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GAMBIT DUAL MODE

AN IMAGE COLLECTION SYSTEM FOR THE 1980'S

APRIL 1977

PREPARED FOR SAFSP JOINTLY BY
EASTMAN KODAK COMPANY AND
LOCKHEED MISSILES AND SPACE COMPANY

CLASSIFIED BY <u>STW/ML/1</u> EXEMPT FROM GENERAL DECLASSIFICATION SCHEDULE OF E.O. 11652, CATEGORY: <u>SI, (S)</u> AUTOMATICALLY DECLASSIFIED UNLESS POSSIBLE TO DETERMINE	NATIONAL SECURITY INFORMATION UNAUTHORISED DISCLOSURE SUBJECT TO CRIMINAL SANCTIONS WARNING NOTICE SENSITIVE INTELLIGENCE SOURCES AND METHODS INVOLVED	HANDLE VIA STEELMAN CONTROL SYSTEM ONLY
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INTRODUCTION

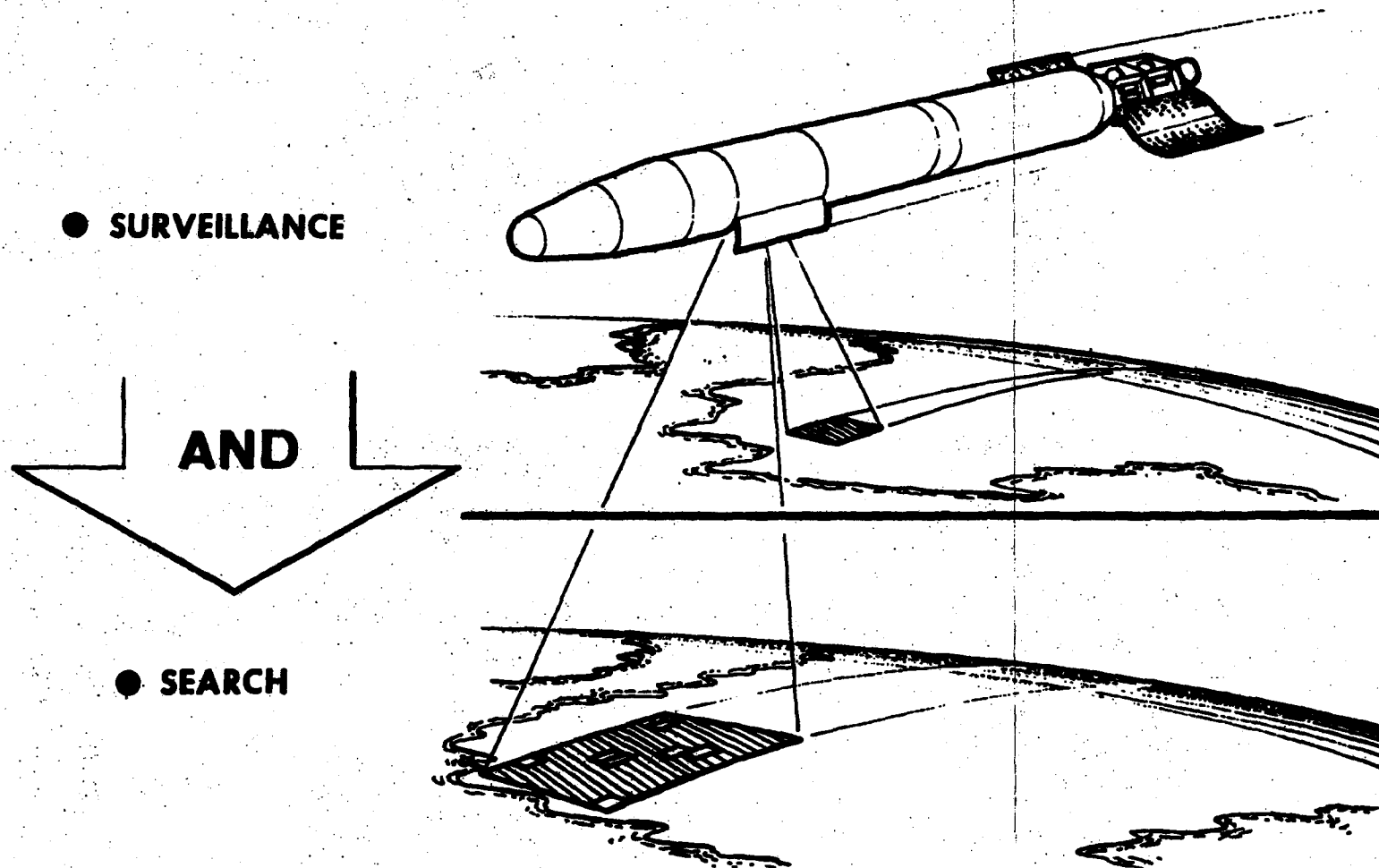
FUNDING LIMITATIONS FOR SATELLITE RECONNAISSANCE MAY CAUSE A REDUCTION IN THE NUMBER OF IMAGING SYSTEMS PROCURED DURING THE 1980s. IF A SYSTEM MUST BE DELETED FROM THE INVENTORY, EITHER GAMBIT OR HEXAGON APPEARS TO BE A LIKELY CANDIDATE. IF SUCH A DECISION IS NECESSARY, CONSIDERATION SHOULD BE GIVEN, DURING THE SELECTION PROCESS, TOWARD MAXIMIZING RECONNAISSANCE REQUIREMENTS SATISFACTION WITH THE RESULTING SYSTEMS MIX.

EMPHASIS SHOULD BE FOCUSED UPON PROVIDING SYSTEMS THAT WILL MAXIMIZE SATISFACTION OVER THE ENTIRE SPECTRUM OF INTELLIGENCE IMAGERY REQUIREMENTS. DELETION OF THE GAMBIT SYSTEM AND RETENTION OF HEXAGON WOULD RESULT IN AN ABUNDANCE OF SEARCH AND MEDIUM RESOLUTION SURVEILLANCE WITH A LOSS OF HIGH RESOLUTION TECHNICAL INTELLIGENCE AND SURVEILLANCE CAPABILITY. CONVERSELY, DELETION OF HEXAGON AND RETENTION OF GAMBIT, IN A DUAL OPERATIONAL MODE, WOULD RESULT IN A CONTINUED SOURCE OF HIGH RESOLUTION SURVEILLANCE AND CONSIDERABLE SEARCH COVERAGE.

THE PURPOSE OF THIS REPORT IS TO SHOW THAT FULL EXPLOITATION OF THE GAMBIT POTENTIAL, BY OPERATING AT LOW ALTITUDE FOR SURVEILLANCE AND HIGH ALTITUDE FOR SEARCH, WILL RESULT IN THE BEST MIX OF SEARCH AND SURVEILLANCE IMAGE COLLECTION WHEN CONSIDERED IN THE LIGHT OF ESTABLISHED REQUIREMENTS AND FUNDING LIMITATIONS.

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GAMBIT DUAL MODE CAPABILITY



GAMBIT DUAL MODE CAPABILITY

- OVERVIEW
- REQUIREMENTS
- SEARCH CAPABILITY
- SURVEILLANCE-SEARCH MISSION ANALYSIS
- VEHICLE MODIFICATION
- SUMMARY
- APPENDIX

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OVERVIEW

THE GAMBIT VEHICLE COMMENCING WITH VEHICLE 48, IS A REMARKABLY VERSATILE RECONNAISSANCE VEHICLE. THE NEW VEHICLES INCORPORATE MORE SOPHISTICATED CONTROL SYSTEMS, GREATER ELECTRICAL POWER CAPACITY, A SECOND CAMERA SYSTEM, AND DRAMATICALLY INCREASED EFFICIENCY OF FILM UTILIZATION DUE TO CAMERA DRIVE IMPROVEMENTS. IMAGE QUALITY POTENTIAL IS EXCELLENT, AS GOOD OR BETTER THAN PRIOR VEHICLES, ESPECIALLY IN THE LIGHT OF SIGNIFICANT FILM TECHNOLOGY ADVANCES.

THE VERSATILITY AND QUALITY POTENTIAL OF BLOCK 48 GAMBIT VEHICLES SUGGEST A GREATLY EXPANDED APPLICATION IN SIMPLIFIED SATISFACTION OF STANDING SEARCH, SURVEILLANCE, AND TECHNICAL INTELLIGENCE REQUIREMENTS. RELATIVELY MINOR MODIFICATIONS TO THE GAMBIT SYSTEM WOULD ALLOW ONE VEHICLE TO ACCOMPLISH AS MUCH OF THE SURVEILLANCE/TECHNICAL INTELLIGENCE MISSION AS PRIOR VEHICLES - AND SUBSEQUENTLY COLLECT A VERY HIGH PERCENTAGE OF THE ANNUAL SEARCH REQUIREMENTS.

AS AN EXAMPLE, ONE VEHICLE COULD BE OPERATED SEQUENTIALLY IN A LOW/HIGH "DUAL MODE" OVER A 120 DAY OPERATIONAL LIFETIME. THE SYSTEM WOULD BE LAUNCHED INTO THE CURRENT LOW ALTITUDE ORBIT (75 X 200 NM), AND PERFORM A STANDARD SURVEILLANCE MISSION FOR 40 DAYS. ROUGHLY 8000 FRAMES WOULD BE

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AVAILABLE FROM THIS PORTION OF THE MISSION, WITH QUALITY IN THE NIRS 5 [REDACTED] RANGE. THE MAJORITY OF THIS MISSION WOULD UTILIZE THE 5-INCH CAMERA SYSTEM. UPON COMPLETION OF THE SURVEILLANCE MISSION, THE ORBIT WOULD BE ADJUSTED TO APPROXIMATELY A 500 NM CIRCULAR ORBIT AND A SEARCH MISSION OF APPROXIMATELY 80 DAYS DURATION PERFORMED. UTILIZING ONLY THE 9-INCH CAMERA SYSTEM, AN ESTIMATED 14 TO 16 MILLION SQ MILES COULD BE ACQUIRED UNIQUELY AT NIRS 4 [REDACTED] QUALITY WITH MONOSCOPIC COVERAGE. STEREO COVERAGE IS ROUTINELY POSSIBLE AT THE EXPENSE OF THE TOTAL UNIQUE COVERAGE ESTIMATE.

THE PRIMARY MODIFICATIONS REQUIRED ARE TO THE FILM SYSTEM (SLOWER SPEEDS AT HIGH ALTITUDE FOR IMAGE MOTION COMPENSATION) AND THE VEHICLE CONTROL SYSTEM (MINOR MODIFICATIONS TO THE GUIDANCE, PROPULSION, AND REACTION CONTROL SYSTEM). ALL REQUIRED MODIFICATIONS ARE STRAIGHT-FORWARD AND COULD BE IMPLEMENTED BY 1980 WITH TIMELY COMMITMENT.

ESSENTIALLY THE DUAL MODE SCENARIO ALLOWS MAINTENANCE OF A VERY HIGH QUALITY PHOTOGRAPHIC CAPABILITY AS WELL AS SATISFACTION OF INTELLIGENCE COMMUNITY SEARCH REQUIREMENTS WITH A LESS COSTLY, WELL PROVEN SYSTEM. IT MUST BE EMPHASIZED THAT A DUAL MODE GAMBIT IN THE CONTEXT OF A TOTAL SYSTEMS MIX IS THE ONLY ALTERNATIVE WHICH PRESERVES ALL CURRENT PHOTOGRAPHIC RECONNAISSANCE CAPABILITY IN THE NEAR FUTURE.

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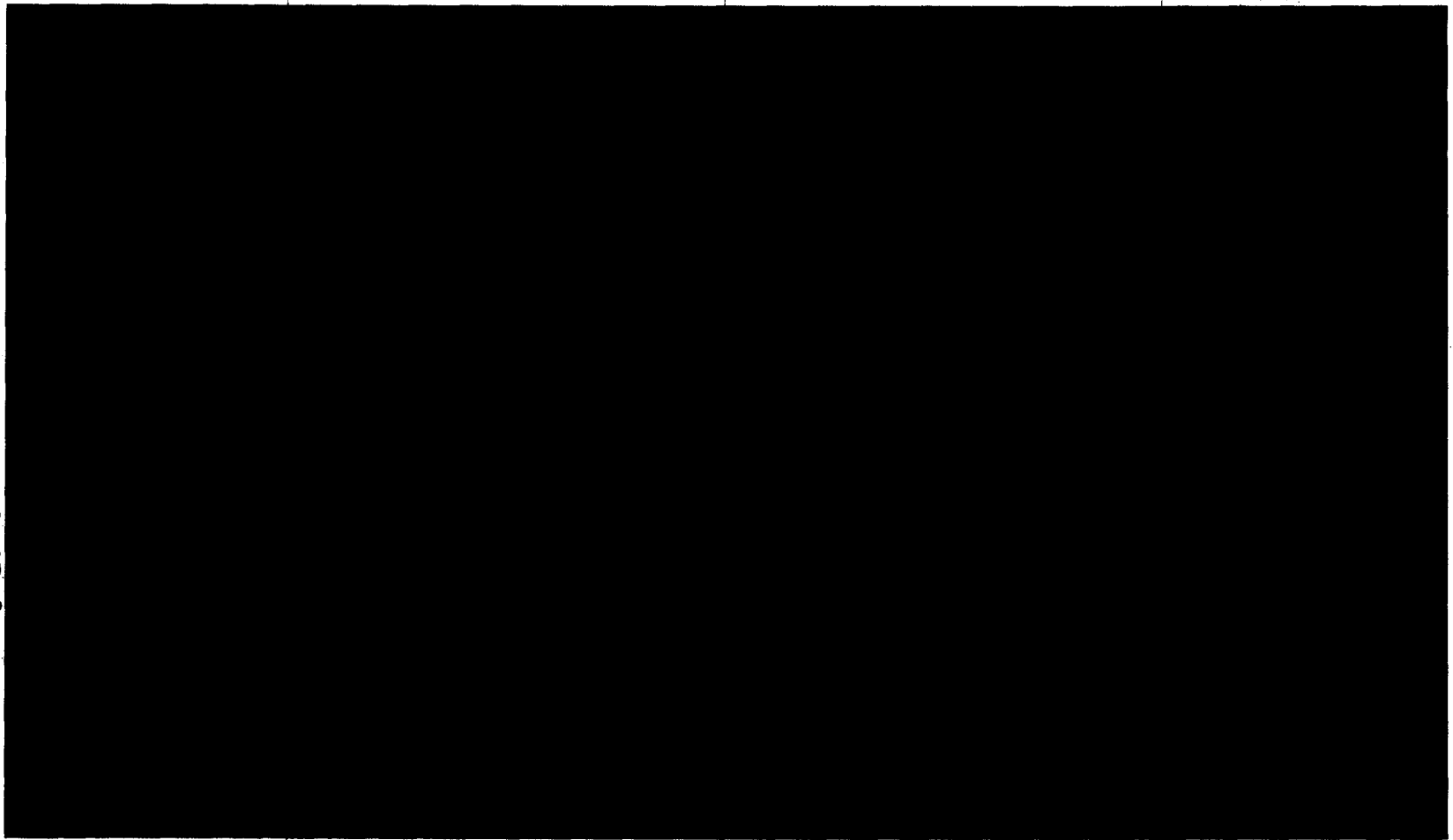
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SEARCH SIMULATION

FROM AN ALTITUDE OF 500 NM, THE GAMBIT SYSTEM CAN
RETURN IMAGERY IN THE 2 TO 4 FOOT GROUND RESOLVED
DISTANCE (GRD) RANGE. EXPECTED NIRS RATINGS WOULD
BE BETWEEN 4 AND 6.

A DUPLICATE TRANSPARENCY IS CONTAINED IN THE APPENDIX.

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HEXAGON SYSTEM
ALTITUDE = 82 NM
SCALE = 1:100,000
AERIAL 15 FILM
SMEAR = 3.5 MICROMETERS
ENLARGEMENT = 72X

GAMBIT SYSTEM
ALTITUDE = 500 NM
SCALE = 1:208,000
SO-209 FILM
SMEAR = 3 MICROMETERS
ENLARGEMENT = 150X

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**NATIONAL
IMAGERY
REQUIREMENTS**

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ALTHOUGH INTELLIGENCE REQUIREMENTS ARE CONSTANTLY UPDATED TO REFLECT COMMUNITY NEEDS, THE CURRENT ANNUAL REQUIREMENTS CAN BE CHARACTERIZED AS SHOWN. THE QUOTED FIGURES ARE CLOUD FREE, UNIQUE COVERAGE, AND ARE SHOWN ONLY TO PLACE THE GAMBIT CAPABILITY INTO CONTEXT.

THE GAMBIT SYSTEM, AS WILL ALL FILM RETRIEVAL SYSTEMS, HAS A PERIODICITY OF RETURN GOVERNED BY THE SCHEDULED RECOVERY OF ITS REENTRY VEHICLES. AS SUCH GAMBIT CAN REASONABLY BE EXPECTED TO OPERATE AGAINST THE OVERLAPPED SURVEILLANCE REQUIREMENTS. OTHER SYSTEMS IN THE SYSTEM MIX, AS WELL AS GAMBIT IN ITS SEARCH MODE, CAN BE ASSUMED TO PERFORM AGAINST THE REQUIREMENTS NOT OVERLAPPED. THE REQUIREMENTS WITH A SAMPLE PERIOD OF 30 DAYS HAVE BEEN INCLUDED IN THE DUAL MODE REQUIREMENTS SINCE GAMBIT IS CURRENTLY ASSUMED TO BE THE ONLY SYSTEM WITH THE POTENTIAL OF ROUTINELY ACHIEVING THE IMAGE QUALITY REQUIRED.

BROAD AREA SEARCH REQUIREMENTS*

AREA	FREQUENCY (1) (MONTHS)	SIZE (M SQ NM)	ANNUAL COVERAGE (M SQ NM)	MODE	QUALITY (2) (NIIRS)
TARGET CLUSTERS		0.306	1.224	S	4.5
CORE BUILT-UP		2.145	4.290	S	4.0
PERIMETER BUILT-UP		1.762	2.349	S/M ⁽³⁾	4.0
UNDEVELOPED		3.467	3.467	S/M ⁽³⁾	4.0
REMOTE		2.744	1.830	M	4.0
TOPOGRAPHICALLY		0.470	0.235	M	4.0
			5.514 S 4.41 S		
			7.881 M 6.31 M		
			13.395 10.72 ⁽⁴⁾		

NOTES:

- (1) FREQUENCY – NOMINAL ONLY.
- (2) DESIRED QUALITY IS 80-90% OF IMAGERY AT NIIRS 4.5/4.0 OR BETTER.
- (3) S/M – STEREO PREFERRED, MONO COVERAGE WILL SATISFY THE REQUIREMENT (UNDER REVIEW).
- (4) TASKING REQUIREMENTS ARE 80% CLEAR IMAGERY (TOTAL 10.716 M SQ NM/YEAR CLEAR).

* COMIREX-ICRS PROJECTED BROAD AREA SEARCH REQUIREMENTS, 17 SEPT 76.

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BROAD AREA SEARCH REQUIREMENTS MAY BE SUMMARIZED AS SHOWN ON THE FACING PAGE. THE ANNUAL COVERAGE REQUIREMENTS ARE DERIVED FROM FREQUENCY OF COVERAGE REQUIREMENTS FOR THE SAME AREA.

A TOTAL OF 13.4 MILLION SQ NM ARE REQUIRED ANNUALLY IN THE NIRS 4.0 - 4.5 RANGE OF WHICH 80% OR 10.7 MILLION SQ NM MUST BE CLOUD FREE.

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MAPPING, CARTOGRAPHY AND GEODESY REQUIREMENTS*

ORIGINAL COMPILATION

- 2.1 M SQ NM/YR - STEREO COVERAGE - 6 FT GRD
- HIGH METRIC ACCURACY
 - 75 FT (90% CIRCULAR ERROR)
 - 55 FT VERTICAL (90% LINEAR ERROR)

MAP PRODUCT REVISION

- 2.4 M SQ NM/YR - MONO COVERAGE - 6 TO 50 FT GRD
- SAMPLING TECHNIQUE - 4 YR/1.2 M; 8 YR/0.7 M; 12 YR/0.5 M

POINT TARGETS

- 46,000 FREE-WORLD TARGETS (ALL SOURCE) - 24 TO 30 IN. GRD
- SAMPLE RATE - 475 TARGETS/YR

CONTINGENCY MAPPING

- 20,000 TO 100,000 SQ NM/YR - 24 IN. GRD (BEST)

* DMA M C & G IMAGERY COLLECTION REQUIREMENTS FOR THE 1980-85
TIME FRAME - DEC 76

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MAPPING, CARTOGRAPHY, AND GEODESY (M C & G) REQUIREMENTS ARE SUMMARIZED ON THE FACING PAGE. THESE REQUIREMENTS ARE WITHIN THE POTENTIAL CAPABILITIES OF THE GAMBIT DUAL MODE SYSTEM WITH THE EXCEPTION OF THE HIGH METRIC ACCURACY (HMA) REQUIREMENTS. THE GAMBIT VEHICLE CAN BE MODIFIED TO PERFORM A HMA MISSION; HOWEVER, SUCH MODIFICATION IS RELATIVELY EXTENSIVE INCLUDING THE ADDITION OF STAR SENSORS, ALIGNMENT SENSORS, AND A GLOBAL POSITIONING SATELLITE SYSTEM RECEIVER. AS A RESULT, ALTHOUGH THE AREA COVERAGE FOR ORIGINAL COMPILATION IS INCLUDED AS A REQUIREMENT FOR THE GAMBIT DUAL MODE SYSTEM, THE HMA REQUIREMENTS WILL BE ASSUMED TO BE MET BY OTHER SYSTEMS, OR THROUGH USE OF GAMBIT DUAL MODE PHOTOGRAPHY COLLATERALLY WITH HISTORICAL DATA AND/OR DATA FROM OTHER SYSTEMS.

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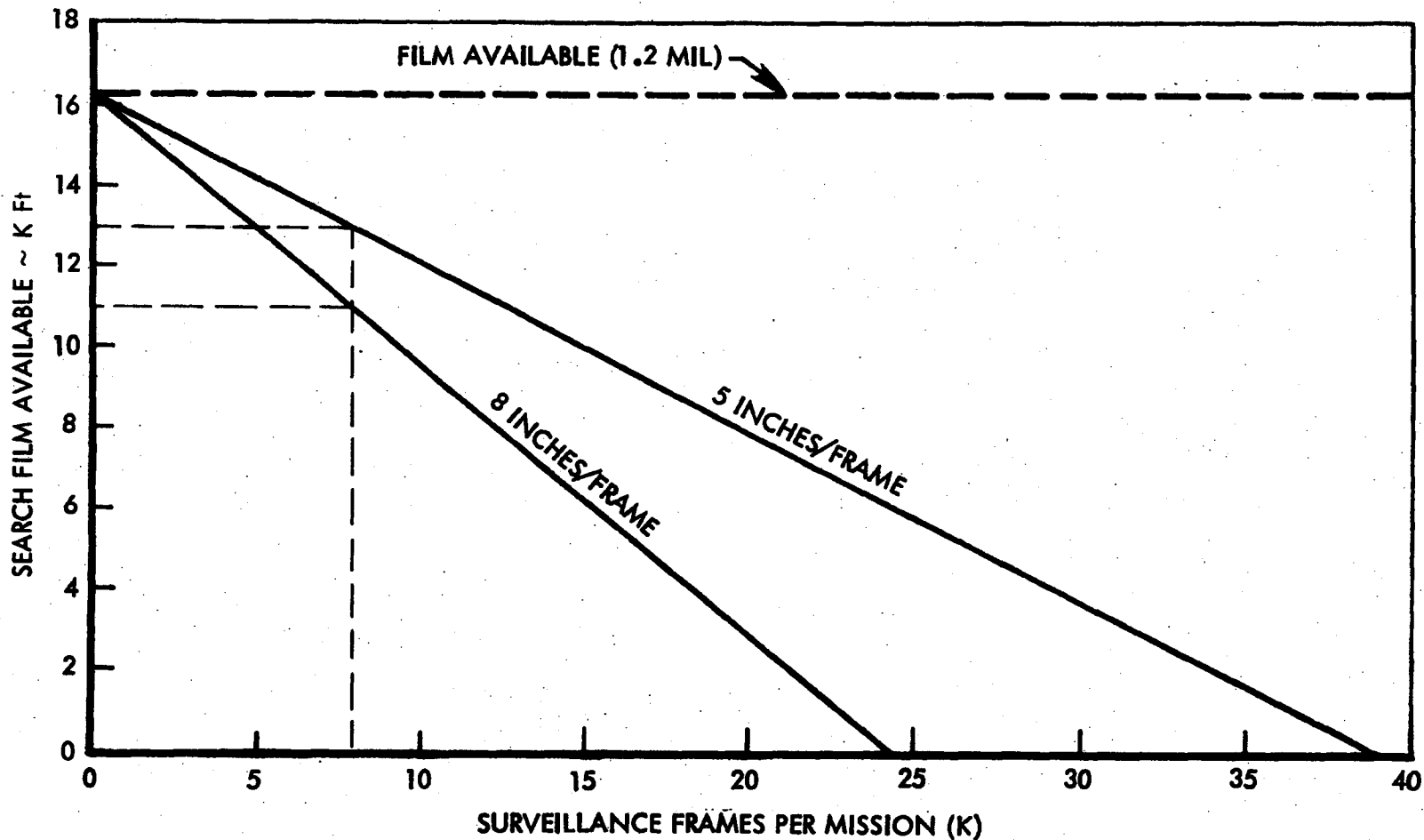
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SEARCH CAPABILITY

- AREA COVERAGE CAPABILITY
- AREA ACCESS
- ACQUISITION RATE & GEOMETRY
- COVERAGE EXAMPLES

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SEARCH FILM AVAILABILITY



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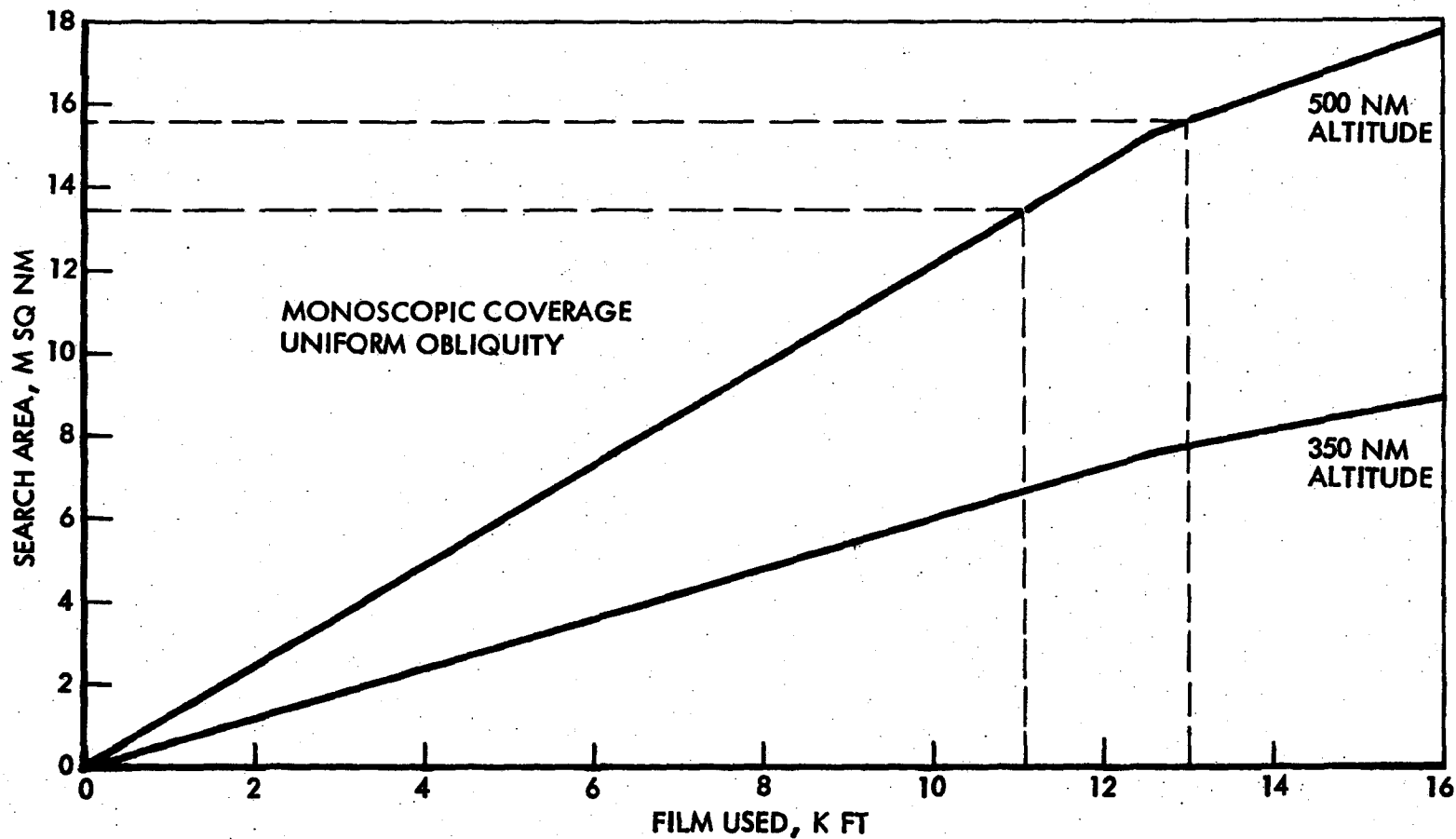
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UTILIZING A FILM WITH A BASE THICKNESS OF 1.2 MILS, THE CURRENT GAMBIT VEHICLE HAS A FILM SUPPLY OF 12,600 FT OF 9-INCH FILM AND 3,600 FT OF 5-INCH FILM FOR A COMBINED TOTAL OF 16,200 FT. THIS FILM MAY BE USED IN THE CURRENT GAMBIT MODE AT LOW ALTITUDE FOR HIGH RESOLUTION SURVEILLANCE, OR ALTERNATIVELY, AT HIGH ALTITUDE FOR SEARCH.

GAMBIT FRAME SIZES FOR BLOCK 42 HAVE RANGED BETWEEN 9 AND 12 INCHES LONG. ALLOWING FOR BLOCK 48'S MORE EFFICIENT FILM UTILIZATION WITH THE 9 X 5 DUAL PHASE LOCK DRIVE CAMERA SYSTEM, THIS EQUATES TO A 5 TO 8 INCH FRAME SIZE ON THE PRESENT VEHICLES. WITH FRAME LENGTHS IN THIS REGIME, SURVEILLANCE FILM USAGE CAN BE COMPUTED AS A FUNCTION OF NUMBER OF SURVEILLANCE FRAMES. THEN, GIVEN A REQUIREMENT FOR SURVEILLANCE, THE DIFFERENCE BETWEEN THE 16,200 FT OF FILM AVAILABLE AND THE FILM USED FOR SURVEILLANCE IS THE LENGTH OF FILM AVAILABLE FOR SEARCH USE. FOR EXAMPLE, ASSUMING A REQUIREMENT FOR 8,000 FRAMES, THE LENGTH OF FILM USED IS APPROXIMATELY 3,000 - 5,000 FT, DEPENDING ON THE AVERAGE FRAME LENGTH, LEAVING A NET OF 13,000 - 11,000 FT FOR USE IN HIGH ALTITUDE SEARCH MODE.

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SEARCH AREA COVERAGE CAPABILITY



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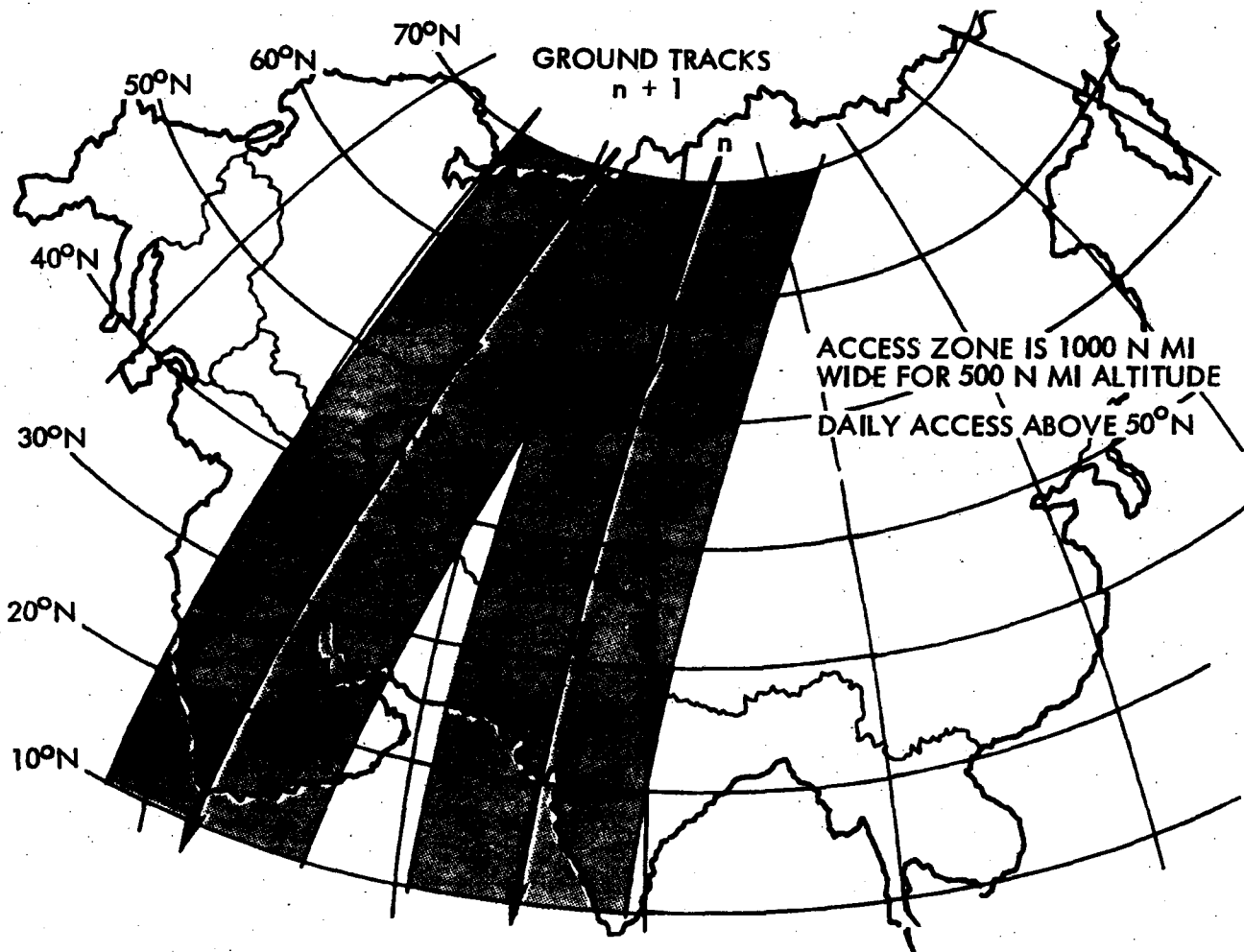
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THE INCREASED SCALE AT HIGHER ALTITUDES PROVIDES THE GAMBIT SATELLITE WITH THE CAPABILITY OF PHOTOGRAPHING A SIGNIFICANT AREA. THE MONOSCOPIC AREA COVERAGE CAPABILITY OF A SINGLE VEHICLE IS SHOWN IN THE FACING FIGURE AS A FUNCTION OF FILM USAGE AT EITHER OF TWO ALTITUDES, 350 AND 500 NM. THE BREAKS IN THE SLOPES OF THE LINES OCCUR AS THE 9-INCH FILM SUPPLY IS EXHAUSTED AT 12,600 FT AND CONTINUES UNTIL THE 5-INCH FILM IS EXPENDED AT 16,200 FT.

FOLLOWING THE EXAMPLE STATED ON THE PRECEDING FIGURES, IF 8000 SURVEILLANCE FRAMES ARE TAKEN LEAVING A RESIDUAL FILM SUPPLY OF 11,000 - 13,000 FT, THEN APPROXIMATELY 14 - 16 MILLION SQ NM CAN BE PHOTOGRAPHED FROM THE 500 NM SEARCH ALTITUDE. FOR REFERENCE PURPOSES, THE AREA OF THE SINO-SOVIET BLOC IS APPROXIMATELY 12 MILLION SQ NM.

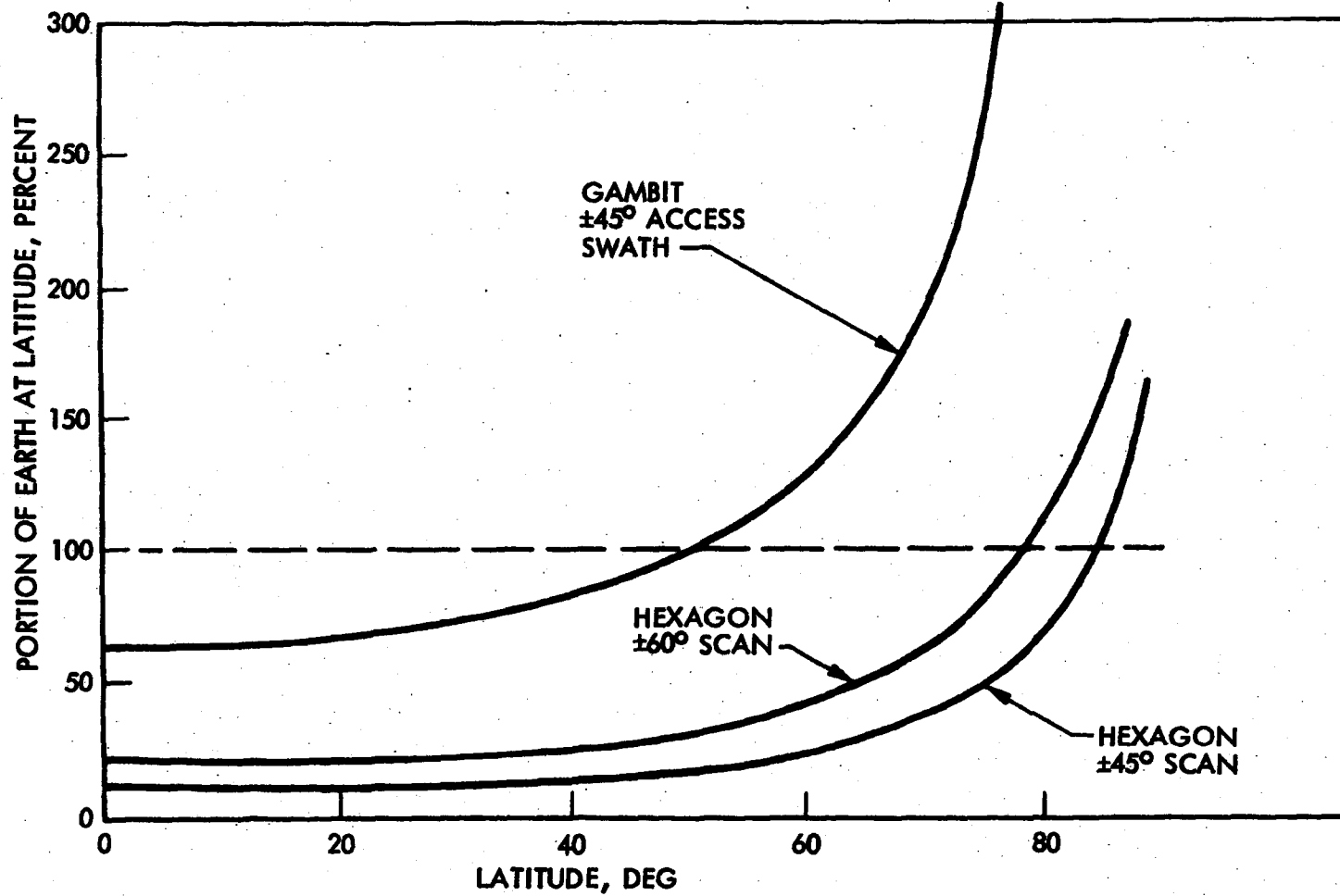
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SEARCH ACCESS SWATH



THE GAMBIT SATELLITE WITH ITS HIGH QUALITY OPTICS AND PROPELLANT CAPACITY CAN OPERATE AT HIGH ALTITUDES TO PERFORM A SURVEILLANCE-SEARCH MISSION WITH RESOLUTIONS IN THE 26-48 INCH GROUND RESOLVED DISTANCE (GRD) DOMAIN. USING THE CROSS TRACK AGILITY LENT BY THE ROLL JOINT AN ACCESS SWATH OF 1000 NM CAN BE ACHIEVED FROM 500 NM ALTITUDE ALLOWING DAILY ACCESS TO TARGET AREAS ABOVE 50° NORTH LATITUDE. DAILY ACCESS TO 83% OF THE EARTH'S TOTAL SURFACE IS REALIZED. TARGETS ACROSS THE ACCESS SWATH MAY BE SELECTIVELY PHOTOGRAPHED FOR REPEATED SURVEILLANCE, OR LARGE AREAS MAY BE SYSTEMATICALLY SEARCHED ON SEQUENTIAL PASSES.

DAILY ACCESSIBILITY



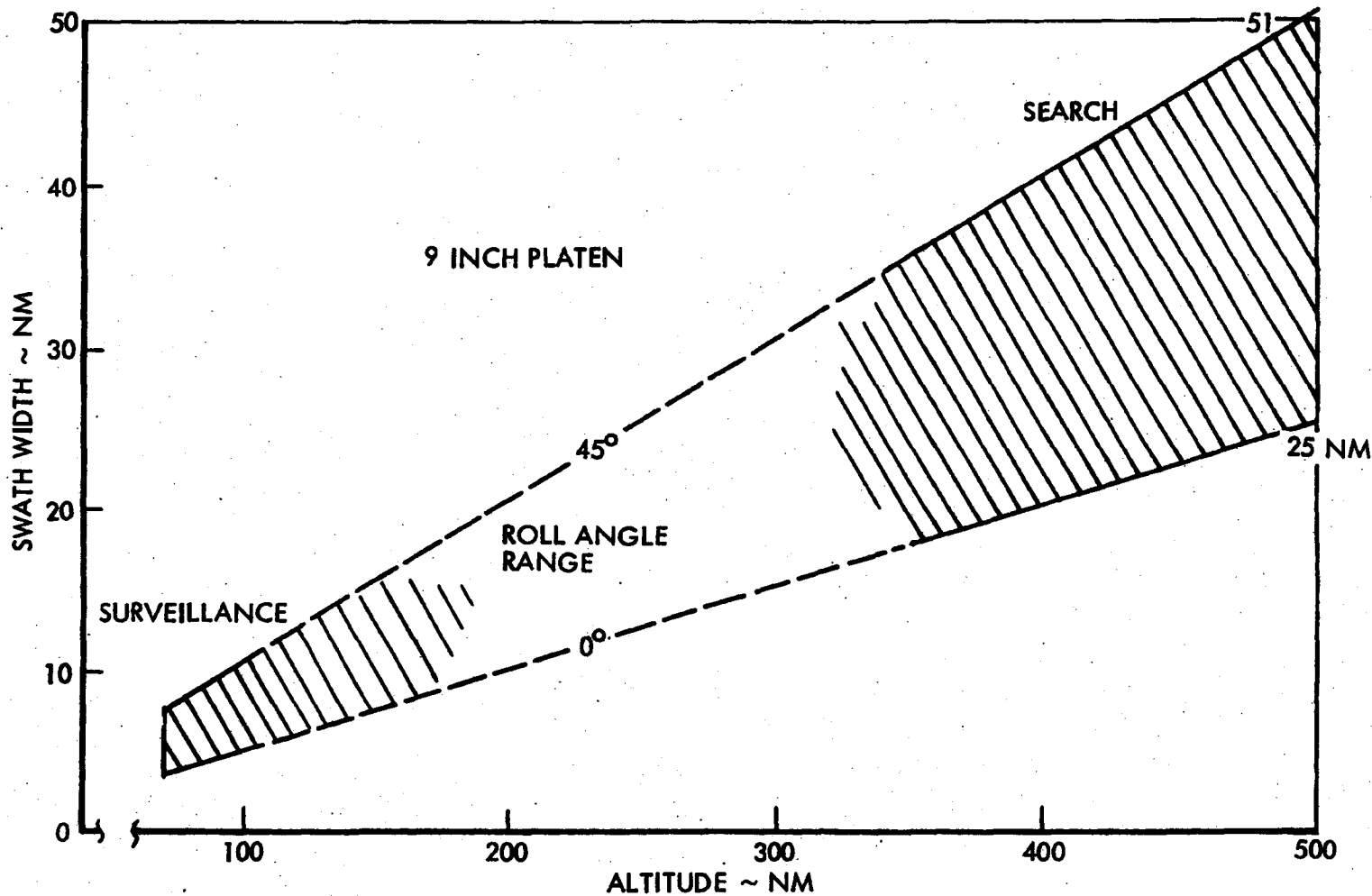
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THE GAMBIT SATELLITE WITH ITS 1000 NM ACCESS SWATH FROM A 500 NM ALTITUDE PROVIDES DAILY PHOTOGRAPHIC OPPORTUNITY AS A FUNCTION OF LATITUDE AS SHOWN. THUS AREAS REQUIRING SPECIFIC TEMPORAL COVERAGE CAN ALWAYS BE ACCESSED, ALBEIT AT VARYING OBLIQUITIES, WITHIN 24 HOURS IF THEY LIE AT LATITUDES GREATER THAN 50° NORTH. AREAS BELOW 50° NORTH LATITUDE BEYOND THE ACCESS SWATH ARE ACCESSED WITH SHIFTS IN THE GROUND TRACE AT ABOUT 2.9 DEGREES OF LONGITUDE PER DAY, REQUIRING A MAXIMUM OF ABOUT 96 HOURS FOR ACCESS TO ANY SPECIFIC AREA; HOWEVER, ONLY 17 PERCENT OF THE EARTH'S SURFACE WILL LIE BEYOND THE DAILY ACCESS. FURTHERMORE, TIMELY RESPONSE TO RELATED CURRENT INTELLIGENCE FROM OTHER SOURCES IS GREATLY FACILITATED BY THE WIDE ACCESS CAPABILITY.

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ACQUISITION SWATH



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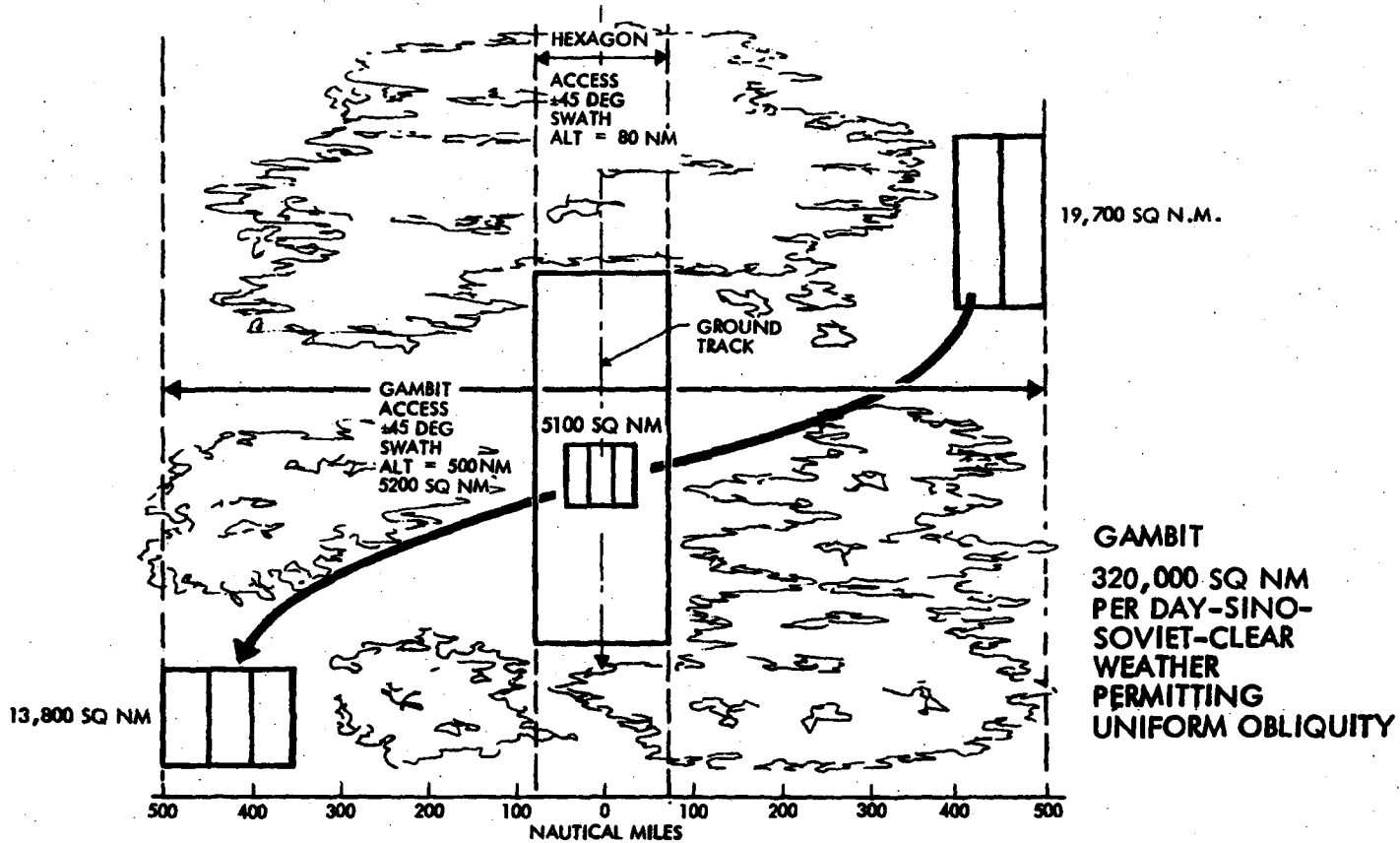
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THE GAMBIT CAMERA SYSTEM HAS A FIXED FIELD OF VIEW (FOV) DETERMINED BY THE WIDTH OF ITS IMAGE PLANE. THE QUALITY OF THE GAMBIT OPTICS AND ITS PROPELLANT CAPACITY ENABLE THE SATELLITE TO OPERATE OVER A WIDE RANGE OF ALTITUDES TO INCREASE ITS ACQUISITION SWATH THROUGH THE INCREASED SCALE AT HIGHER ALTITUDES.

THE SCALE ADVANTAGE OF PHOTOGRAPHY FROM THE HIGHER SEARCH ALTITUDE IS EVIDENT FROM THIS CHART. AT 500 NM ALTITUDES AND 45° ROLL ANGLES THE CROSS TRACK ACQUISITION SWATH IS APPROXIMATELY 51 NM. UTILIZING THE LATERAL TRIPLET MODE, A CROSS TRACK (EAST-WEST) COVERAGE OF OVER 140 MILES IS POSSIBLE AT MAXIMUM ROLL ANGLES.

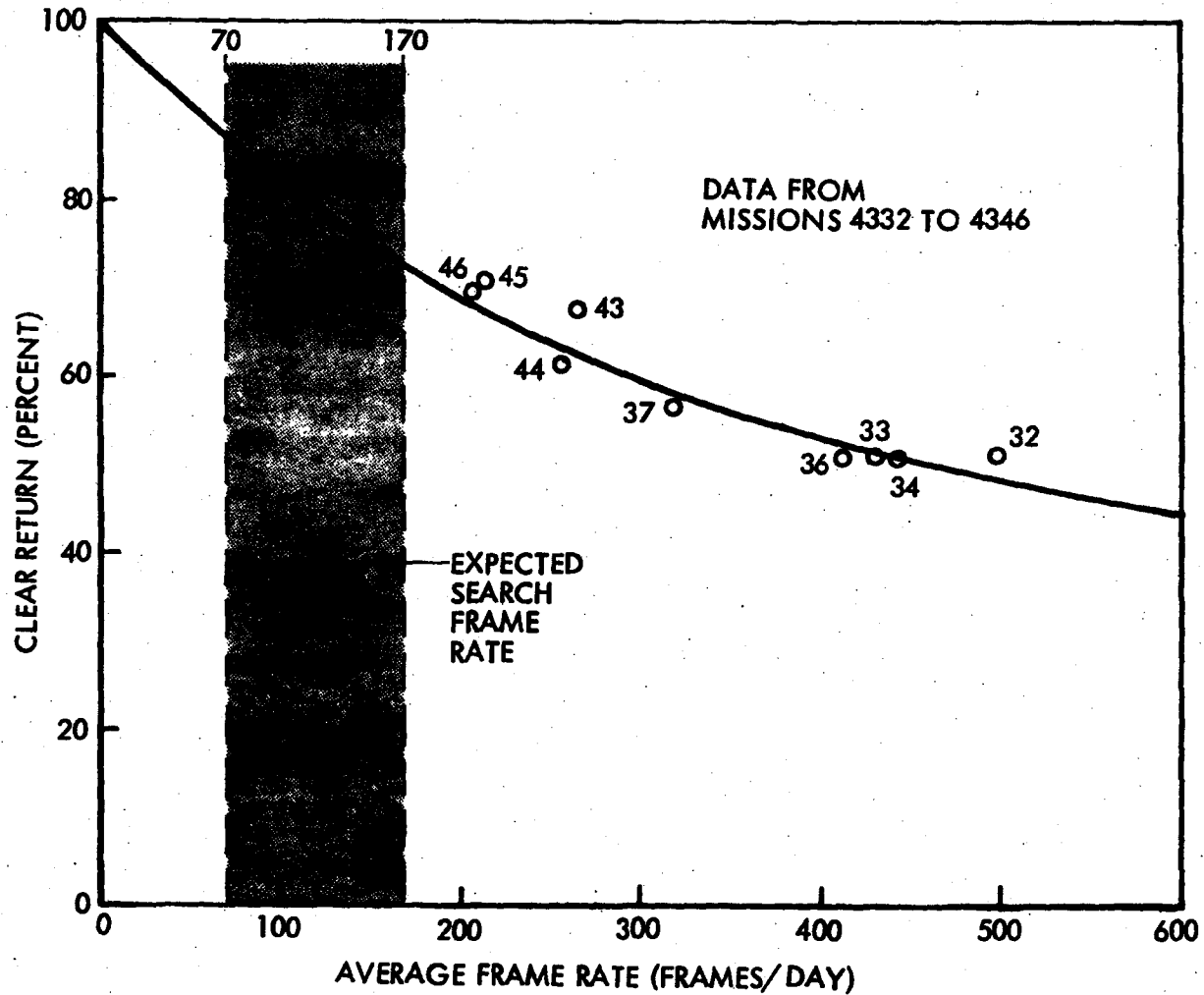
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CLEAR TARGET ACQUISITION



A 500 NM ALTITUDE RESULTS IN A 1000 NM ACCESS SWATH. THIS INCREASED SWATH COUPLED WITH THE AGILITY OF THE GAMBIT VEHICLE AND THE VERSATILITY OF ITS SOFTWARE IN SELECTION OF COVERAGE GEOMETRY ALLOWS USE OF CURRENT WEATHER DATA TO SELECTIVELY PHOTOGRAPH AREA AND INCREASE THE PROBABILITY OF CLEAR ACQUISITION.

EFFECTS OF PHOTOGRAPHIC RATE ON CLEAR RETURN



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HISTORICAL DATA ON THE GAMBIT SYSTEM SUPPORTS THE CONTENTION THAT LONGER MISSIONS WITH REDUCED FILM EXPENDITURE RATES RESULT IN HIGHER CLEAR COVERAGE PERCENTAGES. IN THE AREA SEARCH MODE DAILY FRAME RATES OF 70-170 FRAMES/DAY ARE ANTICIPATED. EXTRA-POLATING THIS DATA TO HIGH ALTITUDE WITH ITS GREATER ACCESS SWATH AND PHOTOGRAPHIC OPPORTUNITY SUGGESTS EXPECTED CLOUD FREE COVERAGE IN EXCESS OF 70% MAY BE ANTICIPATED.

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AREA COVERAGE GEOMETRY

PHOTOGRAPHIC MODE	ROLL ANGLE					
	0°			45°		
	IN TRACK (NM)	CROSS TRACK (NM)	AREA (NM ²)	IN TRACK (NM)	CROSS TRACK (NM)	AREA (NM ²)
STRIP	UNLIMITED	25	-	UNLIMITED	51	-
LATERAL PAIR (1)	140	51	7,140	201	98	19,700
LATERAL TRIPLET (1)	68	76	5,100	99	140	13,800
STEREO PAIR (1)	140	25	3,500	201	51	10,250

(1) IN TRACK VALUES ARE FOR ADJACENT OR OVERLAPPING COVERAGE; IN ALL CASES THE FORWARD SHOT MAY BE UNLIMITED NORTHWARD AND THE AFT SHOT UNLIMITED SOUTHWARD.

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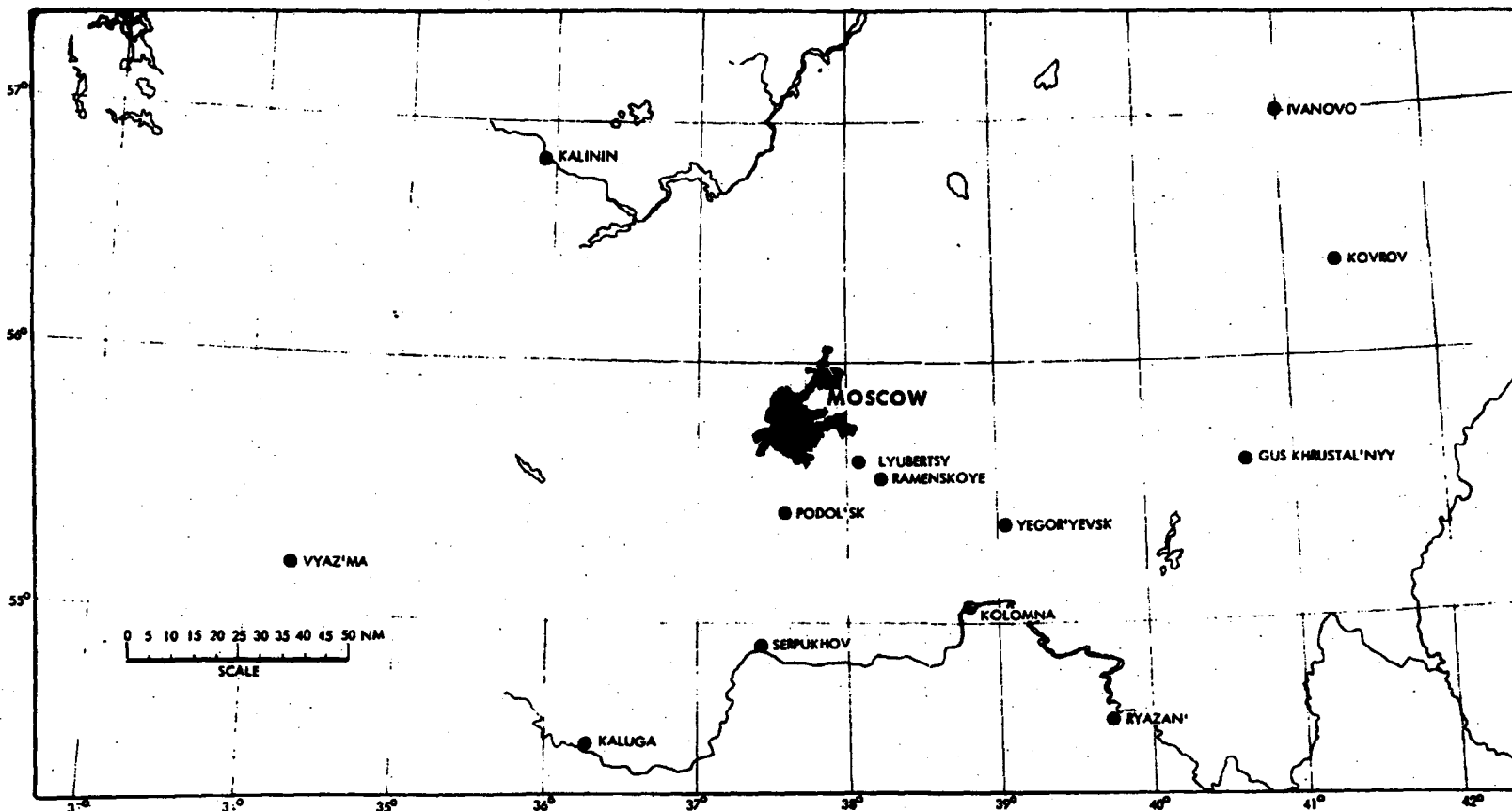
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THE GAMBIT SATELLITE CAN ACQUIRE BROAD AREAS IN MANY DIFFERENT GEOMETRIES THROUGH THE AGILITY OF ITS POINTING MIRROR AND ROLL JOINT.

THESE SELECTABLE PHOTOGRAPHIC MODES CAN BE EMPLOYED TO MODIFY COVERAGE GEOMETRY TO EMPHASIZE EITHER NORTH-SOUTH OR EAST-WEST PROBLEM ORIENTATIONS. HIGH ROLL ANGLES MAY BE FAVORABLY USED TO MAXIMIZE AREA COVERAGE.

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MOSCOW AREA



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SEVERAL COVERAGE METHODS EMPLOYING LATERAL DOUBLETS AND TRIPLETS ARE DEMONSTRATED ON THE ADJOINING MAP OF THE MOSCOW VICINITY AND ITS OVERLAYS. IN TRACK AND CROSS TRACK AREAS WITH DIMENSIONS UP TO APPROXIMATELY 200 X 100 NM FOR DOUBLETS AND 100 X 140 NM FOR TRIPLETS CAN BE ACQUIRED AT ONE TIME AS A SINGLE AREA FROM 500 NM ALTITUDE. FURTHERMORE, AREAS SUCH AS MOSCOW, AT LATITUDES GREATER THAN 50°, CAN BE ACQUIRED ON A DAILY BASIS.

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AN EXAMPLE OF AN OPERATIONAL PASS IN THE [REDACTED] IS SHOWN ON THE FACING MAP AND ITS OVERLAYS DEMONSTRATING THE AGILITY OF THE GAMBIT SYSTEM IN ACQUIRING AREA. THE OVERLAYS ARE ORDERED TO DEPICT THE SEQUENTIAL ACQUISITION OF PHOTOGRAPHY ON A NORTH-SOUTH PASS. OBVIOUSLY, OTHER DIFFERENT SEQUENCES ARE EASILY ACCOMPLISHED BY PERFORMING ADDITIONAL ROLLS OR MIRROR MOVEMENTS WITHIN SERVO CONSTRAINTS TO OPTIMIZE COVERAGE FOR ANY CURRENT PROBLEM SET.



ACCESS AT THIS LATITUDE IS POSSIBLE ABOUT 70% OF THE TIME WITH LAPSES IN COVERAGE OCCURRING APPROXIMATELY 2 DAYS OUT OF 8 DUE TO ORBIT SYNCHRONISM WITH THE EARTH'S ROTATION.

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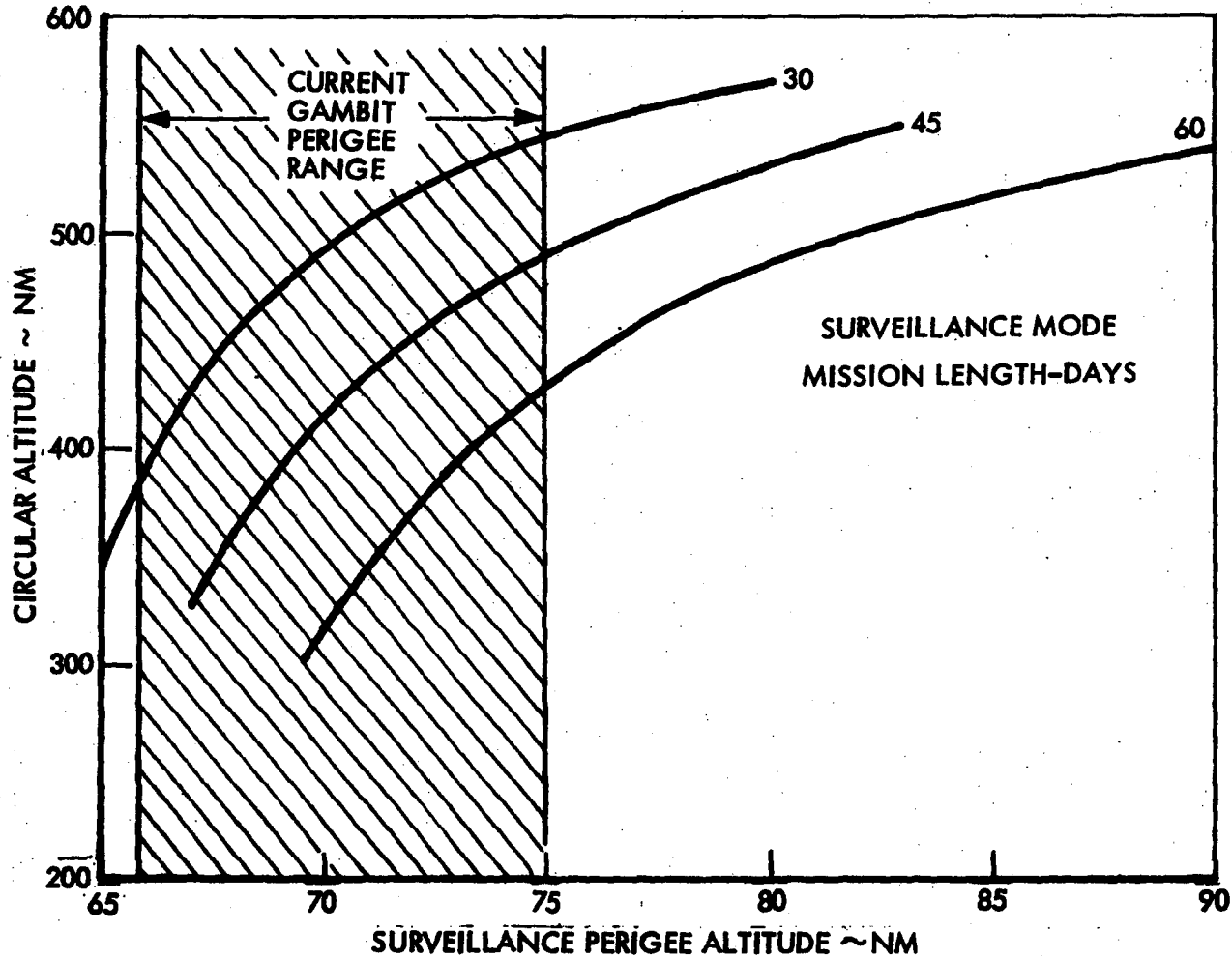
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SURVEILLANCE-SEARCH MISSION ANALYSIS

- ALTITUDE/LIFETIME CONSIDERATIONS
- MISSION PROFILE
- SIMULATION SAMPLES
- SURVEILLANCE/SEARCH CONSIDERATIONS
- LAUNCH RATE EXAMPLES

SEARCH MISSION ALTITUDE



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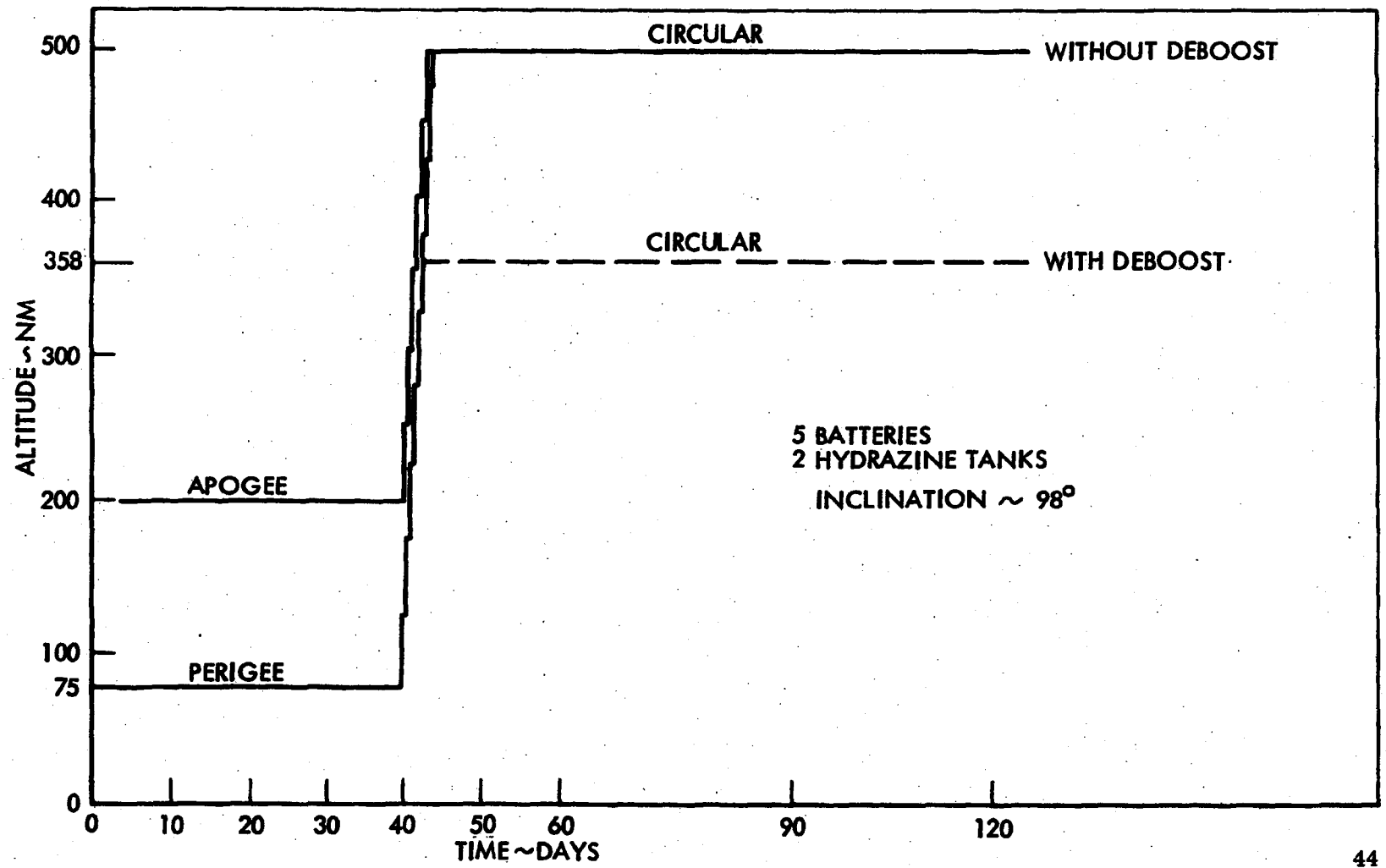
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THE ABILITY OF THE GAMBIT VEHICLE TO CONDUCT LOW ALTITUDE SURVEILLANCE AND HIGH ALTITUDE SEARCH MISSIONS IS A STRONG FUNCTION OF ITS ORBIT ADJUST CAPABILITY. THE CONTINUED IMPROVEMENT OF THE GAMBIT VEHICLE DESIGN, CULMINATING WITH THE SOLAR ARRAY CONFIGURATION FOR MISSION 4348, HAS INCREASED THE NOMINAL ORBIT ADJUST CAPABILITY TO ALMOST ONE TON OF PROPELLANT, THE EQUIVALENT OF AN 1875 FT PER SECOND VELOCITY INCREMENT.

THE ALLOCATION OF THIS PROPELLANT TO THE VARIOUS MISSION SEGMENTS REQUIRES A TRADE-OFF BETWEEN CURRENT HIGH RESOLUTION SURVEILLANCE (MOSTLY SCIENTIFIC AND TECHNOLOGICAL) AND BROAD AREA COVERAGE IMAGE COLLECTION REQUIREMENTS. A PARAMETRIC APPRAISAL OF THE VEHICLE CAPABILITY TO FLY IN A DUAL MODE IS SHOWN HERE. IN THE FINAL ANALYSIS, THE CIRCULAR ALTITUDE THAT CAN BE ACHIEVED IS DEPENDENT UPON THE EFFORT EXERTED, IN TERMS OF TIME AT MINIMUM ALTITUDE, TO OBTAIN HIGH RESOLUTION PHOTOGRAPHS. FOR EXAMPLE, THE PROPELLANT REMAINING AFTER A FORTY DAY HIGH RESOLUTION MISSION AT 75 NM WOULD NOMINALLY LEAVE SUFFICIENT PROPELLANT FOR TRANSFER TO A 500 NM CIRCULAR ORBIT FOR A SEARCH MISSION.

~~TOP/SECRET/G/H~~

DUAL MODE MISSION PROFILE



~~TOP SECRET/G/H~~

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THE INITIAL ORBIT OF A LIKELY DUAL MODE MISSION PROFILE, WITH PERIGEE AND APOGEE AT 75 AND 200 NM RESPECTIVELY, IS AN ORBIT JUST AT THE UPPER END OF THE HISTORICAL RANGE OF GAMBIT MISSIONS. MAINTENANCE OF THIS ORBIT FOR 40 DAYS WOULD CONSUME APPROXIMATELY 32% OF THE AVAILABLE PROPELLANT AND, AT A PHOTOGRAPHIC RATE OF 200 FRAMES PER DAY, WOULD YIELD 8000 FRAMES OF WHICH MORE THAN 70 PERCENT WOULD BE EXPECTED TO BE CLOUD FREE.

AT THIS JUNCTURE THE VEHICLE MAY BE TRANSFERRED TO A CIRCULAR ORBIT AS HIGH AS 500 NM BY EXPENDING THE REMAINDER OF THE PROPELLANT AND NOT LEAVING A RESERVE FOR DEBOOST. IT IS ESTIMATED THAT THE UNCONTROLLED ORBIT LIFE WOULD BE 100 TO 500 YEARS. SHOULD DEBOOST BE REQUIRED, A PROPELLANT RESERVE OF 25% MUST BE RETAINED AND THE CIRCULAR ALTITUDE CAPABILITY WOULD BE REDUCED BY APPROXIMATELY 142 NM.

THIS PROFILE IS SHOWN EXTENDING FOR A TOTAL MISSION LIFE OF 120 DAYS WITH A FIVE BATTERY, TWO HYDRAZINE TANK CONFIGURATION. BASED UPON BEST ENGINEERING ESTIMATES OF SOLAR ARRAY OUTPUT, PROJECTED VEHICLE LOADS, AND HYDRAZINE CONSUMPTION, THIS VEHICLE CONFIGURATION WILL HAVE ADEQUATE EXPENDABLES FOR A 120-DAY MISSION.

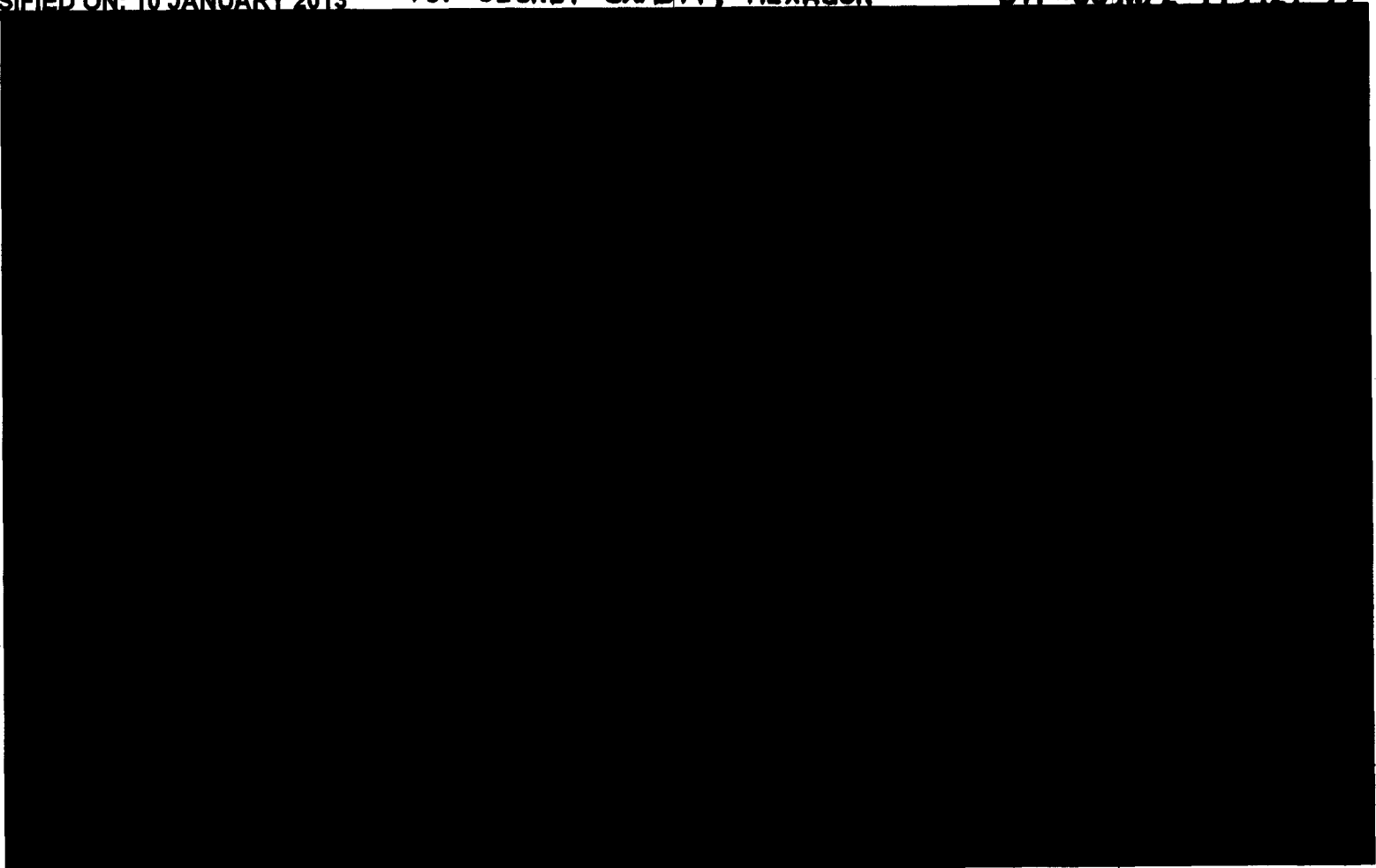
~~TOP SECRET/G/H~~

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GAMBIT SYSTEM
ALTITUDE = 84 MILES
SCALE = 1:35,000
SO-112 FILM
SMEAR = 4.5 MICROMETERS
ENLARGEMENT = 150X

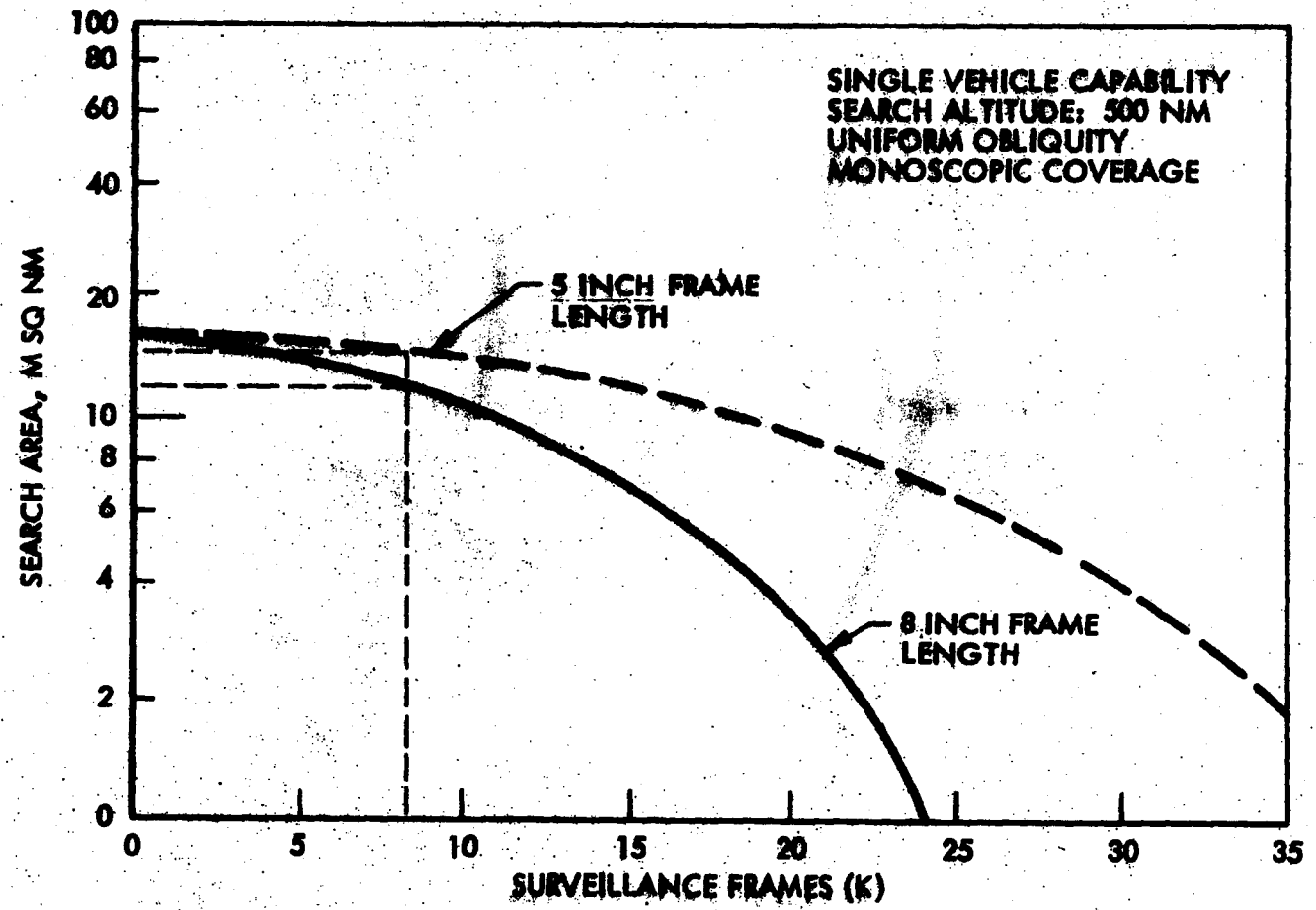
GAMBIT SYSTEM
ALTITUDE = 500 NM
SCALE = 1:208,000
SO-209 FILM
SMEAR = 3 MICROMETERS
ENLARGEMENT = 150X

DUAL MODE PHOTOGRAPHIC SIMULATIONS

THE ABOVE SIMULATIONS REPRESENT THE EXPECTED
PERFORMANCE OF THE GAMBIT SEARCH AND SURVEIL-
LANCE MODES UNDER TYPICAL CONDITIONS. A DUPLI-
CATE TRANSPARENCY IS INCLUDED IN THE APPENDIX.

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SURVEILLANCE / SEARCH RELATIONSHIP



~~TOP SECRET/G/H~~

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THE DUAL MODE RELATIONSHIP BETWEEN SEARCH AREA AND SURVEILLANCE FRAMES FOR THE FIXED 16200 FOOT FILM SUPPLY OF A SINGLE VEHICLE IS SHOWN ON THE FACING CHART. A TRADE-OFF BETWEEN HIGH ALTITUDE SEARCH AREA AND LOW ALTITUDE SURVEILLANCE FRAMES IS DIRECTLY POSSIBLE; HOWEVER, INCREASING THE QUANTITY OF FRAMES WITHOUT A COMMENSURATE INCREASE IN THE TIME AT LOW ALTITUDE WILL PROBABLY DECREASE THE PERCENTAGE OF CLEAR FRAMES DUE TO THE HIGHER FRAME RATE, AS SHOWN PREVIOUSLY, RESULTING IN LESS EFFICIENT FILM UTILIZATION.

FOLLOWING THE 40-DAY, ³⁰⁰⁰~~300~~ FRAME, LOW ALTITUDE MODE EXAMPLE, A HIGH ALTITUDE SEARCH AREA OF ROUGHLY 14-16 MILLION SQ NM CAN BE MONOSCOPICALLY PHOTOGRAPHED; HOWEVER, ANY MIX OF SURVEILLANCE FRAMES AND SEARCH AREA AS SHOWN IS POTENTIALLY POSSIBLE WITHIN LIFETIME CONSTRAINTS.

~~TOP SECRET/G/H~~

LAUNCH RATE EXAMPLES

UTILIZATION	VEHICLES/YEAR		
	1	2	3
<u>SURVEILLANCE</u>			
COVERAGE, DAYS/YEAR _____	40	80	120
FRAMES AT 200 FRAMES/DAY _____	8,000	16,000	24,000
FILM USED AT 5-INCH FRAMES, FT _____	3,300	6,700	10,000
<u>SEARCH</u>			
COVERAGE, DAYS/YEAR _____	80	160	240
FILM USED, FT _____	12,900	25,700	38,600
MONO AREA COVERAGE, M SQ NM (1) _____	15	30	45

(1) FILM MAY BE ALLOCATED FOR STEREO AT THE EXPENSE OF UNIQUE MONOSCOPIC COVERAGE.

~~TOP SECRET/G/H~~

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SYSTEM CAPABILITIES FOR THREE LAUNCH RATE EXAMPLES ARE
ILLUSTRATED ABOVE. USING THE DUAL MODE EXAMPLE FOLLOWED
THROUGHOUT THIS STUDY, MULTIPLE LAUNCHES MAY BE USED TO
PROVIDE EXPANDED COVERAGE IN TERMS OF TIME, HIGH RESOLU-
TION SURVEILLANCE FRAMES, AND/OR SEARCH AREA.

~~TOP SECRET/G/H~~

REQUIREMENTS VS DUAL MODE CAPABILITY

	ANNUAL REQUIREMENTS		GAMBIT DUAL MODE (2/YR) ⁽²⁾	
	TOTAL	GRD/NIRS	TOTAL	GRD/NIRS
<u>SURVEILLANCE (NO. TARGETS)</u>				
TOTAL 138K	10.2 K ⁽¹⁾		11.2 K	
<u>SEARCH (M SQ NM)</u>				
SIX CATEGORIES	4.4 S	-/4.5-4.0	4.4 S	26-48 IN./6-4
	6.3 M	-/4.0	6.3 M	
TOTAL	10.7 S/M		10.7 S/M	
<u>M C AND G (M SQ NM)*</u>				
ORIGINAL COMPILATION (HMA)	2.1 S*	6 FT	1.8-2.0 S*	26-48 IN./6-4
MAP PRODUCT REVISION	2.4 M*	6-50 FT	1.5-2.3 M*	
POINT TARGETS	475	24-30 IN.	475	
CONTINGENCY MAPPING	20-100K	24-30 IN.	50K	26-48 IN./6-4

(1) PROBABLE DUAL MODE REQUIREMENT SUBSET

(2) BASED UPON A RETURN OF 70 PERCENT CLOUD FREE PHOTOGRAPHY

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THE FACING CHART COMPARES GAMBIT DUAL MODE CAPABILITIES
WITH THE PRESUMED DUAL MODE ANNUAL IMAGERY REQUIRE-
MENT SUBSET. THE COMPARISON SHOWS THAT TWO GAMBIT
VEHICLES FLOWN YEARLY IN A DUAL MODE CAN SATISFY THESE
REQUIREMENTS AT PHOTOGRAPHIC QUALITY GENERALLY BETTER
THAN REQUIRED, WITH THE EXCEPTION OF HMA REQUIREMENTS.
THE HMA REQUIREMENTS ARE PRESUMED TO BE MET BY ALTER-
NATIVE MEANS.

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VEHICLE MODIFICATIONS

- **SATELLITE CONTROL SECTION**
- **PHOTOGRAPHIC PAYLOAD SECTION**
- **SCHEDULE MILESTONES**

~~TOP SECRET/G/H~~

VEHICLE CHANGES SATELLITE CONTROL SECTION

SECONDARY PROPULSION SYSTEM

ADD FOUR PYRO VALVES AND TWO FILTERS
CHANGE SEAL MATERIAL IN OXIDIZER LINES

ATTITUDE CONTROL SYSTEM

ADD TERTIARY LOW MODE THRUST CLUSTERS
ADJUST HORIZON SENSOR MOUNTING ANGLE AND ELECTRONIC GAINS
PROVIDE COMMANDABLE RECALL OF ASCENT PROGRAMMED PITCH RATE

COMMAND SYSTEM

PROVIDE 8 ADDITIONAL NORMAL AND 8 ADDITIONAL PROTECTED STORED PROGRAM COMMANDS

ELECTRICAL SYSTEM

MODIFY THREE AFT CONTROL BOXES FOR ADDED SWITCHING FUNCTIONS

THERMAL CONTROL

REVISE PAINT PATTERN

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ONLY MINOR CHANGES TO THE SATELLITE CONTROL SECTION (SCS) ARE REQUIRED TO OPERATE IN A DUAL MODE, PRIMARILY RESULTING FROM THE INCREASED LIFETIME AND MODIFIED ORBIT GEOMETRY. THE SCS HAS THE BASIC PROPELLANT CAPACITY TO OPERATE IN THIS MODE; HOWEVER, THE CORROSIVENESS OF THE PROPELLANTS WILL REQUIRE THAT ONE OF THE TWO SECONDARY PROPULSION SYSTEMS BE KEPT DRY. AS A RESULT, PYRO VALVES WILL BE ADDED TO THE VEHICLE PLUMBING FOR ISOLATION. ADDITIONALLY, SINCE THE FORMATION OF CORROSION BY-PRODUCTS HAS BEEN SEEN TO CLOG OXIDIZER FILTERS IN THE PAST, ADDITIONAL FILTERS AND BY-PASSING WILL BE ADDED AS A PRECAUTIONARY MEASURE.

TO OPERATE THE ATTITUDE CONTROL SYSTEM AT LOW AND HIGH ALTITUDES, THE HORIZON SENSOR MOUNTING ANGLES AND ELECTRONICS WILL BE REOPTIMIZED. RECALL OF THE ASCENT PITCH RATE WILL BE ADDED TO MATCH THE HIGH ALTITUDE ORBIT PERIOD, AS WILL A THIRD SET OF LOW MODE THRUST CLUSTERS FOR LIFETIME.

A FEW ADDITIONAL COMMAND ASSIGNMENTS AND ELECTRICAL SYSTEM CONTROL BOX MODIFICATIONS ARE NECESSARY TO ACCOMMODATE THE INCREASED NUMBER OF CONTROL AND PHOTOGRAPHIC SECTION SWITCHING FUNCTIONS. ALL ASSIGNMENTS CAN BE MADE FROM EXISTING SPARES AND VIA THE REMOTE DECODER WITHOUT MODIFICATION OF THE EXTENDED COMMAND SYSTEM. THE THERMAL PAINT PATTERN WILL BE OPTIMIZED FOR THE DUAL MODE ORBITS.

~~TOP SECRET/G/H~~

VEHICLE CHANGES PHOTOGRAPHIC PAYLOAD SECTION

FILM DRIVE SPEED

ADD SECOND SET OF PICK-UPS TO FPLL OPTICAL ENCODER

FOCUS SENSOR

ADD ADDITIONAL RETICLE — NO CHANGE TO ELECTRONICS

EDGE DATA

ADD SECOND PAIR OF LED'S WITH SMALLER APERTURE

SLANT RANGE COMPENSATION

ADD DISABLE SWITCH TO SRC MOTOR

EXTERNAL FINISH

REVISE THERMAL PAINT PATTERN

TRANSFER ELECTRONICS

ADD NEW RELAY BOX MOUNTED TO SEM

SATELLITE REENTRY VEHICLE

INCREASE RETRO-ROCKET IMPULSE BY 20 PERCENT

PROVIDE VARIABLE BACKUP SEQUENCE TIMER

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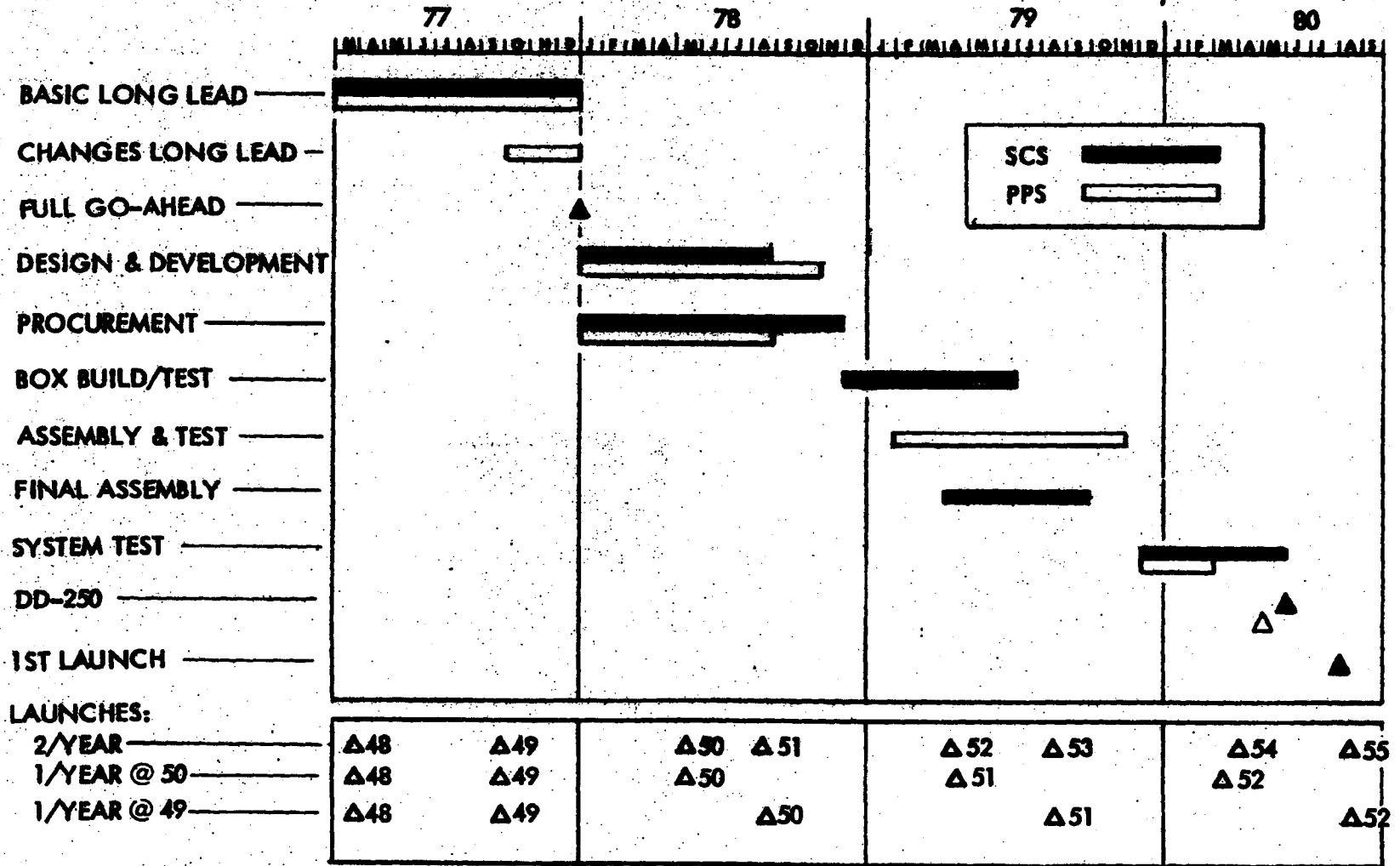
PHOTOGRAPHIC PAYLOAD CHANGES TO ACCOMMODATE A DUAL MODE MISSION CONCEPT ARE SIMPLE AND STRAIGHTFORWARD. THE FREQUENCY PHASE LOCK LOOP OPTICAL ENCODER WILL HAVE THE SECOND SET OF PICK-UPS WIRED TO REDUCE IMAGE MOTION COMPENSATION SPEEDS BY A FACTOR OF FOUR TO ALLOW OPERATIONS AT 500 NM ALTITUDES. A 4X FREQUENCY INCREASE

WILL BE CREATED FOR LOW ALTITUDE OPERATIONS. THE FCCUS SENSOR WILL BE MODIFIED TO A SELECTABLE TWO FREQUENCY RETICLE CONFIGURATION TO PROPERLY SAMPLE GROUND SCENES AT THE TWO RANGES OF SCALE FACTORS ENCOUNTERED. A SECOND PAIR OF LIGHT EMITTING DIODES FOR RECORDING EDGE DATA ON THE FILM ARE REQUIRED FOR HIGH ALTITUDE USE TO AVOID OVERLAPPING THE DATA TRACKS AT THE SLOWER FILM DRIVE SPEEDS UTILIZED. DUE TO THE MUCH LONGER OBJECT DISTANCES FROM SEARCH ALTITUDES, ONLY SMALL CHANGES IN IMAGE DISTANCE OCCUR WITH ROLL ANGLE CHANGES, REQUIRING DISABLING THE AUTOMATIC SLANT RANGE FOCUS COMPENSATION DEVICE. VEHICLE EXTERNAL FINISH PATTERNS WILL BE ALTERED TO PROVIDE PASSIVE THERMAL CONTROL AT THE HIGHER OPERATIONAL ALTITUDES. A NEW RELAY BOX FOR MODE SELECTION WILL BE MOUNTED IN THE SUPPLY ELECTRONICS MODULE.

SATELLITE REENTRY VEHICLES WILL REQUIRE A 20 PERCENT MORE POWERFUL RETRO ROCKET FOR RECOVERY FROM THE HIGHER ORBIT ALTITUDES. A SUITABLE RETRO IS AVAILABLE AND QUALIFIED FOR USE. MODIFICATIONS TO RECOVERY SEQUENCE TIMING IS REQUIRED TO ALLOW LOW OR HIGH ALTITUDE RECOVERY.

~~TOP SECRET/G/H~~

MILESTONE SCHEDULE



~~TOP/SECRET/G/H~~

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THE FACING CHART SHOWS AN INTEGRATED MILESTONE SCHEDULE
DEMONSTRATING ACHIEVEMENT OF GAMBIT DUAL MODE CAPABILITY
IN 1980.

THIS SCHEDULE ALLOWS INCORPORATION OF THE DUAL MODE CON-
CEPT AT VEHICLE 55 WITH NO IMPACT ON ITS PROJECTED LAUNCH
DATE. OTHER STRETCHED SCHEDULES ALLOW MORE THAN ADE-
QUATE TIME FOR DUAL MODE REALIZATION.

~~TOP/SECRET/G/H~~

SUMMARY

- GAMBIT CAN ACCOMPLISH SURVEILLANCE AND SEARCH REQUIREMENTS
- ITS QUALITY CANNOT BE MATCHED
- REQUIRED MODIFICATIONS ARE SIMPLE AND STRAIGHTFORWARD
- IT SHOULD BE A SYSTEMS MIX CANDIDATE IN A DUAL MODE CONFIGURATION

~~TOP SECRET/G/H~~

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IN A TIME WHEN FUNDING LIMITATIONS MAY CAUSE A REDUCTION IN THE NUMBER OF SATELLITE IMAGING SYSTEMS, THE GAMBIT SYSTEM WITH ITS OPTICAL QUALITY, ORBIT LIFETIME POTENTIAL, AND INHERENT VERSATILITY, CAN BE EMPLOYED IN A DUAL MODE TO SATISFY BOTH HIGH RESOLUTION SURVEILLANCE AND BROAD AREA SEARCH REQUIREMENTS. EACH VEHICLE WOULD BE LAUNCHED INTO A LOW ALTITUDE ORBIT TO PERFORM A HIGH RESOLUTION SURVEILLANCE MISSION FOR 40 DAYS, AFTER WHICH THE ORBIT WOULD BE ADJUSTED TO A HIGHER ALTITUDE TO ALLOW BROAD AREA SEARCH FOR 80 DAYS. FOR THE EXAMPLE GIVEN, APPROXIMATELY 8000 HIGH RESOLUTION FRAMES AND 14-16 MILLION SQ NM OF SEARCH AREA CAN BE ACQUIRED BY EACH VEHICLE IN THIS MANNER.

VEHICLE MODIFICATIONS TO ALLOW DUAL MODE OPERATION ARE PRIMARILY REQUIRED TO SUPPORT THE MODIFIED HIGH ALTITUDE ORBIT GEOMETRY AND INCREASED LIFETIME. THESE MODIFICATIONS ARE STRAIGHTFORWARD AND COULD BE IMPLEMENTED BY 1980 WITH TIMELY COMMITMENT.

IN AN ERA WHEN INCREASED VEHICLE LIFETIME CAPABILITIES HAVE MARKEDLY DECREASED THE LAUNCH RATE OF RECONNAISSANCE SATELLITES, GAMBIT DUAL MODE HAS THE ADVANTAGE OF DISPERSING THE IMAGE COLLECTION MISSION OVER MULTIPLE, MEDIUM-LIFE VEHICLES, THEREBY MINIMIZING POTENTIAL INTERVALS OF INTELLIGENCE LOSS DUE TO CATASTROPHIC HARDWARE MALFUNCTION. ADDITIONALLY, THE MULTIPLE VEHICLE CONCEPT ALLOWS FLEXIBILITY IN SCHEDULING OF LAUNCHES TO OPTIMIZE PERIODICITY OF COVERAGE OR POTENTIAL SEASONALLY VARYING INTELLIGENCE REQUIREMENTS.

GAMBIT DUAL MODE ALLOWS MAINTENANCE OF VERY HIGH QUALITY TECHNICAL INTELLIGENCE AND SURVEILLANCE CAPABILITY AS WELL AS SATISFACTION OF INTELLIGENCE COMMUNITY SEARCH REQUIREMENTS. GAMBIT THEREFORE PROVIDES A COST EFFECTIVE MEANS OF MAINTAINING CURRENT PHOTOGRAPHIC RECONNAISSANCE CAPABILITY IN THE 1980's.

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APPENDIX

- SYSTEM CHARACTERISTICS
- IMAGE EXPLOTTATION
- PRECISION MENSURATION
- 
- 9 X 5 CAMERA VERSATILITY
- AVAILABLE ACQUISITION FILMS
- SEARCH SIMULATION TRANSPARENCY
- DUAL MODE SIMULATION TRANSPARENCY

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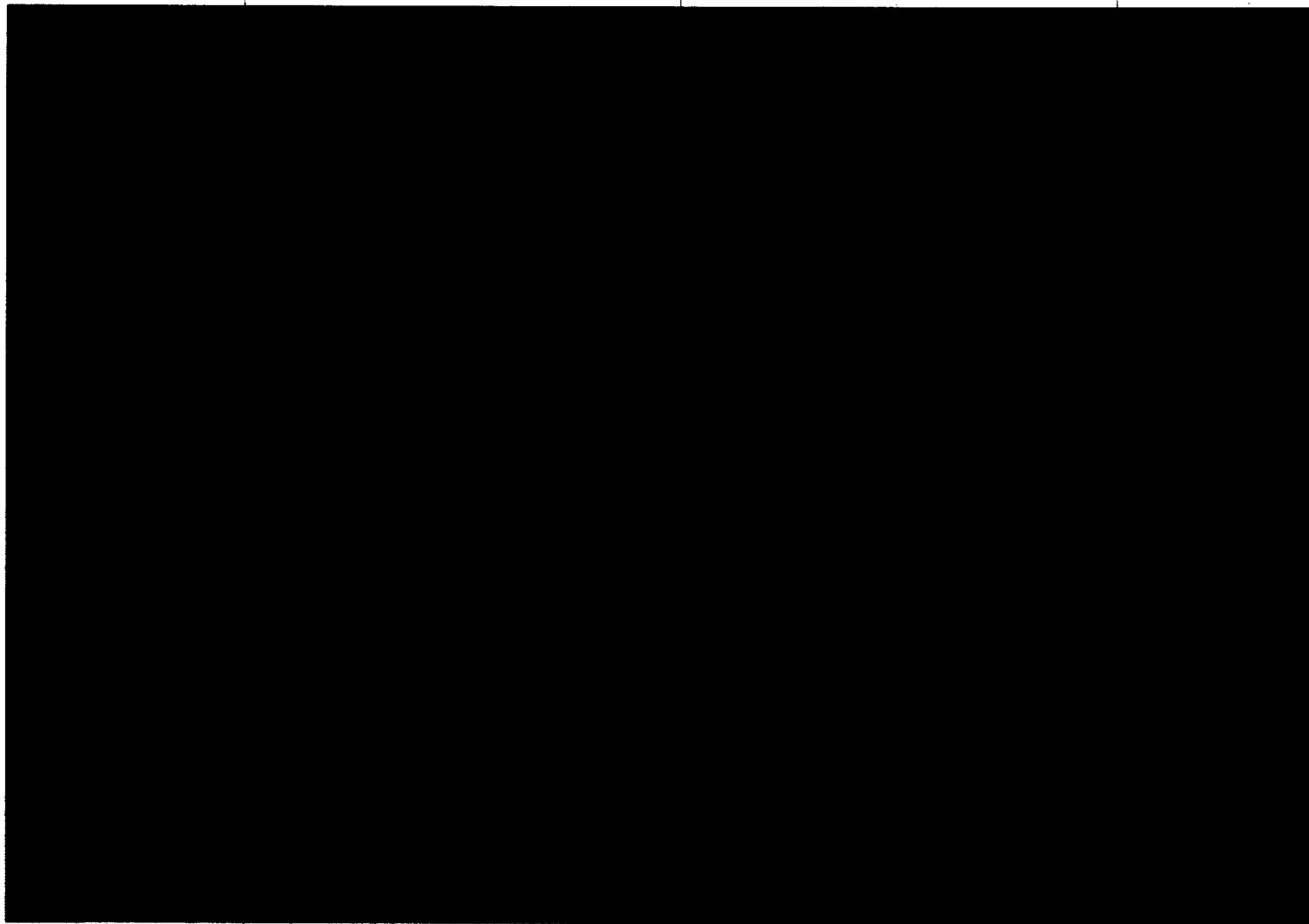
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**EXAMPLES OF PHOTOGRAPHIC QUALITY
EXPLOITATION HIGH RESOLUTION SURVEILLANCE**



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PRECISION MENSURATION

INSEPARABLE FROM INTELLIGENCE EXTRACTION/EXPLOITATION

GAMBIT CAPABILITY (ROUTINE TASKING)*

	HORIZONTAL	VERTICAL
STEREO		$\pm(3.7 \text{ FT} + 1\%)$
MONO		FUNCTION OF OBJECT HEIGHT AND GROUND PRO- JECTED DISTANCE

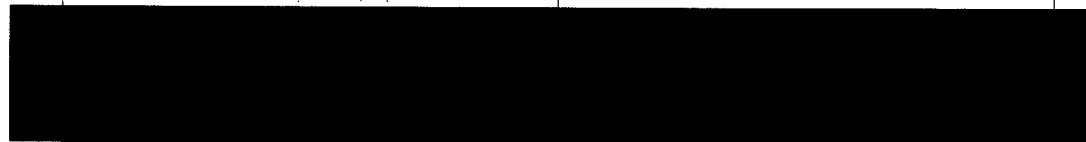
*OBJECT SIZE IN 10-50 FOOT RANGE

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9 X 5 CAMERA VERSATILITY

SIMULTANEOUS CAMERA OPERATIONS

DIFFERENT FILMS

- IR AND COLOR
- IR AND B/W
- COLOR AND B/W
- B/W AND B/W

SELECTIVE IMAGE ENHANCEMENT

- NORMAL AND UNDER EXPOSURE (REDUCED SMEAR, HIGHLIGHT DETAILS)
- NORMAL AND OVER EXPOSURE (SHADOW DETAILS)

TARGET DIAMETER MATCHING

9 INCH: LARGE DIAMETER, TARGET CLUSTERS

5 INCH: SMALLER TARGETS

~~TOP SECRET/G/H~~

AVAILABLE ACQUISITION FILMS

TYPE	RESOLVING POWER	AFS	GRAIN SIZE	BASE THICKNESS
SO-209 (SEARCH)	660	4.0	900 Å	1.2/1.5/1.9 MILS
SO-112 (SURVEILLANCE)	417	5.3	1250 Å	1.2/1.5/1.9 MILS