~~SECRET 10017~~

VOLUME 5

FAST BACK VEHICLE

~~SECRET 10017~~

Handle via BYEMAN
Control System Only

The Fastback Vehicle is the concept which has been proposed by Martin-Denver as a means of obtaining crisis area photographs in less than one day with recovery of film and (reusable) satellite vehicle. This briefing describes the system and mission concept.

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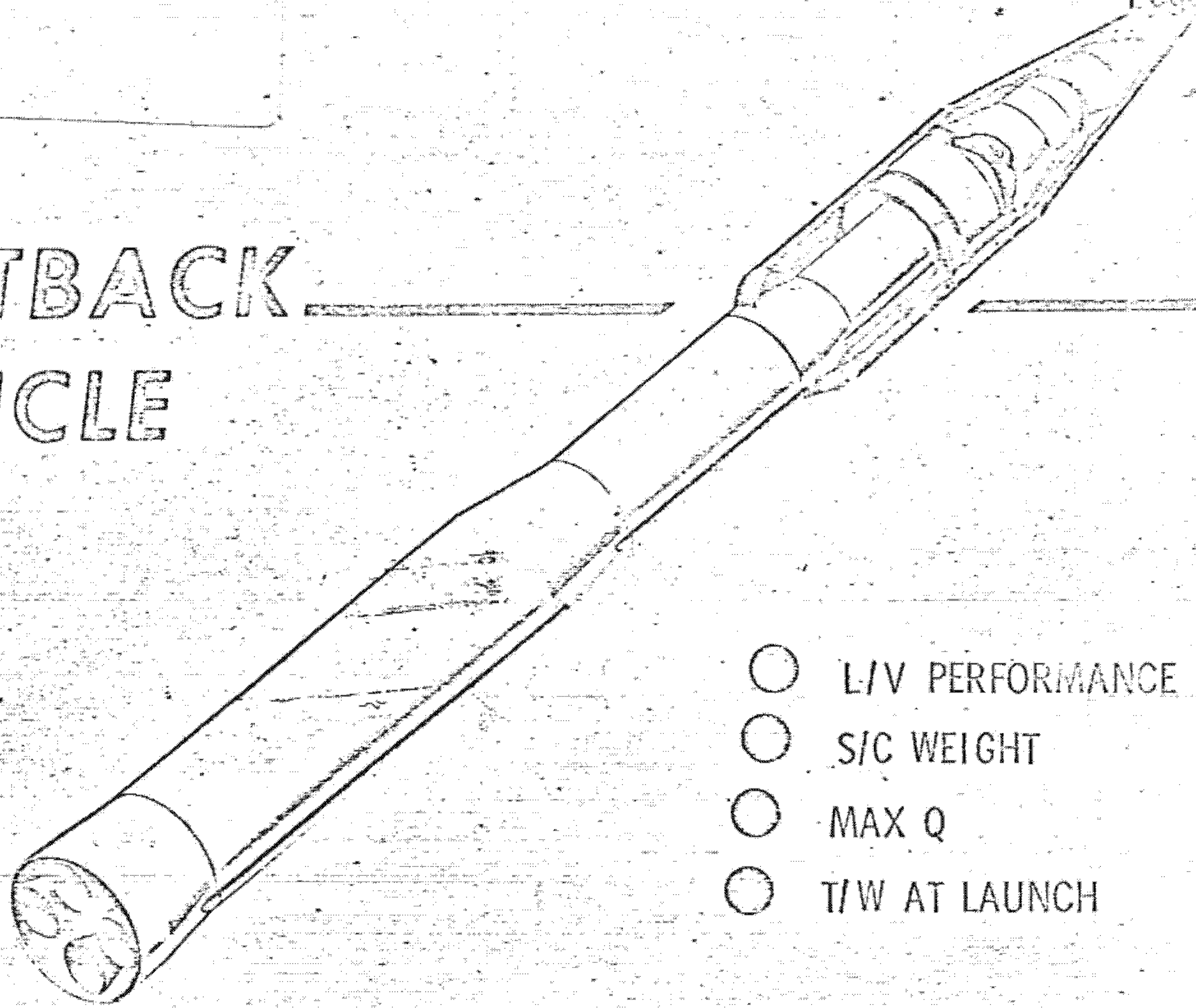
THE FASTBACK VEHICLE



- L/V PERFORMANCE 1130 LB
- S/C WEIGHT 1037 LB
- MAX Q 3800 PSF
- T/W AT LAUNCH 2.6

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The chart lists the principal features of the Fastback concept.

In general, satellites are launched from Johnston Island in a southeasterly direction with the exact launch azimuth chosen to provide at least two looks at the crisis area. Launches will normally be at night so as to arrive over the crisis area in the Sino-Soviet bloc during daylight hours.

For typical orbits the satellite will be deboosted after five revs, and recovered in the air southeast of Bermuda. The recovery aircraft will fly directly to Andrews Air Force Base to deliver the satellite and its exposed film.

After the film is unloaded, the satellite is returned to Johnston Island for refurbishment and reuse.

SYSTEM CONCEPT

LAUNCH	REFURBISHED MINUTEMAN, FROM JOHNSTON ISLAND
ORBIT	70 X 200 NMI; $17^0 \rightarrow 70^0$ INCLINATION; 4 - 10 REVS LIFE
RESPONSE TIME	15 → 21 HOURS FROM ALERT TO DELIVERY AT ANDREWS AFB
COVERAGE	FILM (46 LBS.) PROVIDES TOTAL 2,000 NMI X 140 NMI SWATH, EXCEPT:
	START UP AND SHUT DOWN: 114 NMI / SEQUENCE
	PREDICTION ERRORS: $\pm$30 NMI / REV.
RESOLUTION	2.1 FT. (NADIR)
	> 3.5 FT. (45^0 OBLIQUITY)

ENTIRE PAYLOAD RECOVERED AND REUSED

DAILY REPEAT DURATION	5, 10, OR 170 DAYS (DEPENDING ON COST OPTION)

This chart shows the payload capability of the refurbished Minuteman.

Since the spacecraft weighs 1,114 pounds, it is necessary to select an orbit of slightly reduced apogee for higher orbit inclinations.

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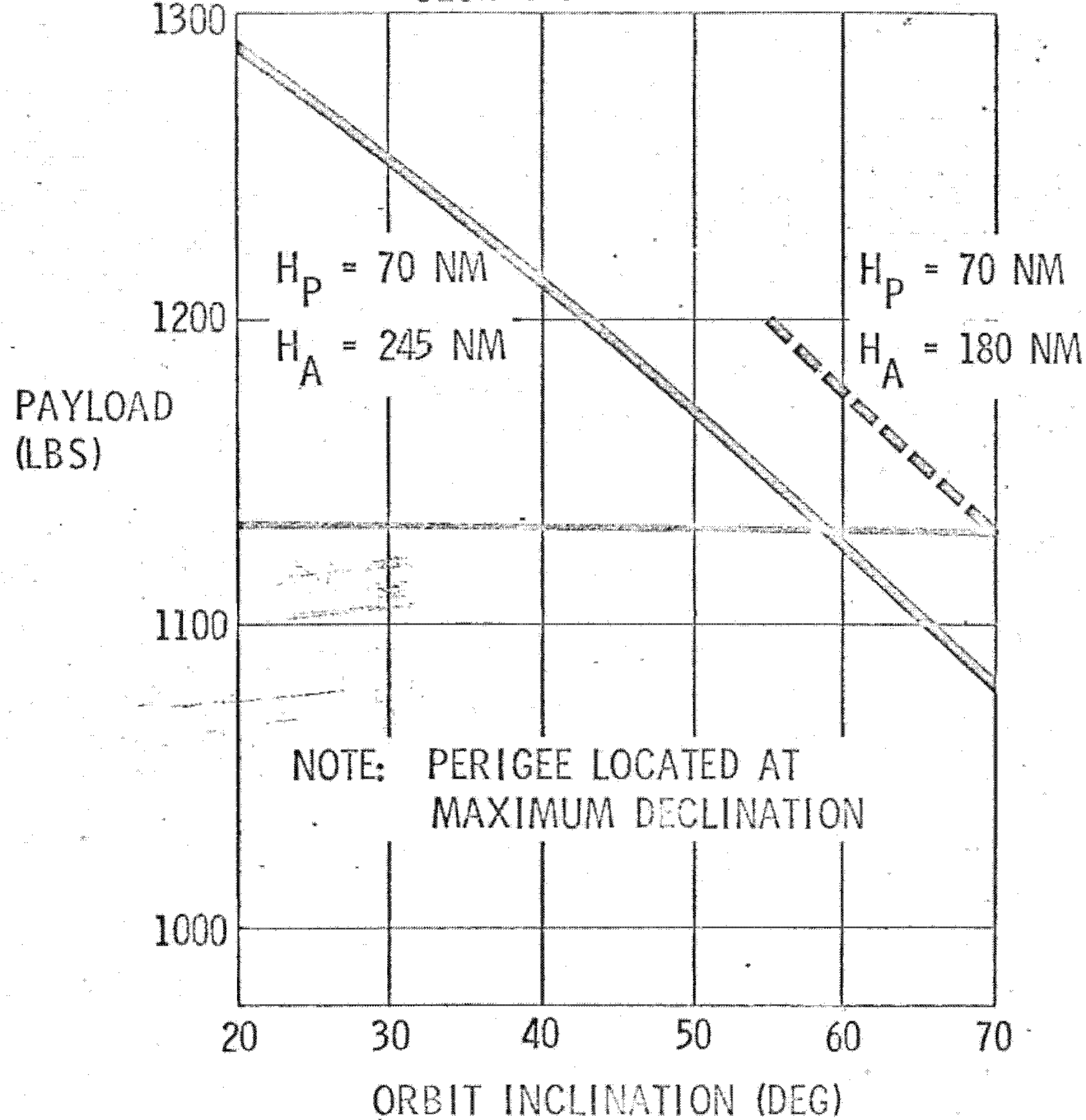

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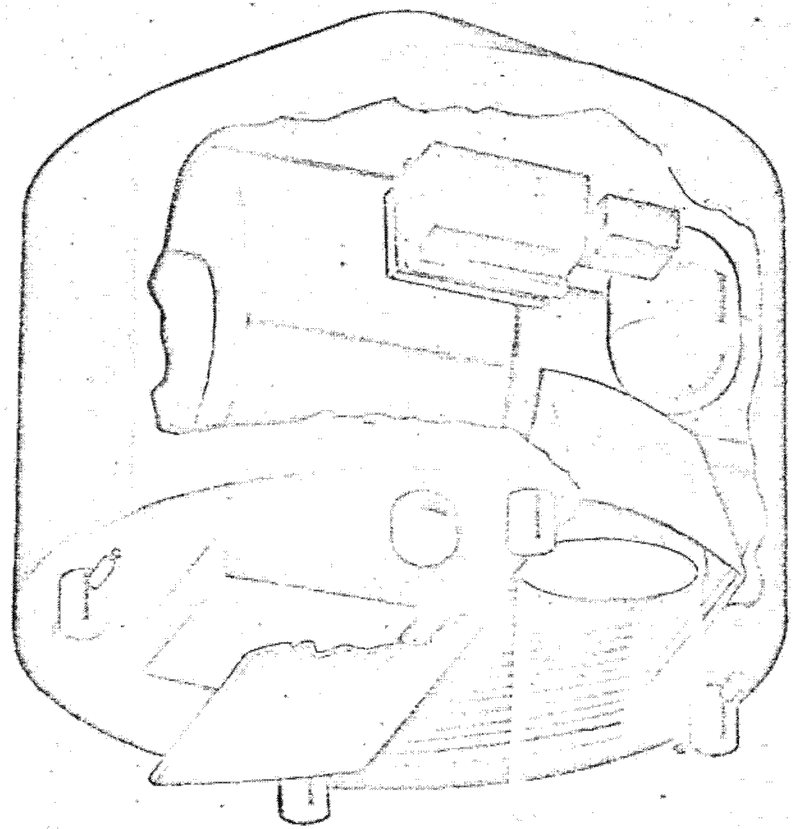
This is a sketch of the spacecraft concept.

The spacecraft is three axis stabilized. Within the spacecraft the large cylindrical object is the payload camera and film. The trap door will be closed except during active photography. Photographic operations are all pre-programmed. On the right is a V/H sensor to ensure that the film drive speed is accurate for the actual satellite attitude. Small thrusters can be seen which use monopropellant hydrazine for active attitude control. The blunt nose of the spacecraft is ablative and protects the satellite during reentry. The entire exterior of the spacecraft must be covered with the ablating material. Small spin rockets are used to spin up the rocket to about 8 rpm for stabilization during reentry.

FASTBACK ORBITING VEHICLE



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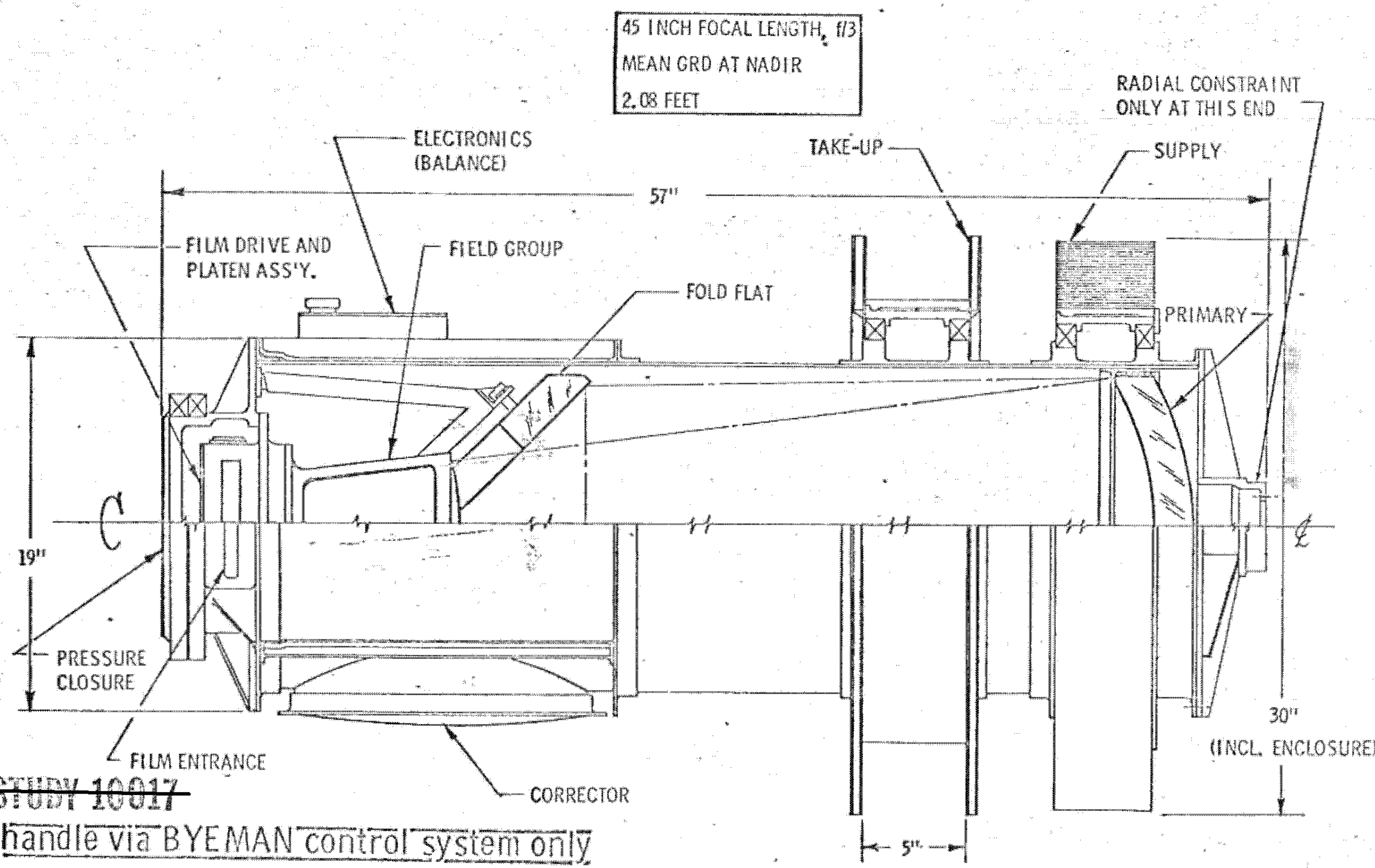
This is a schematic of the payload camera which has been designed by the Perkin-Elmer Corporation. The camera operates in a panning mode, taking abutting strips to cover the area. The optical design is a folded Wright with a focal length of 45" and primary diameter of 15". The film supply and take-up rolls are mounted at the righthand end and rotate opposite to the main barrel to reduce the stored angular momentum. The film is led along the barrel and moves perpendicular to the plane of the paper through the film entrance at the lefthand end of the barrel. The film is skewed slightly to compensate for the forward motion of the satellite, but otherwise the film path is rigidly attached to the barrel to provide a very simple film path.

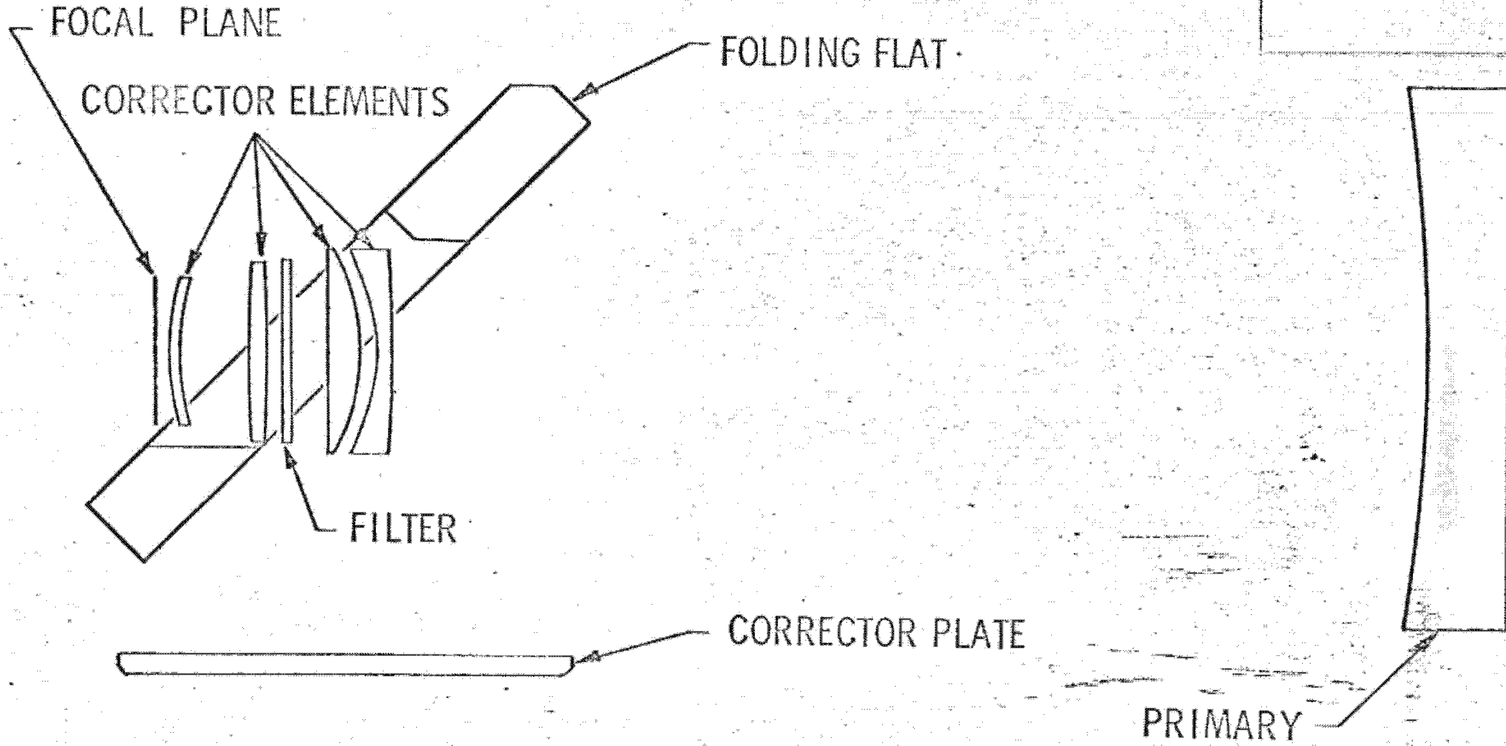
The primary mirror, the folding flat, and the camera barrel are all made of beryllium for good thermal control with a very lightweight design. The entire camera is thermally isolated from the rest of the satellite by super-insulation and is pressurized to one psi.

FASTBACK CAMERA SYSTEM



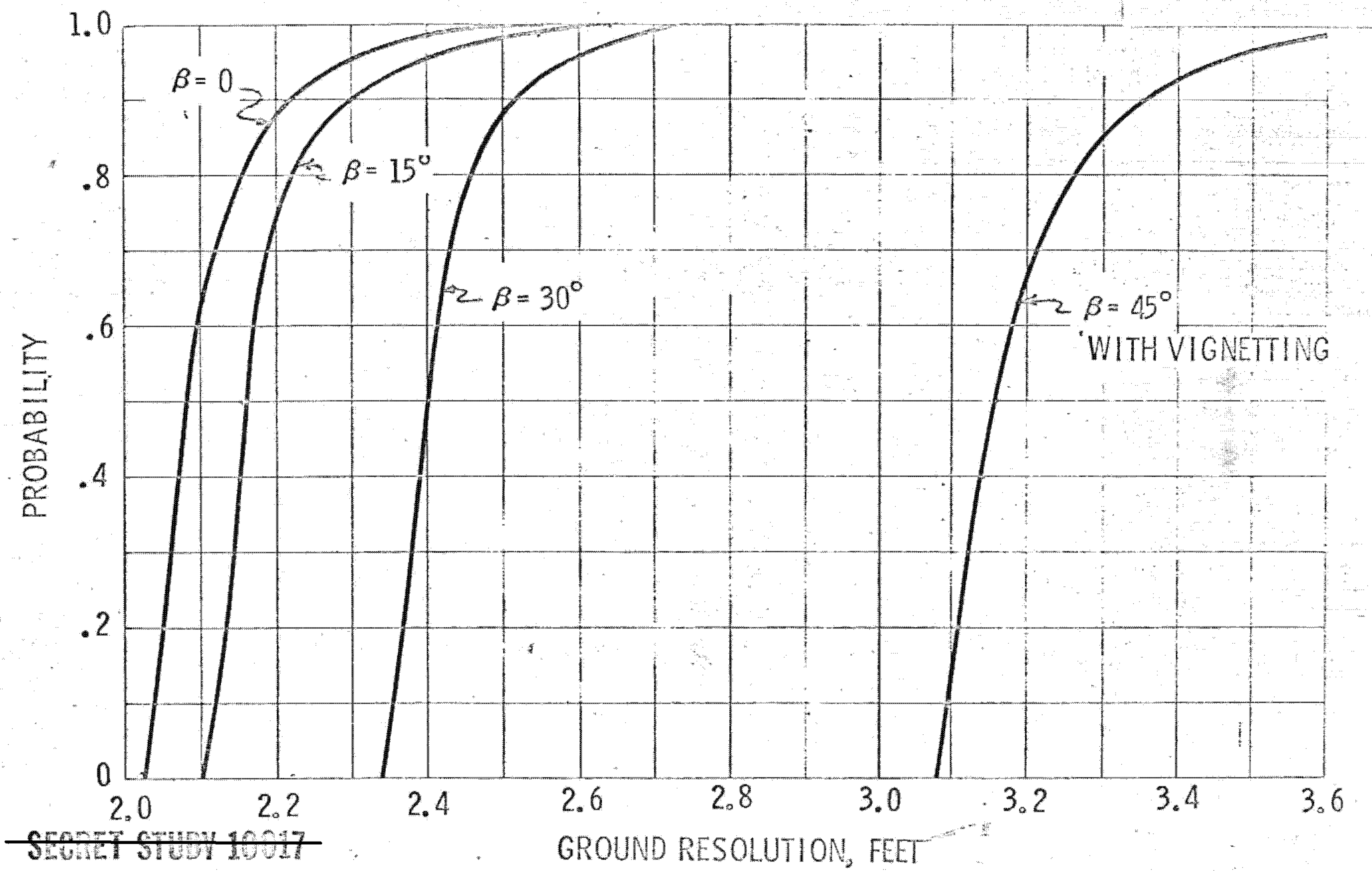
This is a schematic of the optical design.

FASTBACK FOLDED WRIGHT OPTICAL SYSTEM



Performance of the camera system is remarkably good. This graph shows that at nadir an average resolution of 2.1 feet should be obtained. The quality is only slightly degraded at 30^0 obliquity, but the optics are somewhat vignetted for larger angles so that the average resolution is reduced to about 3.2 feet at the maximum obliquity 45^0.

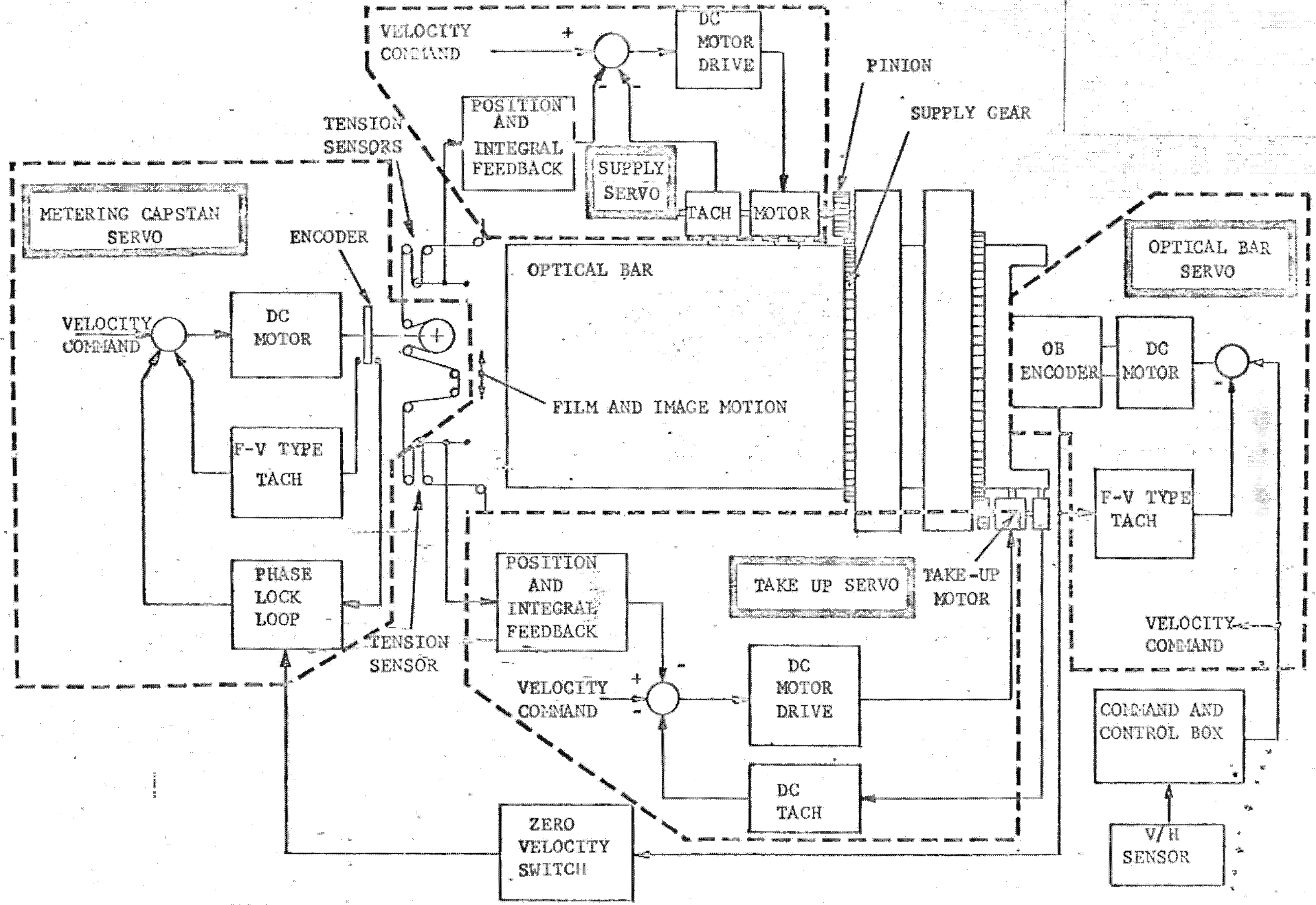
The predicted ground resolution is based on an optical quality factor of about 78% using a Monte Carlo distribution of the various smear and navigation contributors. The target contrast was assumed to be 3 to 1 on the ground with the dark bars having 5% reflectance. This corresponds under typical atmosphere conditions to a target contrast at the satellite of 1.6 to 1. Minimum target brightness was set at 530 foot lamberts.


1.0
.8
.6
.4
.2
0
PROBABILITY
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
GROUND RESOLUTION, FEET
β = 0
β = 15°
β = 30°
β = 45°
WITH VIGNETTING

THIS SHEET LEFT BLANK INTENTIONALLY

This block diagram of the camera system shows that the primary command input is the velocity command of the V/H sensor to the optical bar rotation. The metering capstan servo is phased locked to the optical bar rotation. Supply and pick up servos maintain the proper tension for the film path to and from the platen.

PHOTO SYSTEM BLOCK DIAGRAM



CAMERA CHARACTERISTICS

The principal camera characteristics are tabulated.

Note that once a photograph is initiated, the film is not stopped as the optical bar rotates away from the ground. This means that only 1/4 of the film will have useful imagery. However, the film wastage greatly simplifies the mechanical design of the camera. In addition, weight is saved by avoiding the mechanism otherwise required to start and stop and reverse the film on every rotation of the optical bar.

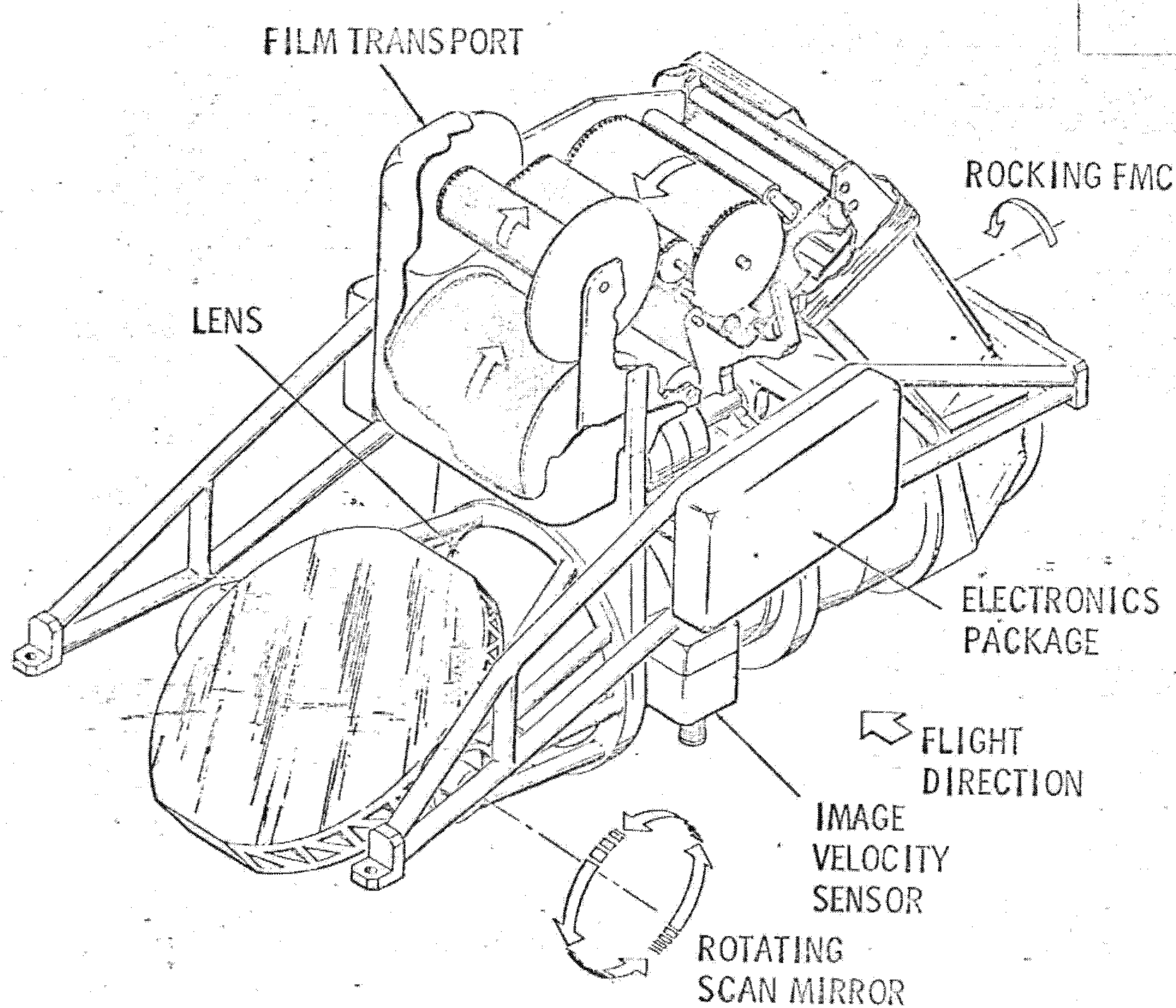
CAMERA CHARACTERISTICS

OPTICS	FOLDED WRIGHT, 45" f/3
FIELD OF VIEW	6^0
FILM SPEED	181 INCHES / SEC; 1^0 SKEW; 1/8" JOG DURING PAN
FILM LOAD	7,800 FEET, 5" WIDE 0.0021" THICK, 46 POUNDS
OPTICAL BAR ROTATES	38.4 RPM
MIRRORS AND STRUCTURE	BERYLLIUM
TOTAL WEIGHT	350 LBS. WITH FILM

The camera which has been described provides monoscopic photography.

If stereo coverage is required, Hycon has proposed a camera with a rotating scan mirror which uses 9.5" film and provides 6° of stereo with 55% overlap. This camera provides resolution roughly 10% poorer than that of the Perkin-Elmer baseline camera.

FASTBACK ALTERNATE CAMERA SYSTEM



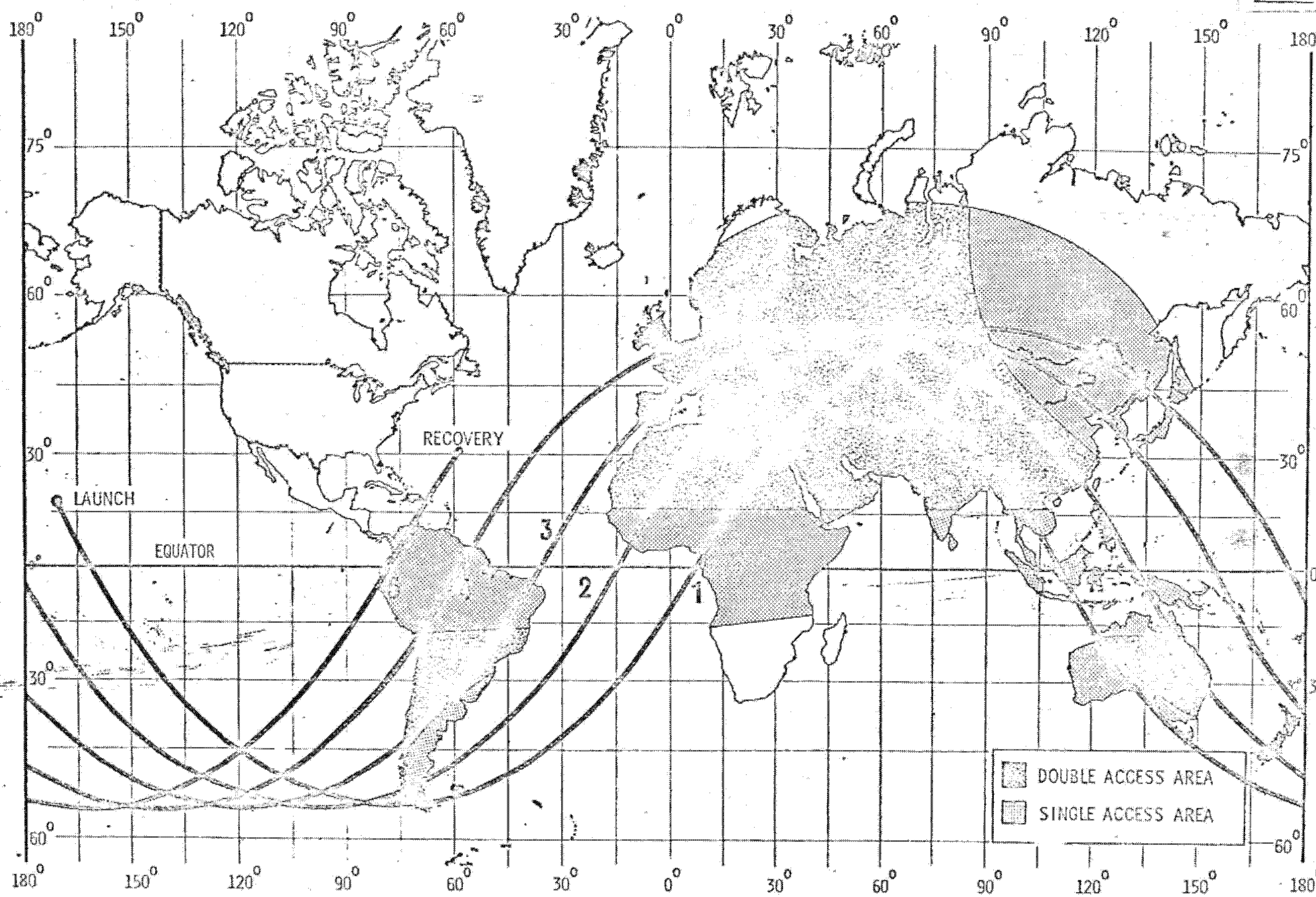
This chart shows a typical deployment of the Fastback camera for concentrated coverage of the central Soviet land mass. As can be seen by the crossing ground tracks, there are a number of areas of this particular increment that have double or triple coverage on successive orbits. If one wished more concentrated coverage at more northerly or southerly lattitudes, the vehicle would be launched at correspondingly higher or lower inclination.

The background map shows the total coverage which can be provided from Johnston Island. The blank areas in eastern Siberia and the North American continent cannot be accessed because of the very short vehicle life. In principle, a polar launch could actually access these areas, but would require vehicle lifetime of at least a day rather than approximately 1/2 day limit of the current concept.

The majority of the politically sensitive areas of Europe, southeastern Asia, northern Africa, and Siberia are accessible by this system, with double access provided for most of the high priority areas.

FASTBACK

GROUND TRACK AND TARGET ACCESS



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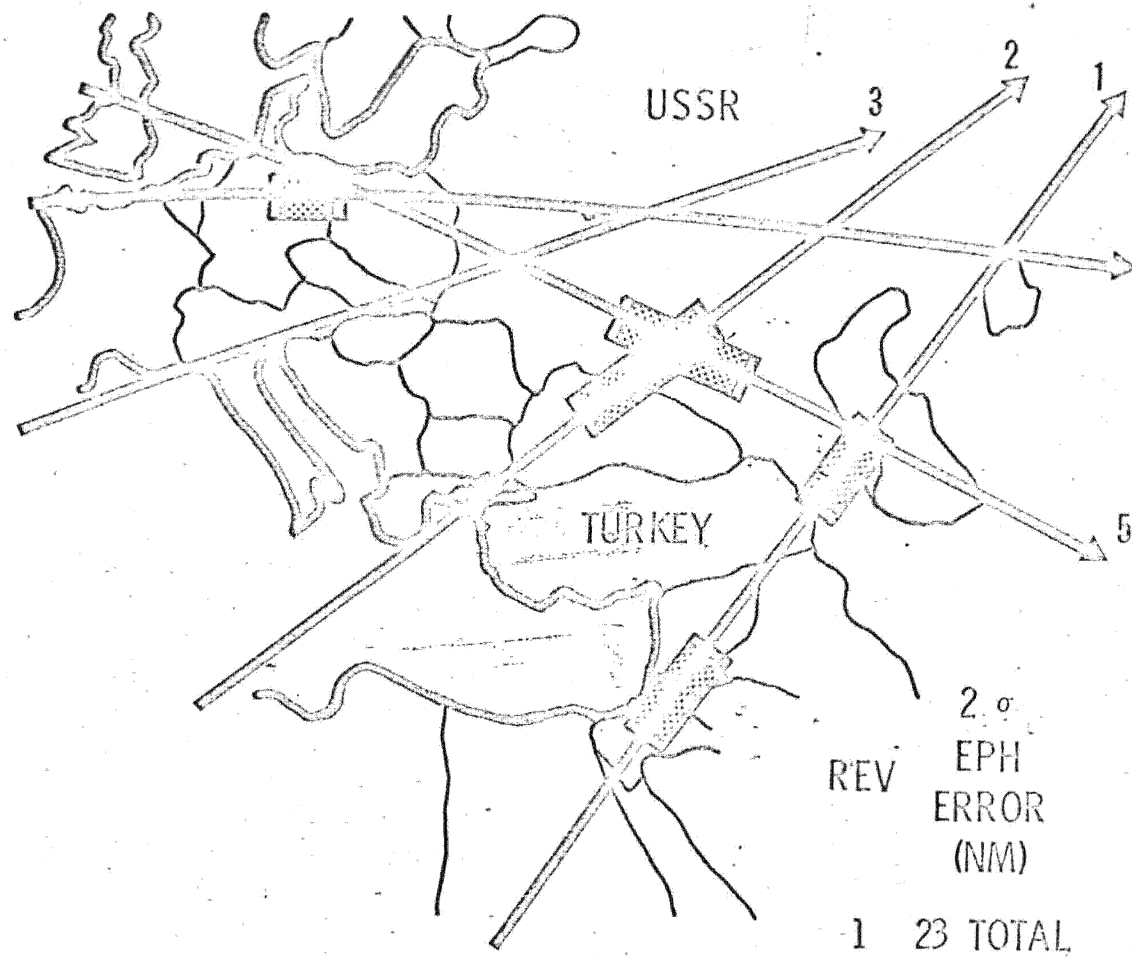
This detail map shows the multiple coverage which is possible using the Jordanian Crisis as an example. The satellite has no command link whatever; therefore, the bursts of photography which are shown here would have been programmed before launch. These bursts must be extended somewhat to allow for ephemeris errors between pre-launch predicts and the actual performance on orbit. However, the total film supply is so large that this film wastage is of no practical importance.

The coverage shown in this diagram is for an inclination of about 60° to secure coverage of selected Soviet Bloc targets. It is clear that a much lower inclination of 30° would have provided concentrated coverage for the mid-east only.



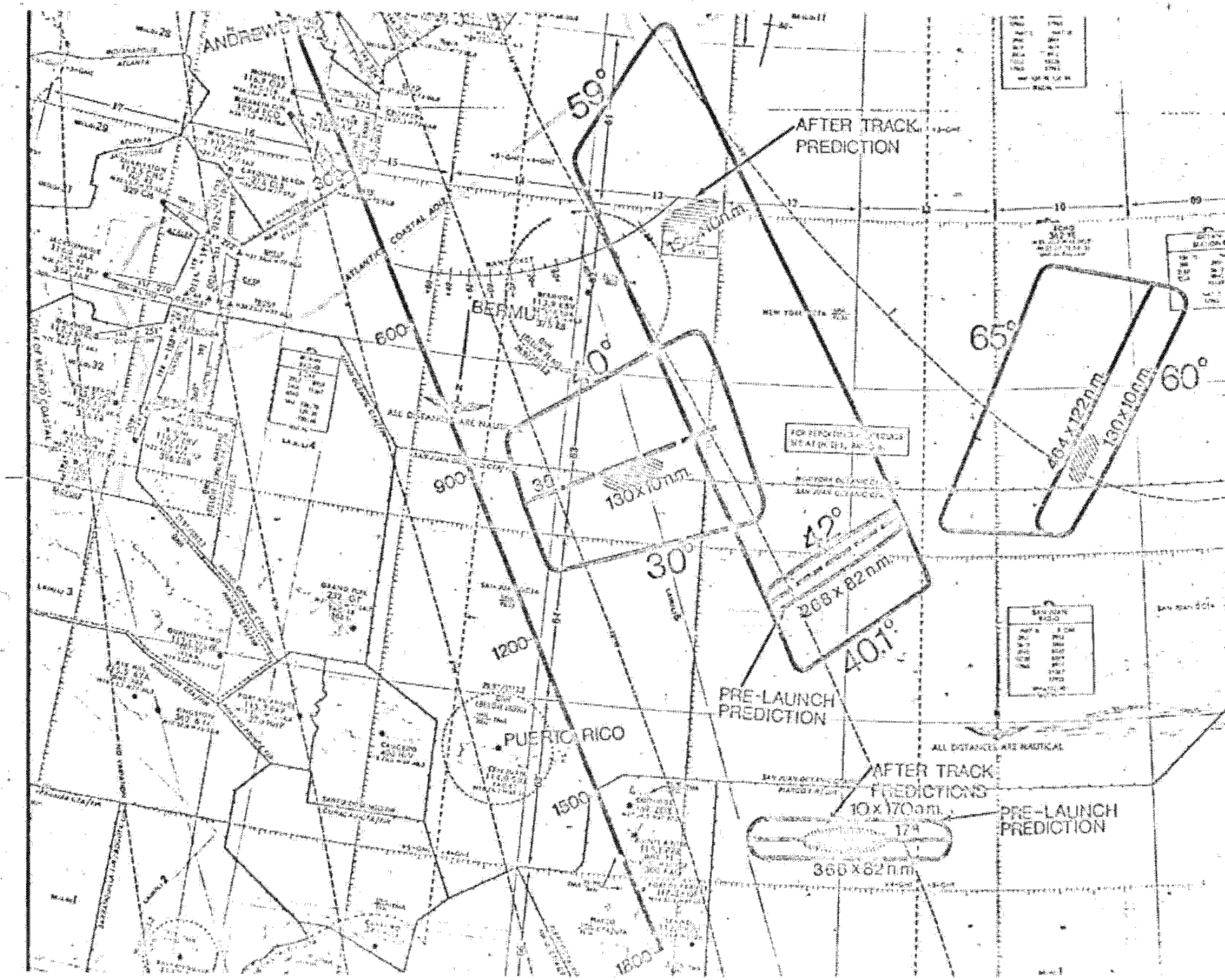
REV	2 σ EPH ERROR (NM)	SU/SD (NM)
1	23 TOTAL	57 TOTAL
2	57	↓
3	103	
4	154	
5	205	

This map shows the recovery area southeast of Bermuda, which is proposed for this program. A fleet of five C130 aircraft would be based in Bermuda and would be deployed for each recovery operation. For each launch the programmer on board the satellite would return the capsule to an area of about 300-500 NMI in-track and about 100 NMI cross-track.

However, this excessively large recovery area can be substantially reduced by tracking the vehicle from the Guam Tracking Station using an SGLS transponder which is on the satellite. Using such tracking eliminates the booster dispersion. The recovery area foot print then reduces to an acceptable 130 to 150 NMI in-track and about 10 NMI cross-track.

C130 aircraft have sufficient range to recover a satellite in the region shown and fly directly to Andrews Air Force Base except for the recovery area chosen east of Puerto Rico for the 17^{0} orbit inclination. For that orbit it would be necessary to refuel the aircraft in Puerto Rico prior to recovery of the capsule. The aircraft would then be able to return the capsule directly to Andrews Air Force Base to minimize the delay in delivering pictures to the Washington area.

FASTBACK DISCOVERY—BERMUDA



The system that has been described provides pictures for only one day for each launch. Daily pictures would generally require a launch every day for the duration of the crisis.

However, reasonable deployment of this system (which has a very fast response) would suggest that an accurate capability to forecast weather over the crisis area an hour or two before launch should be exploited. A Fastback satellite would only be launched on those days in which the weather in the crisis area was acceptable.

The graph shows the weather distribution for a number of possibilities in the crisis area. If one elects to launch only when the weather is predicted 50% cloud free or better, then there are only four days per month in the Moscow area for which photography is reasonable. On the other hand the desert regions of Egypt would provide over twenty days per month of good visibility; and would, therefore, require a very high launch return if one desired to use every opportunity. The generally poor weather in most of the politically unstable regions of the world suggests that sizing a crisis system for desert climates may provide more capability than is useful in most situations.

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FASTBACK

EXPECTED CLOUD COVER

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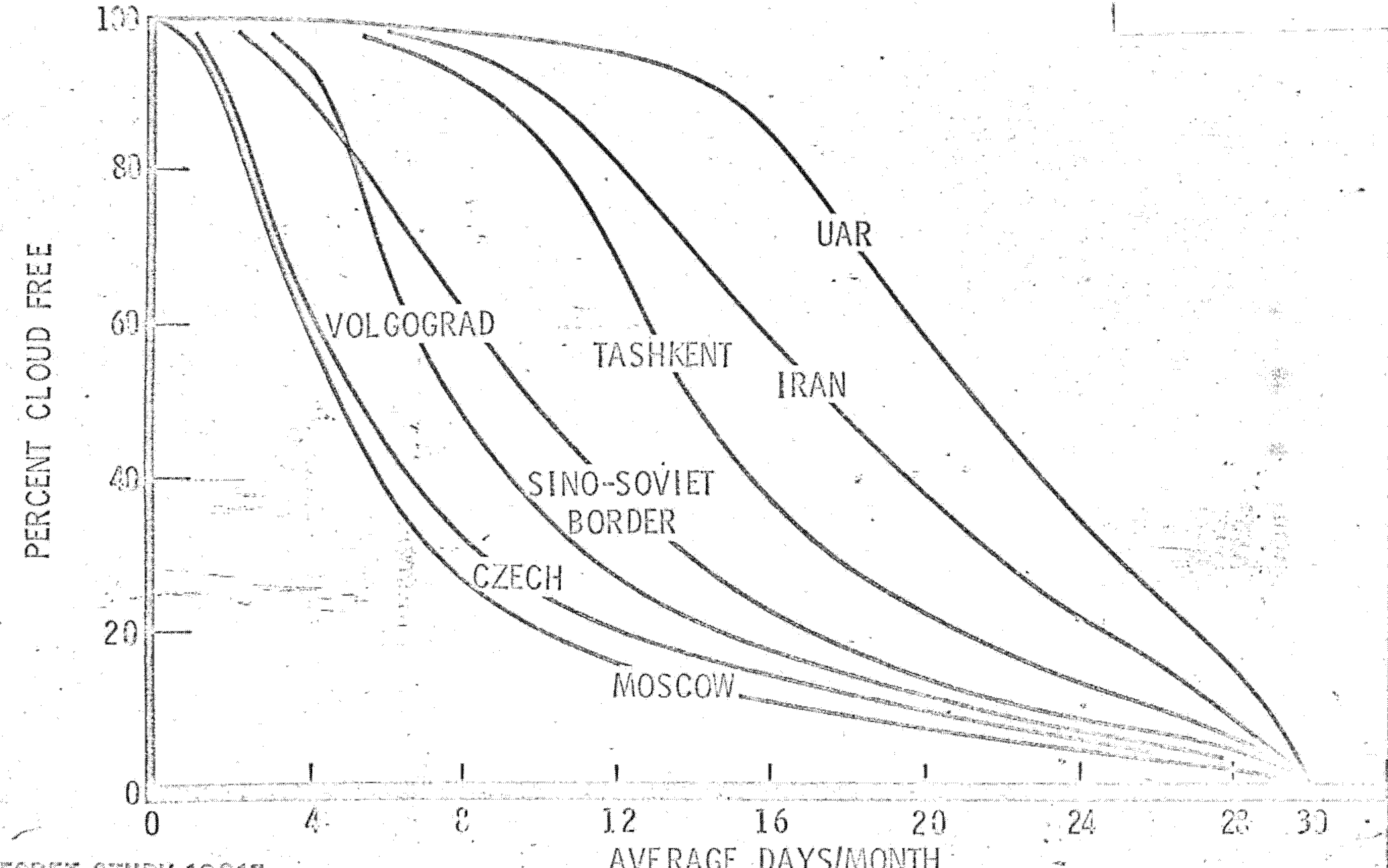

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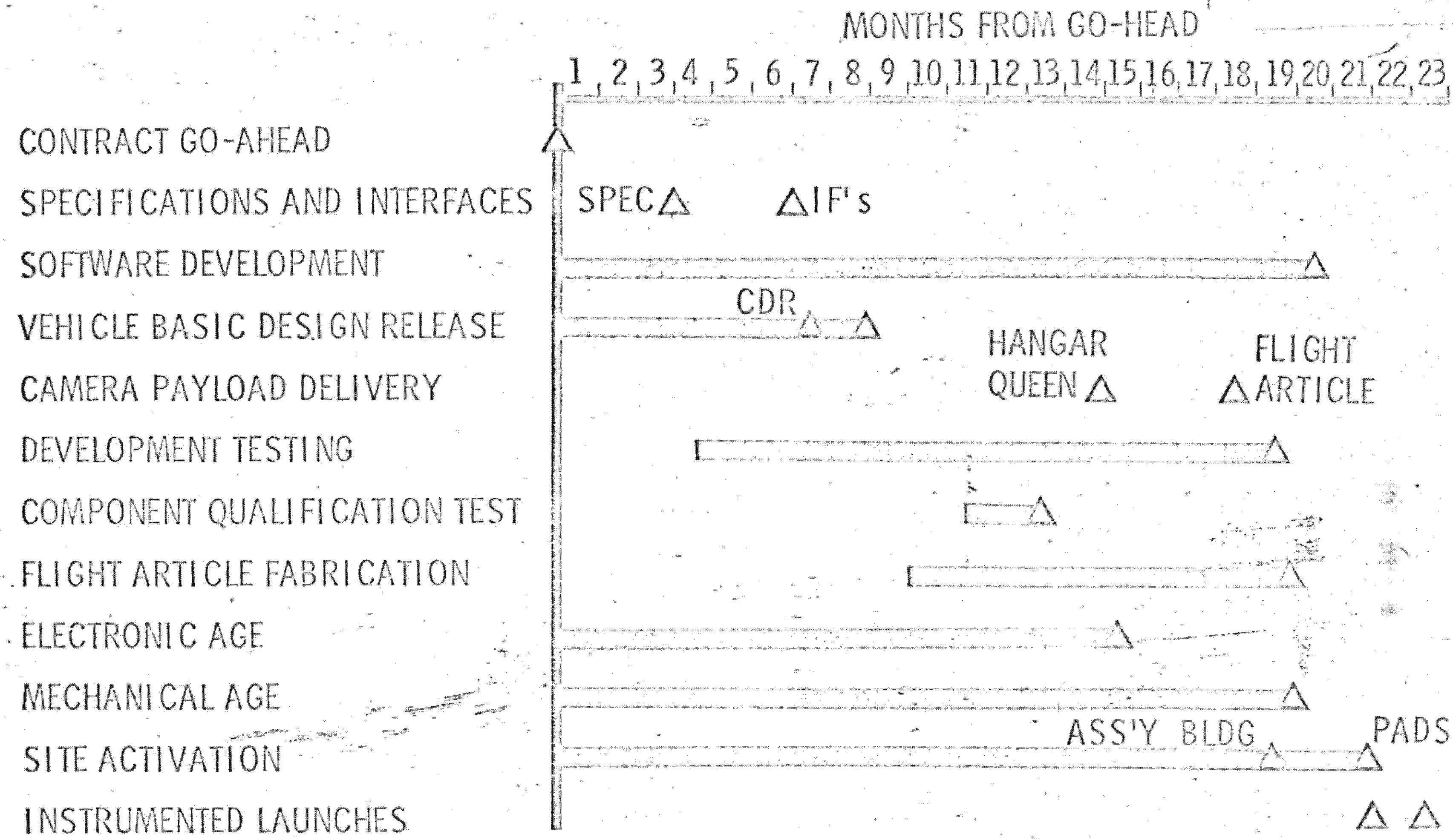
The 23-month development phase shown ends with the ground instrumented launch. This time span is approximately the same as experienced by MMC on other systems of similar complexity such as Titan II -- 22 months; Titan III Transtage -- 21 months; Titan IIIB -- 19 months.

The big concern is the 18-month delivery for the first flight camera. The approach is to scale down an existing tested design. By receiving a qualification unit in the 14th month to support fabrication and test, and receiving the flight camera in the 18th month, the schedule is attainable.

FASTBACK DEVELOPMENT PHASE



Two program concepts are presented. The 75 launch/ year concept provides full coverage, assuming weather conditions will permit no more than 15 launch/ mo., for up to four crises per year. This concept allows consecutive daily launches for up to 13 days. Spacecraft refurbishment, assembly, and launch are performed on a two shift a day basis.

The 12 launch/ year concept provides spot coverage of crises. By ordering 30 refurbishment kits per year (requiring an 8-month lead time) the launch rate can be increased to 30 a year with the same crew and facility, thus providing full coverage for one crisis plus spot coverage. In this concept refurbishment, assembly and launch are performed on a one shift a day basis.

PROGRAM CONCEPTS

	12 LAUNCHES / YEAR (30 LAUNCHES POSSIBLE)	75 LAUNCHES / YEAR
OPERATIONAL VEHICLES	4	10
SPARE VEHICLES	1	3
REFURBISHMENT KITS	12 / YEAR	75 / YEAR
MAXIMUM LAUNCH BURST	1 / DAY FOR 5 DAYS	1 / DAY FOR 13 DAYS
SPACECRAFT RECYCLE TIME	15 DAYS	8 DAYS

APPROX. 350 MM-I AVAILABLE BY 1974

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Costs, including both contractor and government costs, are given for 53-month programs for both concepts previously described. The work-in-progress item is for refurbishment kits being manufactured for the following year, therefore actual net totals for the 12/year and 75/year concepts are $200 M and $425 M respectively.

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SUMMARY OF FASTBACK COSTS

COST TYPE	LAUNCH RATE: 12 LAUNCHES / YEAR WITH 30 LAUNCHES / YEAR CAPACITY	LAUNCH RATE: 75 LAUNCHES / YEAR
NON-RECURRING	78 M	108 M
SUSTAINING	72 M	93 M
OPERATING	53 M	249 M
TOTAL	$203 M	$450 M
WORK IN PROGRESS	(3 M)	(25 M)
PER LAUNCH OPERATING & SUSTAINING	2.3 M (53 LAUNCHES)	1.0 M (325 LAUNCHES)

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Martin Company has done a very creditable job in developing the Fastback concept. The system concept partially fulfills the targeting requirements established for crisis management reconnaissance and, in addition, offers the relatively low vulnerability associated with the short time in orbit and the fact that no active communication is required between the bird and the remote tracking stations. However, for the reasonably common crisis scenarios in which daily coverage is required for long periods, say three weeks or more, Fastback is expensive. Furthermore, establishment and maintenance of an Atlantic recovery force is unattractive. In weighing its performance against these disadvantages, we are inclined to recommend deletion of Fastback from the list of principal candidates.

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SUMMARY FASTBACK CONCEPT

- o PARTIALLY FULFILLS CRISIS MANAGEMENT REQUIREMENT
  - ONE-DAY TURNAROUND
  - ADEQUATE RESOLUTION
  - ADEQUATE ACCESS AND COVERAGE
  - EVERY-DAY RETURN NOT FEASIBLE
- o VERY FLEXIBLE TARGETING
  - EACH LAUNCH CAN COVER INDEPENDENT AREAS
- o HEAVY OPERATIONAL LOAD
  - NEW BOOSTER EVERY DAY
  - BERMUDA-BASED RECOVERY FORCE
  - LOGISTICS OF PROBLEM IN DELIVERING OF PAYLOADS AND BOOSTERS TO JOHNSTON ISLAND
- o VERY EXPENSIVE FOR COVERAGE PROVIDED