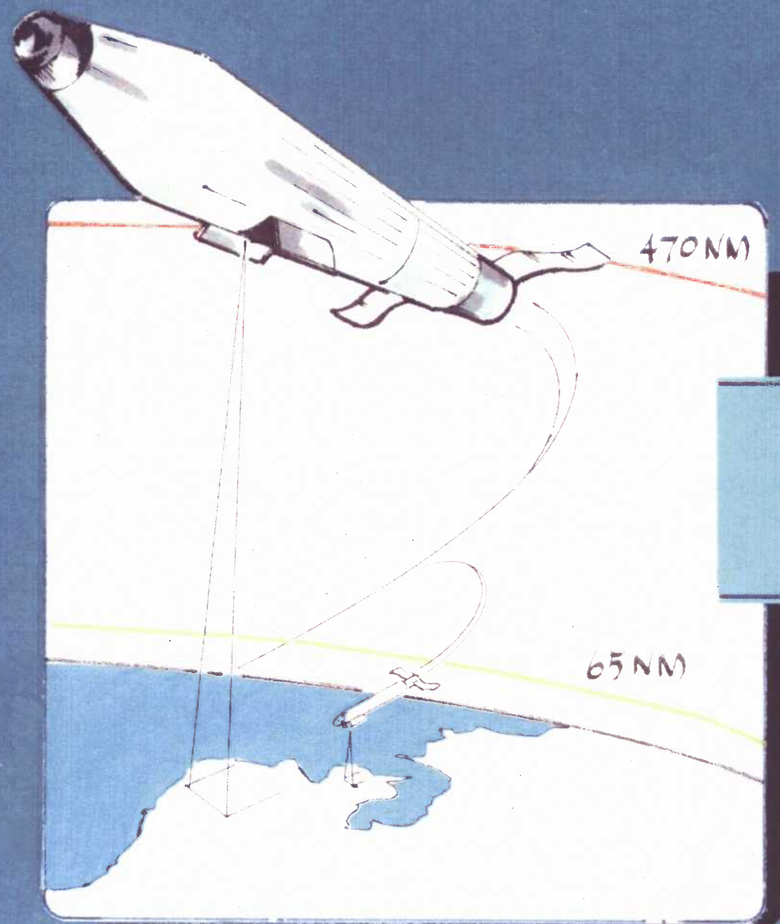
BYE-111589-79

GAMBIT EXTENDED ALTITUDE RECONNAISSANCE SYSTEM



SEARCH & SURVEILLANCE

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SYSTEM DESCRIPTION
SYSTEMS OPERATION
MISSION PLANNING
MISSION SIMULATIONS

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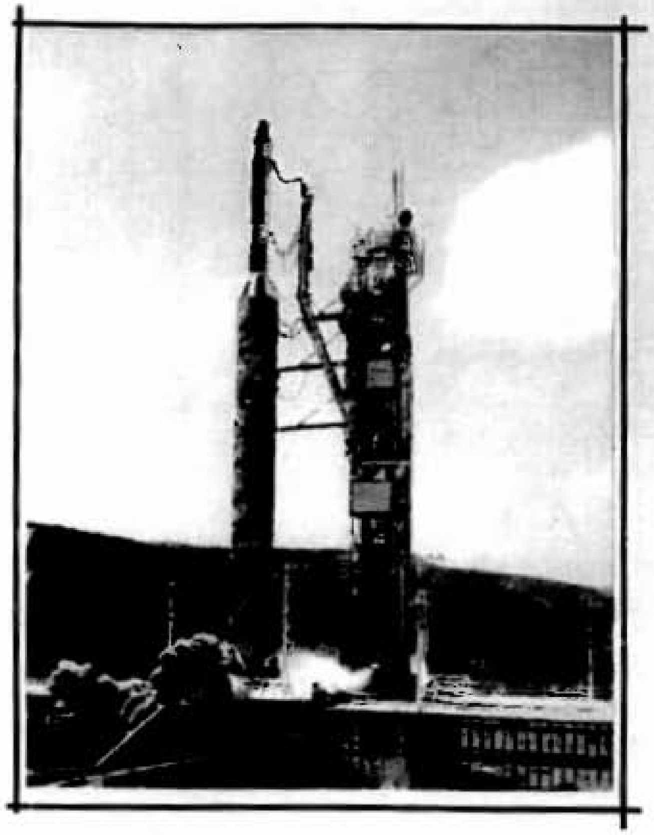
THE GAMBIT PROGRAM

The Gambit system continues to set the highest standard of image quality for orbital reconnaissance systems. This capability has been traditionally, and highly successfully, tasked against problems requiring resolution of the smallest possible details of a target area - primarily for surveillance, technical intelligence, and treaty verification purposes. The very high focal plane resolution delivered by Gambit sparked a recent modification to allow operations from altitudes as high as 470 n.mi. The objective of this modification is to provide the intelligence community with a standby search capability which may be exercised in either a back-up or supplemental role. Area collection is enhanced by the increasing footprint of the Gambit optics at higher altitudes. The benign orbital environment at high altitudes vs the conventional 70 x 200 n.mi. orbits results in enhanced vehicle stability; this stability in turn allows very high resolution films to be used to their maximum capability. The ultimate result is imagery of the requisite search quality of a very large area from a system designed for surveillance of point targets. This extended altitude capability, the Dual Mode configuration, retains the full low altitude capacity for very high quality surveillance missions.



OBJECTIVES

- HIGH RESOLUTION SURVEILLANCE
- TECHNICAL INTELLIGENCE
- TREATY VERIFICATION
- STAND-BY SEARCH

PAYLOAD DATA

- STEREO-STRIP CAMERA
- 2.9° FIELD OF VIEW
- 12,700 FEET, 9.5 INCH FILM
- 3,600 FEET, 5 INCH FILM
- [redacted] BEST RESOLUTION
- 25,000 FRAME POTENTIAL
- 17 (10^6) NM^2 SEARCH POTENTIAL
- TWO SATELLITE RECOVERY VEHICLES

ORBITAL DATA

- 60-120° INCLINATION
- 90-120 DAY MISSIONS
- 65-470 NM ALTITUDES
- VARIABLE ALTITUDE PROFILES

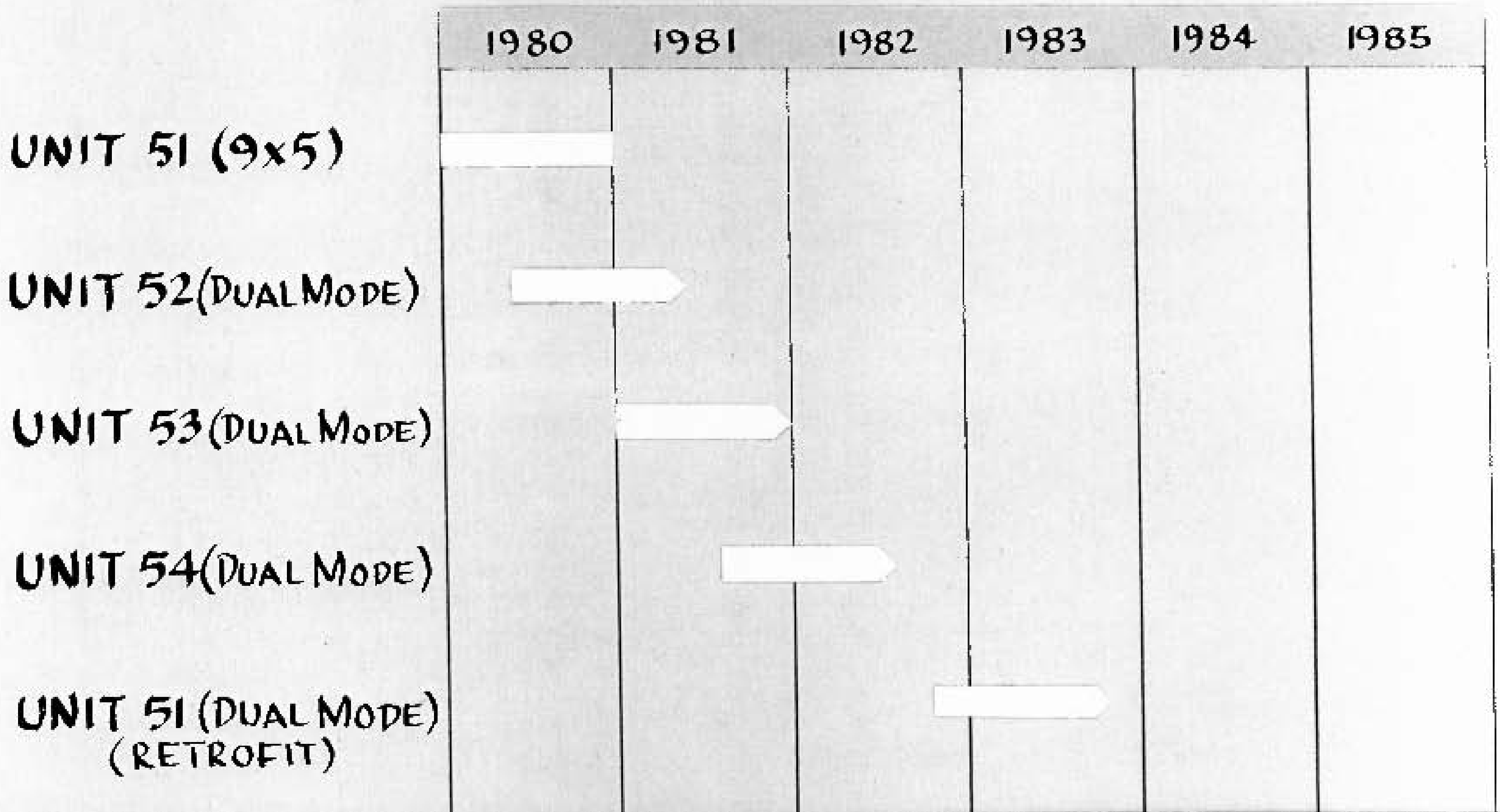
VEHICLE AVAILABILITY

Gambit currently is in a launch on demand status. Units are available for operations upon 45 days' notice and a launch minus 20 day status is available if directed. The hardware is available as shown. The unit currently available, 51, if not expended for surveillance purposes, will be retrofit to the Dual Mode Configuration after completion of unit 54.

The Gambit program is managed and operated by the Secretary of the Air Force, Special Projects Office. The major contractors involved in the system are shown below:

Launch Vehicle	-	Martin Marietta Aerospace
Satellite Control System	-	Lockheed Missiles and Space Company
Photographic Payload System	-	Eastman Kodak Company
Satellite Recovery Vehicle	-	General Electric
Satellite Command System	-	General Electric
Target Selection Software	-	TRW
Command/Control Software	-	General Electric

VEHICLE AVAILABILITY



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➤ SYSTEM DESCRIPTION

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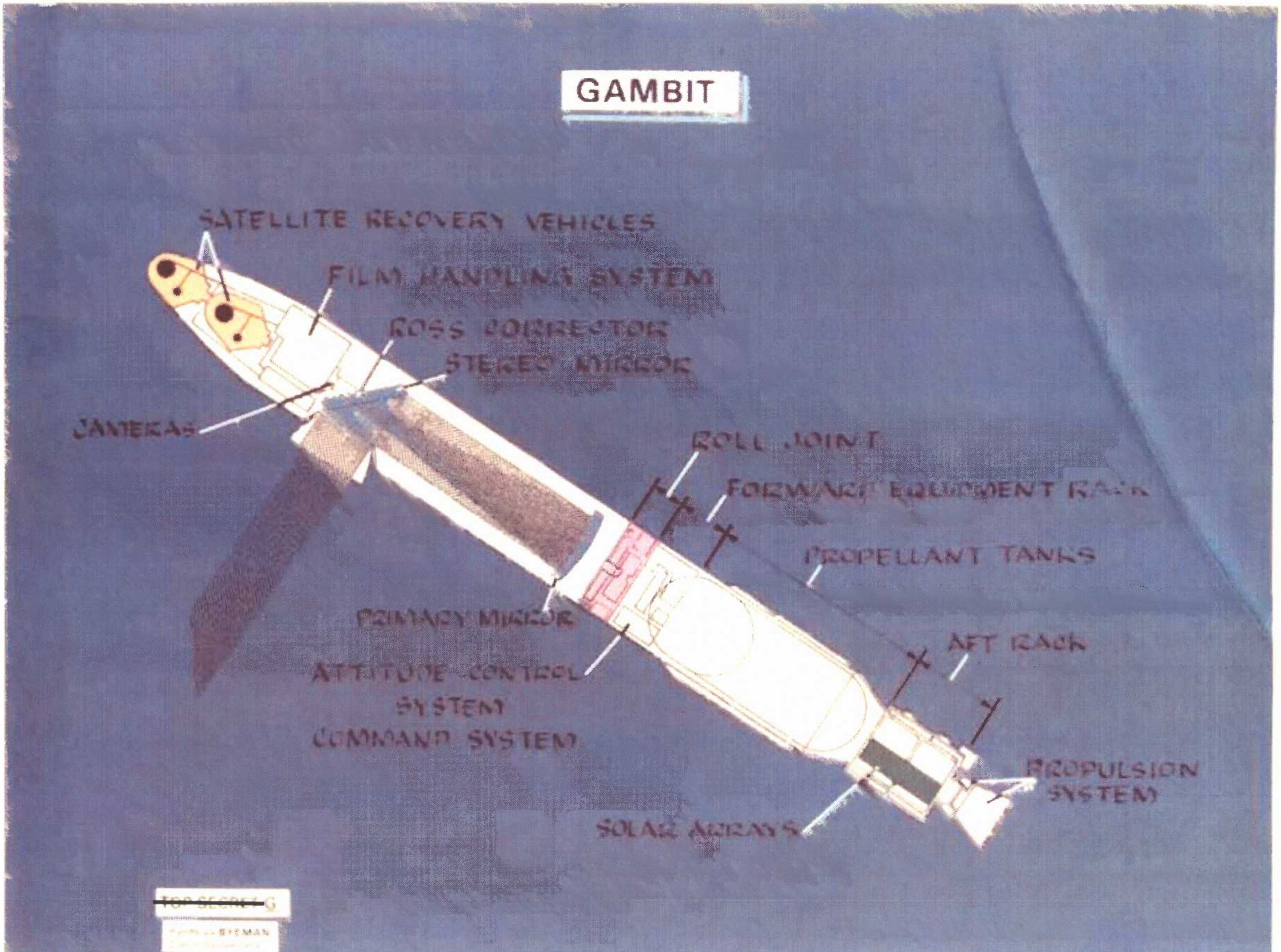
GAMBIT

The Gambit Photographic Satellite Vehicle (PSV) is comprised of two major modules, the Photographic Payload and the Satellite Control Section (SCS). The vehicle is five feet in diameter and forty-eight feet long and weighs 24,000 pounds at lift-off - 10,000 pounds at nominal orbit insertion.

The Photographic Payload Section includes a 175-inch focal length, f/4, Ross corrected optical telescope with a three position stereo mirror. Two strip camera systems share the optics and use nine-inch and five-inch films respectively. Each camera is independent, having its own film supply and takeups. The takeups are housed by, and returned from orbit in, two Satellite Recovery Vehicles.

The Satellite Control Section is basically an Agena spacecraft employing common bipropellant for both primary and secondary propulsion systems and a separate monopropellant for reaction control. Electrical power is delivered from primary batteries supplemented by solar arrays. Command, telemetry, and attitude control services for the entire satellite are provided, primarily by electronic elements housed in the forward rack and reaction control thrusters on the aft rack. A momentum compensated roll joint joins the PPS and SCS and affords ±45 degree roll agility to the sensor system.


GAMBIT
SATELLITE RECOVERY VEHICLES
FILM HANDLING SYSTEM
ROSS CORRECTOR
STEREO MIRROR
CAMERAS
ROLL JOINT
FORWARD EQUIPMENT RACK
PROPELLANT TANKS
PRIMARY MIRROR
ATTITUDE CONTROL
SYSTEM
COMMAND SYSTEM
AFT RACK
PROPULSION
SYSTEM
SOLAR ARRAYS
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SATELLITE CONTROL SECTION

The Gambit Satellite Control Section (SCS) for the current block of vehicles is an extensively modified Agena D. In addition to basic satellite functions, the SCS supplies orbit injection propulsion and roll agility for the photographic payload system. The propulsion system consists of a main engine and redundant secondary propulsion engines with associated pumps and controls which share the same fuel and oxidizer tank. Ordinarily the main engine is used for orbit injection and orbit transfers while the integrated secondary propulsion system is used for orbit adjusts. Electrical power is supplied by three to five primary batteries (silver zinc) and 40 square feet of solar arrays feeding a common distribution system. The guidance and control system provides a stable platform for photographic operations by employing three axis gyros, horizon sensors, and attitude references to control a monopropellant hydrazine hot gas reaction control system. Primary and emergency command systems provide storage, decoding, and execution functions for controlling operation of the SCS and the PPS. Tracking and telemetry systems are typical satellite PCM systems using master and remote units to provide instrumentation sampling and playback.

The SCS required minor modification to accommodate the longer life and higher altitude of Dual Mode operations. The propulsion system was modified to allow main engine restart and enhance corrosion control in the secondary propulsion system. Due to the range of orbits required for Dual Mode, the attitude control system was modified to optimize horizon sensor operation and allow selection of appropriate pre-programmed pitch rates. A tertiary reaction control thruster was added for lifetime reasons.

VEHICLE 48 SATELLITE CONTROL SECTION

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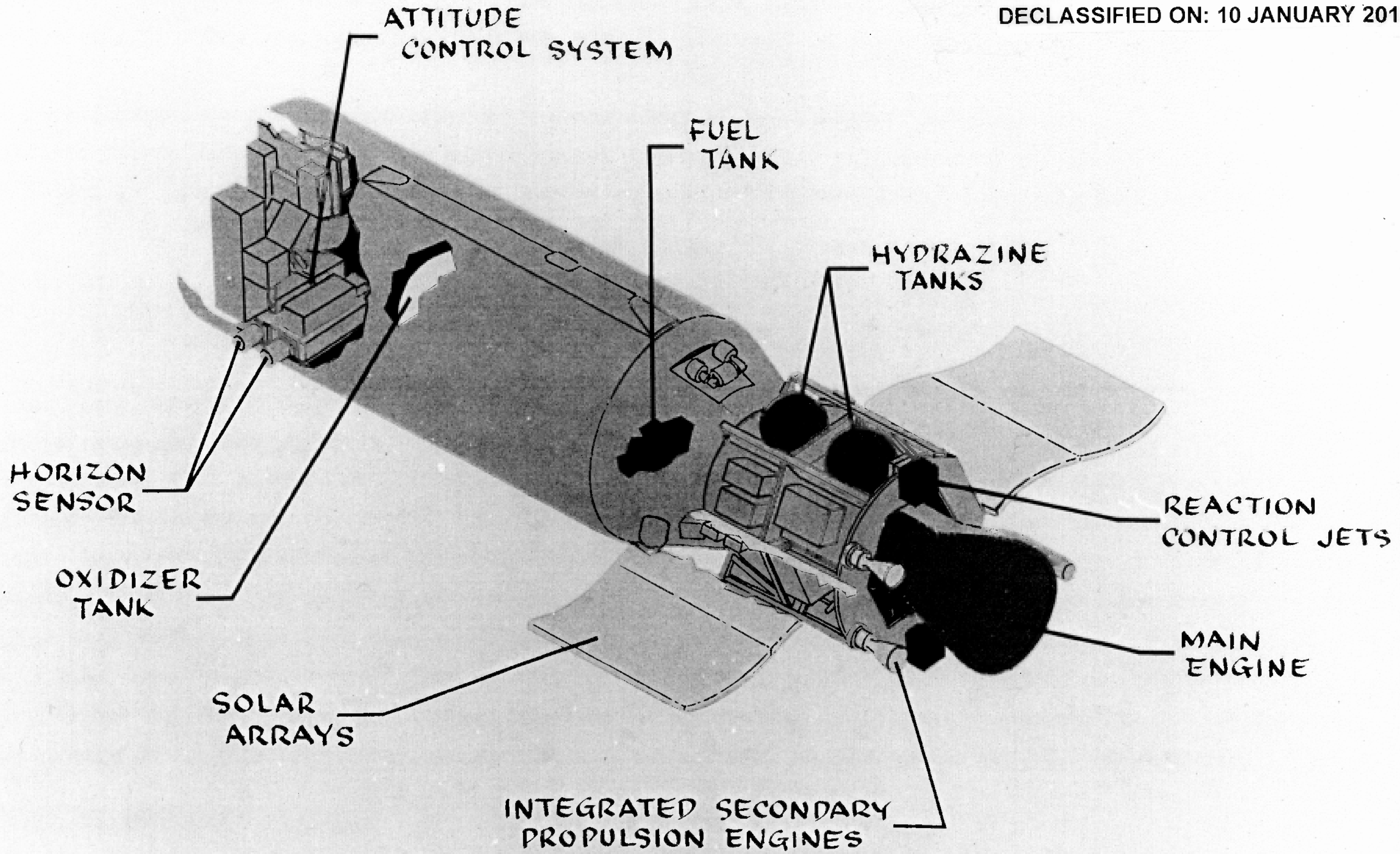
DECLASSIFIED ON: 10 JANUARY 2013



GAMBIT PAYLOAD CHARACTERISTICS

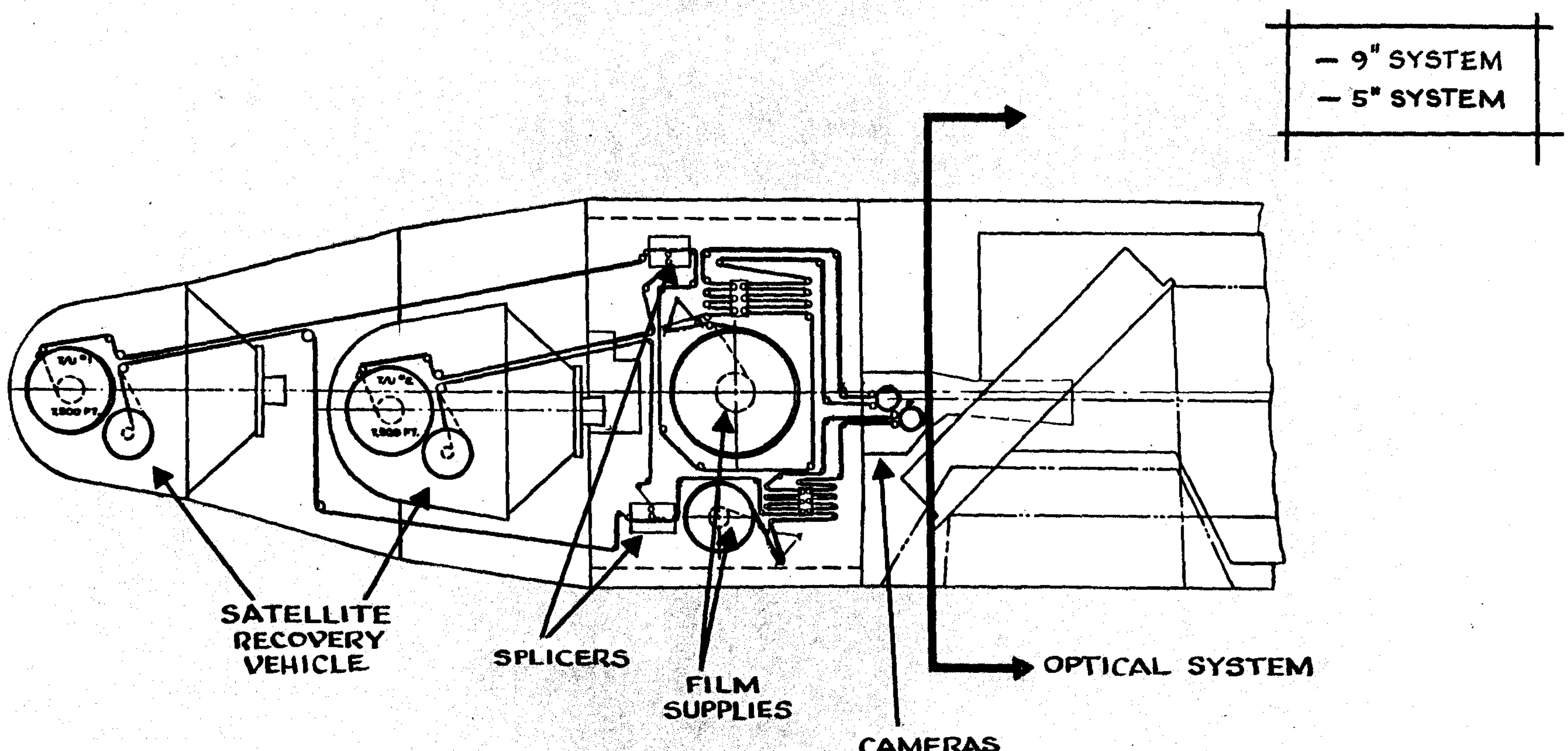
The Gambit payload is configured so that the two strip camera systems share a single optical path. The five-inch camera employs a folding mirror slightly below the optical axis, and consequently points slightly aft (0.2°) of the nine-inch camera. The cameras each employ cylindrical drive elements controlled by a frequency phase lock loop to move film past a variable width exposure slit at precise velocities. Film handling system components include nine and five inch supplies holding 12,700 and 3,600 feet of film respectively (assuming 0.0012 inch base film is used), camera isolation buffers (film loopers), splicers, film position and tension rollers, and protective tunnelling. The optical system consists of a 58 x 44 optical flat for stereo pointing, a 44-inch aspheric primary mirror, and refractive corrector elements for field flattening and color correction. Optical data is shown below:

Focal Length	-	175 inches
f/Number	-	4.02
Field of View (9-Inch Camera)	-	2.90 Degrees
Field of View (5-Inch Camera)	-	1.48 Degrees
Spectral Bandpass	-	400 - 780 Nanometers
Spatial Cutoff	-	[redacted] line Pairs/mm

In operation, the relative motion of the target to the image plane is compensated by precisely aligning the apparent motion vector to the film motion vector via a crab axis adjustment of the stereo mirror. The film is then driven past the exposure slit at a speed equal to the apparent image motion.

Camera modifications for Dual Mode operation were accomplished to allow the film to be driven at the slower speeds required at high altitude, to accurately sense focus over the complete range of altitudes, and to accurately expose ancillary data at all film speeds. The Satellite Recovery Vehicle required higher thrust rocket motors and variable recovery sequence timers to allow high or low altitude recoveries.

GAMBIT CAMERA AND FILM HANDLING SYSTEM



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SYSTEM DESCRIPTION

➤ **SYSTEMS OPERATION**

MISSION PLANNING

MISSION SIMULATIONS

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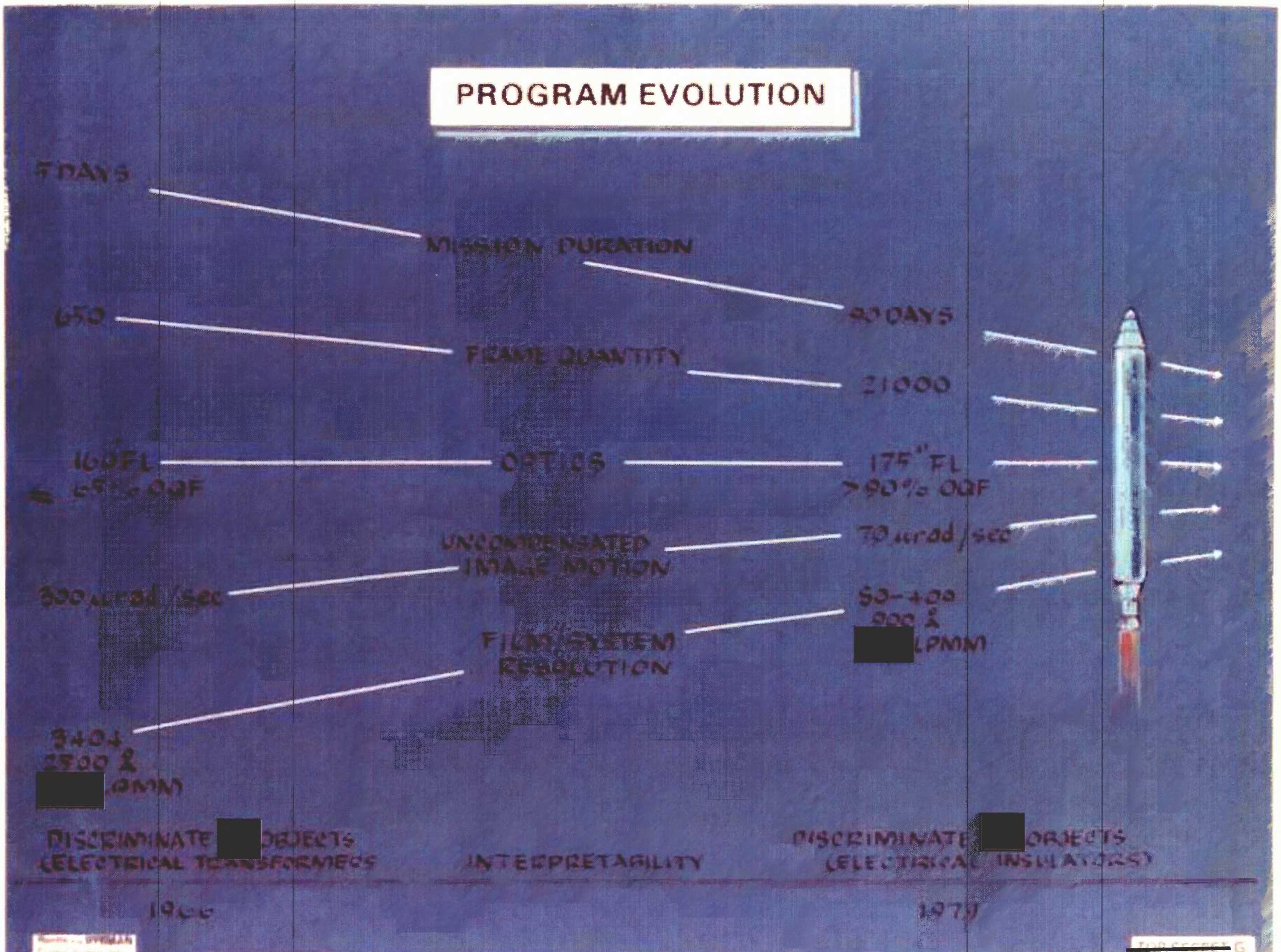
PROGRAM EVOLUTION

Gambit's progress has been a series of evolutionary improvements punctuated by occasional revolutionary adaptations or modifications. The key system characteristics and the extent of their change are illustrated here. Full program potential allows significant increases in the frame quantity over the attained value shown, and 120-day missions are planned for future vehicles. Optical quality factor (OQF) is the ratio of optical modulation transfer in the manufactured lens to that of a perfect lens for the specific formula. The very high OQFs measured for recent Gambit optical systems represent near diffraction limit performance potential. Exploiting this potential requires extreme accuracy in compensating for relative motion between the image and the target. This has been achieved through a series of SCS and PPS improvements. The 70µrad/sec average error corresponds to the rate of movement of the hour hand in a 24-hour clock. This combination of optical performance and motion compensation allows the use of very high resolution films which require long exposure times. The steady improvement in all system aspects results in a vastly improved exploitation product. Strict operational emphasis on image quality for technical intelligence purposes or treaty verification could yield further improvements in operational interpretability of Gambit imagery.


PROGRAM EVOLUTION
7 DAYS
MISSION DURATION
90 DAYS
650
FRAME QUANTITY
21000
160" FL
65% OQF
OPTICS
175" FL
>90% OQF
UNCOMPENSATED IMAGE MOTION
70 µrad/sec
300 µrad/sec
FILM/SYSTEM RESOLUTION
[redacted] LPMM
[redacted] LPMM
DISCRIMINATE [redacted] OBJECTS (ELECTRICAL TRANSFORMERS)
INTERPRETABILITY
DISCRIMINATE [redacted] OBJECTS (ELECTRICAL INSULATORS)
1966
1979

GAMBIT IMAGE QUALITY - BEST RESOLUTION

Gambit image quality has been traditionally evaluated by analysis of tribar resolution target acquisitions. These targets are acquired under favorable operational conditions and provide an objective check on how well the system is performing on a given mission. The overall performance improvement evident over the life of the Gambit program has been the result of a succession of hardware, software, film, and operational improvements. The net effect has been a factor of five gain in delivered image quality to the photointerpreter since the early Gambit missions.

System resolution is the result of the interplay between the optical modulation of the lens, information capacity and speed of the film, physical stability of the system, atmospheric conditions during acquisition, and physical characteristics of the target itself. Operationally the current Gambit routinely delivers [redacted] line pairs/mm resolution. The optics alone, in a static situation, will pass [redacted] line pairs/mm and representative film capacities are shown below:

FILM RESOLUTION (Peak at 1.7:1 Contrast)

	Line Pairs/mm
SO-409 (Black-and-White)	[redacted]
SO-312 (Black-and-White)	
SO-315 (Black-and-White)	
SO-255 (Color)	
SO-130 (False Color IR)	64

[redacted]

GAMBIT IMAGE QUALITY - NIIRS

The current measure of the intelligence potential of reconnaissance imagery is based upon the National Imagery Interpretation Rating Scale (NIIRS). The NIIRS is based upon a photointerpreter's evaluation of the photograph's intelligence potential (not value), and ranges from 0 (no intelligence potential) to 9 (discern facial features). At surveillance altitudes, Gambit imagery has been concentrated in the NIIRS [redacted] range. Conventional search requires NIIRS 3 to 5 quality. Illustrated here are the results of a study to determine if a high altitude Gambit operation could deliver adequate image quality for search purposes. The study employed a camera/optical system delivering similar quality to Gambit and a scene consisting of models of Soviet military equipment and resolution targets which could be moved during photography to simulate image motion. The results were rated by photointerpreters as shown in the graph. The scale is indicative of the Gambit operational envelope and the probable operational films of SO-209/409 (search) and SO-112/312 (surveillance).

[redacted]

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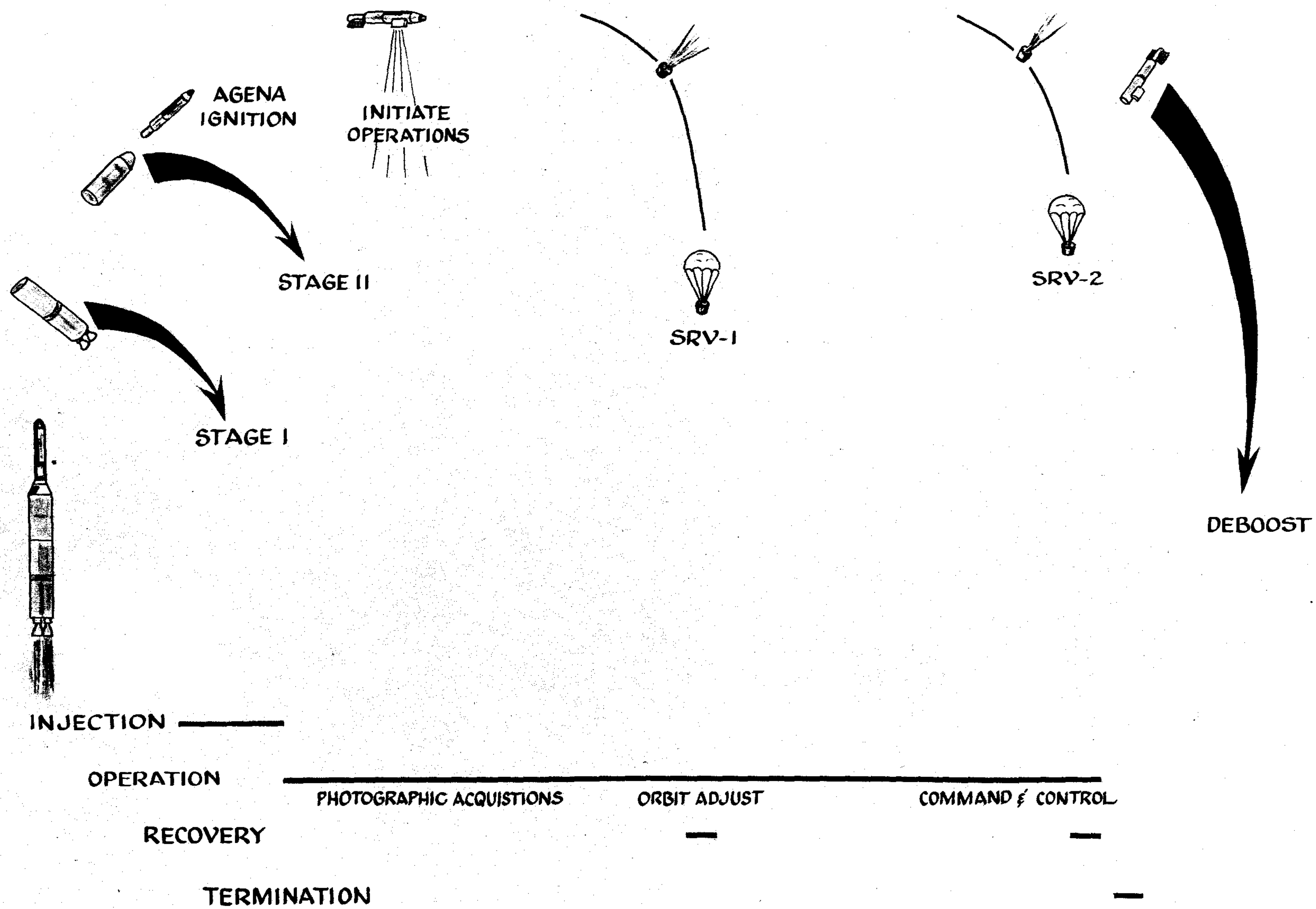
MISSION OPERATIONAL SEQUENCE

A Titan IIIB is the current launch vehicle for the Gambit system. The two stages of this liquid fueled booster burn for approximately 350 seconds. At stage two engine cut-off and separation the Agena main engine is ignited to complete the orbit insertion, usually to a nominal 75 x 200 n.mi. orbit. Depending upon mission objectives, the orbit is then adjusted to the appropriate operational conditions. Initial Photographic Satellite Vehicle health checks are completed and photographic activity initiated by Rev. 4. Orbit adjust requirements are planned on a daily basis and executed as necessary to maintain required orbit parameters. Command and control is accomplished via Satellite Control Facility remote tracking station network with chronological command sequences employed to execute photographic acquisitions on a rev-by-rev basis. System expendables (film, propellants, electrical power) are managed and merged with mission requirements to yield two approximately equal mission segments. At the termination of each segment, a Satellite Recovery Vehicle (SRV) is recovered via parachute descent for air retrieval in the vicinity of Hawaii. Following recovery of SRV 2, the PSV is precision deboosted into an open ocean area.

MISSION OPERATIONAL SEQUENCE



LAUNCH

In preparation for launch the Titan booster must be in place for at least 60 days before launch to accommodate checkout and fueling operations. The conventional launch minus 45 day posture requires shipment of the SCS from Lockheed to Vandenberg 17 days prior to launch for mating with the Titan. Fourteen days prior to launch the Photographic Payload Section is shipped from Kodak to Vandenberg and mated with the SCS. The period remaining until launch is used for hardware and software checkout, fueling and command loading. If the L-20 posture has been directed, the SCS and PPS are in a condition to be shipped at L-14 and L-11 days respectively.

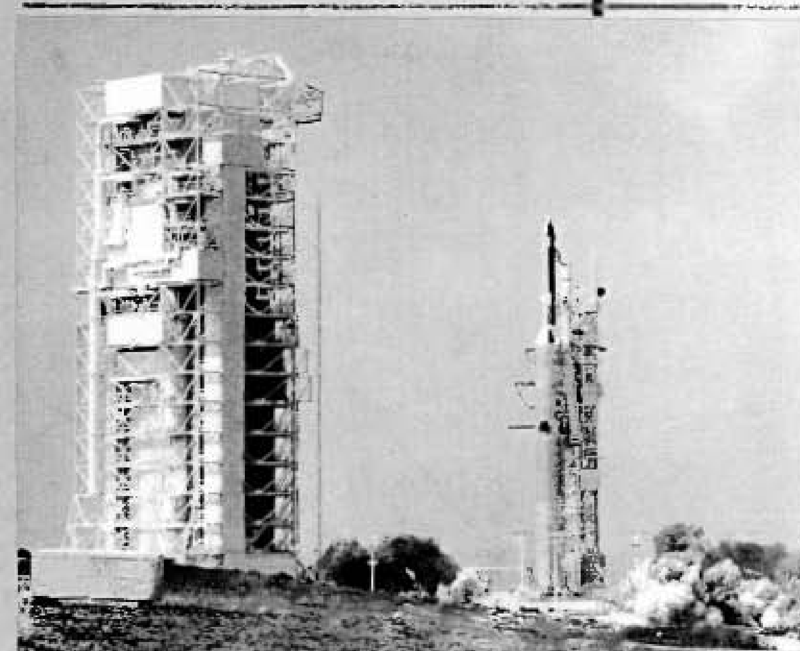
LAUNCH: SLC-4W, VANDENBERG AFB

LAUNCH VEHICLE : TITAN III B

WEIGHT 407,600

LENGTH 149.5 FT.

STAGE 1 THRUST 450,000 Lb.
STAGE 2 THRUST 102,000 Lb.
AGENA THRUST 17,000 #



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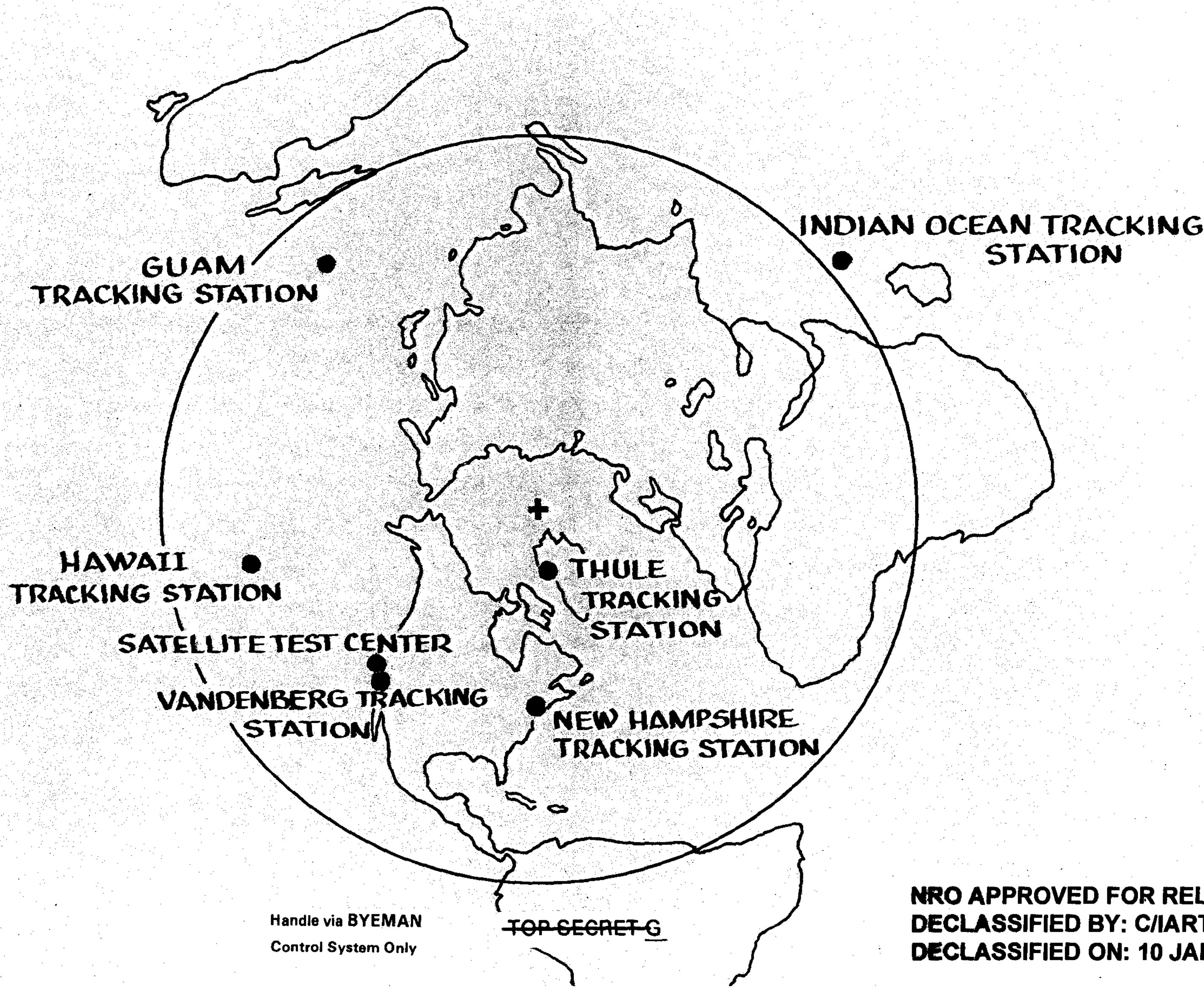
USAF REMOTE TRACKING STATION NETWORK

The Gambit system is controlled during operations by the Satellite Test Center. The ephemeris and weather data inputs are combined with a prioritized target selection to yield an optimized operational sequence. This data results in a series of commands which are transmitted to the vehicle via the remote tracking station network shown here on a polar projection of the earth. Vehicle instrumentation and telemetry is returned via the RTS network to the STC for health checks and status updates.

USAF SATELLITE TRACKING NETWORK



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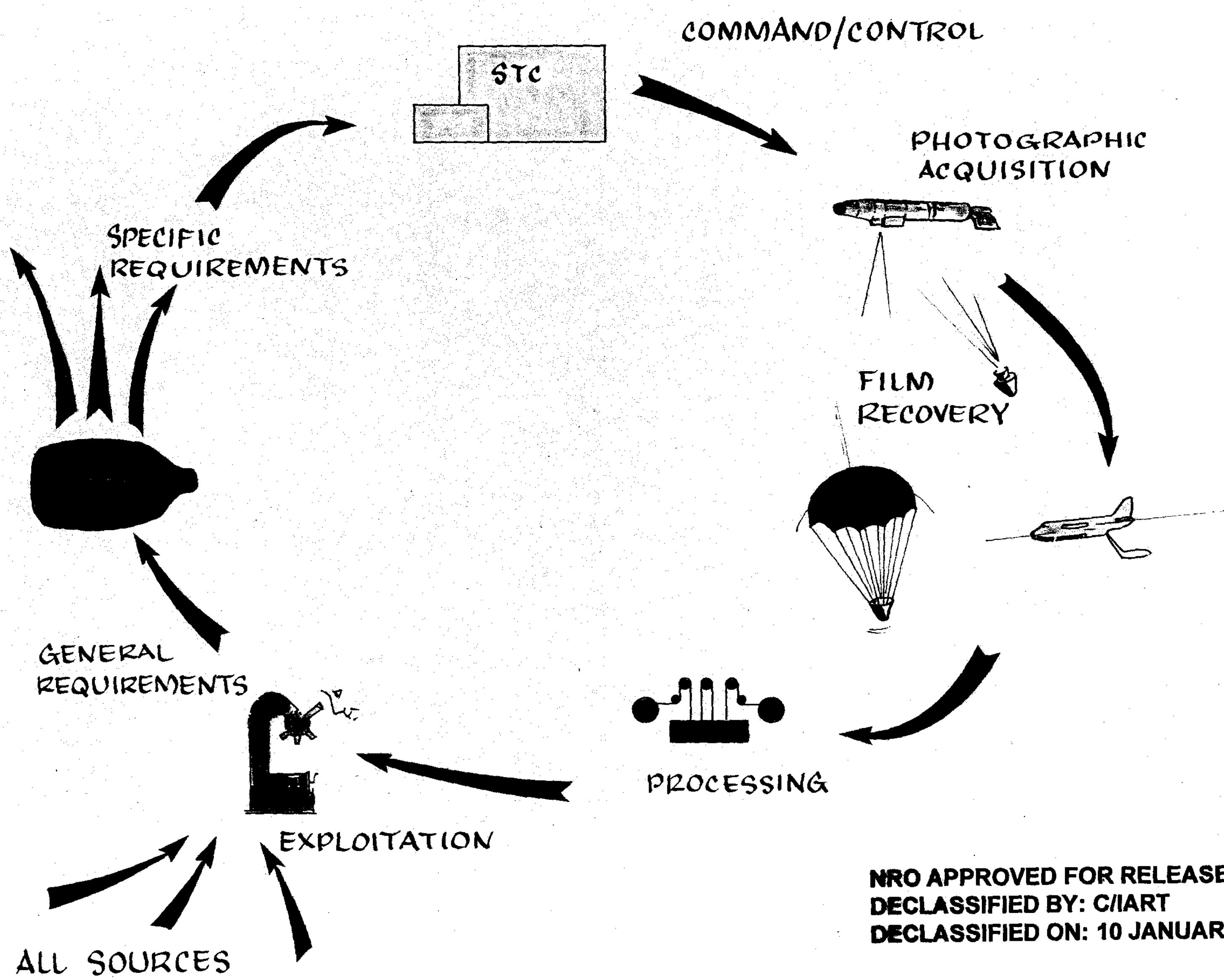
GAMBIT OPERATIONAL TASKING LOOP

The Intelligence Collection Requirements Staff (ICRS) levies collection requirements for a Gambit Mission. These requirements are the basis of the mission planning, optimization and execution directed through the Satellite Test Center (STC). Operational software at the STC considers all candidate target requirements and current weather on a rev-by-rev basis to choose the optimum acquisition sequence and maximize requirement satisfaction. This sequence becomes a series of commands which are merged with current ephemeris and SCS sequences to generate a chronological command message. The commands are telemetered to the satellite, executed and status updated based on downlinked vehicle data. At the completion of a mission segment, the filled Satellite Recovery Vehicle (SRV) is air recovered and returned to the Bridgehead facility for processing and initial evaluation. "Quick Look" results are used to update target status and requirements; as are the results of subsequent detailed evaluation of Gambit and other data sources. This updated status is again funneled through ICRS and back into the targetting loop.

GAMBIT OPERATIONAL TASKING LOOP

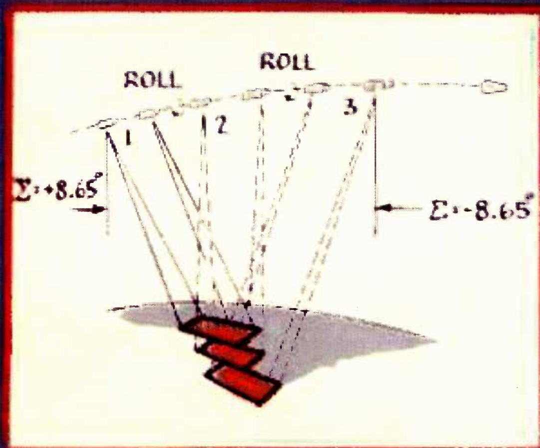


PHOTOGRAPHIC MODES

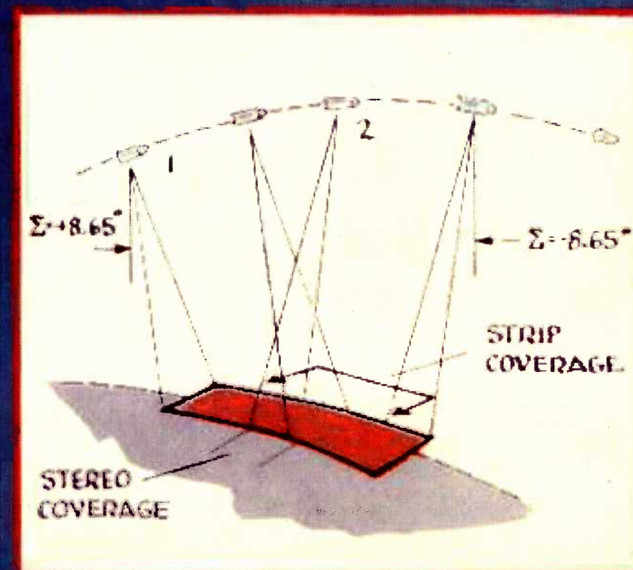
Three basic photographic operations are employed in Gambit collection sequences; monoscopic, stereo, and lateral strip coverage. Monoscopic collection involves photographic acquisition of a designated target area with the mirror in only one position. Stereo collection requires first acquiring the target with the mirror in the forward position, resetting the mirror to the aft position, and reacquiring the same target from a different aspect. Half stereo is possible by using the nadir position of the stereo mirror in conjunction with the forward or aft positions. Lateral strips employ the forward and aft or all three mirror positions to collect two or three adjacent strips. This feature significantly increases the collection performance against large diameter targets or target clusters.

The shared optical system allows simultaneous or sequential operation of the nine-inch and five-inch camera systems to optimize photographic acquisition. Simultaneous operations allow extension of dynamic recording range (exposure for shadow and highlights), extension of spectral recording range (combinations of color, black-and-white, and IR films), and enhanced probability of very high-quality photographs (statistical advantage in grain noise suppression and instantaneous image smear reduction). Sequential operations allow acquisition of larger numbers of targets, versatility in use of special films, and collection efficiency by matching target diameter to the appropriate film size.

PHOTOGRAPHIC MODES



LATERAL TRIPLETS
(OR PAIRS)



STEREO PAIRS
(OR MONO STRIPS)

5" AND/OR 9" CAMERA COVERAGE

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STEREO FRAMING CAPACITY

All operational hardware options are retained in high altitude search operations. The stereo framing envelope is shown here for the Dual Mode altitude range. The framing limits are imposed by the ground projection distance of the line of sight between forward and aft stereo positions. For a given altitude and obliquity, this distance determines how long a strip photograph may be acquired with the stereo mirror in the forward position before it must be moved to the aft position to reacquire the same area.

STEREO FRAMING CAPACITY

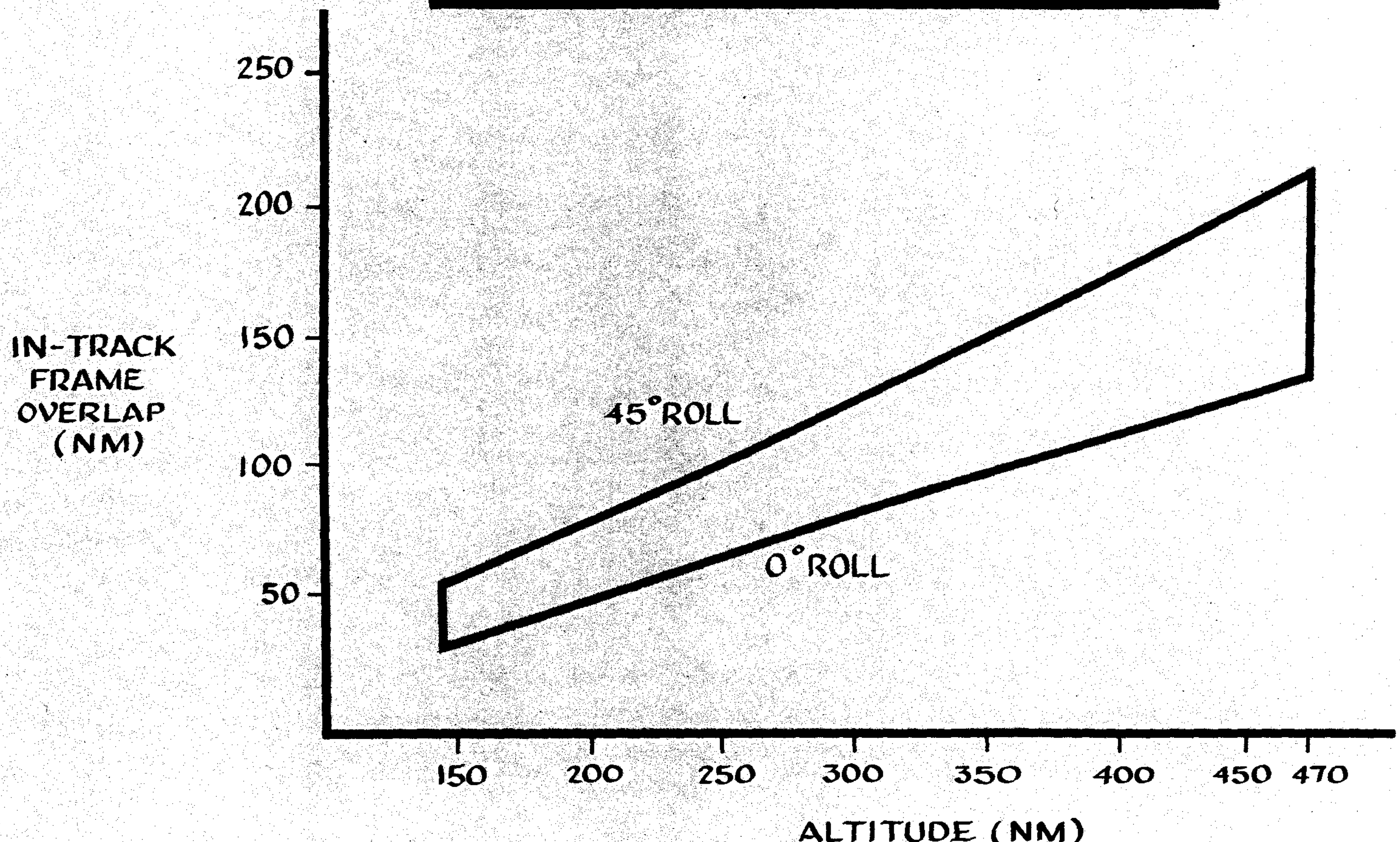
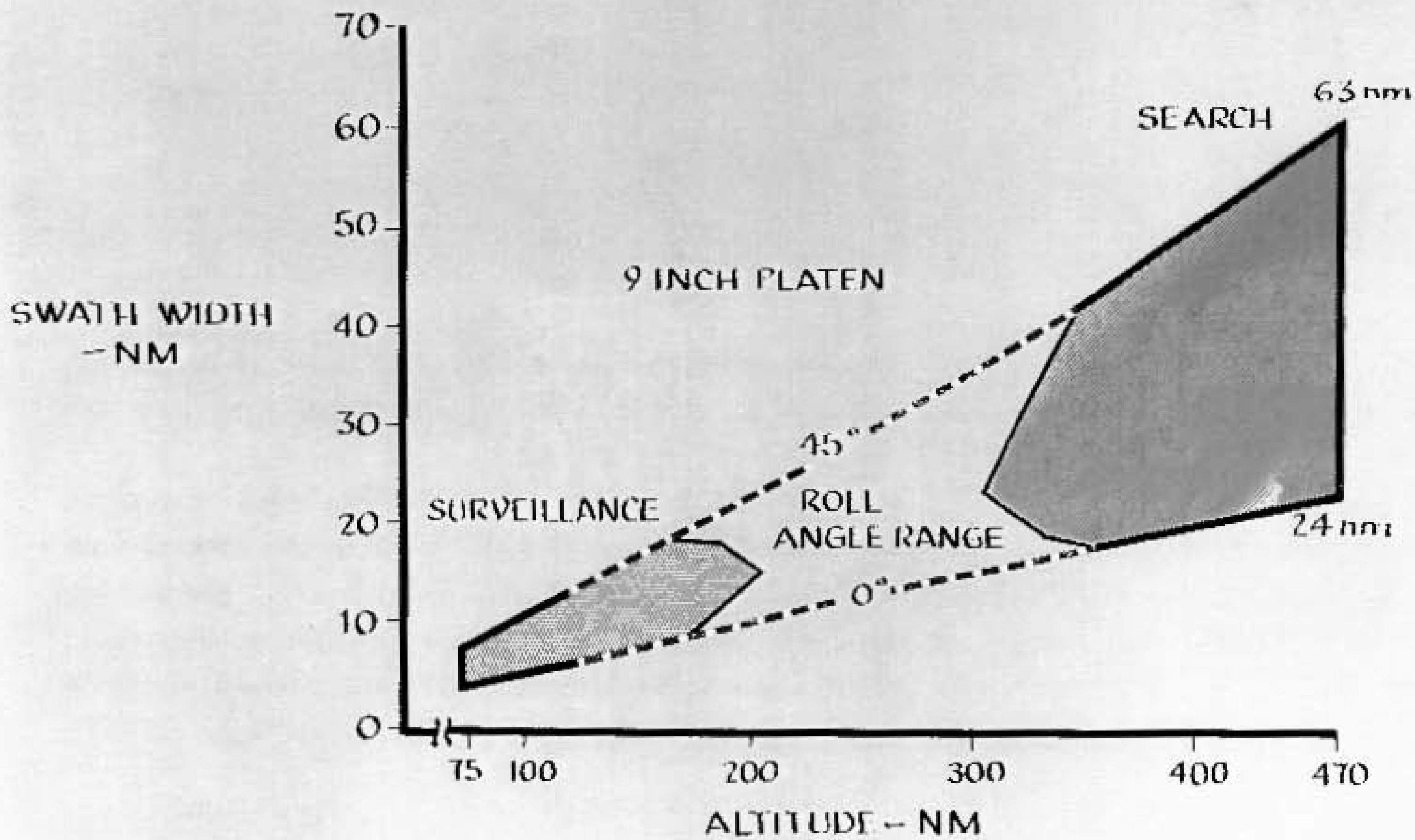


IMAGE SWATH

The Gambit system acquires photography by optically aligning apparent image motion vectors and matching image velocity via film motion. This results in practically unlimited in-track coverage; however, cross-track coverage is limited by the field of view of the optical system. The projection of this field of view for the complete Gambit altitude and obliquity range results in the imaging swath envelope shown for the 9.5-inch camera. The 5-inch system has half the field of view of the 9.5-inch camera, and acquires roughly half the image swath shown.

IMAGE SWATH

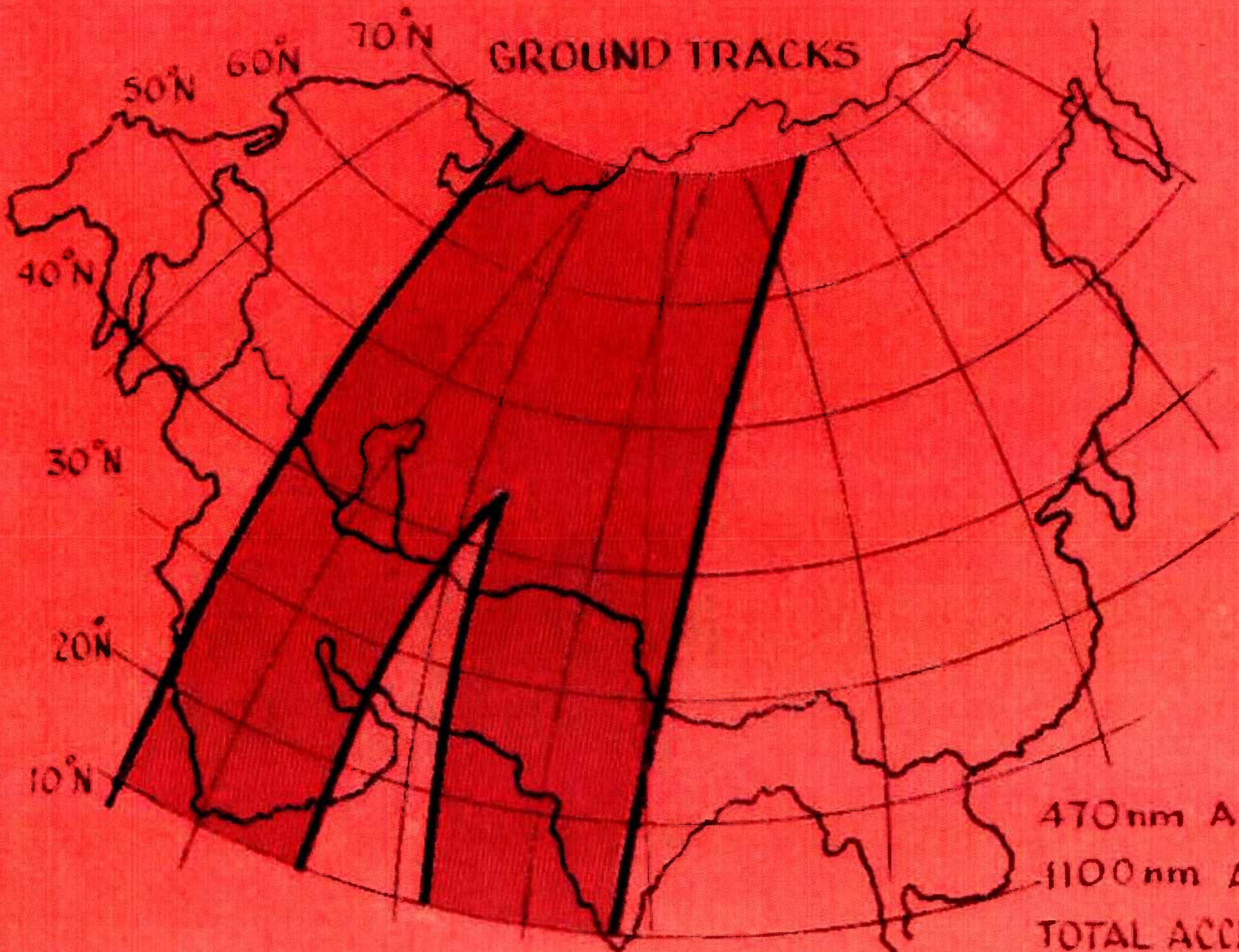

70
60
50
40
30
20
10
0
SWATH WIDTH
– NM
63 nm
SEARCH
9 INCH PLATEN
45°
ROLL
ANGLE RANGE
SURVEILLANCE
24 nm
0°
75
100
200
300
400
470
ALTITUDE – NM

SEARCH ACCESS SWATH

The Dual Mode vehicle operated at high altitude retains the full 90 degree roll capability of the earlier Gambit systems. This allows targetting of any required area within 550 n.mi. either side of the orbit ground trace from the maximum altitude of 470 n.mi. For circular orbits, this results in one or more daily opportunities at all targets above 44 degrees of latitude and rapid closure to targets below this region. Operationally this feature allows timely response to any global crisis without the major mission perturbations caused by use of large quantities of propellants for orbit alterations.

With any orbit selected, the target access is at least twice the instantaneous vehicle altitude in breadth. The effect of earth curvature at high altitude further increases this access swath.

SEARCH ACCESS SWATH



470nm ALTITUDE
1100nm ACCESS/REV
TOTAL ACCESS ABOVE 44°N
GLOBAL ACCESS IN 3 DAYS

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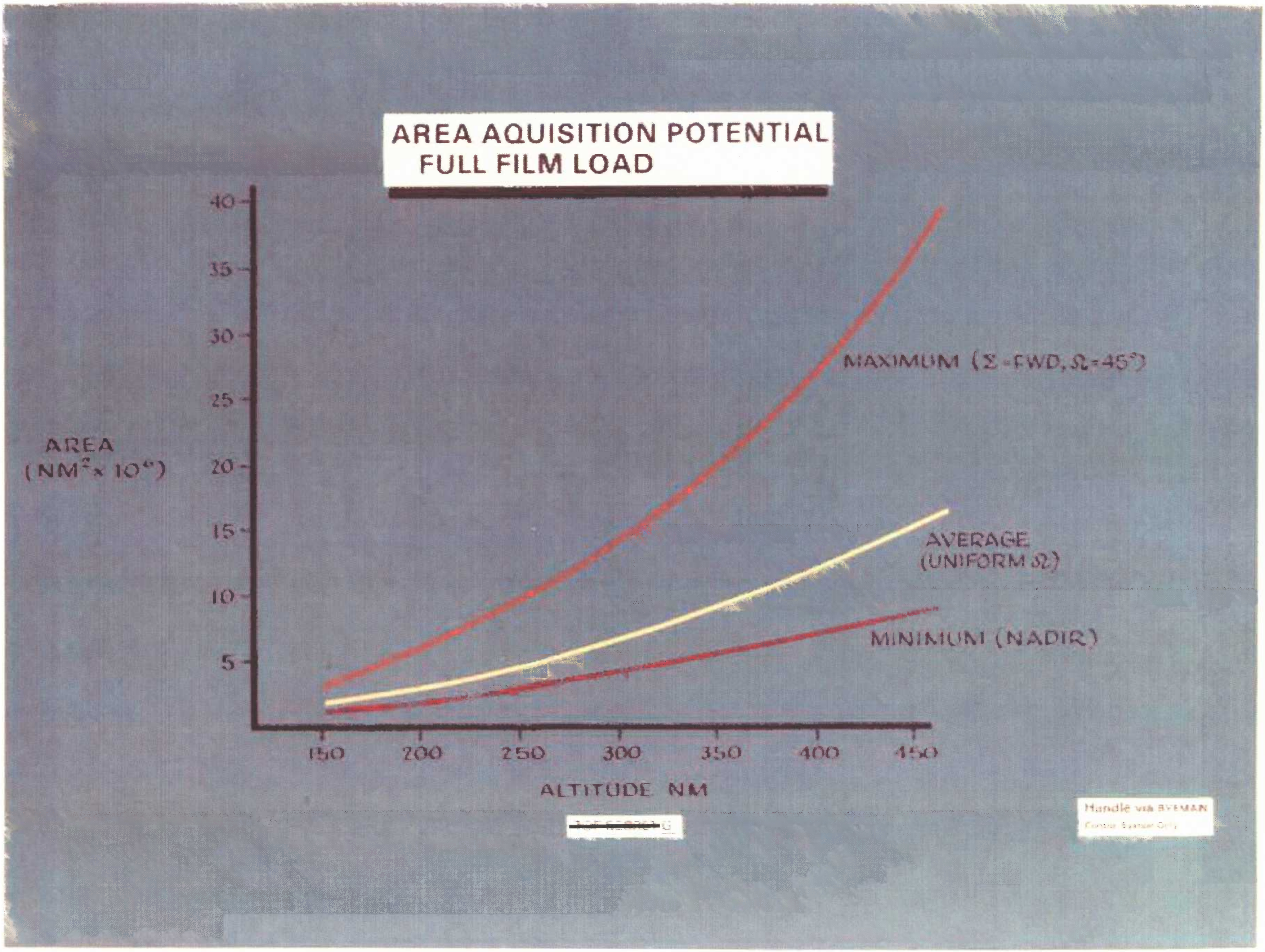
AREA ACQUISITION

The area collection potential of operating the Gambit system at high altitudes for search purposes is evident in this chart. The top and bottom lines represent equally unlikely mission extremes; roll lockup at 45 degrees to maximize collection quantity and roll lockup at nadir to maximize collection quality. Most operational simulations of Dual Mode, as well as low altitude mission experience, suggest the 30 degrees uniform obliquity curve will typify actual search experience. The curves represent a full load of 12,700 feet of 9.5-inch film employed at 90 percent efficiency (start/stop and weather loss = 10 percent).


AREA AQUISITION POTENTIAL
FULL FILM LOAD
AREA
(NM^2 x 10^4)
40
35
30
25
20
15
10
5
150
200
250
300
350
400
450
ALTITUDE NM
MAXIMUM (Σ = FWD, Ω = 45°)
AVERAGE
(UNIFORM Ω)
MINIMUM (NADIR)
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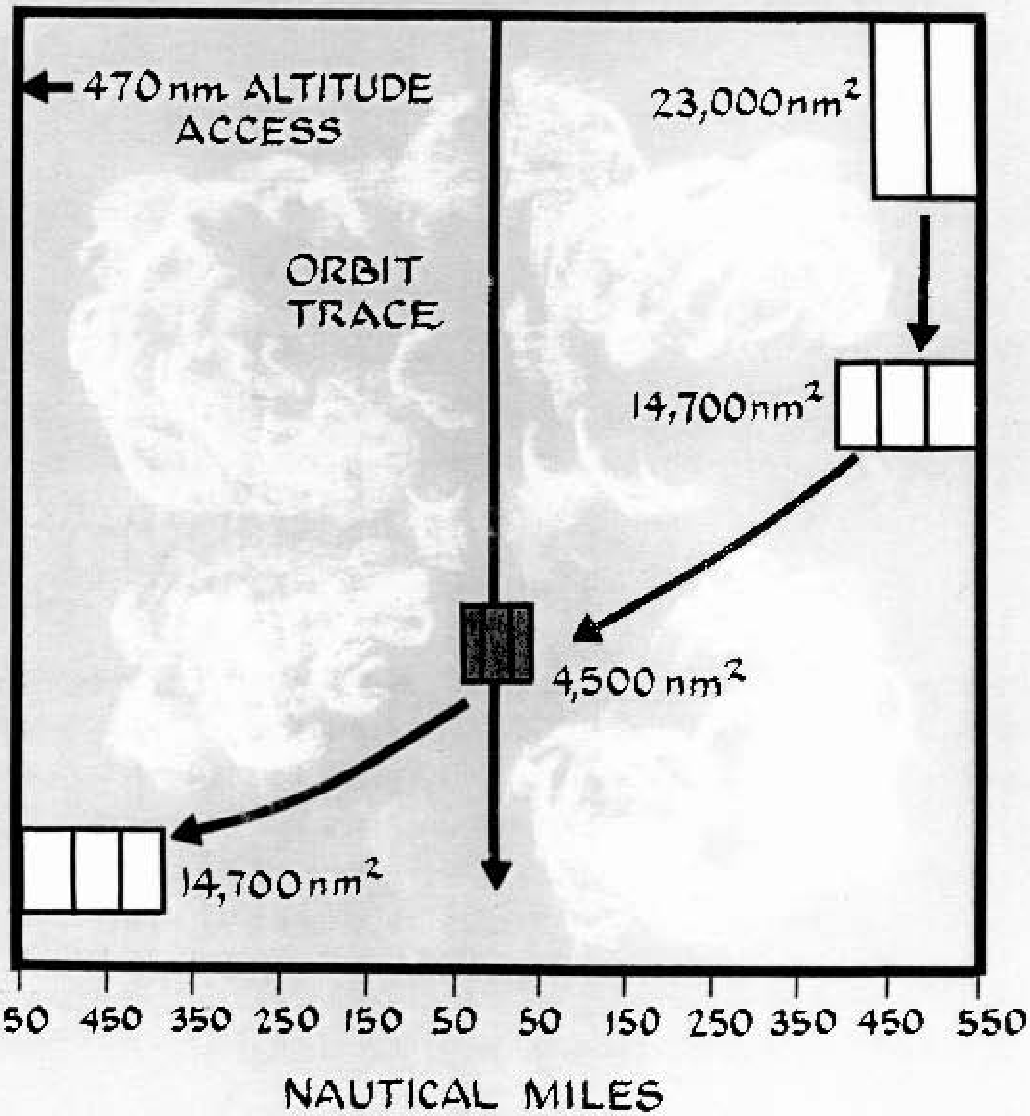
ACQUISITION STRATEGY

The combination of versatile Dual Mode hardware and sophisticated target conflicting and selection software enhances the Gambit mission efficiency. The full agility of the hardware/software system is employed to maximize cloud-free return, minimize unnecessary or redundant coverage, and insure a high rate of requirement satisfaction.

The example illustrates the use of target status, current weather, and vehicle capability to maximize successful photographic opportunities from high altitude.

AQUISITION STRATEGY



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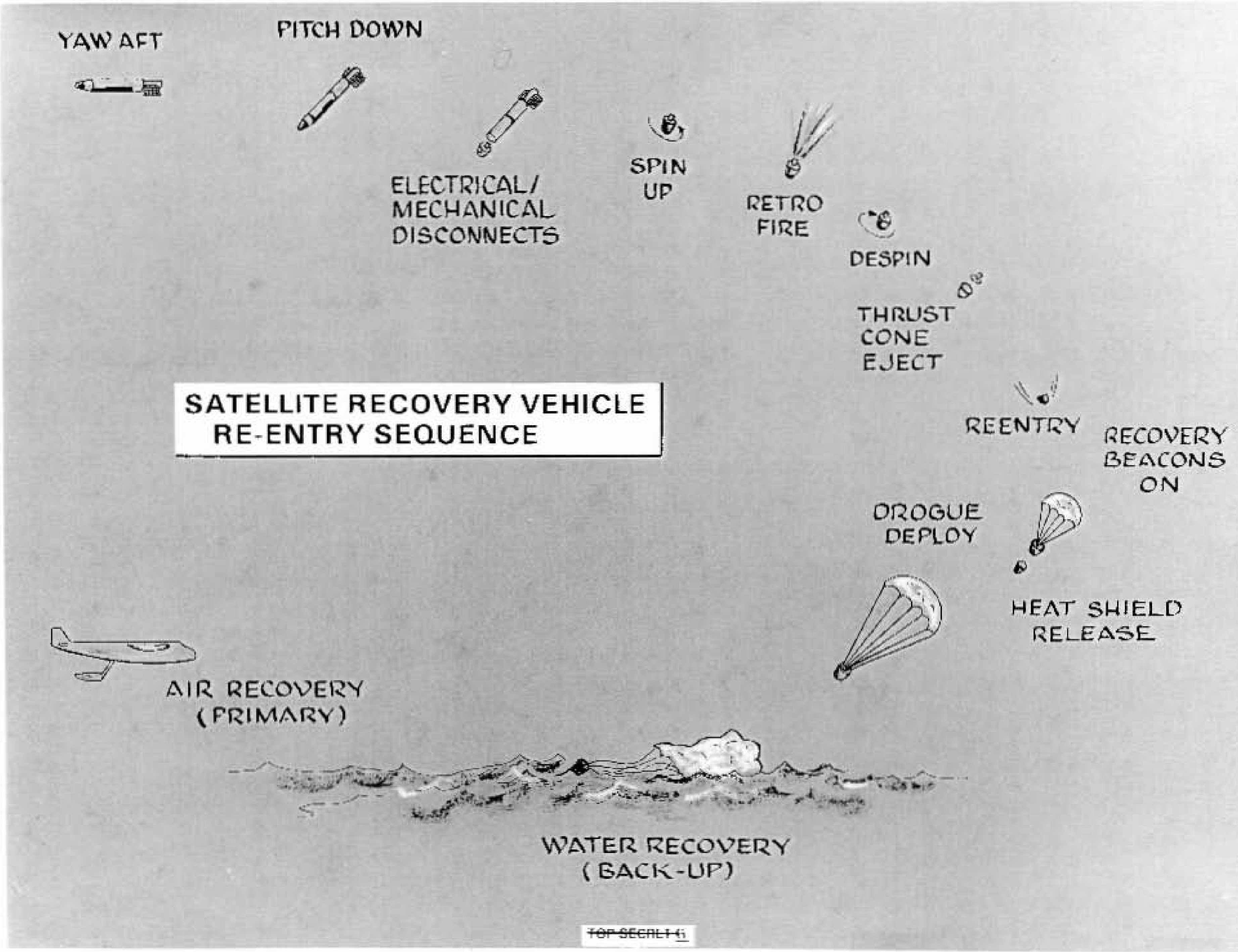
[redacted]

[redacted]

RECOVERY

The Satellite Reentry Vehicle consists of a deorbit system, a recoverable film capsule, an ablative forebody and a parachute with thermal cover. The SRV operates from a series of timers and contains beacons to aid in locating the SRV for retrieval. The deorbit system contains a solid propellant rocket motor and a cold gas attitude control system to control the reentry trajectory. This trajectory is determined by the thrust of the rocket motor applied along a vector established by the spin/despin cold gas system. To aid the recovery aircraft in rendezvous, a recovery beacon is activated throughout the recovery sequence. As the vehicle slows in the upper atmosphere, the ablative forebody and parachute thermal cover are separated and the reefed parachute is deployed by a drogue chute, the main chute blossoms, and the recoverable capsule is retrieved by an HC-130 aircraft. If the air retrieval is unsuccessful, a water recovery may be accomplished. After approximately 40 hours, salt soluble plugs dissolve and the capsule will sink if not retrieved.


YAW AFT
PITCH DOWN
ELECTRICAL/
MECHANICAL
DISCONNECTS
SPIN
UP
RETRO
FIRE
DESPIN
THRUST
CONE
EJECT
SATELLITE RECOVERY VEHICLE
RE-ENTRY SEQUENCE
REENTRY
RECOVERY
BEACONS
ON
DROGUE
DEPLOY
HEAT SHIELD
RELEASE
AIR RECOVERY
(PRIMARY)
WATER RECOVERY
(BACK-UP)
TOP SECRET

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SYSTEM DESCRIPTION

SYSTEMS OPERATION

➤ MISSION PLANNING

MISSION SIMULATIONS

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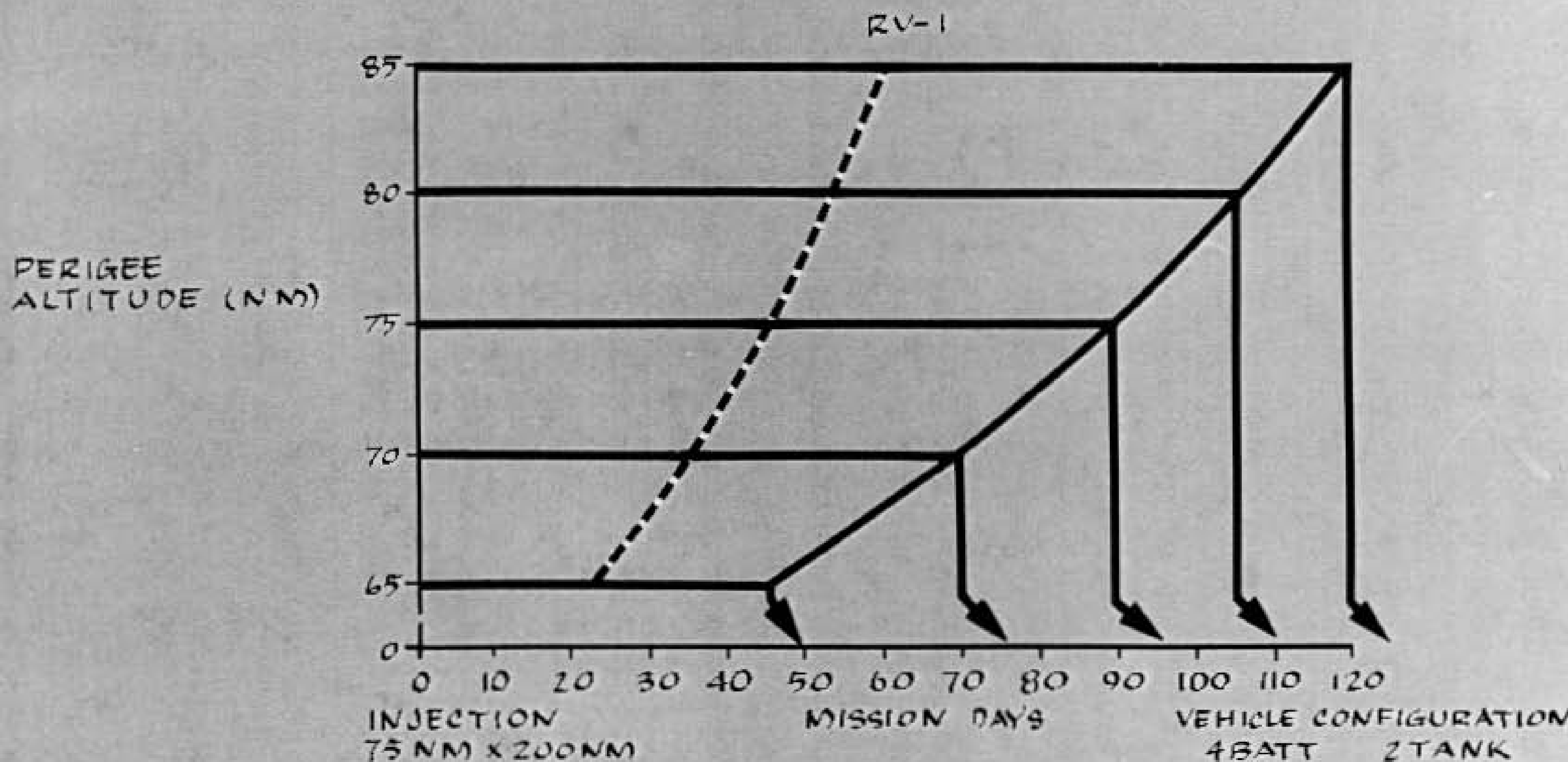
LOW ALTITUDE MISSION ENVELOPE

The Dual Mode Gambit vehicles retain full capability to accomplish the traditional low altitude surveillance mission. The mission envelope illustrates the requirement for more frequent and substantial orbit adjusts at the higher atmospheric drag of low altitudes. This translates to shorter duration missions due to the higher rate of fuel expenditure. Altitudes below 70 n.mi. require a slightly increasing altitude profile toward the end of the mission to maintain thermal/pressure equilibrium in the SCS propellant system. Assumptions inherent in the chart are listed below:

1. 75 x 200 n.mi. injection altitude (2,170 pounds propellant remaining).
2. Equal mission segments.
3. 96.5° (sun synchronous orbit inclination).
4. ISPS engine used on orbit adjusts.
5. Normal propellant reserves (150 pounds) retained.
6. Perigee maintained between 45 - 60° North Latitude.
7. Four batteries, two hydrazine tanks.

DUAL MODE ORBIT PLANNING
FLY LOW ONLY



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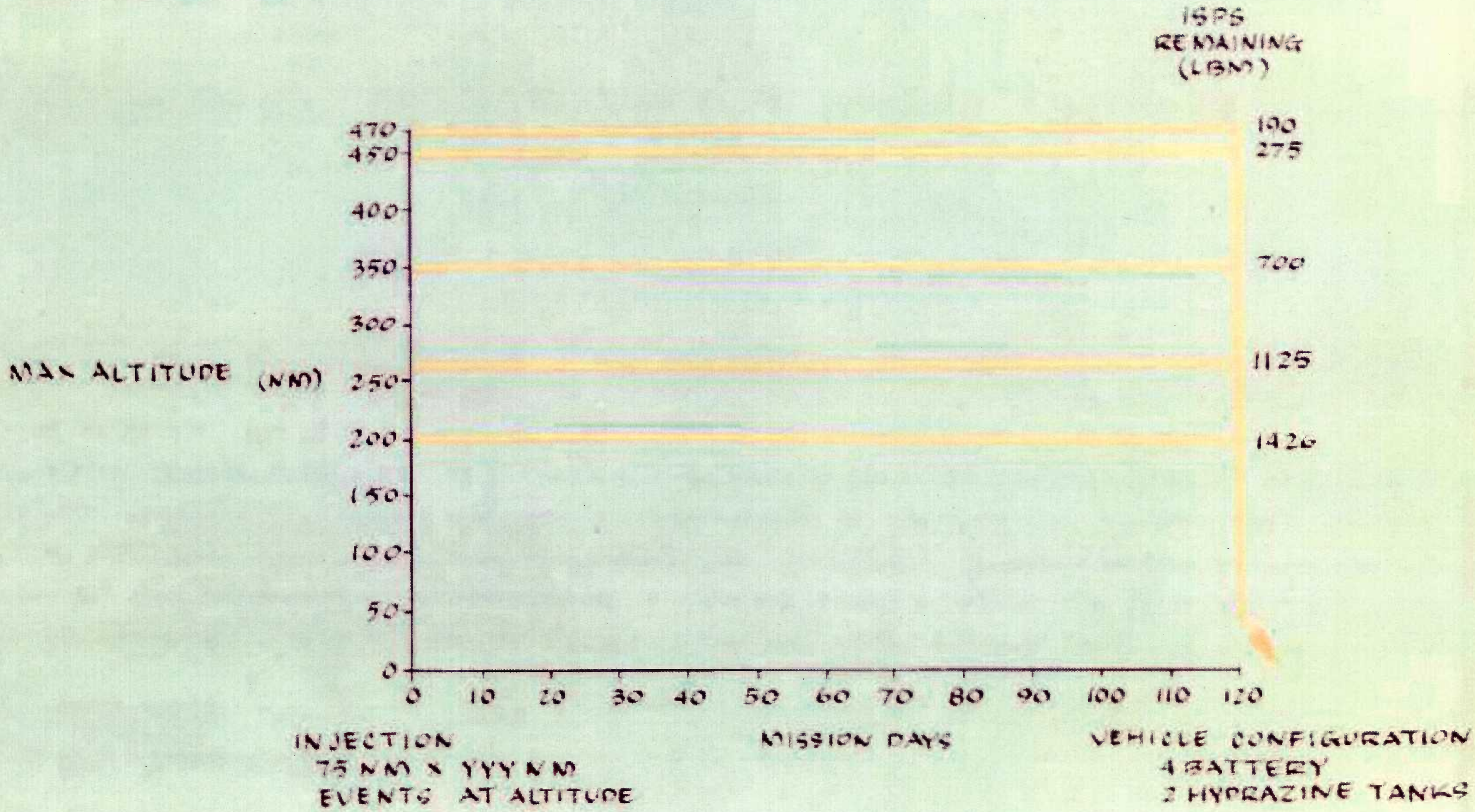
HIGH ALTITUDE MISSION ENVELOPE

Exclusive tasking against search objectives would result in only a high altitude mission being flown. The altitude profile is attained by injecting into a 75 n.mi. perigee with apogee at the desired final altitude. A series of altitude adjustments are made to the orbit to circularize at the apogee altitude. This mission option is constrained in altitude by the deboost propellant requirement and in duration by electrical power availability. The ISPS propellants shown remaining are at deboost impact and 120 days electrical power are a conservative estimate. Expendables available after 120 days could be used for mission extension in either a high or low mode. Available ISPS propellants allow operations at the full 470 n.mi. range, [redacted] and orbit closure control over selected areas. In general, the assumptions for the high altitude profiles parallel those made for the low altitude case.

DUAL MODE ORBIT PLANNING
FLY HIGH ONLY



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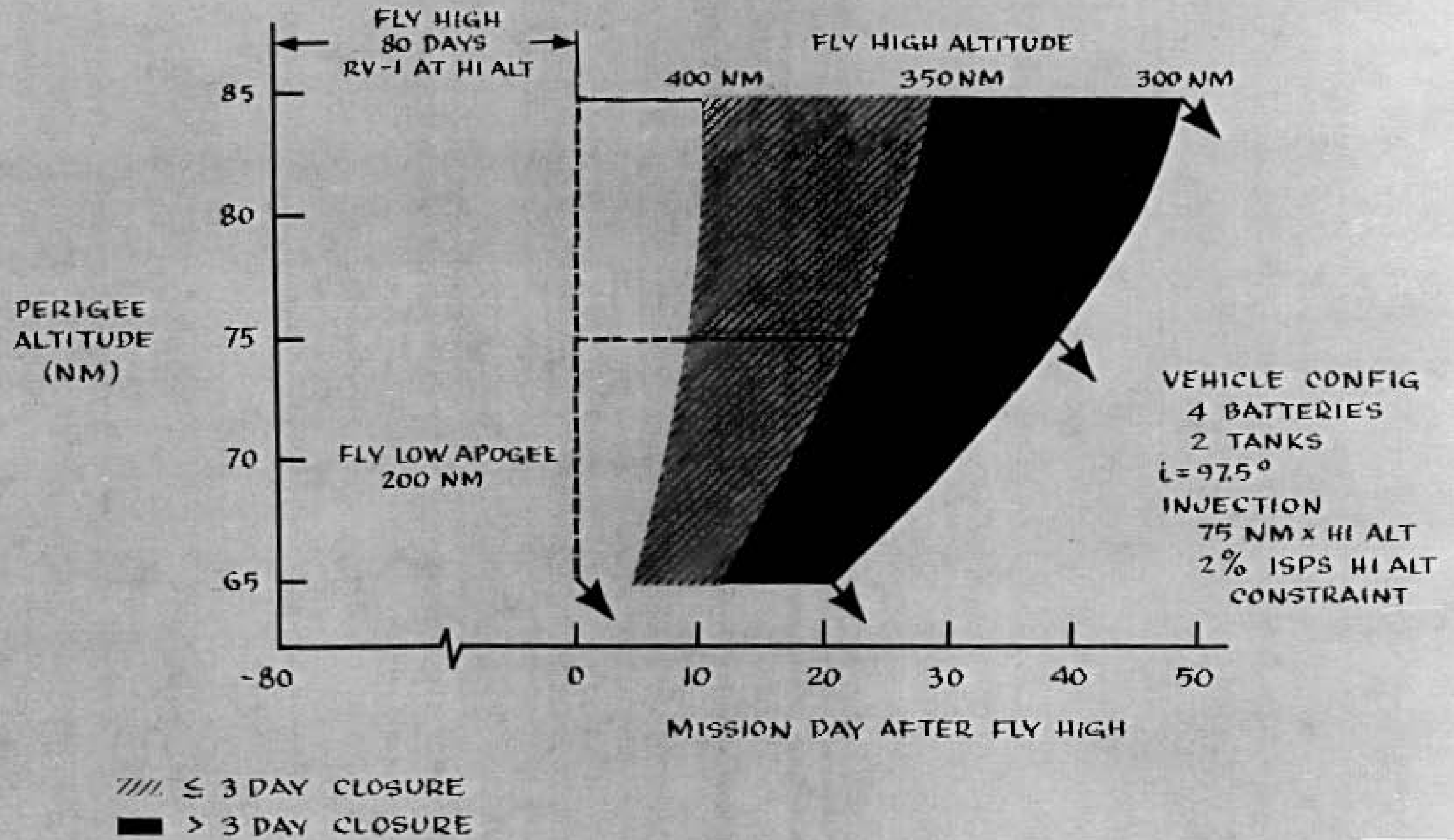
DUAL MODE MISSION ENVELOPE

Hi-Low Profile

Initial operations at high altitude are possible within the nominal envelope shown. The penalty for selecting this sequence of mixed operation is that the total time at low altitude is shorter than if this segment were flown first. One option to alleviate this limitation is to reduce perigee only for the low altitude portion; e.g., fly 75 x 400 n.mi. vs a conventional 75 x 200 n.mi. low altitude orbit. Argument of perigee would be controlled within the 45 to 60°N latitude band. This highly elliptical orbit would increase the time available for high quality imaging within the traditional area of interest; however, the rapidly increasing slant range as the satellite leaves perigee restricts high resolution opportunities at third world latitudes.

DUAL MODE ORBIT PLANNING
HI-LO CAPABILITY



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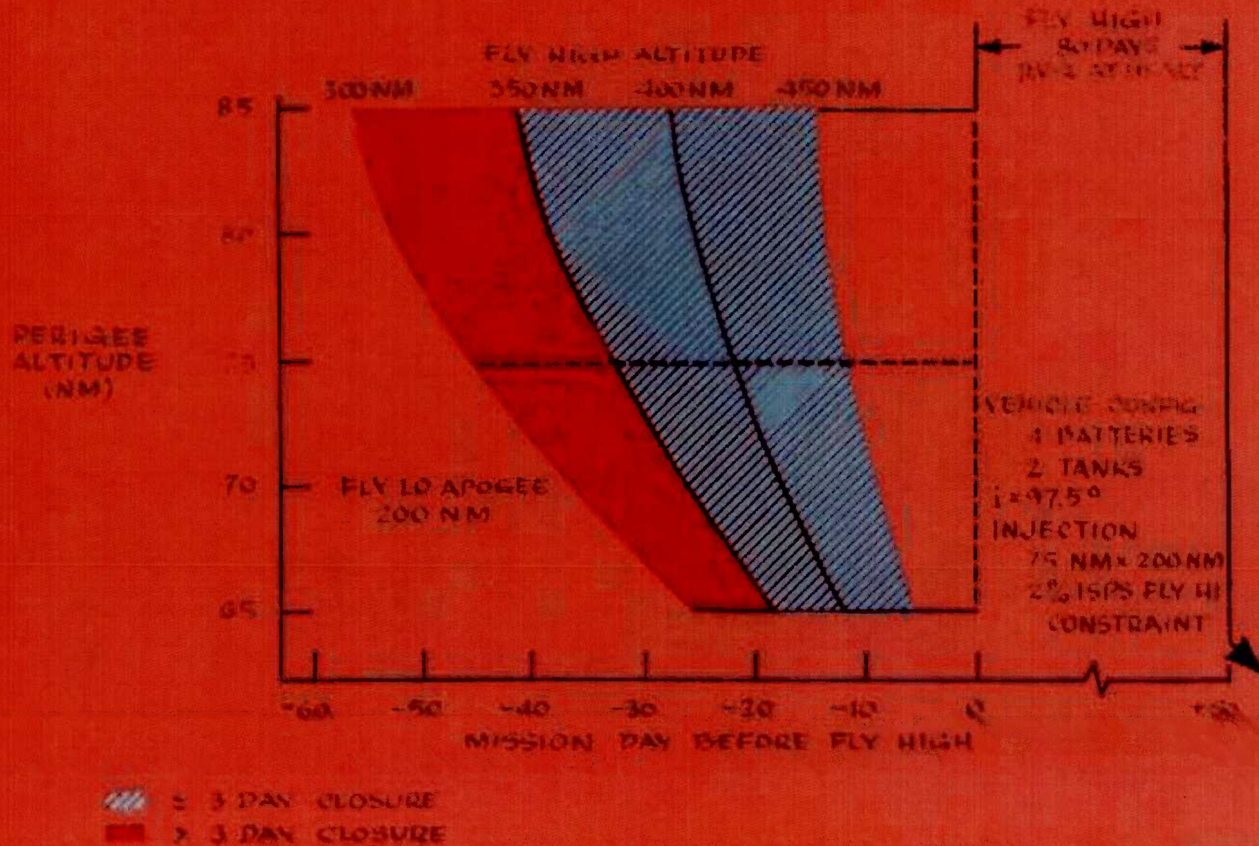
DUAL MODE MISSION ENVELOPE

Low-High Profile

Hybrid missions may be planned to include both low and high altitude segments. Low altitude lifetime is maximized if this portion is flown first. This allows significant propellant savings due to a lighter vehicle being boosted to the high altitude profile. These boost savings in turn are translated into days of low altitude operations. The nominal mission envelope is shown. The degree of post-launch flexibility afforded the mission director is determined by low altitude perigee, final high altitude desired, and whether SRV 1 is recovered at low or high altitude. For the nominal envelope shown, SRV 1 is assumed to be recovered prior to boost to high altitude. If this were not the case, there is a one day penalty in low altitude life, or about a 10 n.mi. penalty in altitude achieved. The actual duration of the high altitude segment is not restricted to 80 days; longer missions are definitely possible depending upon actual electrical power used. If intermediate altitudes are chosen for both search (350 n.mi.) and surveillance (75 n.mi.) missions, a short, highly elliptical (75 x 350 n.mi.) surveillance mission could be flown using available propellant to revisit technical intelligence targets prior to termination of the flight.

DUAL MODE ORBIT PLANNING LO-HI CAPABILITY

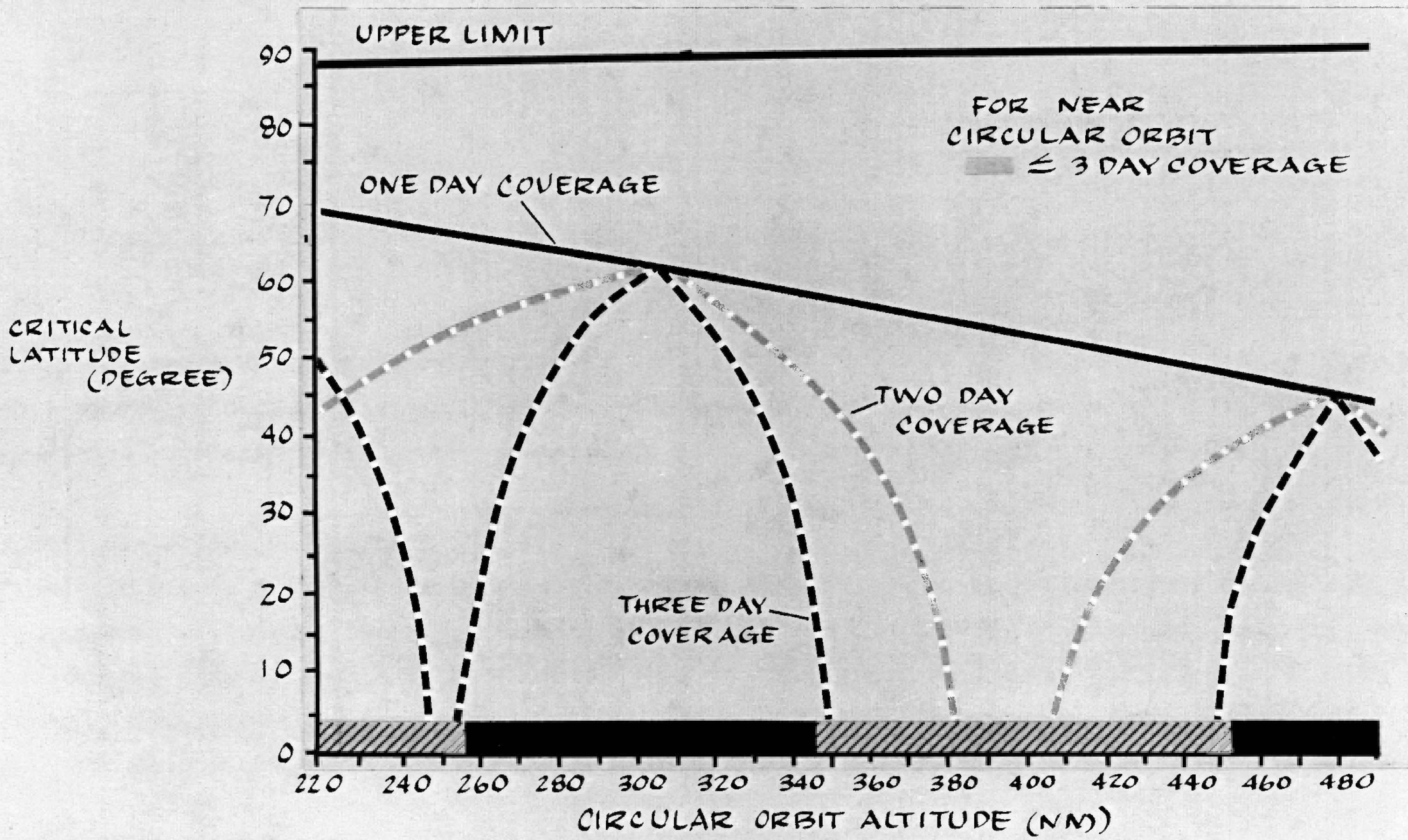


LATITUDE ACCESS PROFILE

This chart illustrates the latitude at which total daily access is achieved for circular orbits; as well as the time required to complete the access for lower latitudes. A circular orbit at 400 n.mi. yields daily access above 51 degrees and global access every other day for example. A 450 n.mi. orbit results in daily access above 48°N and requires three days for total access.

The data is valid only for circular orbits. Although elliptical orbits react in similar fashion, orbit period and apogee/perigee altitude and location may be varied to control access and closure to a desired area.

LATITUDE ACCESS PROFILE



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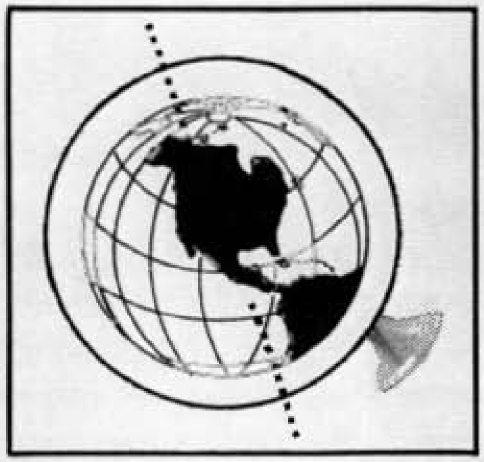
RADIATION CONSIDERATIONS

The combination of longer mission duration and higher altitude capability with Dual Mode introduces a new complication to mission planners. The "Van Allen Belts" are concentrations of charged particles trapped by the earth's magnetic field. Photographic film is susceptible to partial fogging when exposed to high concentrations of charged particles over an extended period. Orbits below 500 n.mi. primarily encounter the energetic proton belt which sags into the region known as the South Atlantic Magnetic Anomaly, located between Brazil and northwest Africa.

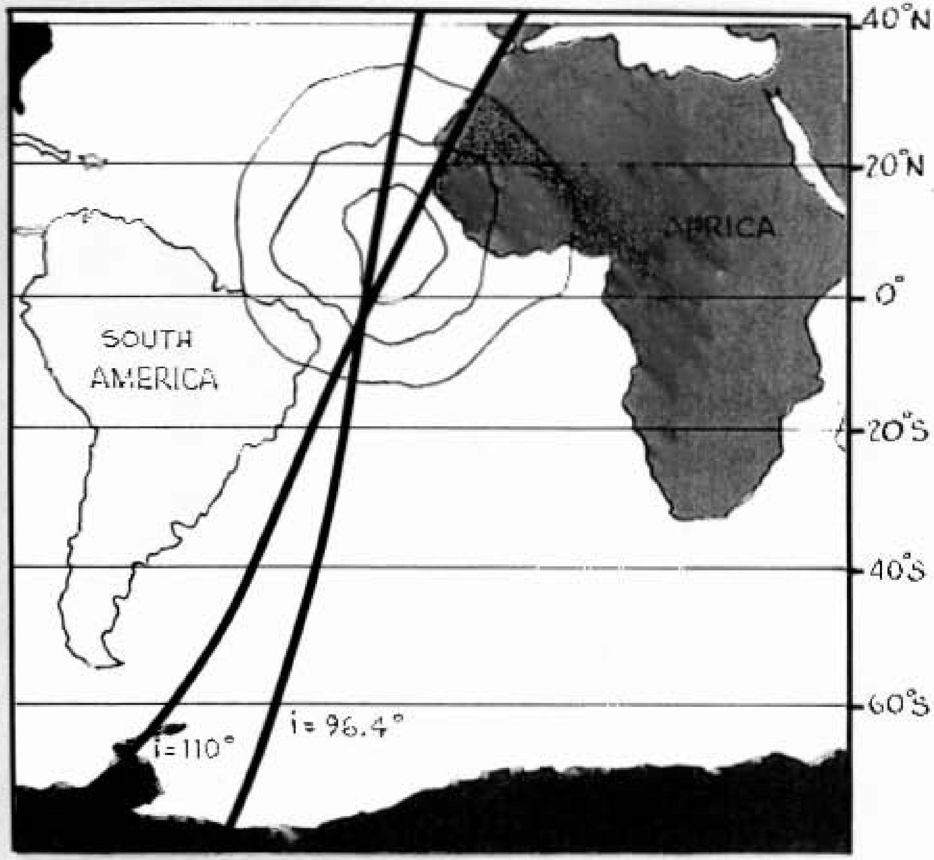
Radiation intensity in this area varies with solar and cosmic activity. Understanding this variation, as well as the effects of vehicle shielding in protecting the film, allows orbit planning and adjustment to limit or eliminate mission degradation.

DUAL MODE ORBIT PLANNING RADIATION CONSIDERATIONS



INFLUENCING FACTORS

- SOLAR ACTIVITY
- ORBIT PROFILE



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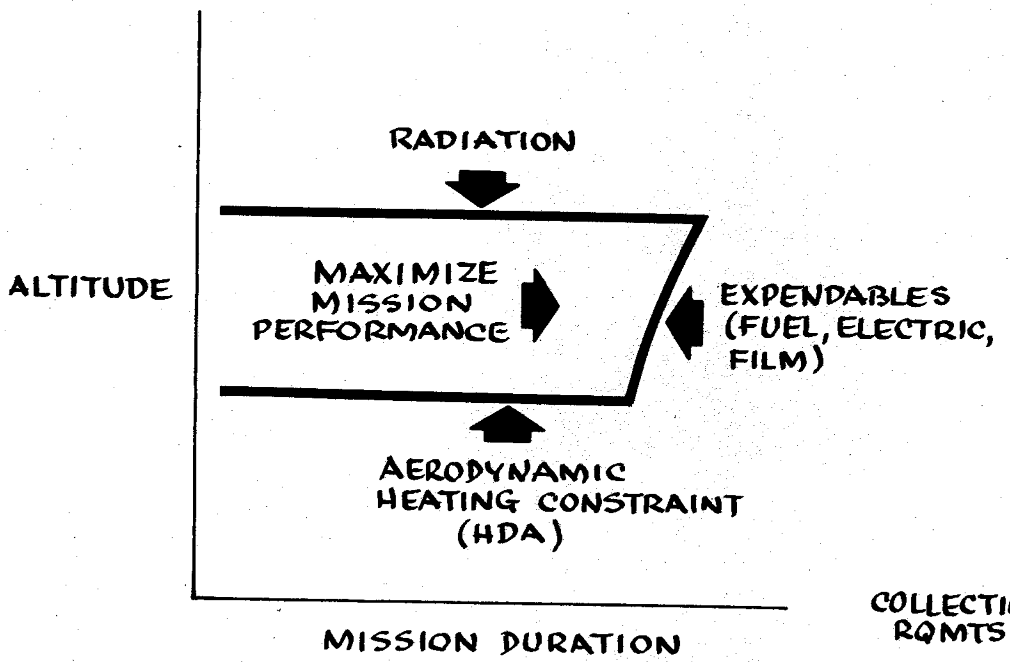
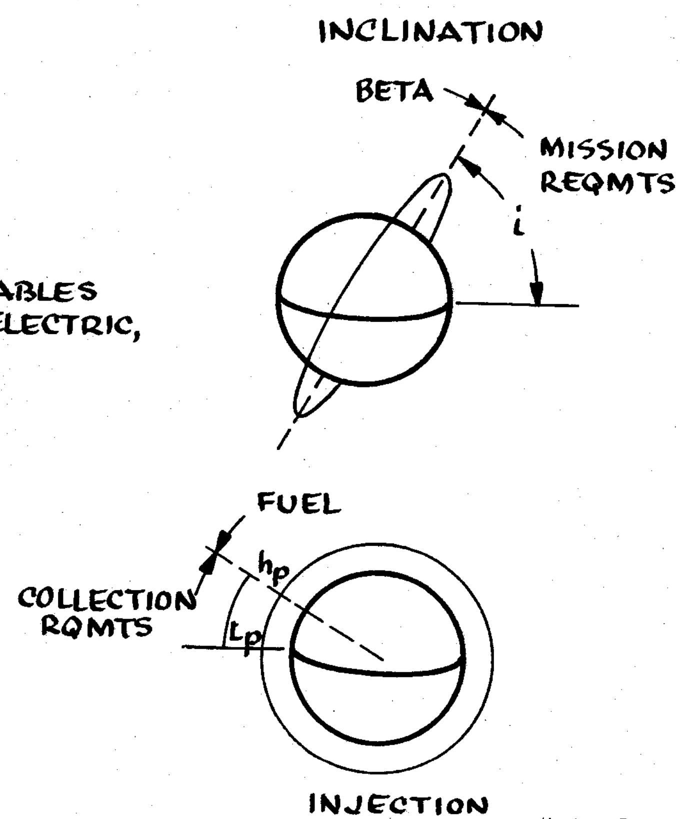
DUAL MODE MISSION PLANNING

Dual mode mission planning consists of optimizing operational conditions against a defined set of target collection requirements. This optimization must be accomplished within the physical limits of orbit and hardware constraints. The inherent versatility of the Dual Mode payload imposes additional difficulties since a gamut of missions from search to surveillance to quick reaction is possible and may be directed on short notice.

The major bounds on the mission envelope are identified. Generally the mission length is constrained by the rate of expendables consumption. Available electrical power limits the high altitude missions, orbit maintenance fuel use limits low altitude missions, and rate of film use can limit any mission. Altitude is primarily limited by aerodynamic heating at the low altitudes and Van Allen radiation at high altitudes -- available film drive speeds span the 65 to 470 n.mi. range at full obliquity. Photographic conditions are optimized by choice of lift-off time and inclination (target illumination), mission altitude profile (photographic scale and coverage), and film load (slow speed/high resolution film high, medium speed/medium resolution film low).

DUAL MODE MISSION PLANNING





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SYSTEM DESCRIPTION
SYSTEMS OPERATION
MISSION PLANNING
➤ MISSION SIMULATIONS

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SEARCH MISSION SIMULATIONS: 350 N.Mi. ORBIT

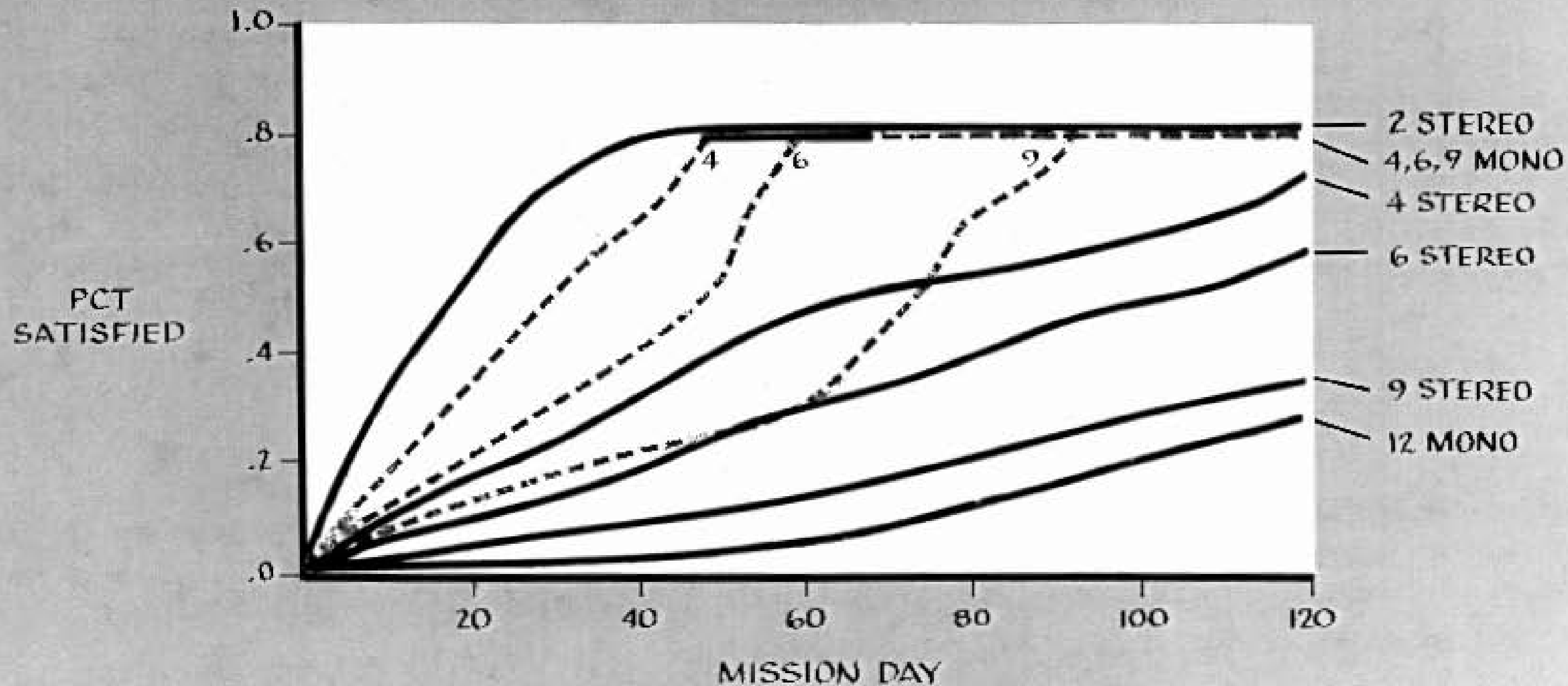
The following five charts illustrate the results of computer simulations of Dual Mode collection performance against an actual search target deck. Each simulation involved an 1830Z lift-off time into a circular sun-synchronous orbit. The simulations were run for 120 days and assumed 10,800 feet of SO-112 film on the nine-inch camera. Cases were run at 350 n.mi. and 450 n.mi. altitudes. The specific area distribution against which the missions were targetted are shown below:

Standing Search Target Sets (Months)	Area		Mode
	N.Mi^2	Cells	
2	187,500	868	Stereo
4	1,126,224	5,214	Stereo
6	987,336	4,571	Stereo
9	1,712,232	7,927	Stereo
12	3,733,560	17,285	Mono

The performance charts illustrate rate of satisfaction of the specific area requirements. In general, the solid red lines indicate stereo collection and the solid green lines monoscopic. The dashed lines indicate expected performance if monoscopic coverage was accepted against all target sets except the two month.

Expected performance assuming no other search mission has been successful for 12 months prior to launch is illustrated here. This is obviously a worst case situation since all requirements are initialized at zero satisfaction levels.

GAMBIT DUAL MODE SEARCH ACCOMPLISHMENT STEREO & MONO FOR 350 NM ORBIT



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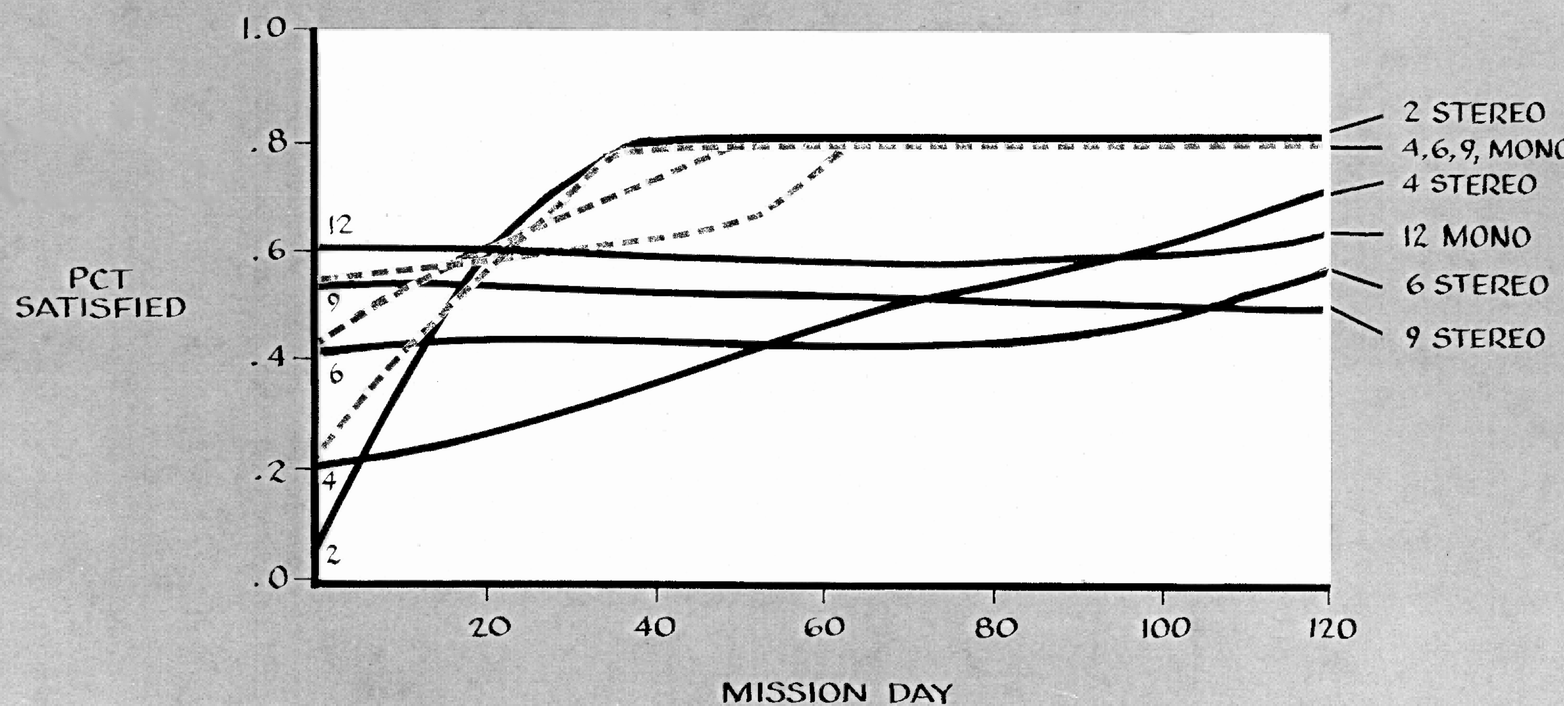
SEARCH MISSION SIMULATIONS: 350 N.Mi. ORBIT

This chart illustrates the more likely application where a contingency search mission is launched in response to failure of the primary search vehicle or as a gap filler between search missions. The situation assumes a three month search gap before the Gambit mission or the primary search vehicle has failed after three months of operation. The search target sets are initialized at satisfaction levels reflecting the aging of the previously acquired cells.

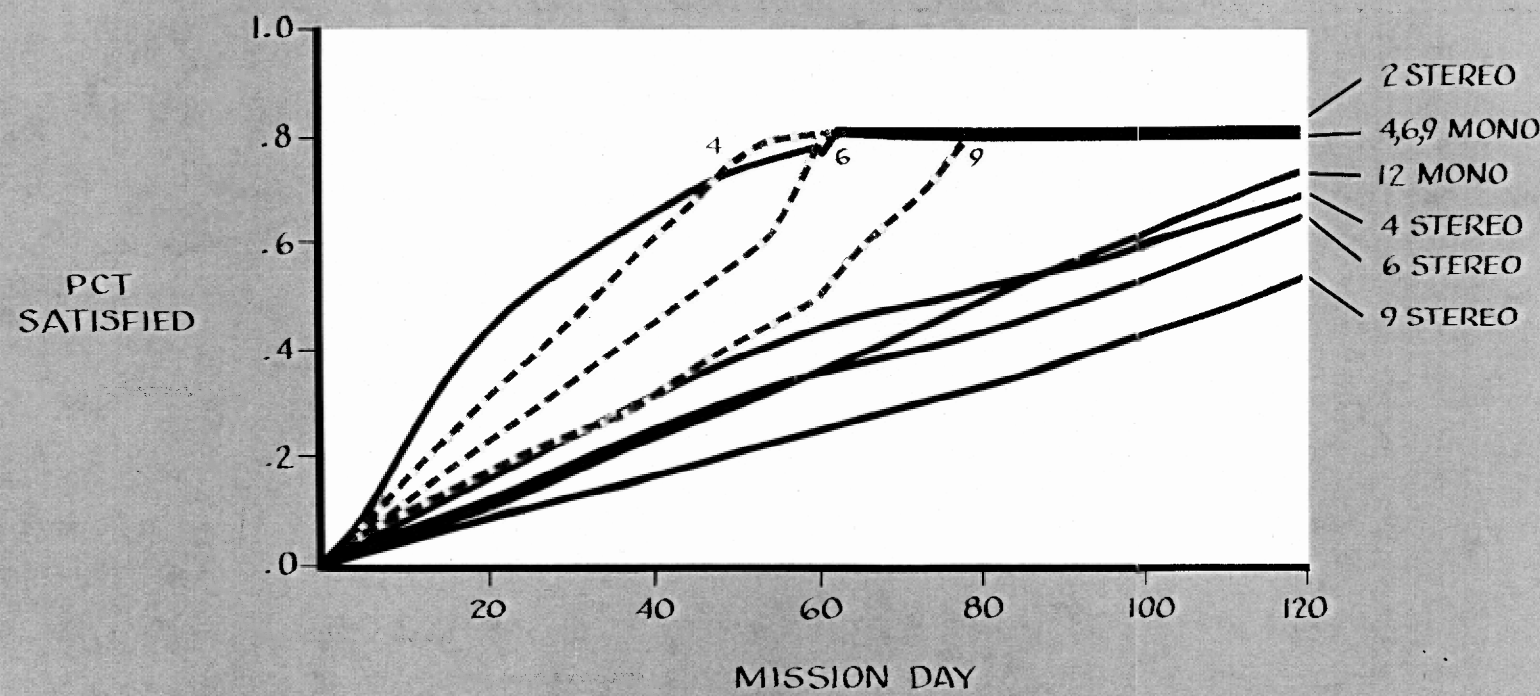
GAMBIT DUAL MODE SEARCH SATISFACTION
STEREO & MONO FOR 350 NM ORBIT
3 MONTHS INTO OR 3 MONTHS AFTER
A SEARCH MISSION



SEARCH MISSION SIMULATIONS: 450 N.Mi. ORBIT

As expected, the scale advantage of high altitude yields a significant improvement in collection efficiency. Again this is worst case since the simulation is based upon no other search system operating in the previous year.

GAMBIT DUAL MODE SEARCH ACCOMPLISHMENT STEREO & MONO FOR 450 NM ORBIT



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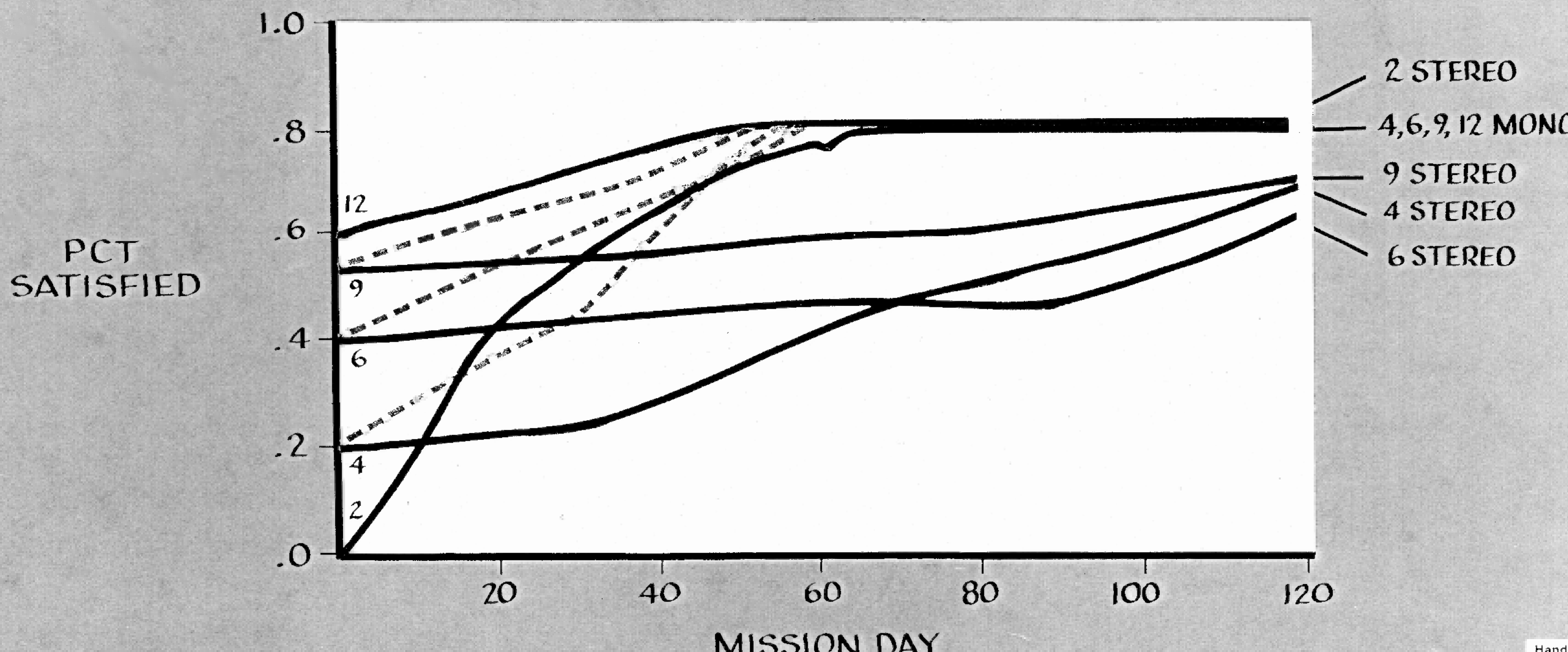
SEARCH MISSION SIMULATIONS: 450 N.Mi. ORBIT

The 450 n.mi. case of launch on failure of the primary system or supplemental operation in between missions is illustrated here.

GAMBIT DUAL MODE SEARCH SATISFACTION STEREO & MONO FOR 450 NM ORBIT 3 MONTHS INTO OR 3 MONTHS AFTER A SEARCH MISSION



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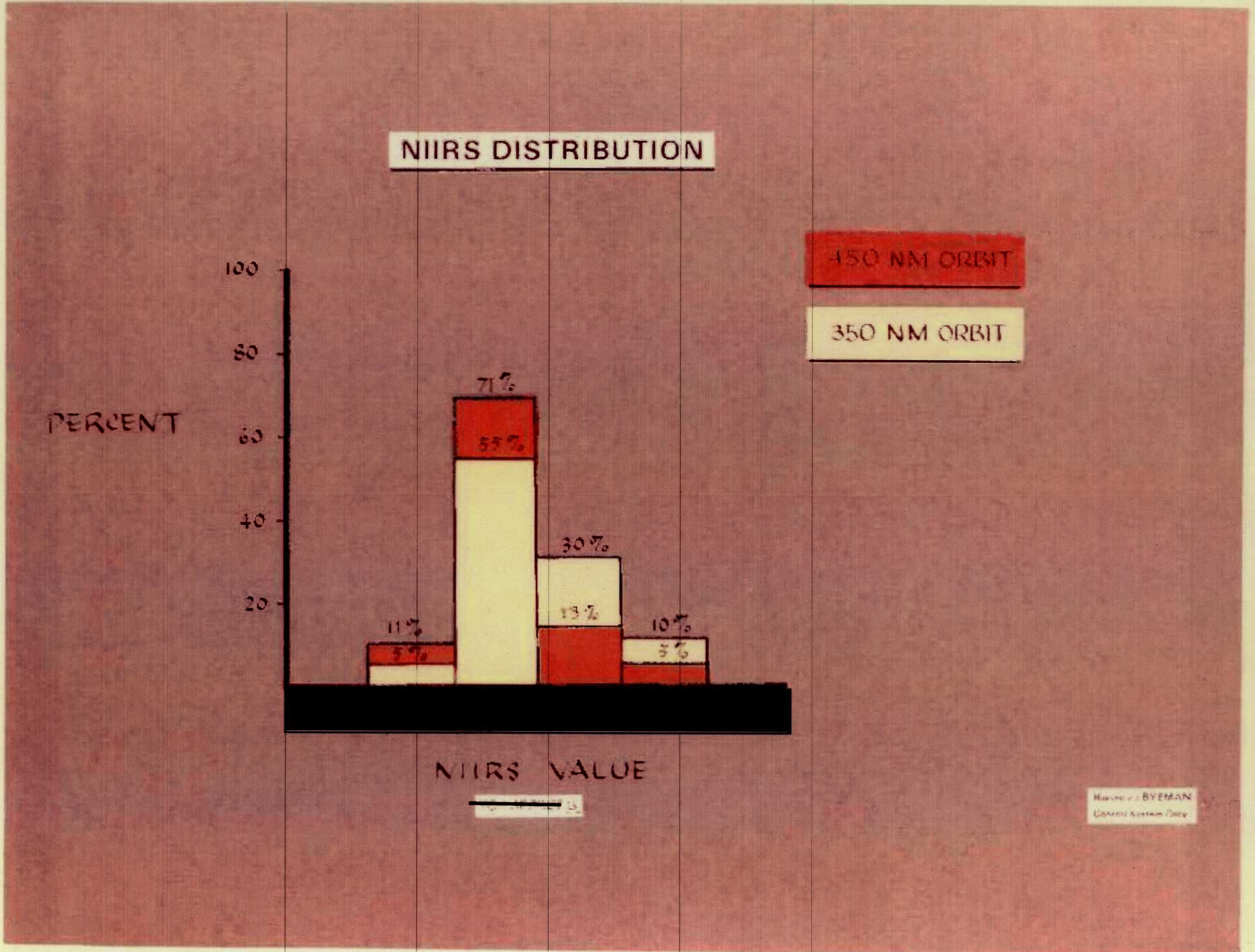
NIIRS DISTRIBUTION

This data reflects expected NIIRS distribution for the previous collection simulations. The values are based upon average performance across the film strand, and illustrate successful operation in the NIIRS 3 to 5 range for search targets.


NIIRS DISTRIBUTION
450 NM ORBIT
350 NM ORBIT
PERCENT
100
80
60
40
20
71%
55%
30%
15%
11%
5%
10%
5%
[redacted]
NIIRS VALUE
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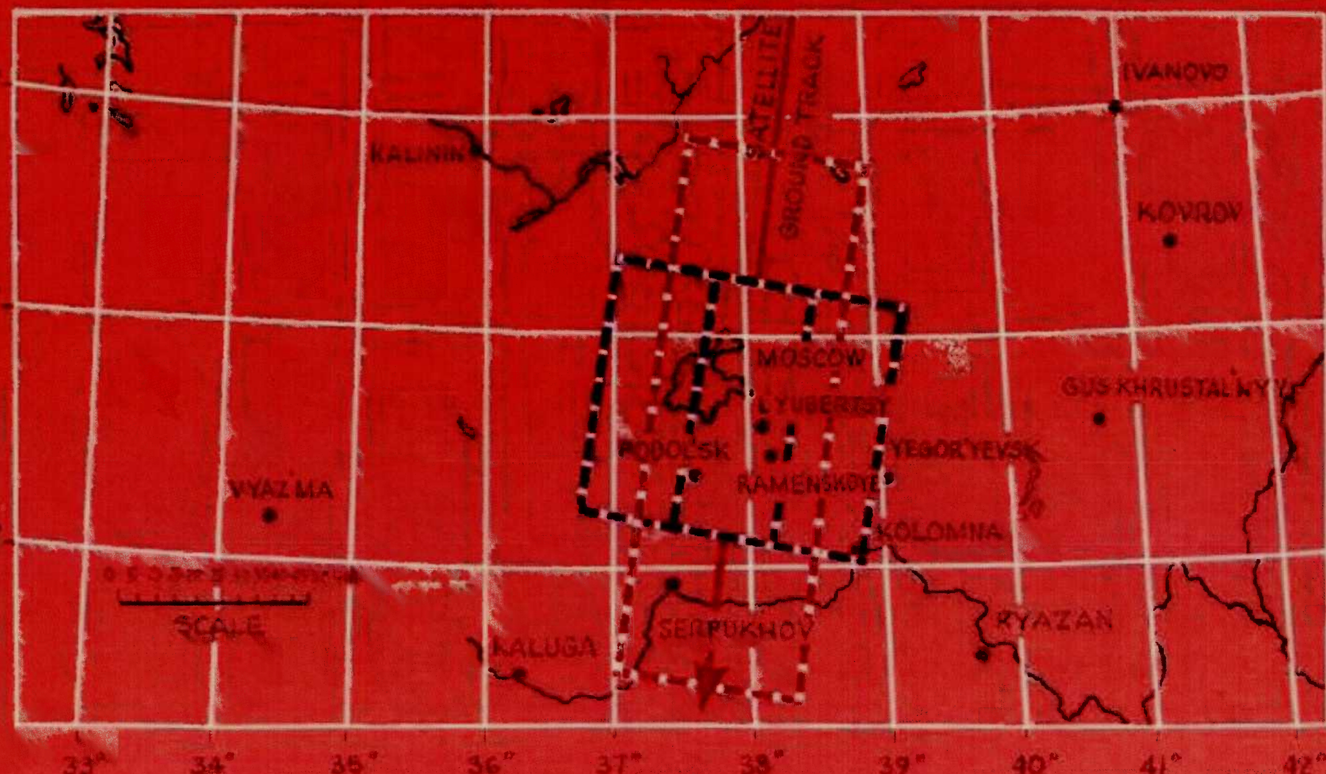
NADIR OPERATIONAL EXAMPLE

Operations with the roll joint near the nadir position maximize image quality but minimize the acquisition footprint. From 470 n.mi. altitude the strip frame would be approximately 24 n.mi. across. The lateral coverage may be increased significantly by employing lateral pairs or triplets as shown. For this specific example, the lateral pair would acquire an area 134 by 48 n.mi. (in-track by cross-track), the lateral triplet 65 by 72 n.mi. Film used for the pair would be approximately six feet; for the triplet four and a half feet.

NADIR OPERATIONAL EXAMPLE



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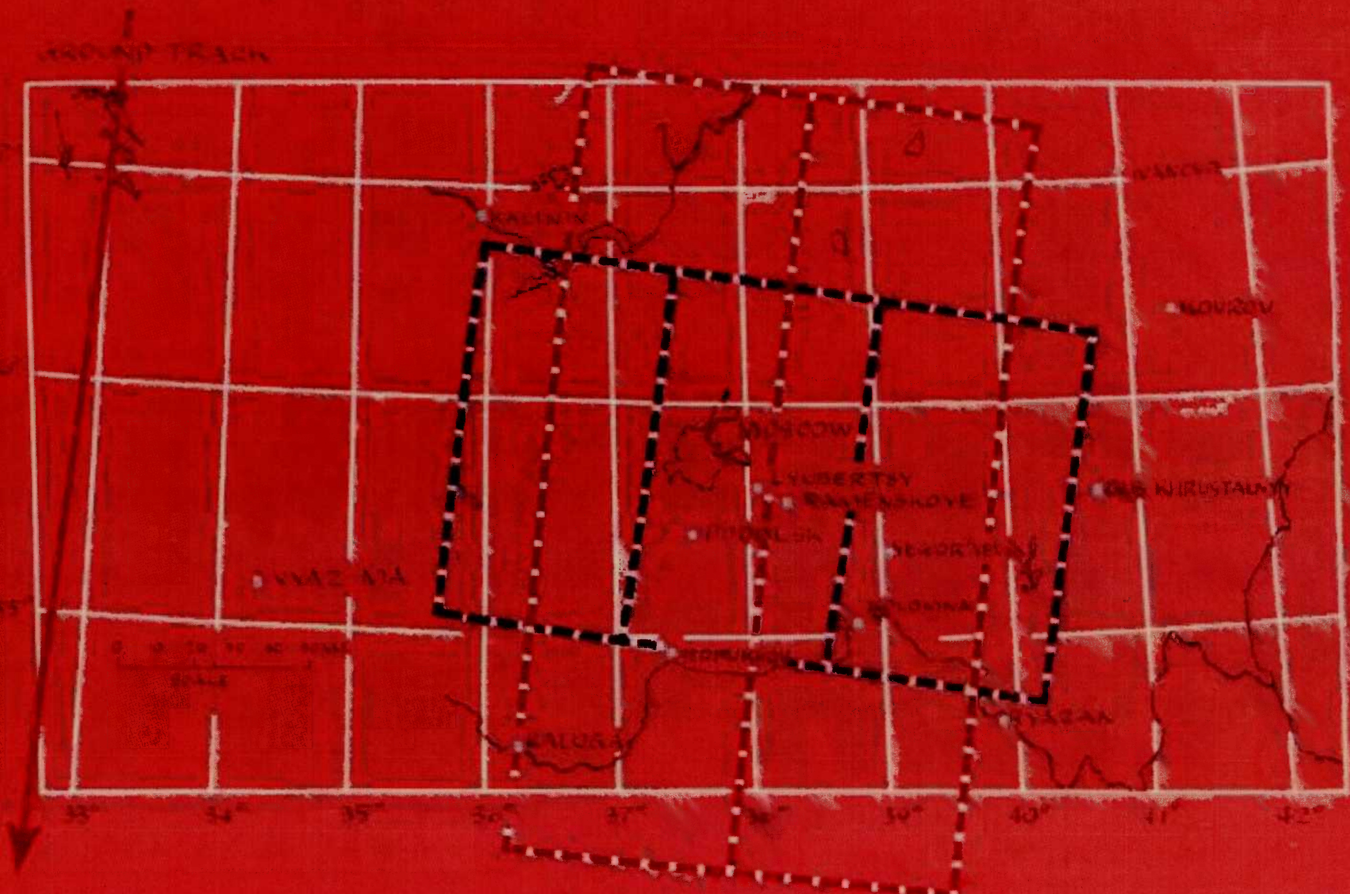
FULL OBLIQUITY OPERATIONAL EXAMPLE

Operations with the roll joint near its maximum of 45 degrees result in dramatic increases in area acquired. The strip mode from 470 n.mi. yields a continuous lateral coverage of 63 n.mi. Lateral pairs could be employed to collect areas as large as 202 by 116 n.mi. (in-track by cross-track); lateral triplets to acquire 99 by 164 n.mi. respectively. The lateral pair requires eight feet of film and encompasses 23,400 n.mi.^{2}; the triplet six feet and 16,200 n.mi.^{2}.

FULL OBLIQUITY OPERATION EXAMPLE



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OPERATIONAL AGILITY

A portion of a typical Dual Mode search acquisition sequence is illustrated. The combination of cross-track agility, afforded by the roll joint, with the in-track agility of the stereo mirror allows a series of photographic operations which efficiently acquire large areas of intelligence interest. This selectivity has the potential of significantly reducing the exploitation burden on the photointerpreter.

The example consists of two monoscopic strip sequences, separated by a slight roll maneuver, with the stereo mirror in the forward position. These are followed by a moderate roll to acquire [redacted]. This acquisition consists of a lateral triplet sequence of abutted strip frames with the stereo mirror in the forward, nadir, and aft positions respectively.

OPERATIONAL AGILITY

[redacted]

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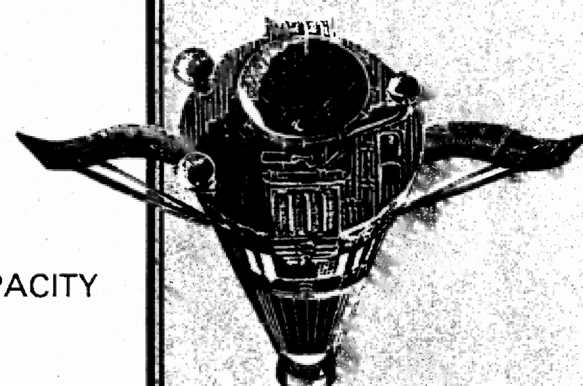
The extended altitude capability of the Gambit reconnaissance program allows a system designed essentially for point target surveillance to be effectively tasked against wide area search requirements. The versatility of the system allows the highest quality images of technical intelligence targets to be delivered from a mission which also satisfies a large portion of the standing search task. Full operational potential of the system will be realized through thorough understanding of the interactions of all system components. This overview is presented as a refresher to the Gambit program, an update on current system capabilities, and as an aid in optimal tasking and exploitation of the system.

SYSTEM SUMMARY

VERSATILITY
- 65 - 470 NM ALTITUDE ENVELOPE
- 90 - 120 DAY MISSIONS

QUANTITY
- 17 (10^6) NM^2 SEARCH CAPACITY
- 25,000 FRAME SURVEILLANCE CAPACITY

QUALITY
- NIIRS 3 - 5 SEARCH QUALITY
- NIIRS [redacted] SURVEILLANCE QUALITY



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