readout capacity for the maximum sustained rate of two FROG vehicles.

MAXIMUM CAPACITY (TWO VEHICLES)

	AVERAGE CONTACT TIME PER DAY (MINUTES)	NUMBER OF FRAMES PER DAY: TO GROUND STATION		NUMBER OF FRAMES PER DAY: IMMEDIATE RELAY TO WASHINGTON VIA
BOSS	36	504	OR	188
		252	AND	188
			440	
BOSS + KODI	84	1176	OR	440
		588	AND	440
			1028	
COOK	36	504		

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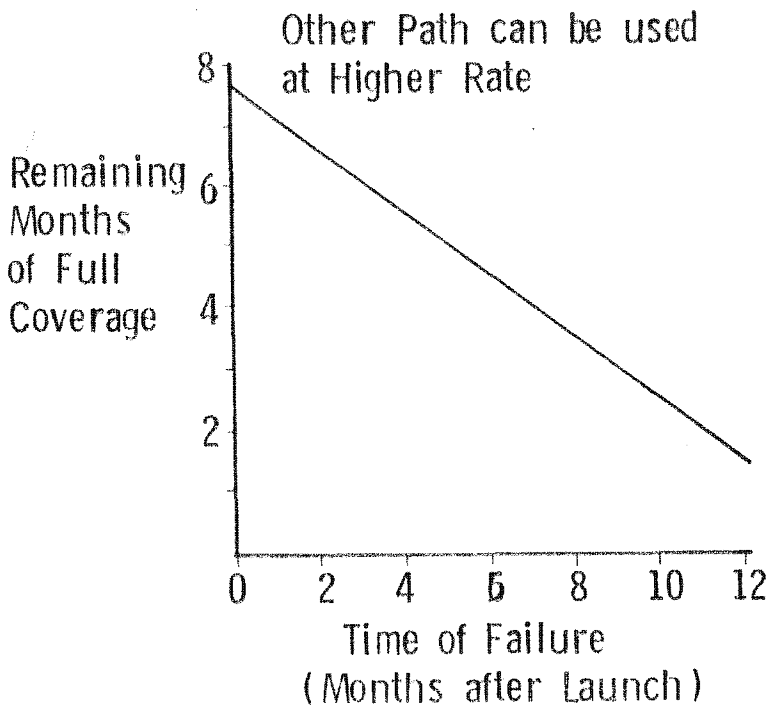
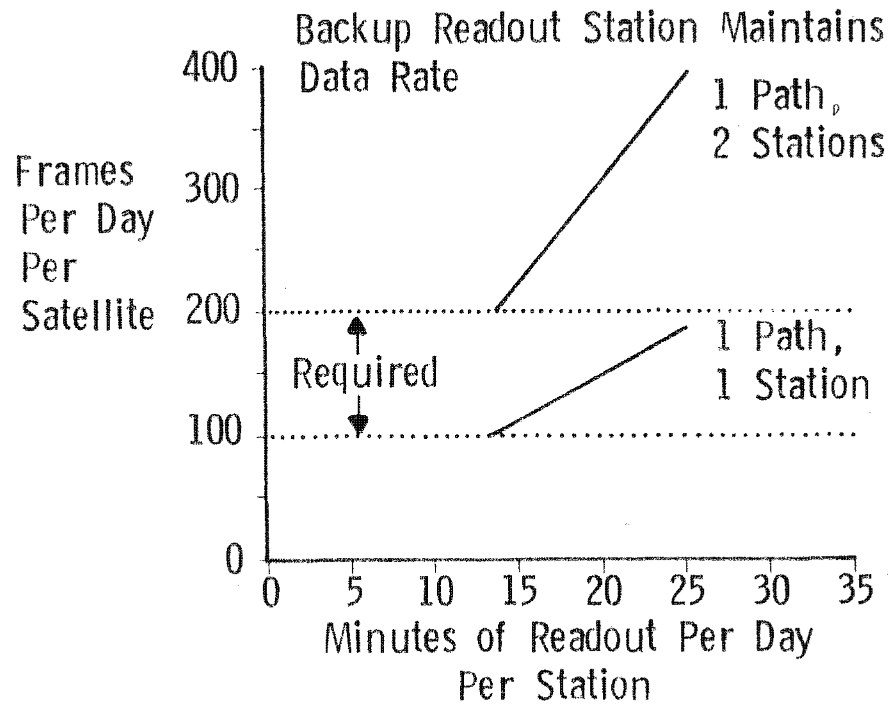
The payload is being designed with functionally redundant film paths. To exploit this characteristic, each film path is designed to hold 15,000 feet of film and BIMAT. A nominal mission requires about 1,000 feet of film per path per month. The extra capacity can be used to extend the mission, if other mission expendables permit, to take extended strip or other non-standard photography or to provide a reliability contingency. The figure shows that a single film path operating at twice its normal 100 frames per day rate can by itself provide many months of full operation if a failure occurs in the other path. The readout capability to one station will limit the data return if only one channel is used. However, the full 200 frames per day rate can be maintained if the backup station is used. It is interesting to note that, if two satellites are in operation, 400 frames of photography can be returned on an average day into a single station even if one film path on one satellite fails.

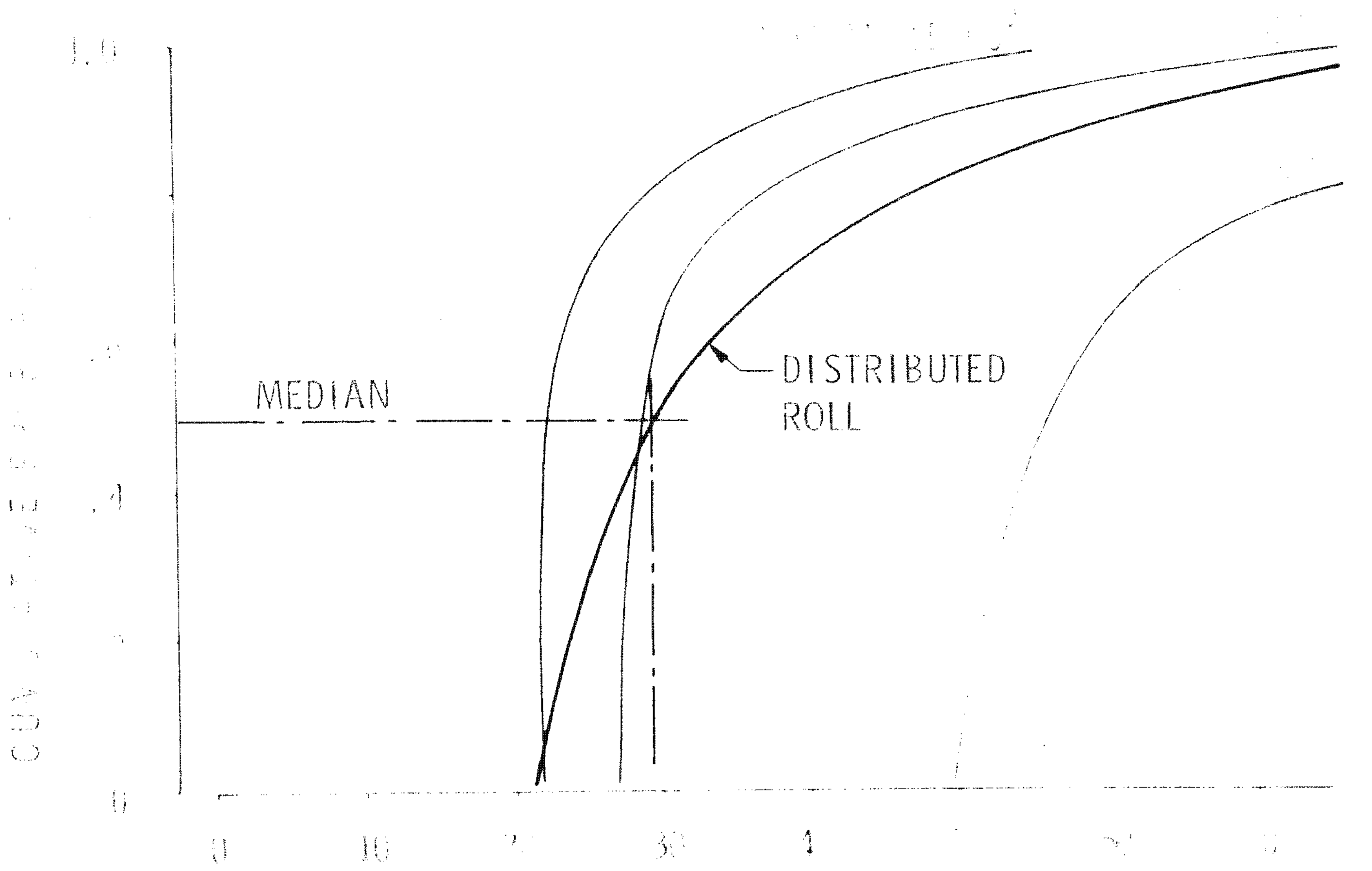
- EACH FILM PATH HAS 25% EXTRA CAPACITY
- IF ONE PATH FAILS





This chart presents predicted ground resolution for the system operating in circular orbit at 170 NM altitude. To obtain the data which was used to prepare this chart, a Monte Carlo analysis was performed varying the pertinent system parameters according to reasonable distributions. Target latitude was distributed uniformly between 20° and 70° N. The time of year was considered to be any day with equal probability, photography occurring at local noon. Smear was distributed according to the system smear budget and for the distributed roll case the target was considered to be anywhere along the latitude line between ± 60° with equal probability.

In these Monte Carlo analyses, resolution was calculated taking into account all of the significant system transfer functions, gain factors, and noise terms. Effects of film, Bimat processing, laser scanner, readout link, and ground reconstruction are accounted for by the Pierson Threshold Modulation Model. The target contrast shown was held fixed at 3:1. The atmospheric haze was accounted for by the use of the Aerospace Photometric Atmosphere Model providing a varying contrast at the entrance aperture of the system ranging from about 2:1 in the best case to below 1.2:1, with about 1.6:1 as an average. Note that median resolution in the distributed roll case is approximately 2 1/2 feet and nadir best is somewhat better than the 2-foot requirement.


MEDIAN
DISTRIBUTED
ROLL
1.0
0
0
10
30

The effects of laser scanning, data link, and ground image reconstruction are considered here. The degradation is small at flight film resolutions less than about 100 line pairs/millimeter and increases slowly with increasing flight film resolution. At two feet reconstructed ground resolution, the flight film resolution is about 18 inches. No image processing is assumed. Techniques for on-line analog image processing are available, but insufficient data is available at present to predict the exact gains realized.

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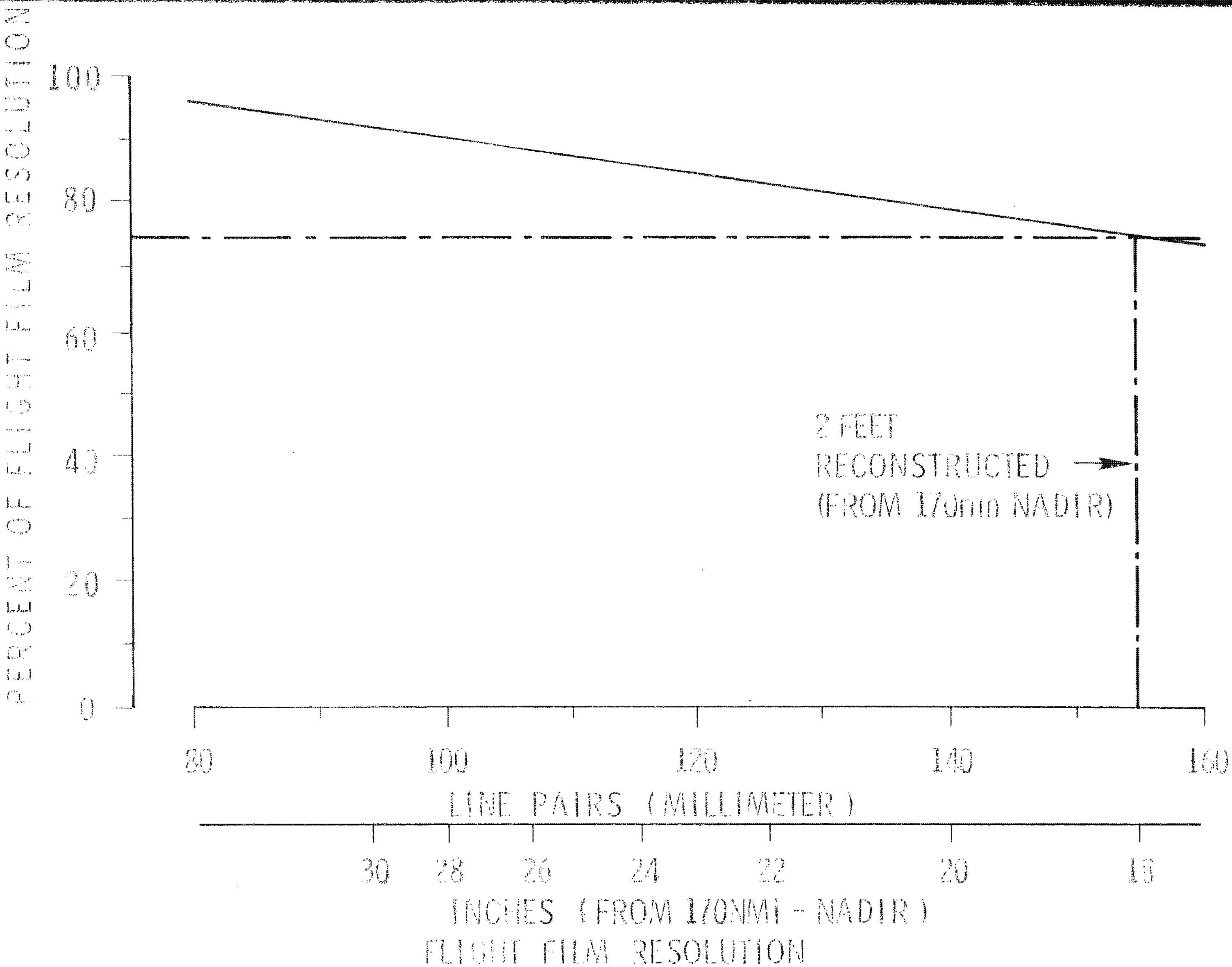
RECONSTRUCTED RESOLUTION vs FLIGHT FILM RESOLUTION



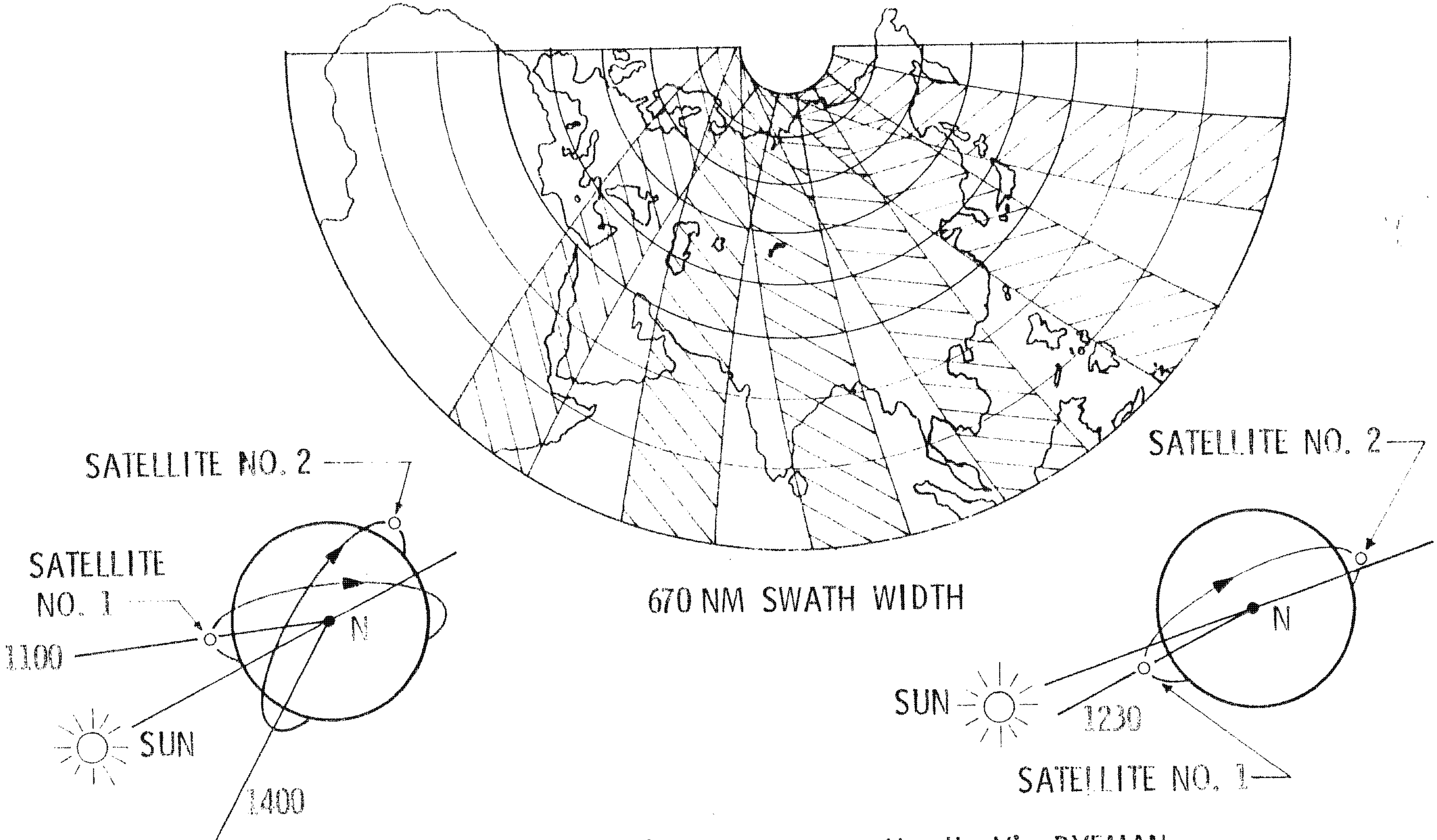
This chart shows several representative south-to-north swath patterns of a single satellite at 170 NM altitude superimposed upon a northern half hemisphere containing the area of interest.

The small diagram in the lower left indicates a possible phasing and orbit plan separation of two satellites. The phasing shown was selected to maximize geographic coverage, distribute ground station contacts across the day, and provide acceptable solar or local times for photographic conditions in the target areas. To further distribute tracking station workloads, the satellites are phased 180° apart in their respective planes.

The small diagram in the lower right indicates both satellites in the same orbit plane. This arrangement would maximize optical performance since both satellites would be in position to take advantage of the best sun angles during photographic operations.

The access swath at 170 miles is 670 NM.

170-NM CIRCULAR ORBIT - SINGLE VEHICLE



The first overlay chart superimposes the second satellite at 170 NM altitude over the first and shows the near total ground coverage achieved by the system. Note that 99% of the earth is visible with two satellites in orbit every day. Also note that 64% of the earth above $40^{O}N$ latitude is visible at least twice each day to two satellites at 170 NM

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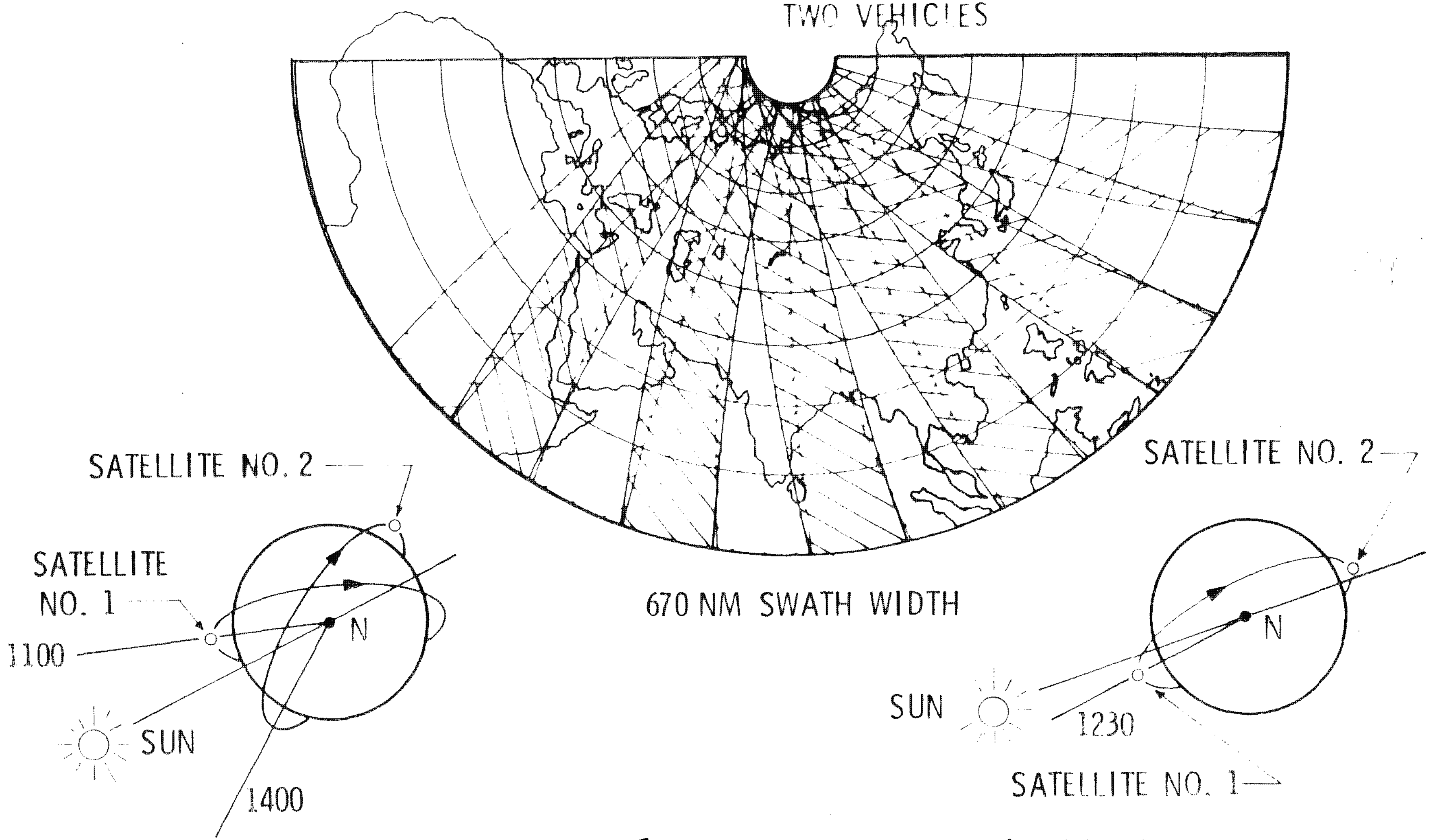
SATELLITE DEPLOYMENT

170-NM CIRCULAR ORBIT - [redacted]

TWO VEHICLES



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The second overlay superimposes the second satellite at 85 NM altitude over the first at 170 NM. The second set of swath patterns is narrower than the first (320 NM versus 670 NM), and the patterns will rotate with respect to each other. Many other useful combinations of patterns are also possible. For example, both satellites could be placed in a one-day repeat orbit over a crisis area. Such a scheme would provide coverage of the crisis area twice a day at the expense of coverage elsewhere. The interval between accesses for the dual coverage would depend on the angle between orbit planes and the phasing of the two satellites. Note that this dual access could be arranged to obtain high resolution and search a given area on the same day, and then repeat such coverage daily if required.

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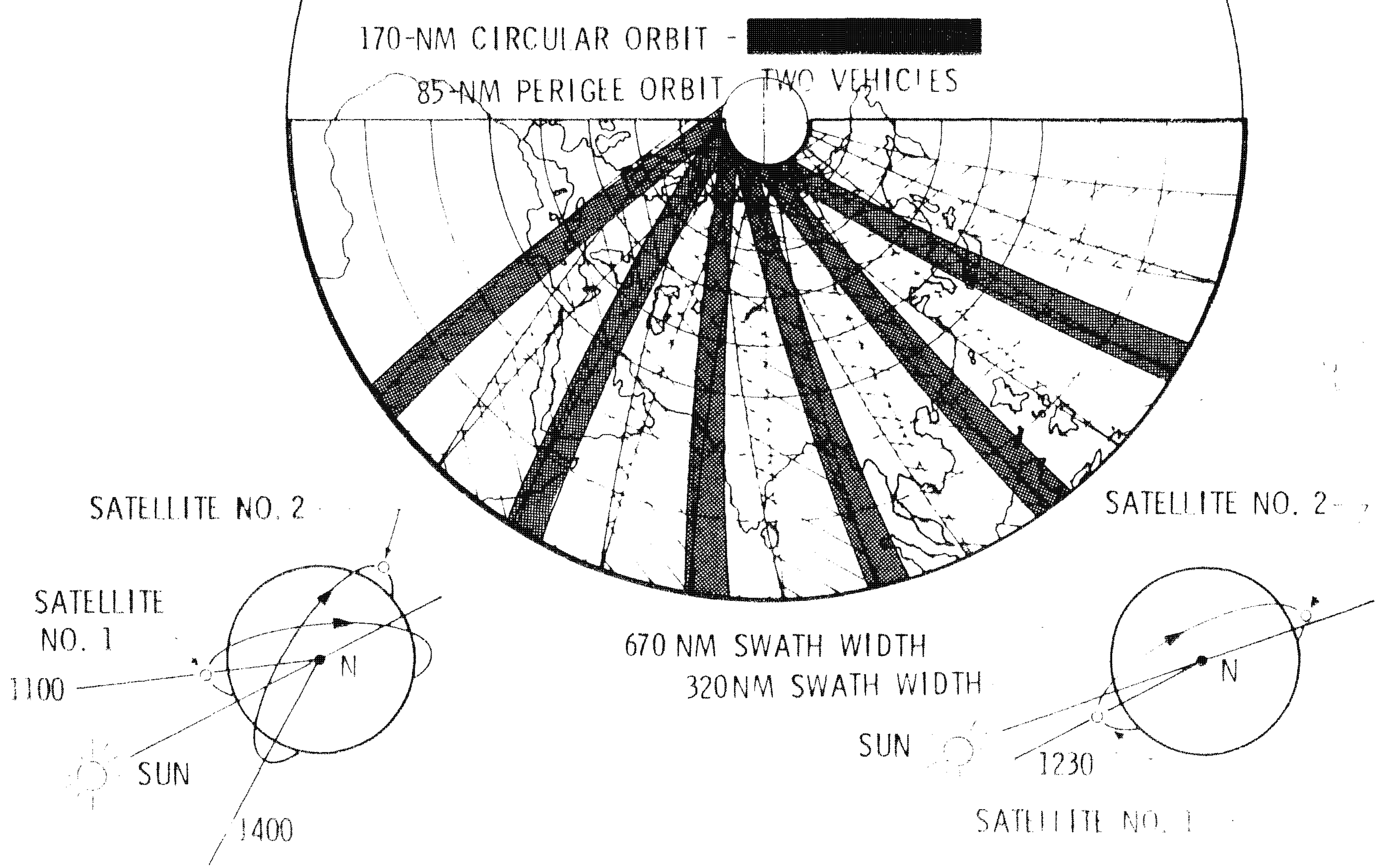
SATELLITE DEPLOYMENT



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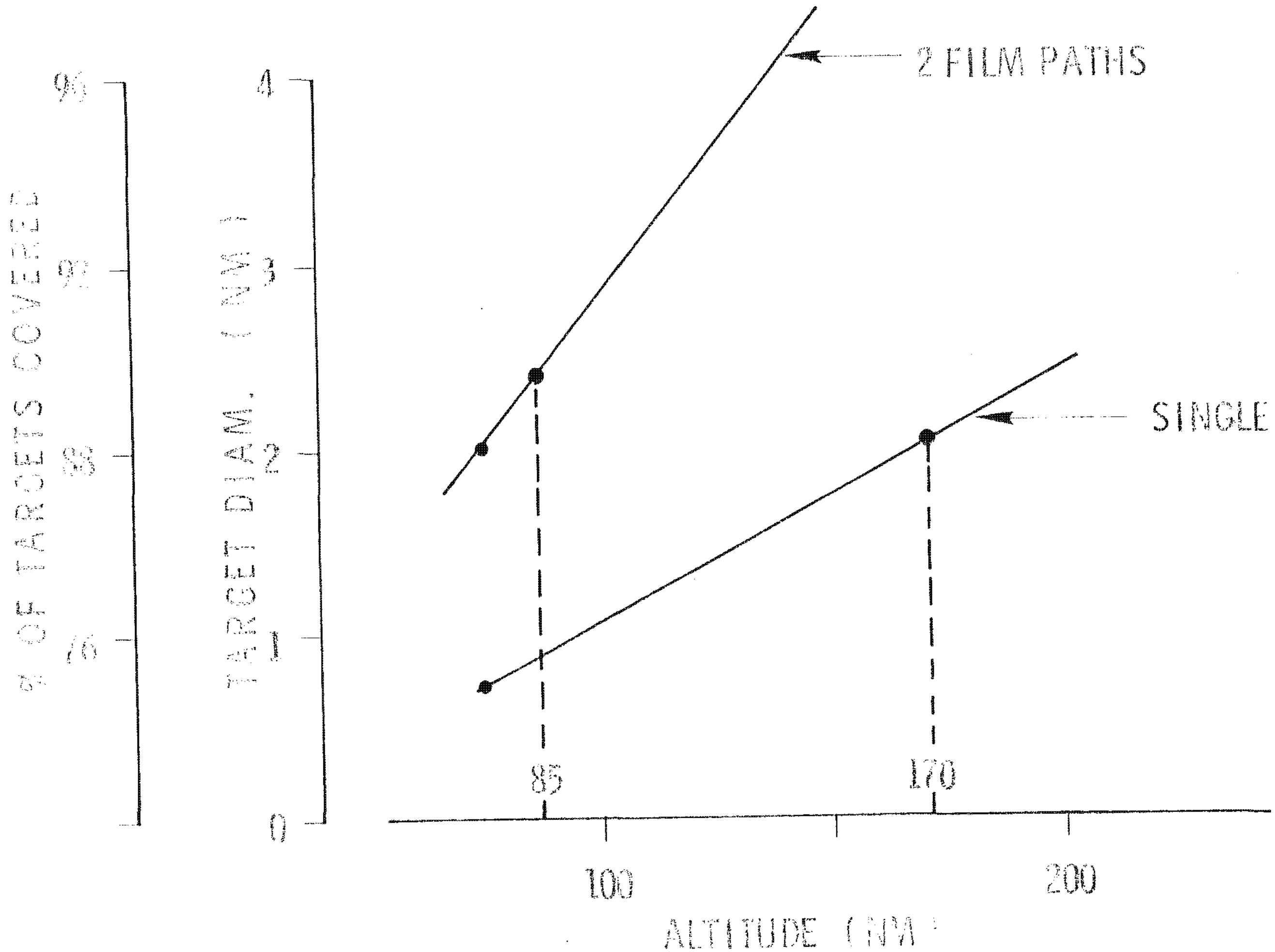
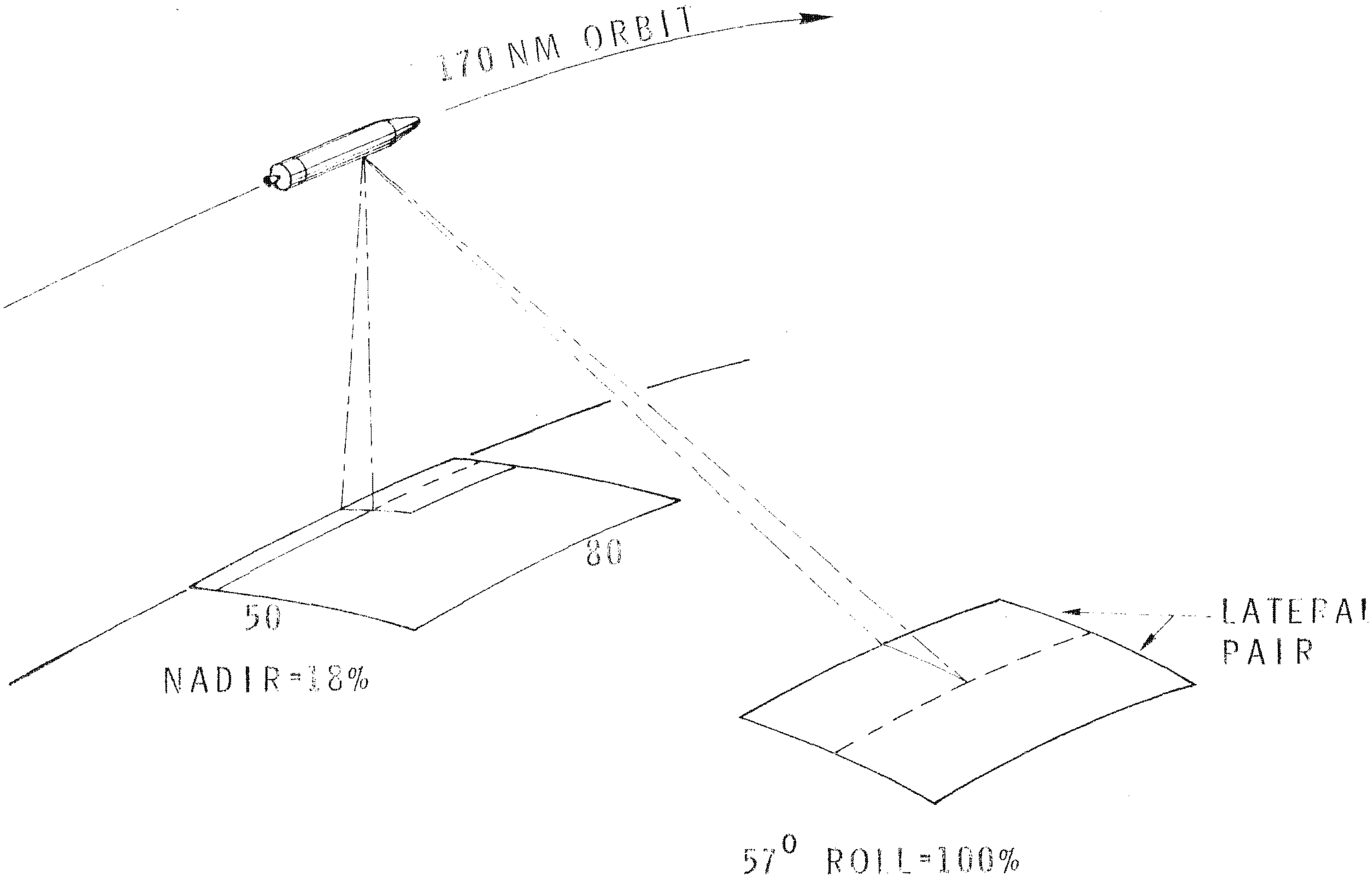
The figure shows the 95% probability of imaging targets of varying sizes as a function of orbital altitude. Note that at 170 NM, 88% of the GAMBIT targets would be imaged with a single film path in operation. A high probability of imaging larger target areas could be obtained by using both film paths at the same time.

95% PROBABILITY



The ability to image rather large areas is sometimes important in a crisis situation. There are two techniques which may be used with a FROG vehicle to obtain images of these rather large areas. The first is illustrated in the sketch and involves placing the vehicle so it can take highly oblique photography of a crisis area. Note that a vehicle at nadir can image only 18% of a 50 X 80 NM crisis area, while a vehicle placed so that the area is viewed at a 57° roll angle can image the whole area. Orbit adjust propellants aboard the FROG vehicle can be expended to position the vehicle for highly oblique photography of a crisis area if a search is required before the vehicles would normally drift into a highly oblique position. Note that some photography of a crisis area would be available every day with a two-satellite system, and a search covering large areas is possible for most of the earth's surface within two days without adjusting the orbits. If a single FROG satellite is in operation, an orbit adjust maneuver will enable an area search anywhere on the earth within 48 hours and more than half of the earth within 24 hours.


170 NM ORBIT
80
50
NADIR=18%
LATERAL PAIR
57° ROLL=100%

The second technique of imaging large areas involves pitch agility. The term pitch agility refers to the technique of pitching the satellite vehicle axis above and below horizontal in order to shift the optical line of sight to access targets or increase camera operation time and swath width for additional area coverage.

Starting at position 1 in the sketch, approaching a target area such as the 50 X 80 NM one shown, the vehicle is pitched up, the ORM rolled, and the stereo mirror flipped to its forward angle limit. The camera is operated for 20 sec. The second camera operation (position 2) begins 8 sec. later, to allow mirror flip and roll with settling, and lasts 20 sec. A period of approximately 120 sec. follows to pitch and roll to the new angles. The remainder of the sequence is the reverse of the initial part and, as can be seen, the entire area is covered.

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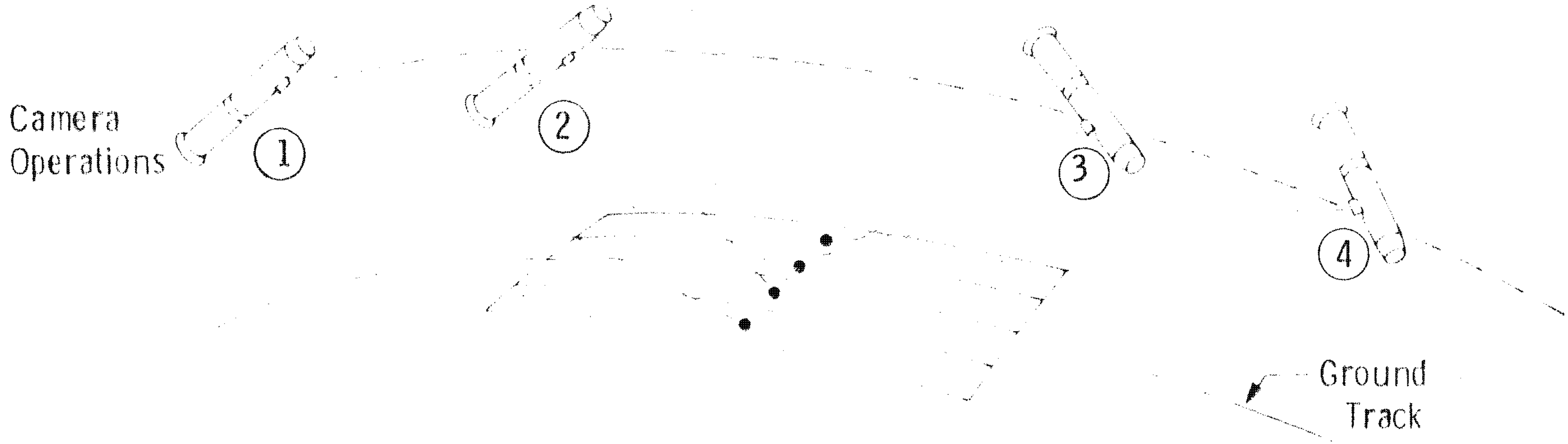
CRISIS MISSION COVERAGE

PITCH AGILITY OPTION 2 FILM PATHS, 1 SATELLITE



CAMERA OPERATIONS	1	2	3	4
Pitch Attitude (Deg)	53.60	53.60	-53.60	-53.60
Mirror Angle (Deg)	8.65	0	0	- 8.65
Roll Angle (Deg)	-3	-1	1	3

Coverage: 100% OF 50 x 80 NM AREA

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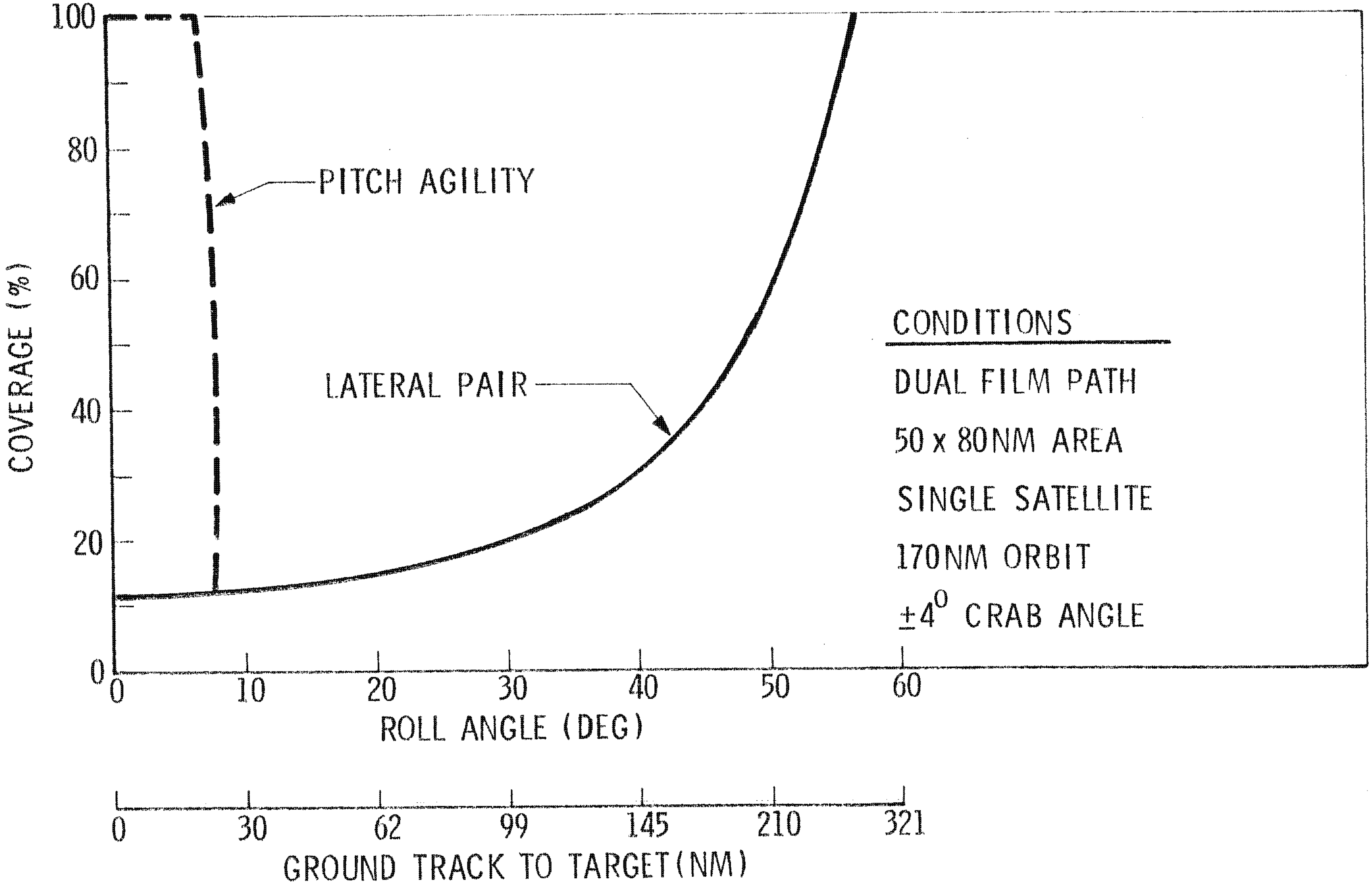
This plot of coverage of a 50 X 80 NM target area summarizes the previous charts and shows that complete coverage is achieved when the ground track is at nadir with pitch agility, or when it is over 280 NM from the edge of the target area. The region in between does not allow complete coverage because of the stereo mirror crab angle limit. This area could be accessed if the satellite axis could be yawed, and a vehicle yaw mechanization is under investigation. Note that the combination of orbit adjust, highly oblique photography, and pitch agility (with present yaw constraints) provides an excellent capability to search areas up to 6,000 square NM.



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The nominal mission profile shown here presumes injection, by second burn of the AGENA main engine, into a 170 NM circular orbit. At two random times, orbit-adjusts are made placing the satellite into an elliptic orbit with a low point altitude of 135 NM positioned over a crisis zone. This orbit also repeats its ground track daily for repeated access to such a zone. Ten days of crisis operations were assumed, after which the satellite is returned to its normal 170 NM altitude for routine operations.

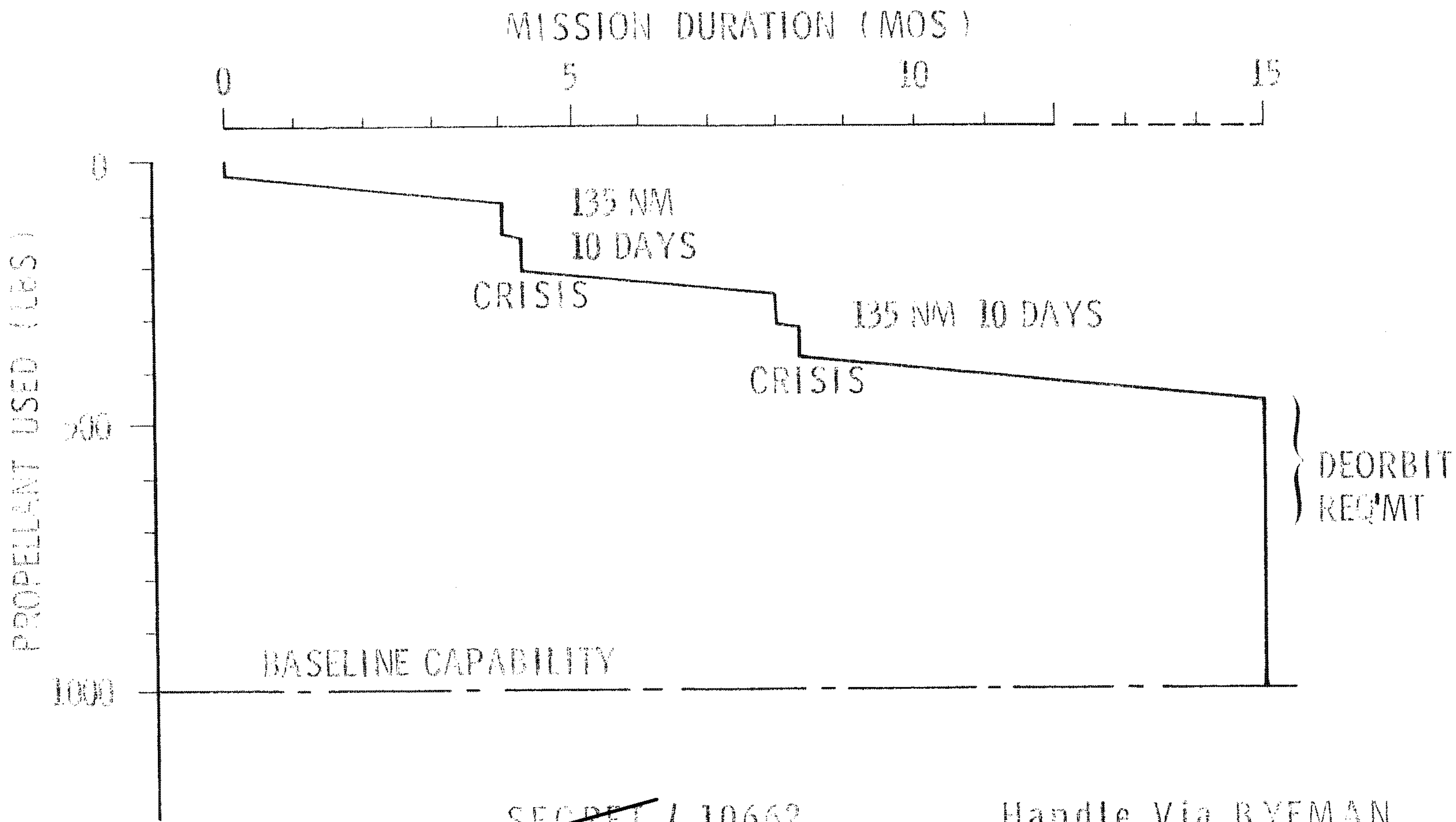
At the end of useful life, the satellite is de-orbited into a broad ocean area, to prevent a random orbit decay and possible undesired recovery of identifiable debris.

The propellant used during the course of the mission is shown on this chart. Initially, about 20 lbs. are expended to correct for injection errors. To maintain either the 170 NM orbit or the crisis orbit, propellant is used to overcome drag, as shown by the negatively sloped regions. The steps occur at the points where the orbit adjusts are made to achieve the daily repeating crisis orbits, and return.

The amount of propellant required for de-orbit from the 170 NM orbit is indicated by the bracket. As is evident, about 200 lbs. of spare propellant is available which could be used for additional crisis, longer times in the crisis orbit, or "phasing" orbits (for rapid positioning of the ground track) as needed.

Note that changing orbits to a daily repeat would be required when only one satellite is operational, since 99% of the earth's surface is visible every day to two satellites.

NOMINAL MISSION WITH CRISIS OPTIONS



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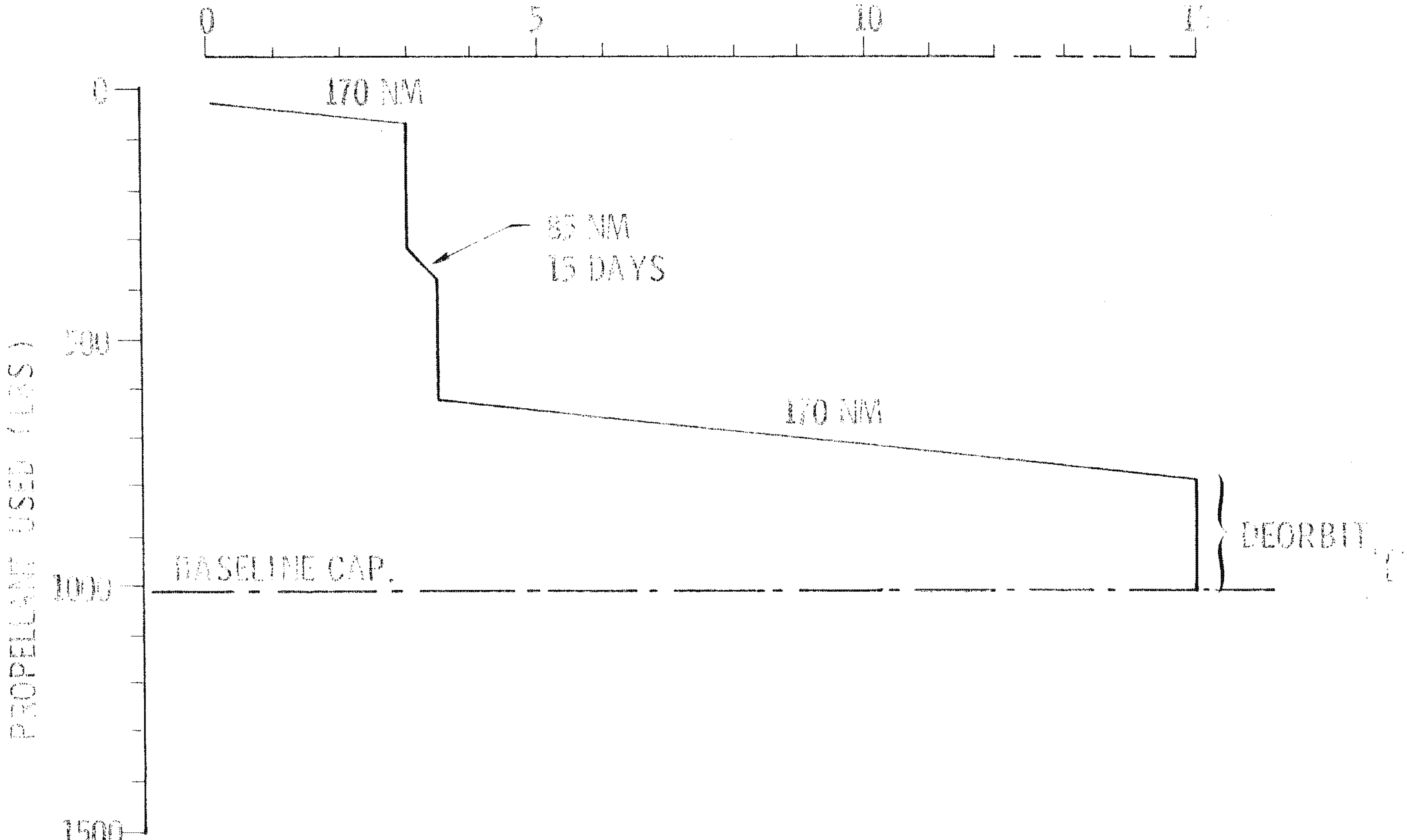
In the event of a crisis where high resolution photography is needed, the option illustrated here is available. An elliptic orbit may be commanded placing the low point of 85 NM (nadir resolution = 1 ft.) over the crisis zone daily. With the baseline configuration, this option can be sustained for about 15 days while retaining the ability to return to the routine 170 NM operations and de-orbit at the end of the mission. Longer periods in the 85 NM orbit are of course available, up to 50 days, by not returning to routine operations. It should be noted that more than one such crisis period cannot be accommodated without some loss of routine operating life and/or de-orbit capability.

SAFSP

ON-ORBIT PROPULSION CAPABILITY

- CRISIS OPTION TO 85 NM

MISSION DURATION (MOS)



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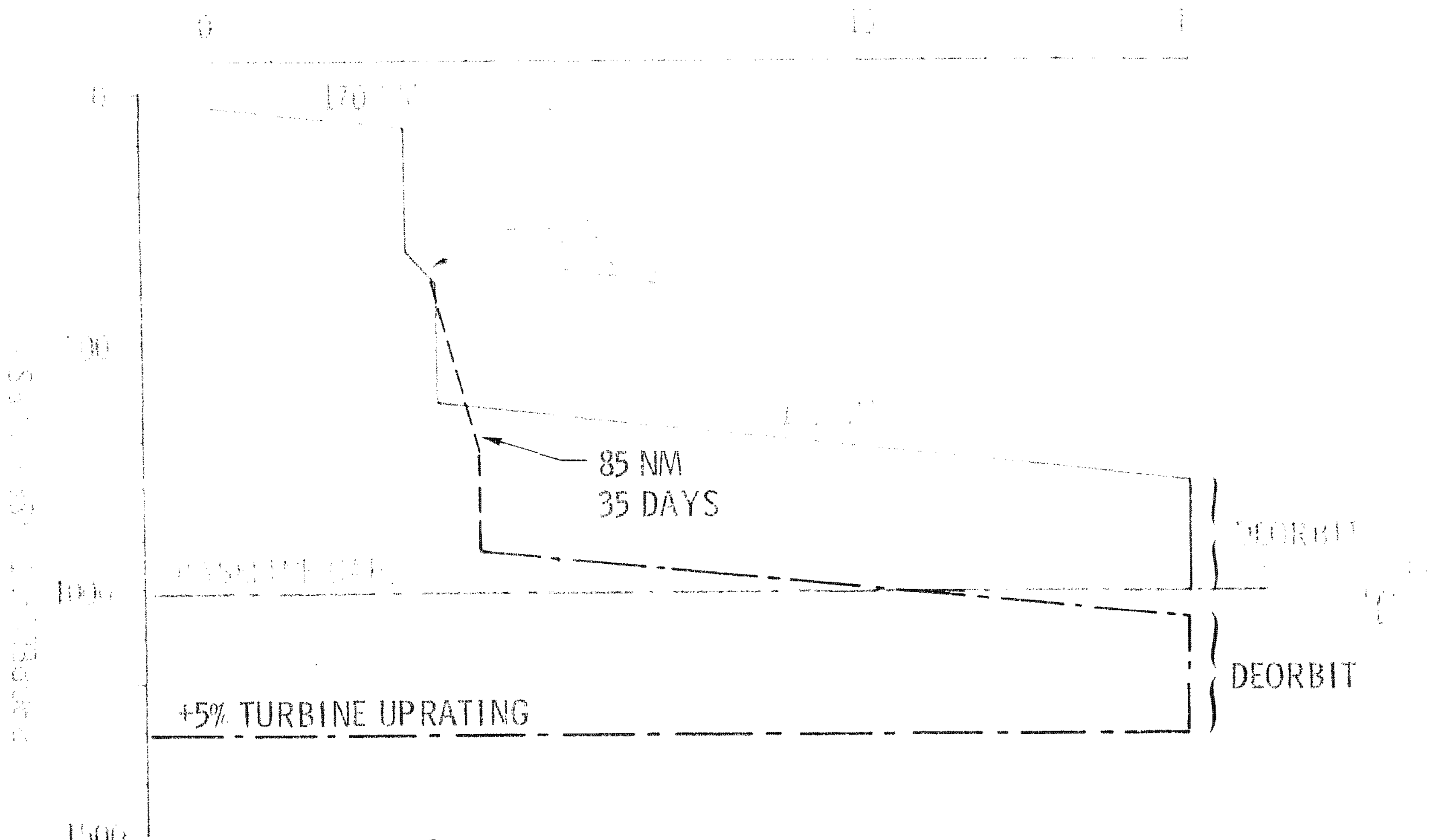
If a 5% increase in turbine speed (first stage booster) is available, the 85 NM crisis orbit can be sustained for about 35 days while retaining capability to return to 170 NM and final de-orbit.

Note the relatively rapid use of propellant associated with extended low altitude operations beyond about ten days. This is necessary to maintain the low point of the orbit over the crisis zone (orbit apsidal rotation correction).

SAFSP



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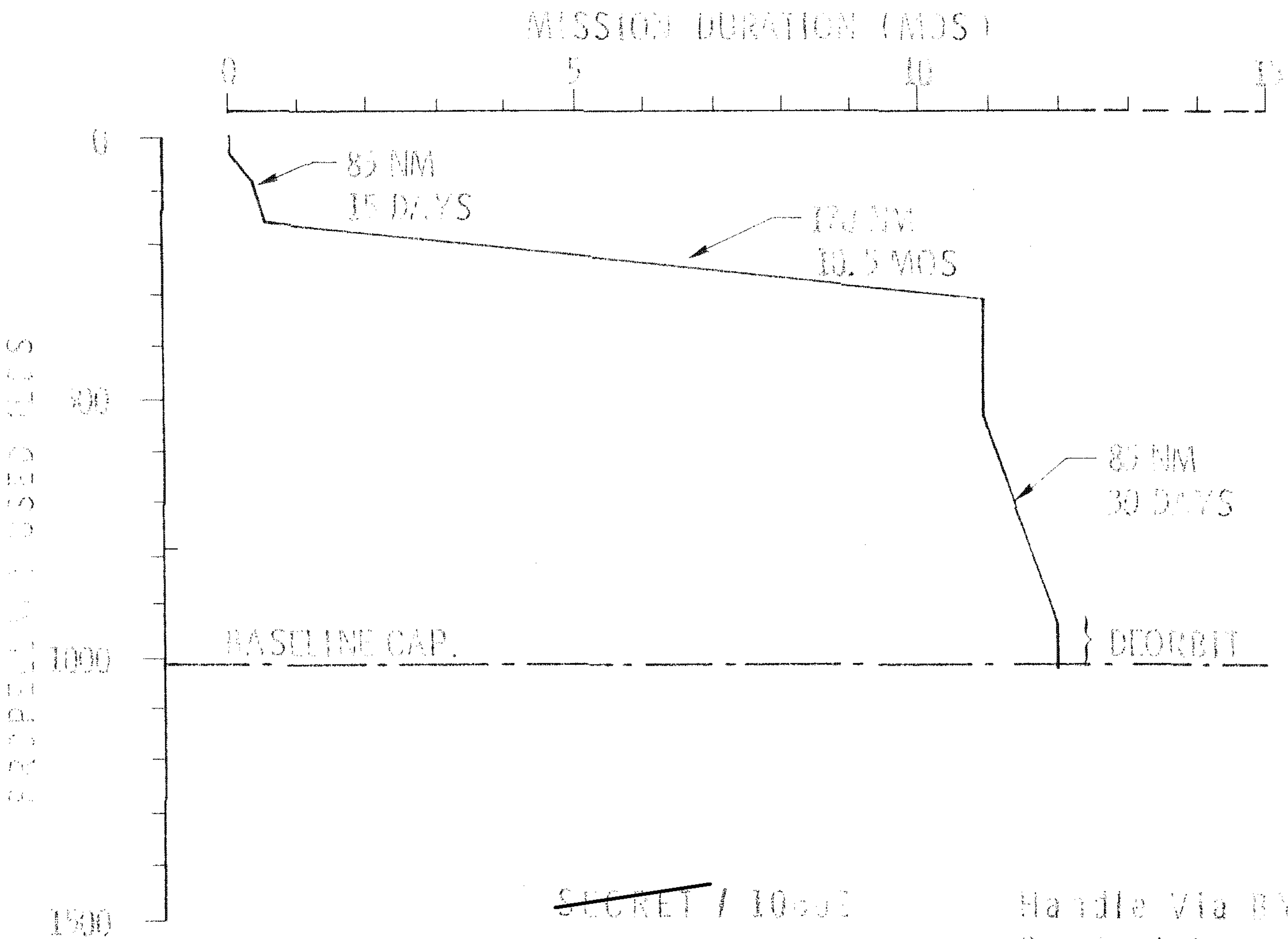
If low altitude operations for high resolution photography can be scheduled at the beginning and end of the mission, about 45 days in this mode may be had with little compromise of routine operations at 170 NM. One potential profile is illustrated. The advantage results from timing the orbit altitude changes to be part of the nominal ascent and de-orbit sequences.

After booster injection into the low orbit, the satellite is sustained for 15 days. Circularizing is then accomplished with the second burn of the main AGENA engine. At the end of the mission, the adjust to 85 NM effectively reduces the amount later required for de-orbit, and thus a high percentage of the propellant is available to sustain the 170 and 85 NM orbits. Note the example shows de-orbit at 12 months, but this is not significant. It could have been programmed at 15 months at a cost of only one or two days to the low orbit period.

SAFSP

ON-ORBIT PROPULSION CAPABILITY

\- NON-CRISIS OPTION



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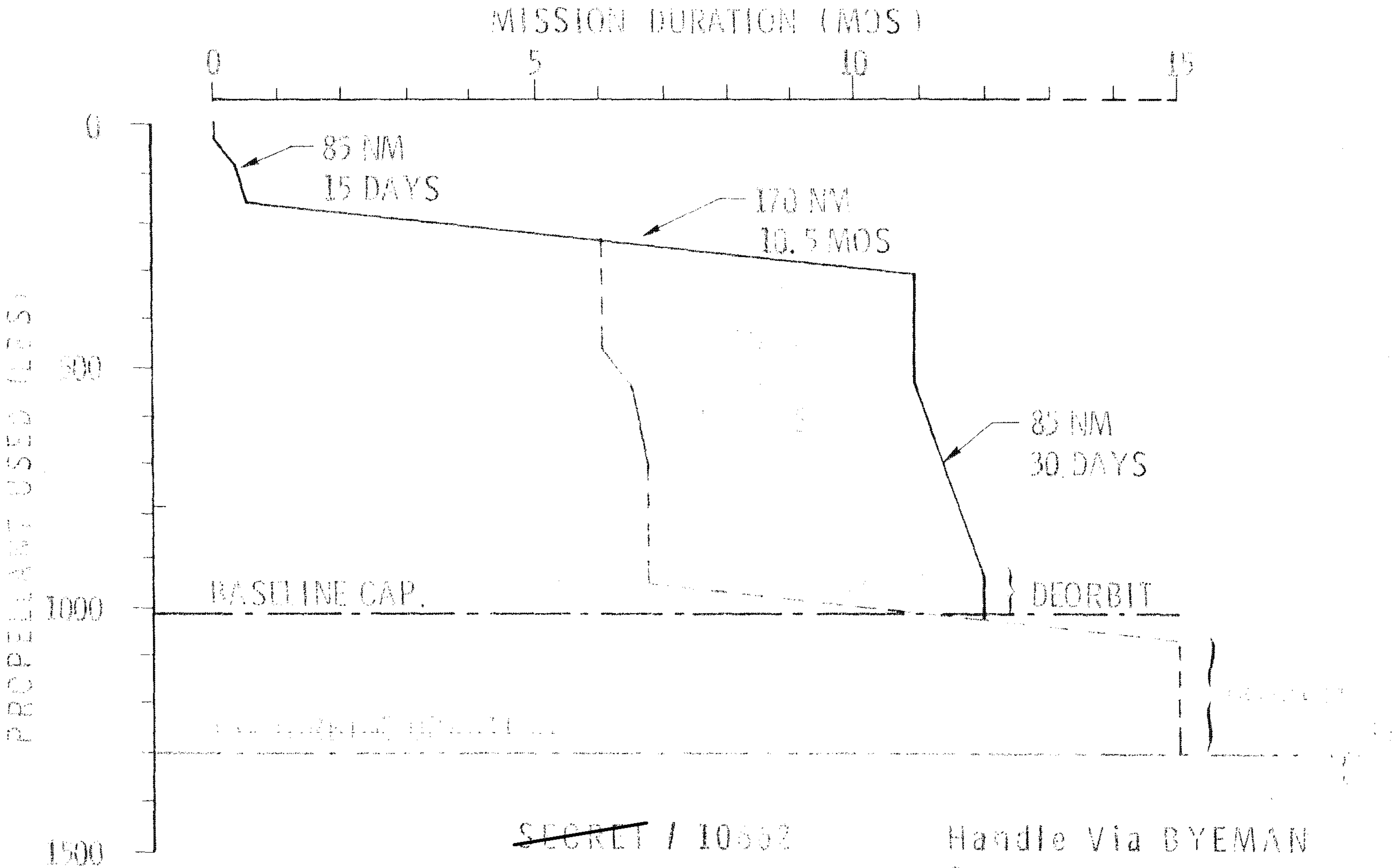
In the event of a crisis after an intial low altitude period of 15 days had been programmed, a second period of 20 days at 85 NM may be achieved followed by return to routine operations. Without the 5% turbine uprating, the de-orbit capability would be lost in this example.

SAFSP

ON-ORBIT PROPULSION CAPABILITY

- NON-CRISIS OPTION



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This chart summarizes the FROG system performance capabilities.

FILM READOUT SYSTEM PERFORMANCE SUMMARY

TWO VEHICLES IN 170 NM ORBIT

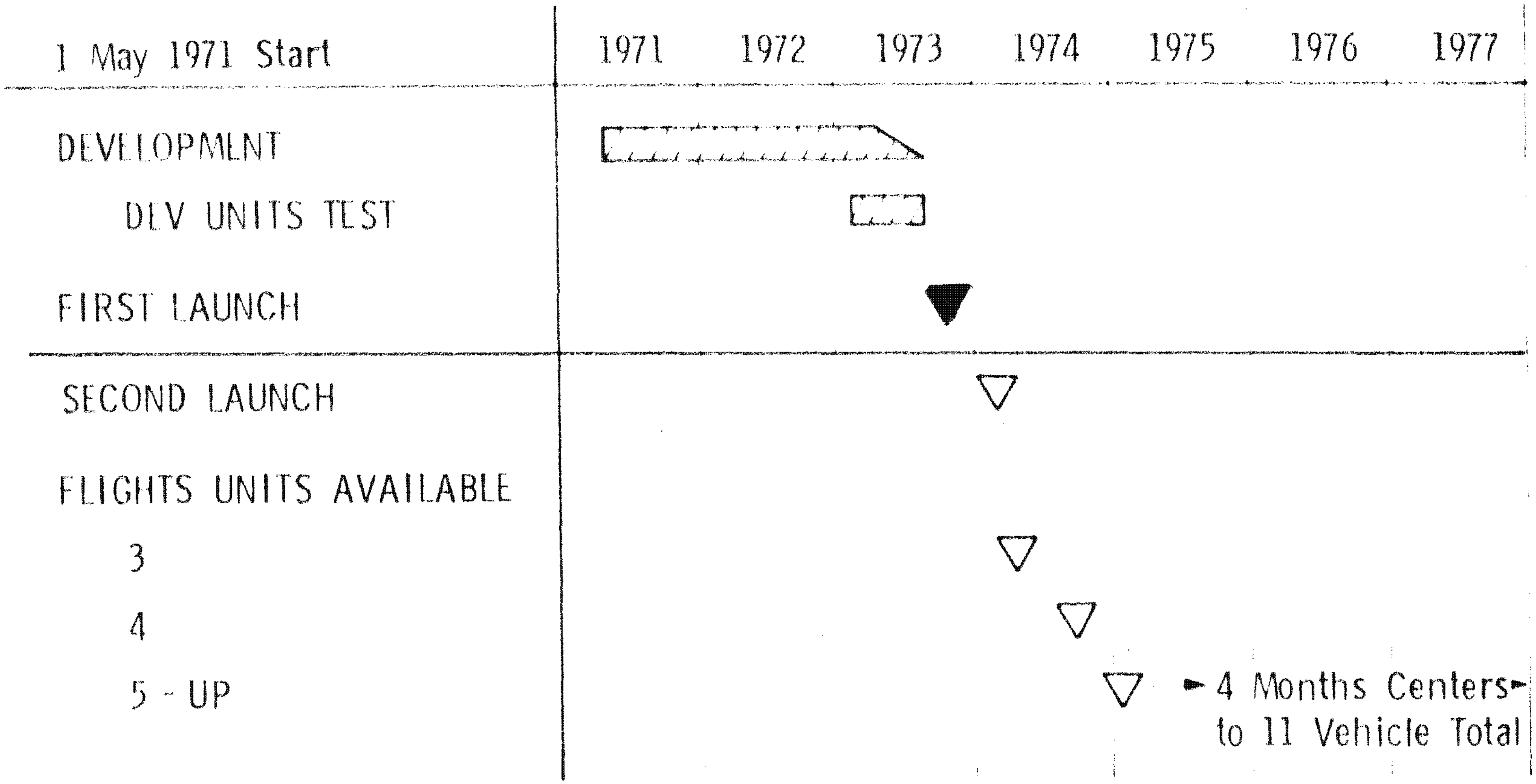
SYSTEM WILL PROVIDE:

o COVERAGE	- 365 DAYS PER YEAR(2.8 LAUNCHES/YR)
o ACCESS	- DAILY TO 99% OF EARTH (100% IN 2 DAYS)
o DATA RETURN	- 400 FRAMES PER DAY (MIN) TO PRIME READOUT STATION (800 F/DAY WITH BOTH STATIONS)
o EXPOSURE TO READOUT TIME	- PRIORITY - 3-12 HOURS; ROUTINE - 12-24 HOURS
o RESOLUTION	- (MONO OR STEREO) - AT 170 NM ALTITUDE - AT NADIR - 60% ≤ 2 FEET - AT 60 DEG VIEW ANGLE - 60% ≤ 5 FEET - ONE FOOT NADIR BEST AT 85 NM ALTITUDE
o AREA COVERAGE	- SPECIFIC CRISIS AREA - TWO FILM PATHS
EACH SATELLITE:	UP TO 6,000 SQ MILE AREAS
TWO SATELLITES:	CONTINUE WORLD WIDE COVERAGE OBTAIN TWICE AS MUCH CRISIS COVERAGE
o RELAY OPTION	- RELAY THROUGH [redacted] SATELLITE ENHANCES FAST DATA RESPONSE

First launch of a FROG vehicle would be 30 months after a decision to proceed with the program. If such a decision were made on 1 May 1971, the first launch would be 1 Nov 1973. The second vehicle would be launched three months later (1 Feb 1974), and the third vehicle would be available for launch six months after the first launch (1 May 1974). Vehicles would then be produced at the rate of three per year to maintain a two-satellite system.

SAFSP

PROGRAM SCHEDULE



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This chart summarizes the non-recurring costs, recurring costs per year, and the recurring costs per launch for an 11-FROG vehicle program through FY 1977.

COST SUMMARY

	MILLIONS
TOTAL NONRECURRING	165
RECURRING PER YEAR	103
RECURRING PER LAUNCH	
VEHICLE	30.4
OPERATIONS	6.3
TOTAL	36.7

Estimates for the orbital control vehicle (OCV) are based on current GAMBIT Program costs.

Estimates for the optics and readout module (ORM) are based on the B-2 development executed from 1967 through 1969.

Data link estimates are based on related equipment experience.

The launch and orbital operations estimates include all program related costs to the SCF for operations and data retrieval assuming readout stations at BOSS and COOK.

All estimates assume continuation of the GAMBIT Program.

Subtraction of "work in progress" from the total funding required allows comparison with other options on either a continuing or a truncated program basis.

FUNDING REQUIREMENTS

1 MAY 1971 START 1 NOV 1973 FIRST LAUNCH	FY71	FY72	FY73	FY74	FY75	FY76	FY77	TOTAL
DEVELOPMENT (NONRECURRING) TIIIB	0.3	1.0						
OCV	2.4	31.4	10.4	0.3				
ORM	4.0	57.0	33.0	4.0				
DATA LINK	0.8	6.1	1.2	0.2				
TOTAL	7.5	95.5	44.6	4.5				152
RECURRING								
T-IIIB (INCL LAUNCH)		6.0	15.0	19.2	19.2	19.2	19.2	
OCV		11.5	22.4	25.4	30.5	31.3	29.6	
ORM		16.0	32.0	35.0	33.0	33.0	34.0	
DATA LINK		0.1	1.8	1.8	1.9	1.9	1.3	
TOTAL		33.6	71.2	81.4	84.6	85.4	84.1	440
LAUNCH AND ORBITAL OPERATIONS								
(BOSS & COOK) NONRECURRING		5.0	8.0					13
RECURRING			1.2	15.4	16.9	17.7	18.8	70
TOTAL		5.0	9.2	15.4	16.9	17.7	18.8	83
TOTAL FUNDING CONTINUING PROGRAM	7.5	134.1	125.0	101.3	101.5	103.1	102.9	675
WORK IN PROCESS					(11.2)	(33.5)	(61.6)	(106)
NET COST 11 VEHICLES THRU FY77	7.5	134.1	125.0	101.3	90.3	69.6	41.3	569

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This chart shows the additional funding required to add a readout capability at KODI and a [redacted] relay capability at both BOSS and KODI.

RELAY OPTION

	FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	TOTAL
TOTAL FUNDING (BOSS PLUS COOK)	7.5	134.1	125.0	101.3	101.5	103.1	102.9	675
ADD KODI PLUS RELAY CAPABILITY AT BOSS AND KODI		1.0	14.6	7.3	3.6	3.6	3.6	34
TOTAL	7.5	135.1	139.6	108.6	105.1	106.7	106.5	709

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