TOP SECRET

HANDLE VIA
BYEMAN
CONTROL SYSTEM

4-1-1

~~(S)~~ NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

THE NRO STAFF

17 February 1972

XCD
NWD

MEMORANDUM FOR COLONEL NEUNER, [redacted]

SUBJECT: Mission 1201 Summary

The enclosed Mission Summary of HEXAGON Mission 1201 and appropriate attachments are provided for your information. Mission summaries are internal SOC documents used mainly as a historical record of the mission. These summaries are not distributed outside the SOC; however, due to the uniqueness of this first HEXAGON effort, certain portions of the summary are of interest to you and these are being forwarded.

CLARK T. LEHMANN
Major, CE USA
HEXAGON Project Officer,
Satellite Operations Center

10 Attachments
1. Mission 1201 Summary
2. Atch 1 - Camera Actions Summary
3. Atch 2 - RV Recovery Summary
4. Atch 3 - Accomplishments
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MISSION 1201 SUMMARY

I. INTRODUCTION.

This is the first HEXAGON mission summary. This summary with its attachments provides historical data regarding the mission planning and intelligence collection objectives, system performance, resource allocation, mission accomplishments, film evaluation and cloud cover assessment performance, critiques of the SOC/STC/GWC/System interface and the SOC/ICRS interface, and an analysis of the mission performance with the aid of the HSIM mission simulator. The intelligence collection and readout efforts and collection accomplishments are emphasized. Additional information and data on the camera and vehicle performance can be found in the Mission 1201 Sensor Subsystem Post Flight Analysis (PFA) Report and the Performance Evaluation Team (PET) report. Other information is contained in the 1201 mission folder and the 1201 data binder.

II. MISSION PLANNING.

A. General. The mission was planned using the CRYSPER resolution prediction software and the HAMPER mission statistical prediction software. Data from these programs were presented to ICRS/COMIREX. Once the mission strategy, film allocation, and acceptable satisfaction levels were agreed to by ICRS, HAMPER was rerun and the Mission Objectives (MOB) file was transmitted to the STC in accordance with the Reports Control Manual (RCM) time line of L minus 13 days.

B. CRYSPER. CRYSPER was run in two sections. The first was against a special target deck used during sensor subsystem development, the second was against a SOC deck created from the ICRS requirements list. No specific targets were used to influence any decision on the part of ICRS. What was used was a general resolution prediction table displaying ground resolved distances (GRD) of 6.5 feet or better for camera operations within a 45-degree obliquity angle from nadir. It was determined by ICRS that nearly all of the requirements should be photographed within this 45-degree obliquity limit to insure a certain, but undefined, quality of coverage. GRD could drop off to as low as 10-to-15-foot resolution at or near a 60-degree obliquity angle. In reality there was some question as to whether the camera system would even work, and, if so, would the CRYSPER predictions represent anything close to reality.

Further, if 60-degree obliquity angles with their corresponding resolutions were acceptable now, perhaps one might wonder why a HEXAGON was ever built, when 10-to-15-foot GRD was already easily attainable with existing systems. Thus the 45-degree obliquity limit constraint was imposed.

C. HAMPER. HAMPER was run twice during the mission planning phase. Obliquity limits of 45 and 60 degrees were used in generating OC curves for special and general search (see REBOUND-235 message in mission folder) requirements on the first run to assist ICRS in setting obliquity constraints. Operating points on curves were reviewed at the SOC and adjusted, where appropriate, prior to presenting this first run to ICRS. Operating point adjustments yielded 25,000 feet of film (180,000 feet assumed to be available for intelligence collection) which could not be used efficiently except for mapping and charting collection. ICRS concurred in the SOC film allocation and mission objectives, but wished to commit an additional 5,000 feet of film for mapping and charting and 10,000 feet towards 6-month China search. The remaining 10,000 feet was uncommitted, so the second HAMPER run was based on an assumed 170,000-foot film load.

III. ON-ORBIT OPERATIONS.

A. On 15 June 1971 the first HEXAGON vehicle was launched from Vandenberg AFB, California at 1141 Pacific Daylight Time (1441 Eastern Daylight Time) by a Titan IIID booster, the first of its kind to be used in a launching. The vehicle was placed in a near-perfect orbit of 96.39-degrees inclination, 99.3 nm perigee (100.6 nm planned), 165.0 nm apogee (164.9 nm planned), and a period of 89.38 minutes (89.37 minutes planned). Solar panels deployed satisfactorily. Payload health checks and vehicle monitoring dominated activities during the first day on orbit. The SOC maintained 24-hour operations for the first three days of the mission. A heating problem developed in two of the four main batteries during the first day of operations. Initially this constrained camera operations to 15 minutes of operating time per four revs. After some means of control was developed, the constraint was eased to 30 minutes of camera on-time per four revs. Finally the heating cycle was understood and the constraint was lifted. Although this flight was equipped with reserve batteries, the situation did not deteriorate to the point where they had to be used.

B. First Recovery. The prelaunch plan called for no orbit adjustments (o/a) until the first SRV was recovered. Recovery was planned for Day 5 with an o/a soon after recovery. The drag on the vehicle was so much lower than anticipated, that the o/a was not needed on Day 5. However, recovery was still accomplished on Day 5, 20 June 1971, at 1744 Eastern Daylight Time. The recovery chute had a damaged cone, so the recovery force correctly decided on water retrieval. Both the SRV and the chute were recovered by recovery helos for analysis of the chute problem. Three days later the first o/a was successfully executed.

C. Second Recovery. Operations were normal throughout Bucket 2. Some chute damage occurred during recovery, but the SRV was still aerially retrieved by a C-130. The helos recovered the ablative shield for analysis. Recovery occurred on Day 11, 26 June 1971, at 1740 Eastern Daylight Time.

D. Extended Mission Life. After the success of two recoveries and 11 days of flight, some thought was given to extending the mission length beyond 30 days. HAMPER was run in the monitor mode using Bucket 1 readout to determine what could be accomplished by a 1-day and 6-day extension of mission life. A 31-day mission appeared to be quite easy to achieve and a 36-day mission was based on the performance of the Lifeboat (back-up recovery system) battery, as this battery was located in the compartment where the heating problem existed with the main batteries. HAMPER data showed improvement in achieving collection goals (see message in mission folder), but the decision was made based more on a hardware decision complimented with HAMPER data. Accordingly, the mission was stretched in RV-3 to achieve a 36-day mission life. When it appeared that the Lifeboat battery was no longer a critical item, a 45-day mission appeared feasible, but no decision was to be made until after the third recovery. Nevertheless, the possible 45-day mission length affected film usage rates in RV-3, and it required 14 days of operations to fill the bucket. In the meantime, a 45-day mission HAMPER was run using readout from Buckets 1 and 2 in order to determine what MOB changes would be required (see attachment 8, paragraph 5).

E. Third Recovery. At recovery time on 10 July 1971, Day 25, all events went properly until main chute deployment. At this time there was a catastrophic load on the system and the capsule apparently tore off the chute and continued on a ballistic trajectory to the water where it sank almost immediately. Only the drogue chute was visually observed by recovery forces.

F. Emergency Shutdown (ESD).

1. On Rev 314, Day 20, 5 July 1971, the first emergency shutdown (ESD) of the sensor subsystem occurred. Operations over the Middle East and Eastern Europe were not possible due to the ESD. Operations were resumed before the next pass over the bloc.

2. During the transfer of operations from RV-3 to RV-4, a malfunction occurred in the film path which caused an ESD of the sensor subsystem. This was quickly cleared and routine operations continued. In spite of the loss of RV-3, the goal for a 45-day mission remained.

3. On 13 July another ESD occurred towards the end of operations over the Sino-Soviet bloc. The next day's operations were curtailed and efforts to overcome the ESD were made. On 15 July operations were resumed prior to Sino-Soviet bloc operations.

4. An ESD occurred on Rev 497 on the last day of operations, 16 July 1971, but was cleared on the same rev.

G. Pyro Battery Problem. On 14 July, Day 29, one of the two pyro batteries began to decay rapidly. The pyro battery is used in separating the RV from the satellite vehicle (SV). The battery degradation was predictable and, although the second battery was still good, contingency plans were made in the event it too began to decay. The next day, 15 July, Day 30, the first degradation of the second battery was observed. Film consumption rates were greatly increased in order to terminate the mission after 31 days of flight.

H. Fourth Recovery. A successful aerial recovery took place on 16 July 1971 at 1722 Eastern Daylight Time. However, the capsule was only half full with some 30,000 feet of film left on board the SV.

I. Solo Flight. SV operations and maneuvers continued for 3 weeks after RV-4 recovery. With the exception of a gyro failure in one of the attitude reference systems, the SV functioned perfectly. This solo exercise resulted in an early commitment to fly a 45-day mission on 1202.

IV. POSTFLIGHT ACTIONS.

A. General. Changes to operational procedures and software programs were implemented following the mission. The new procedures and some software changes will be in effect for Mission 1202.

B. RCM. Many procedural changes, as well as new data messages, were adopted with Change 1 to the Reports Control Manual. This change, was distributed on 19 November 1971 and consisted of 152 new or changed pages.

C. Written MOB. A need was recognized for written mission guidance and collection instructions from the SOC to the STC to accompany the Mission Objectives (MOB) data tapes. This is mentioned in paragraphs 2f(1) and 6c(2) of the ICRS/SOC Interface Critique for Mission 1201, Attachment 9 to this summary, and again in paragraphs 4(2) and 9a of the unpublished "Mission 1201 Critique," Inclosure 2 to Attachment 10, written by the Chairman, ICRS.

It was further determined that if such instructions are provided for special interest and high priority area collection, the emphasis should also be placed on weather forecasting and GWC, too, should be an info addressee on any written MOB.

Accordingly, both the STC and GWC were provided the COMIREX target list and a definition by cell of the 143 quarterly clusters to assist in interpreting a clear text MOB. This procedure is being adopted immediately and should cut down appreciably on the amount of on-orbit data transmissions to the STC.

D. Load Cycles. A goal in HEXAGON is to achieve the vehicle loading timeliness and frequency used in previous search systems, i.e., single rev loading with a weather forecast lead time of approximately 90 minutes prior to station load time. During this flight the system was loaded for 3 revs at a time with a 150-minute weather forecast lead time. It was felt that the next mission could be flown under a 2-rev load scheme with a 95-minute weather lead. The final goal is being rapidly approached, but some problems still remain. A discussion of load cycles and weather support capabilities is contained in Attachment 8, Trip Report - 1201 Critique.

E. High Obliquity Photography. With few exceptions, this mission was constrained to photography within a 45-degree obliquity limit. This was primarily due to the lack of experience with a camera system at obliquities between 45 and 60 degrees, and the desire to achieve better resolution in a search system than has previously been experienced. Photography was evaluated at the high obliquities to determine if the quality was suitable for general search purposes. Both NPIC and ACIC recommended full scan operations out to 60-degree obliquities for general search and mapping on future missions - TOPOCOM, on the other hand, desires the 45-degree obliquity constraint for non-bloc mapping, but only because they have no rectification equipment to handle high oblique materials. The mapping community generally agrees that any obliquity is satisfactory in the equatorial belt, because of the difficulty in acquiring clear photography of any kind.

F. Cluster Accounting. In order to simplify quarterly cluster satisfaction accounting, a software program was written in the SOC to handle this chore on a daily basis. This will eliminate the manual calculations required during Mission 1201.

G. Targeting Software - 'TUNITY.

1. Immediate changes in the 'TUNITY program were implemented as follows:

a. The C1 factor was eliminated from the value algorithm pending a software change to 'TUNITY. This eliminates OSP prelaunch processing of the HAMPER cell weight using a launch date value of C1, and extends the HAMPER weight range from 256 to 511. It also conserves on ACAT's, since the prelaunch processing created several ACAT's within the same requirement category. Readout will not be handled through C1, as was the case this mission, but will be handled with Pcum's and the C2 factor for Mission 1202.

b. ACAT's are now correlated to intelligence categories and become much easier to manipulate. Eliminating C1, as mentioned above, permitted this action. Due to the still limited number of ACAT's, search areas must be targeted on an "equal weight" basis. When more ACAT's are available the "equal return" method can be applied.

c. The efficiency threshold, T1, is being changed from a fixed point integer to a floating point number. Multipliers, such as the

An value of 0.2 used in the C1 factor for this mission, are no longer required.

d. The Kcum in the C2 factor is being changed from 2.0 to 1.6 for Mission 1202. This means that countdown will begin at a Pcum of 37.5 (near climatology) instead of the arbitrary 50 used in Mission 1201. The Kcum of 2.0 did not permit adequate countdown and contributed to higher than planned T1 values.

e. The software has been corrected to account for inter-operation film wastage between revs. During the mission the first operation of each rev took place under less than acceptable weather conditions in those cases where a small camera operation occurred. This was caused by an omission of film losses between operations, as a part of the value algorithm, that made operations falsely more efficient than they really were. The impact was an excessive number of camera operations in the far north of USSR, e.g. Franz Josef Land, and in mapping areas on non-bloc revs.

2. MOD 1 change to the FOC 'TUNITY software contract is expected to be implemented for Mission 1203 and consists of the following:

a. New C1 test logic. This will permit use of the C1 factor without requiring preflight processing of HAMPER weights and will be more responsive to multiple coverage requirements.

b. ACAT's will have a "mandatory" capability, which will provide more positive control of unique intelligence requirement categories. Nearly simultaneous coverage of non-contiguous areas and scattered targets is more readily implemented within the software logic and many manually selected operations can be avoided under this scheme.

c. Polygons will have a "mandatory" capability to provide more positive control over special interest and other small contiguous areas. The polygon will also have a "weight override" capability to permit targeting changes without using the "mandatory" option and will require only a single data card change.

d. The available number of ACAT's will be increased from 250 to 1,000. This will permit ideal correlation between ACAT's and intelligence categories and, therefore, better control of collection strategy over requirement areas during flight. An "equal return" method of setting weights will be possible in the search areas with the additional ACAT's. The 'TUNITY Mission Performance Evaluation (MPE) Report, used at the STC, will be meaningful for the first time, as it sorts accomplishments by ACAT's, and ACAT's are now directly correlated to intelligence categories. The tradeoff for additional ACAT's is a decrease in the allowable number of polygons from 400 to 100.

H. Weather Error. A weather forecast error model has been developed and will be incorporated in HAMPER for Mission 1203. This will significantly improve HAMPER predictions on cloud free return and film expenditures.

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Attachments

ATTACHMENT 1

CAMERA ACTIONS SUMMARY

DATE	MISSION DAY	THRU REV	DAILY CAMERA OPERATIONS INTELL	ENGR	TOTAL	DAILY FILM UTILIZATION (FT) INTELL	ENGR	TOTAL
JUNE	PAD	0	0	0	0	0	3,165	3,165
16	1	15	0	4	4	0	1,246	1,246
17	2	31	9	3	12	7,934	2,014	9,948
18	3	47	14	4	18	8,222	3,060	11,282
19	4	63	16	3	19	6,828	2,564	9,392
20	5	75	9	1	11	5,349	120	5,469
BUCKET TOTAL			48	15	63	28,333	12,169	40,502
20	5	80	1	0	1	304	0	304
21	6	96	19	2	21	7,024	691	7,715
22	7	112	22	1	23	10,827	118	10,945
23	8	128	9	2	11	9,471	180	9,651
24	9	144	23	2	25	7,436	724	8,160
25	10	160	17	4	21	5,024	1,027	6,051
26	11	176	21	1	22	9,312	120	9,432
BUCKET TOTAL			112	12	124	49,398	2,860	52,258
27	12	192	14	1	15	3,651	66	3,717
28	13	208	15	1	16	4,601	66	4,667

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29	14	224	15	1	16	5,690	66	5,756
30	15	240	18	2	20	5,820	585	6,405
JULY								
1	16	257	10	2	12	2,108	348	2,456
2	17	273	13	2	15	3,425	183	3,608
3	18	289	17	2	19	5,616	286	5,902
4	19	305	17	3	20	2,909	224	3,133
5	20	321	10	2	12	2,930	386	3,316
6	21	337	10	3	13	4,493	120	4,613
7	22	353	9	1	10	3,544	66	3,610
8	23	369	7	1	8	2,416	66	2,482
9	24	386	5	1	6	2,166	66	2,232
10	25	402	6	0	6	2,208	0	2,208
	BUCKET TOTAL		166	22	188	51,577	2,528	54,105
11	26	418	0	0	0	0	0	0
12	27	434	6	1	7	2,441	110	2,551
13	28	450	10	1	11	3,111	88	3,199
14	29	466	0	0	0	0	0	0
15	30	482	10	4	14	4,387	345	4,732

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16	31	498	16	5	21	13,448	1,788	15,236
	BUCKET TOTAL		42	11	53	23,387	2,331	25,718
	MISSION TOTAL		368	60	428	152,695	19,888	172,583

DISTRIBUTION OF SCAN MODES

Scan Mode (degrees)	Number of Intelligence Operations					Engineering Operations	Total Operations
	RV-1	RV-2	RV-3	RV-4	Total		
30	1	55	78	3	137	6	143
60	20	20	52	22	114	40	154
90	25	35	36	12	108	9	117
120	2	2	0	5	9	5	13

Scan Mode (degrees)	Percent of Intelligence Operations				Mission Total
	RV-1	RV-2	RV-3	RV-4	
30	2	49	47	7	37
60	42	18	31	52	31
90	52	31	22	29	29
120	4	2	0	12	3

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ATTACHMENT 2

RV RECOVERY SUMMARY

	RV 1	RV 2	RV 3	RV 4
Recovery Rev	82	179	405	501
Active Revs	14-75	77-172	180-397	420-497
Recovery Time	2144Z	2140Z	2146Z	2222Z
Recovery Date	20 June 71	26 June 71	10 July 71	16 July 71
Days On Orbit	5	6	14	6
Recovery Mode	Water	Aerial	None	Aerial
Recovery Altitude (ft)	0	9,400	----	12,000
Parachute Condition	Damage to target cone	Damage	Failure	No damage
Payload Condition	Good	Good	Not Recovered	Good
Film Load (ft)	40,502	52,258	54,105	25,718
A(Fwd)	20,469	26,094	26,994	13,004
B(Aft)	20,033	26,164	27,111	12,714
RV Weight (lbs)	1,431	1,511	1,528	1,303
Film Weight (lbs)	319.0	418.0	419.5	204.1

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ATTACHMENT 3

Mission 1201 Accomplishments

	PERCENT CLOUD FREE		
	Predicted	Actual	Unique To This Mission
QUARTERLY SURVEILLANCE	63.5	33.9	33.9
o High Priority	63.9	40.1	40.1
o Low Priority	63.3	28.3	28.3
SEMIANNUAL SEARCH	75.3	64.1	33.3
o China	63.0	60.1	36.7
o E. Europe	61.0	16.7	15.9
o Mongolia	83.6	74.7	31.2
o USSR	82.0	69.3	32.7
o N. Korea	68.5	36.7	0.7
o N. Vietnam	29.0	24.5	16.5
o Middle East	95.9	92.5	80.2
ANNUAL SEARCH	81.6	65.3	23.2
o China	87.0	83.5	30.3
o E. Europe	76.0	94.3	85.2
o Mongolia	88.0	83.5	12.7
o USSR	79.0	58.5	19.9

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ATTACHMENT 4

1201 Mission Accomplishments -- Mapping, Charting, and Geodesy

Unique Cell Count:

	Bucket 1			Bucket 2			Bucket 3			Bucket 4		
	Attpt	Exp Rtn	Rtn	Attpt	Exp Rtn	Rtn	Attpt	Exp Rtn	Rtn	Attpt	Exp Rtn	Rtn
Priority 1	149	128	107	370	142	148	164	83	0	145	135	111
Priority 2	139	72	73	659	284	278	197	66	0	214	46	97
Priority 3	76	12	14	339	43	28	97	25	0	236	76	50
Priority 4	291	88	115	384	211	122	248	98	0	216	181	275
Total	655	300	309	1752	680	570	706	272	0	811	438	533

Unique Area (sq n.m.):

	Bucket 1			Bucket 2			Bucket 3			Bucket 4		
	Attpt	Exp Rtn	Rtn	Attpt	Exp Rtn	Rtn	Attpt	Exp Rtn	Rtn	Attpt	Exp Rtn	Rtn
Priority 1	30,247	25,984	21,721	75,110	28,826	30,044	33,292	16,849	0	29,435	27,405	22,33[illegible]
Priority 2	28,217	14,616	14,819	133,777	57,652	56,434	39,991	13,398	0	43,442	9,338	19,9[illegible]
Priority 3	15,428	2,436	2,842	68,817	8,729	5,684	19,691	5,075	0	47,908	15,428	10,50[illegible]
Priority 4	59,073	17,864	23,345	77,952	42,833	24,766	50,344	19,894	0	43,848	36,743	55,2[illegible]
Total	132,965	60,900	62,727	355,656	138,040	115,710	143,318	55,216	0	164,633	88,914	108,9[illegible]

NOTES:

1. Return in Bucket 4 includes a mosaicing of Buckets 1, 2, and 4.
2. Area is computed on a basis of 1 cell equalling 203 square nautical miles.
3. Expected return column is based on verified weather of 70 or better.
4. Total clear readout for the mission is 286,636 sq n.m. of 653,254 sq n.m. attempted uniquely in Buckets 1, 2 and 4.
5. Total gross MC&G coverage for all Buckets was 814,030 sq n.m.
6. TOPOCOM reported approximately 270,000 sq n.m. acceptable for mapping.
7. Mission objective was 535,360 sq n.m. clear return.

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ATTACHMENT 5

1201 Coverage Statistics

These coverage statistics are based on 3 x 3 nautical mile subcell centers being photographed and clear. The average subcell area is 8.46 square nautical miles. Figures do not represent unique area but rather the total gross coverage.

SRV (bucket)	Area Photographed Subcells	Area Photographed Sq. N. M.	Area Clear Subcells	Area Clear Sq. N. M.	Cloud Free Photography (Pct)
1	585,588	4,954,074	348,003	2,944,105	59.43
2	718,758	6,080,693	379,301	3,208,886	52.77
3	---------	----------	-------	---------	Not Recovered
4	452,288	3,826,356	194,560	1,645,978	43.02
Total	1,756,634	14,861,123	921,864	7,798,969	52.48

Mission efficiency is expressed in two ways. One of these is only an indicator and is based on the amount of cloud free coverage on cloud free photography. Past experience with a search system yields 70 to 75 percent on an annual average with the highest achieved of 86 percent. These figures are given in the preceding paragraph for this mission. The other efficiency expression is the percent of unique cloud free coverage obtained of the total gross area attempted. The average in the past has been 40 percent. The following data sets are below that average, and the reasons are attributed to 3-rev load cycles, weather forecast lead times, the accuracy of the weather support, and the poorer weather always experienced in area search missions during the summer months.

a. Search 3, 6, and 12-month.

	Total cells Attempted	Clear Unique cells	Percent Efficiency
Total (less SRV-3)	55,852	15,054	26.95
SRV-1	16,079	5,598	34.82

SRV-2	26,571	7,083	26.66
SRV-3	26,754	------	-----
SRV-4	13,202	2,373	17.97

(1) 3-month only

Total (less SRV-3)	3,129	629	20.10
SRV-1	641	248	38.69
SRV-2	1,329	240	18.06
SRV-3	1,739	------	-----
SRV-4	1,159	141	12.17

(2) 6-month only

Total (less SRV-3)	30,661	8,179	26.68
SRV-1	8,854	3,530	39.87
SRV-2	12,709	3,250	25.57
SRV-3	17,045	------	-----
SRV-4	9,098	1,399	15.38

(3) 12-month only

Total (less SRV-3)	22,062	6,246	28.31
SRV-1	6,584	1,820	27.64
SRV-2	12,533	3,593	28.67
SRV-3	7,970	------	-----
SRV-4	2,945	833	28.29

b. Special Search (RCG's 48-67)

Total (less SRV-3)	11,762	3,505	29.80
SRV-1	3,765	1,215	32.27
SRV-2	5,794	1,977	34.12
SRV-3	4,870	------	-----
SRV-4	2,203	313	14.21

c. Mapping and Charting

Total (less SRV-3)	2,591	1,418	54.73
SRV-1	664	309	46.54
SRV-2	1,116	576	51.61
SRV-3	758	------	-----
SRV-4	811	533	65.72

The return on quarterly surveillance collection was far below expectations. Poor weather combined with the loss of Bucket 3 were the major factors. The data presented below shows that 93.42 percent of the quarterly cells were attempted at least once during the mission. An average of 1.69 photographic attempts per cell were made on recovered film and 2.62 attempts per cell were made when Bucket 3 is included.

	Cells Attempted	Unique Cells Attempted
3-month total	3,129	1,733
SRV-1	641	426
SRV-2	1,329	791
SRV-3	1,739	354
SRV-4	1,159	162

ATTACHMENT 6

FILM EXPENDITURES - MISSION 1201

	PLANNED	ACTUAL		
		TOTAL	SRV 1, 2, 4	SRV 3
SPECIAL AREAS	37,331	38,768	26,633	12,135
QUARTERLY CLUSTERS	25,346	21,396	13,178	8,218
SEMIANNUAL SEARCH	51,328	51,890	33,206	18,684
CHINA	21,988	24,998	13,799	11,199
USSR	20,343	18,108	13,170	4,938
E EUR	2,680	1,744	421	1,323
MG	20	24	14	10
NK	1,252	1,229	949	280
NV	1,456	1,078	729	349
MIDEAST	3,589	4,709	4,124	585
ANNUAL SEARCH	41,935	33,909	23,855	10,054
CHINA	6,542	6,609	5,036	1,573
USSR	32,080	22,442	14,930	7,512
E EUR	1,854	3,994	3,313	681
MG	1,459	864	576	288
MAPPING & CHARTING	14,029	6,392	5,541	851
TOTALS	169,969	152,355	102,413	49,942

ATTACHMENT 7

Correlation of Quick Readout to Final Readout

Prior to HEXAGON flights a study was conducted to determine the reliability of quick cloud cover assessments of photography at the processing site compared to a more time consuming and deliberate evaluation by machine of cloud covered photography. It revealed a 91 percent correlation with higher correlation in winter months and poorer correlation in summer months. The following data shows Mission 1201 readout correlation:

UNIQUE CELL READOUT

	Total Readout	Clear	Cloudy	Clear But Reported Cloudy on Quick Readout	Cloudy But Reported Clear on Quick Readout	Percent Correlation
Bucket 1	21,935	7,972	11,083	1,951	929	86.9
Bucket 2	26,551	8,683	15,158	1,743	967	89.8
Bucket 4	17,432	4,424	11,291	793	924	90.2
OVERALL	65,918	21,079	37,532	4,487	2,820	88.9

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ATTACHMENT 11

MISSION 1201 PERFORMANCE ANALYSIS

1. Introduction

a. An analysis was made of Mission 1201's performance in order to compare preflight HAMPER predictions with actual mission results. This comparison was necessary to develop confidence in HAMPER and to identify HAMPER shortcomings. Analysis data permitted a means of evaluating the impact of some mission anomalies. Flight conditions were normalized such that differences between climatology used in planning and actual weather conditions experienced during the mission could be used to measure their impact on mission performance. More detailed analyses were made of other related parameters, such as the efficiency threshold, T1 (see Attachment 12) and the decision element (DE) length, but are not discussed in detail in this attachment.

2. Method

a. A comparison of the preflight HAMPER predicted return and actual mission return is contained in Attachment 3. Attachment 6 contains HAMPER predicted film expenditures vs. mission expenditures. Mission expenditures are further broken down in Attachment 6 to reflect recovered film (SRV-1, 2, and 4) and unrecovered film (SRV-3). When Attachments 3 and 6 are compared, it becomes quite obvious that the loss of SRV-3 greatly contributed to the lower returns in quarterly surveillance, semi-annual Eastern Europe, and annual USSR. Semi-annual China would have been impacted more had a South China polygon not been activated during the flight. On the other hand, good weather breaks in SRV-1 and SRV-4 helped a great deal in annual Eastern Europe. Besides the loss of RV 3 and half of RV 4, weather conditions contributed to the problem. Weather was generally worse than climatology in North Korea, all of USSR, semi-annual Mongolia, and semi-annual Eastern Europe. Poor weather not only affected return, but did not permit the film to be expended as planned, i.e., film was diverted through the selection logic to better weather areas.

b. A comparison between predictions and actual results, for purposes of attaching some degree of confidence to HAMPER, is not a valid approach. Such a comparison looks at a mission plan based on:

(1) A 30-day mission.

(2) Average weather for June-July.

(3) Four successfully recovered RVs containing some 170,000 feet of film expended for intelligence collection.

(4) A constant T1 or mission average T1.

(5) A normal and healthy vehicle and payload.

c. This planned mission is then compared to the actual mission flown with:

(1) Film consumption managed, first, for 30, then 36, and finally 45 days' mission duration at various times during flight.

(2) Actual June-July 1971 weather, not climatology, influencing camera operations.

(3) Three successful RVs recovered containing some 152,400 feet of film expended for intelligence collection.

(4) A variable T1, which averaged higher than that used in planning (see Attachment 12).

(5) Camera operating constraints caused first by main battery heating and later by emergency shutdowns of the system.

(6) Forced early recovery of RV 1. Although this had been planned prior to launch, it was not possible to plan such an event in HAMPER.

(7) 'TUNITY selection algorithm was not permitted to freely select camera operations at all times, i.e., there were a number of manually-selected operations (MOPs) by the STC -- some directed by the SOC and others dictated by various hardware, software and flight constraints.

d. In order to compare apples with apples, it was necessary to resolve these differences through a modification of HAMPER and reconstruction and modification of the actual mission through simulation. At the outset, it was recognized that RV 4 was of no value in this analysis, since it simply started operations at the same point that RV 3 started with respect to those areas remaining to be photographed. Therefore, RV 4 was dropped. RV 3 was retained, since it was a 14-day effort, well managed in terms of targeting and resource allocation, and could be assumed successfully recovered for analysis purposes. Film readout was determined by gaming the weather assessments in the simulator.

e. The first modifications were made to HAMPER and the mission, itself, as follows:

(1) HAMPER was rerun based on three RVs and some 136,900 feet of film for intelligence collection to be flown over a 25-day period. Actual length of RVs 1 through 3 of Mission 1201 was 25 days. Cell weights, previously determined in HAMPER prior to 1201 launch, were used, but the percent accomplishments and expected film usage were allowed to change.

(2) Mission 1201 was reconstructed through RV 3 using a 25-day mission life, actual intelligence/mapping camera operations as they occurred during the flight, ESDs, and the 30-degree-scan-mode malfunction.

f. Inclosure 1 compares planned film expenditures and return with actual film expenditures and readout from RV 1 and RV 2, and actual film expenditures with simulated readout from RV 3. Thus, the loss of RV 3 has been compensated for, but RV 4's actual accomplishments have been ignored. The high return achieved in annual Eastern Europe was accomplished for the most part in RV 4 and would, therefore, not be reflected in Inclosure 1. On the other hand, the addition of RV 3 readout has improved the situation somewhat in quarterly clusters and semi-annual Eastern Europe. The poor weather experienced in the quarterly areas, North Korea, and annual USSR is still quite apparent.

g. In order to validate HAMPER it was necessary to eliminate actual camera operation selections, some of which were manually selected; early RV 1 recovery; system anomalies; and the actual T1 profile. In short, run an unconstrained mission simulation with a new T1 profile, selected by the simulation program, and with camera operations selected by the simulator's "B" algorithm. Now, HAMPER could be compared to a nominal mission, as shown in Inclosure 2. Under such ideal conditions, we are essentially comparing the differences between real weather and climatology. The poor weather experienced in the quarterly areas, which are mainly located in South China, Western USSR, and built-up Eastern Europe, was obviously not expected. Although some parts of 12-month Eastern Europe improved later in RV 4, we are confined here to only the first three RVs; however, it does point out the advantage of long-life missions. North Korea and annual USSR are bad-weather standouts. Film consumption compared with return will show where film was diverted to other areas as well as where film was expended in vain, simply due to poor weather. The weather forecast/assessment error is also a contributing factor here, as such error was not a part of HAMPER planning.

h. To carry the analysis even further, a simulation was run similar to the "unconstrained" simulation, except that the 30-degree-scan-mode malfunction and the actual T1 profile were introduced to evaluate, mainly, the impact of the mode constraint. Such a constraint would cause deletion of operations or extension to larger, less efficient operations. A comparison of the "unconstrained" simulation and the "constrained" simulation (no 30-degree scan modes) is at Inclosure 3. In general, there was the expected loss in return, and in most cases less film was expended indicating a greater tendency to delete operations rather than expand them. The increased return in North Korea and North Vietnam is probably the result of pessimistic weather forecast errors, where an inefficient but expanded operation yielded more return than would have been expected from such a forecast.

i. One could go further and compare the "constrained" mission to the "reconstructed" mission to evaluate the actual camera operation selections with a free-selecting "B" Algorithm. Inclosure 4 summarizes the conditions under which HAMPER and HSIM programs were run.

3. Conclusions

The comparison of the modified HAMPER with an unconstrained mission simulation (Inclosure 2) reflects good correlation in most cases between film expenditure and return, predicted and simulated. Differences can be traced to the weather/climatology differential experienced during the flight. HAMPER is being improved to handle climatology in shorter mission segments, i.e., 2- or 3-week segments, and the HAMPER climatological data and "OC" curves will soon be biased by a built-in weather forecast error model. These steps alone should cut down the weather/climatology differentials on future missions.

1201 ANALYSIS

	MODIFIED HAMPER 3 RV ACCOMP	MODIFIED HAMPER 25 DAYS FILM	RECONSTRUCTED MISSION 1201 3 RV ACCOMP	RECONSTRUCTED MISSION 1201 25 DAYS FILM
SPECIAL AREAS	56.9	29,100	64.3	34,400
QUARTERLY CLUSTERS	53.9	20,200	39.7	16,200
SEMIANNUAL SEARCH	71.9	43,320	68.0	41,420
CHINA	58.4	18,100	61.0	20,300
USSR	79.2	16,800	71.0	14,500
E EUROPE	55.4	2,200	57.0	1,600
MONGOLIA	82.5	20	81.0	20
N KOREA	52.9	800	39.0	600
N VIETNAM	33.4	1,300	32.0	1,100
MIDEAST	93.6	3,100	95.0	3,300
ANNUAL SEARCH	80.1	37,300	68.0	30,500
CHINA	84.6	5,200	83.0	6,000
USSR	77.7	28,600	61.0	21,700
E EUROPE	76.5	1,800	68.0	2,100
MONGOLIA	86.2	1,100	83.0	700
MAPPING	----	6,970	----	5,100
TOTAL	----	136,890	----	127,620

TOP SECRET
BYEMAN CONTROL SYSTEM
HEXAGON

1201 ANALYSIS

REQUIREMENT	MODIFIED HAMPER 3 RV	25 DAYS	MISSION 1201 SIM (UNCONSTRAINED)	
	ACCOMP	FILM	ACCOMP	FILM
SPECIAL AREAS	56.9	29,100	67.2	33,800
QUARTERLY CLUSTERS	53.9	20,200	45.0	16,900
SEMIANNUAL SEARCH	71.9	43,320	69.0	40,720
CHINA	58.4	18,100	64.0	20,400
USSR	79.2	16,800	73.0	14,200
E EUROPE	55.4	2,200	51.0	1,600
MONGOLIA	82.5	20	81.0	20
N KOREA	52.9	800	39.0	500
N VIETNAM	33.4	1,300	40.0	1,500
MIDEAST	93.6	3,100	96.0	3,600
ANNUAL SEARCH	80.1	37,300	70.0	31,800
CHINA	84.6	5,200	84.0	6,400
USSR	77.7	28,600	63.0	22,300
E EUROPE	76.5	1,800	65.0	2,200
MONGOLIA	86.2	1,100	84.0	900
MAPPING	----	6,970	----	4,300
TOTAL	----	136,890	----	127,520

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Inclosure 2 to Attachment 11

1201 ANALYSIS

REQUIREMENT	MISSION 1201 SIM (UNCONSTRAINED)		MISSION 1201 SIM (CONSTRAINED)	
	ACCOMP	FILM	ACCOMP	FILM
SPECIAL AREAS	67.2	33,800	59.8	33,900
QUARTERLY CLUSTERS	45.0	16,900	41.0	15,300
SEMIANNUAL SEARCH	69.0	40,720	65.0	39,020
CHINA	64.0	20,400	60.0	20,500
USSR	73.0	14,200	69.0	12,700
E EUROPE	51.0	1,000	48.0	900
MONGOLIA	81.0	20	78.0	20
N KOREA	39.0	500	43.0	500
N VIETNAM	40.0	1,500	45.0	1,100
MIDEAST	96.0	3,600	92.0	3,300
ANNUAL SEARCH	70.0	31,800	67.0	32,100
CHINA	84.0	6,400	83.0	5,700
USSR	63.0	22,300	60.0	23,600
E EUROPE	65.0	2,200	64.0	1,800
MONGOLIA	84.0	900	83.0	1,000
MAPPING	----	4,300	----	3,800
TOTAL	----	127,520	----	124,120

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Inclosure 3 to Attachment 1

HAMPER	30 DAYS	4 RV	170,000'	CONSTANT T_1	o NORMAL SYSTEM PERFORMANCE
MOD HAMPER	25 DAYS	3 RV	136,700'	CONSTANT T_1	o NORMAL SYSTEM PERFORMANCE
MISSION 1201 SIM (UNCONSTRAINED)	25 DAYS	3 RV	127,900'	COMPUTED T_1	o NORMAL SYSTEM PERFORMANCE o CAM OPS SELECTED BY "B" ALGORITHM
MISSION 1201 SIM (CONSTRAINED)	25 DAYS	3 RV	124,900'	ACTUAL T_1	o 30-DEG MALFUNCTION o CAM OPS SELECTED BY "B" ALGORITHM
MISSION 1201 SIM (RECONSTRUCTED)	25 DAYS	3 RV	127,713'	ACTUAL T_1	o BATTERY PROBLEM o 30-DEG MALFUNCTION o EARLY RV-1 RECOVERY o ACTUAL CAM OPS
MISSION 1201	31 DAYS	2 1/2 RV	152,400'	ACTUAL T_1	o BATTERY PROBLEM o 30-DEG MALFUNCTION o EARLY RV-1RECOVERY o EARLY RV-4RECOVERY o ACTUAL CAM OPS

ATTACHMENT 12

SUMMARY OF T1 STUDY

I. HAMPER was run preflight with an assumed T1 of 20.8. All WAC cell weights were then computed accordingly with accesses, climatology, and desired levels of accomplishment as the prime ingredients. During the flight T1 oscillated around, but averaged in the 50 to 60 range. The following table helps to explain this difference.

II. PREMISSION VALUES OF T1

Mission Length (days)	29	36	45	
Buckets considered	1 thru 4	2 thru 4	3 thru 4	1 thru 4
T1 value	20.8	24.3	36.0	29.3 (average)

III. SIMULATION VALUES OF T1

	3 RVs 25 days	4 RVs Actual Msn
A. Reconstructed Mode using 1. Actual T1 profile. 2. Actual malfunction profile. 3. Actual camera operations. 4. Actual weather.	52.9	54.9
B. Constrained Mode using 1. Actual T1 profile. 2. Actual malfunction profile. 3. Actual weather.	51.9	
C. Constrained Mode using 1. Actual malfunction profile. 2. Actual weather.	46.8	
D. Unconstrained Mode using actual weather only:	46.5	
E. Unconstrained Mode using 1965 historical weather:	39.1	

IV. WEATHER COMPARISON FOR A 30-DAY, 4 SRV NORMAL MISSION

Case	Climatology	1965 Wx	1201 Forecasts Only	1201 Forecasts and Assessments
T1 value	20.8	25.4	32.7	35.5

V. It was concluded that the T1 mission average was higher than that planned due to the following:

A. T1 was kept high early in the mission to avoid exceeding camera on-time and operations-per-day constraints.

B. Lengthening the mission first to 36 days and then to 45 days, after already having expended a large amount of film in a relatively short time (mission film load was 50 percent expended after only 11 days), drove T1 up.

C. The loss of bucket 3 eliminated the countdown, reinstated many assumed-to-be-satisfied areas, and forced T1 up to stretch the remaining film to 45 days.

D. Weather forecasts were generally optimistic. This forced film consumption with less than the expected return. Therefore, requirements were not satisfied nor counted down and with less film available to do the job, T1 is forced up.

E. From paragraph IV, it appears that a combination of the previously mentioned weather optimism (unintentional by GWC) and better-than-climo weather held T1 at a higher level.

F. T1 is very sensitive to:

1. Differences between climatology and actual weather.
2. Accuracy in the correlation between weather forecasts, assessments, and readout.
3. Changes on-orbit to mission length or available film load.
4. Actual film expenditures vs planned film expenditures. This occurs when there are hardware considerations and constraints, mandatory camera operations, and significant changes to intelligence collection requirements areas.

VI. No change is planned for T1 for Mission 1202.