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Copy
25 November 1968

MEMORANDUM FOR: Deputy Director for Science and Technology

SUBJECT : Comparative Evaluation of Mission 1105

1. There has been concern expressed over the varying opinions relative to the performance of mission 1105. Engineering analysis of system performance, by this Office, NPIC's Technical Services and Support Group, and the camera contractor (Itek) has resulted in reports of considerable variability in image quality. At this point all evidence indicates that this variability is attributable to the introduction on this system of Ultra Thin Base (UTB) SO-380 film. The NPIC photointerpreters report, on the other hand, that this was a good mission.

2. I do not believe that this difference in opinion, between the engineering and photointerpreter groups, is particularly important, nor should it influence our decision to convert CR-6 and CR-7 back to the STB configuration.

3. Attached is a summary paper discussing performance rating techniques, and the history of differences between the photointerpreter and engineering analysis groups for the J-3 system. This paper makes the following points.

a. There has been a history of disagreement between engineering and photointerpreter assessment of mission performance.

b. The fact that the photointerpreters rate a mission as good or bad is based on target coverage, target scale and intelligence content of the mission.

[redacted]

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HANDLE VIA [redacted]
CONTROL SYSTEMS ONLY

SUBJECT: Comparative Evaluation of Mission 1105

The PI ratings are of interest to the Project Office from a standpoint of mission planning but are not necessarily of any engineering consequence. Engineering assessments are concerned solely with evaluating how well the camera system hardware performed vis-a-vis how well it should have performed under the existing conditions of weather, altitude, et cetera.

c. The flight results obtained with mission 1105 are not inconsistent with the history of UTB testing with J-3 systems. Although this system passed final film flatness tests, considerable variability in film flatness has been observed on every J-3 system tested with UTB.

4. It must be remembered that the J-3 system was not designed specifically for UTB, as UTB was only a design goal and not a requirement. At this point in time, there is no guarantee that 1.5 mil estar base UTB will ever perform satisfactorily with the J-3 system as now configured. The Technical Task Force established in [redacted] has started work to evaluate every aspect of UTB in the J-3 camera, and I will report to you as results of their work become available.

[redacted]

Director of Special Projects

Distribution:

[redacted]

OSP [redacted] (25 Nov 68)

[redacted]

[redacted]

COMPARISON OF QUALITY RATINGS OF

CORONA PERFORMANCE

INDEX

Attachment to
[redacted]
Copy of

COMPARISON OF QUALITY RATINGS OF

CORONA PERFORMANCE

1.0 INTRODUCTION

Several evaluations of the CORONA system imagery are made by various groups for various purposes. These evaluations and their use are listed below in the order of their occurrence.

[redacted] Message

This is a twx report issued by the NPIC "Breakdown Team" at the processing site. This report is intended to give the community an immediate readout on image quality and system performance.

In this report, NPIC assigns an MIP (Mission Information Potential) number. This is a relative rating which is aimed at giving an indication of the best imagery seen. It is not directed at assessing overall performance. The average MIP rating for the J-1 series was 85. The best MIP ever assigned a J-1 was 90.

OAK Reports

The initial PI readout from the mission is summarized in the OAK. For each target read, NPIC PI's assign a quality rating on a scale that includes unusable, poor, fair, good, excellent. One measure of system performance is to average these performance ratings to arrive at the percentage of targets given a good, etc., rating. This accounts for only a very small percentage of the total mission, however, as these ratings generally are only for Priority 1 targets. It is interesting to note that the average PI ratings (from the OAK's) for the past ten J-1 missions was as follows:

Good	13%
Fair	50%
Poor	37%

Technical Performance Evaluation Team (PET)

The PET, consisting of representatives from major elements of the program, is convened approximately two weeks after each mission to assess the technical performance of the system, identify problems, causes and indicate solutions. The PET report is issued as a twx and is known as the PEIR (Photographic Evaluation Interim Report).

There are frequently distinct differences in opinion about system performance between the three reports. In most cases, these disagreements can be explained. A summary of the essence of each report for the J-3 series is given below and the differences noted.

2.0 MISSION 1101 (CR-1)

2.1 NPIC [redacted]

2.1.1 1101-1

"The imagery of the fwd-looking camera record is good and comparable to better J-1 missions; however, it is not comparable to the best imagery obtained from the J-1 system.

"The imagery of the aft-looking camera record is not comparable to that obtained from the forward camera. The imagery is soft and has an out of focus appearance."

"MIP 95."

2.1.2 1101-2

"The best image quality of the fwd-looking camera record is good and compares favorably with the best imagery obtained from the J-1 system.

"The image quality of the aft-looking camera is not comparable to the fwd-looking camera."

"MIP 95."

Note here that even though this mission was rated only as good as the best J-1, it got a higher MIP (i.e. 95 vice 90).

2.2 OAK Summary

The average of the PI ratings for the Priority 1 targets was as follows:

Good	14%
Fair	57%
Poor	29%

This compares with the "average" J-1 performance of

Good	13%
Fair	50%
Poor	37%

On the basis of this comparison, one would conclude that CR-1 was about the same as an average J-1 and does not compare with the best J-1.

For example, the comparison of PI ratings for Mission 1101 with the best J-1 from the last ten is as follows:

	1101	1044
Good	14%	21%
Fair	57%	51%
Poor	29%	28%

2.3 PET Report

"The best photography of Mission 1101 is equal to or better than any previous CORONA photography. The best photography was obtained with the fwd-looking camera. The aft-looking camera produced softer imagery than normally obtained with the CORONA system because of an out of focus condition."

2.4 Synopsis

Both the PET and the NPIC Team essentially agreed on system quality, rating it generally to be equal to or better than the best J-1. However, performance was not as good as expected, the major reason being an out-of-focus condition on both cameras (being decidedly more severe on the aft camera).

The PI quality assessment disagreed, in a minor way, with the other assessments, rating the mission as comparable to an average J-1, and not comparable to the best J-1.

3.0 MISSION 1102 (CR-2)

3.1 [redacted]

3.1.1 Mission 1102-1

"The image quality of the fwd-looking camera record is good and slightly better than that obtained from the aft camera. The best imagery of both camera records is better than the best imagery observed on Mission 1101-2."

"MIP 100."

Note that this is the first time an MIP of 100 was ever assigned to a CORONA system.

3.1.2 Mission 1102-2

"The best imagery is comparable to Mission 1102-1."

"MIP 100."

3.2 OAK Summary

The summary of the PI ratings for the mission were as follows:

Good	27%
Fair	58%
Poor	15%

This compares with the "best" from a J-1 system (1044) of

Good	21%
Fair	51%
Poor	28%

3.3 PET Report

"The PET group and Photointerpreters agree that the best photography of Mission 1102 is better than any previous CORONA photography.

"Several very favorable factors combined to produce the best CORONA mission to date. The primary factors were good atmospheric conditions, increased scale through lower altitude and improved camera performance."

3.4 Synopsis

There appears to be no significant differences in the judgment of quality between the three reports.

4.0 MISSION 1103 (CR-3)

4.1 [redacted]

4.1.1 Mission 1103-1

"The best imagery of the fwd-looking camera record is comparable to that obtained from Mission 1101."

"MIP 95."

4.1.2 Mission 1103-2

"The best image quality of the forward-looking camera record is equal to the best obtained on Mission 1103-1. This "best" quality is, however, not indicative of the overall mission quality. An out-of-focus condition exists for approximately 1.5 inches from the supply and take-up end of most frames on the mission.

"The overall and best quality of the aft looking imagery is poorer than that of the forward looking imagery."

"MIP 95."

4.2 OAK Summary

The summary of PI ratings from the OAK is as follows:

Good	5%
Fair	63%
Poor	32%

This compares with the average J-1 ratings of

Good	21%
Fair	51%
Poor	28%

This would indicate that Mission 1103 was considerably worse than the average J-1 mission and significantly poorer than 1101.

4.3 PET Report

"The PET judged the general image quality of Mission 1103 as fair, and not as good as Mission 1102. There was a significant variability in image quality that was greater than normally encountered with a CORONA system.

"The exact cause of the variability is not clear; major factors, however, appear to be haze and focus.

"Focus variability appears to have been the major cause of image degradation."

4.4 Synopsis

There appears to be differences in opinion about 1103 quality. The general agreement of the PET and the NPIC Team was that, while not as good as Mission 1102, it was about as good as 1101. These technical assessments certainly do not indicate that the Mission was anywhere near as bad as the PI ratings would indicate. The PI ratings would indicate that this mission was the worst in a year. From the technical analysis by both the PET and NPIC, the cameras did not perform that poorly.

These differences between technical and PI assessments can be surmised to be due to two major factors:

1. The prevalence of haze; the PET further reported that "this mission was severely affected by haze." Whereas the PET tries to "subtract" haze from the technical analysis, the PI's obviously cannot.

2. Variability; the variability in quality can also explain some of the differences. Whereas the technical assessments are from the mission as a whole, the PI's judgments are target oriented.

5.0 MISSION 1104 (CR-4)

5.1 [redacted]

5.1.1 Mission 1104-1

"The best imagery of the fwd-looking camera is better than that from Mission 1102. The fwd-looking imagery provides better imagery than the aft-looking record."

"MIP - 115."

NOTE: This is the highest MIP rating ever given to a CORONA system.

5.1.2 Mission 1104-2

"The best imagery of the fwd-looking camera record is comparable to that of Mission 1104-1."

No MIP assigned.

5.2 OAK Summary

The summary of the PI ratings for Mission 1104 was as follows:

Good	18%
Fair	48%
Poor	34%

This compares with the ratings for J-1 as follows:

	Average J-1	Best J-1
Good	13%	21%
Fair	50%	51%
Poor	37%	28%

NOTE: Based on the PI ratings, 1104 can be judged to be not as good as the best J-1 (1044), and slightly better than the average J-1's. Further, Mission 1104 would be judged to be not as good as Mission 1102.

5.3 PET Report

"The overall image quality of Mission 1104 is the best yet obtained from the CORONA system.

"The best of the forward camera record is rated as being very good; the best of the aft camera photography is also good but not as good as that of the forward."

NOTE: The best mobil CORN target ever observed on a CORONA mission was also seen on 1104, being read at five feet.

5.4 Synopsis

Here, again, there is a disagreement between the PI's and the technical analysis of quality. The technical judgment that this was the best CORONA mission ever flown is not justified by the PI ratings. This, too, is explainable, however, in that the PI's later reported to the PET team that:

> "The overall cloud cover estimate of 20% fails to reflect the percentage of cloud cover or degrading atmospherics in the prime target areas.
>
> "There is generally a high incidence of cloud cover in the areas of intelligence interest."

6.0 MISSION 1105 (CR-5)

6.1 [redacted] - Mission 1105-1

"The forward panoramic camera imagery is degraded in varying degrees throughout the mission. The degradation is in the form of a variable out-of-focus condition compounded by image smear. The focus is generally poor and is variable within a frame as well as between frames. Image sharpness varies significantly across the minor axis of the film as well as along the major axis, however, the pattern of degradation varies between frames. The image smear is always present for approximately six inches at the beginning and end of most frames as well as randomly within a frame. The direction of smear varies from one area of degradation to the next. The smear is not confined to along and/or across track directions. The only consistent pattern seems to be that the supply side (half) of a frame is less degraded than the take-up side. It also appears that the better imagery usually occurs along the binary edge of the format vice the time-track edge. This pattern, however, is not consistent; the reverse is sometimes true. The degree of image quality variability within a frame is such that an observer may expect to see engine nacelles on an aircraft at one location on a frame while he is unable to distinguish the outline of an aircraft at another location within the same frame in a similar format position. The degradation does not appear to be associated with 'hardware focus' or with uncompensated image smear but rather it appears that the film (UTB) did not maintain a stable position during scan/exposure.

"The quality of the aft camera photography is generally similar to that of the fwd. The imagery displays a general out-of-focus condition and like the forward camera photography, has areas of image smear."

"MIP - 100."

6.2 OAK Summary

The summary of the PI ratings for Mission 1105-1 is as follows:

Good	41%
Fair	33%
Poor	26%

Based on these ratings, this would be judged the best CORONA mission ever, being significantly better than any previous mission.

6.3 PET Report

The PET for this mission has not yet convened. However, the camera contractor (Itek) has made the following statement from their analysis of the imagery made [redacted]

> "After viewing many passes of 1105-1, it became apparent that the photography is of varying quality. These variations occurred predominantly throughout the central portion of many formats and consisted of two abnormal effects unlike any previous flights. One variation appears to be a bubble while the other shows an 'oil canning' effect (snapping in and out during the exposure) on the bubble. The bubble places the film in varying planes of focus while the oil canning introduces multi-directional motion. These effects, occurring simultaneously, produce smear and defocus in local areas.
>
> "No systematic pattern has been identified (with reference to pass or frame number) while some frames are considered to be free of these disturbances.
>
> "It is believed that these disturbances occurred on both cameras but was readily detectable due to the high performance lens of the forward camera which has high sensitivity to film plane changes."

The NPIC statement to COMIREX on 21 November 1968 is quoted below:

> "On balance, NPIC believes that use of the KH-4B with ultra thin base (UTB) film in Mission 1106 would be more productive from the point of view of intelligence than use of the KH-4A with standard thin base film. This recommendation applies only to Mission 1106 and is based on the assumption that degradation of the imagery is not likely to exceed that on 1105-1. This opinion seems justified in view of the added coverage provided by use of the UTB film.

[redacted]

"While the photography of Mission 1105-1 is generally out-of-focus and displays areas of image smear, the best of the mission is comparable to the best of Mission 1102. However, there is a limited amount of imagery of such high quality.

"Since the KH-4 is a search system, the added coverage contributed by the use of UTB film in some degree outweighs the disadvantages inherent in loss of image detail. However, in the longer view, it is of the utmost importance that the full potential of the system be realized so as to enhance further the intelligence productivity of future missions."

6.4 Synopsis

There is, again, significant differences in opinion between the technical evaluation and the PI's on quality. Although a difference of the magnitude indicated is difficult to explain, the following points may be pertinent.

1. Again, it should be emphasized that the technical evaluation is judging overall mission performance, whereas the PI summaries presented here are for only the Priority 1 targets, a very small percentage of the total mission take. Where performance is extremely variable, it is highly likely that some targets will be covered with good quality photography.

2. Atmospherics obviously play a significant role in the PI ratings, whereas the PET tries to assess camera (or system) performance only. This mission was apparently quite free of degrading atmospherics (which is a classical occurrence for a full mission), which the PI's always prefer.

3. This mission had a lower average altitude than most past CORONA missions. This, of course, produces larger scale which the PI's, again, always like, even when a system malfunction occurs. A good example was Mission 1006, which has historically been thought of as one of the best CORONA missions ever. This feeling persists even though the system was injected too low (≈ 80 mi.), and produced an average IMC mismatch of 15%.

[redacted]

7.0 SUMMARY

A summary table (TAB A) of the quality ratings is attached. The difficulties of rating system performance are obvious. It is interesting to compare how the J-3 systems would be rated (relative to each other) on the basis of the three reporting techniques.

ORDER	NPIC [redacted]	PET		PI's
1 (Best)	1104 (MIP 115)	1104		1105-1
2	1102 (MIP 100)	1102		1102
3	1105 (MIP 100)	1103		1104
4	1103 (MIP 95)	1105	*	1101
5	1101 (MIP 95)	1101		1103

What is of primary concern is the occurrence of significant differences between the technical assessments and the PI assessments. There are several factors which can explain this, some of which have been noted. There is, however, one remaining point that is pertinent.

The technical assessments (PET and NPIC) are aimed at judging the quality primarily from a technical point of view; that is, how well did the system perform vis-a-vis what it should have done. The technical assessments do not attempt to make any judgments of intelligence utility. In a similar manner, the PI's judge mission quality not based on camera performance per se, but on the basis of how well the mission fulfilled intelligence requirements.

In this context, it is not incongruous (nor necessarily even pertinent) that the PI's judged Mission 1105-1 as excellent, whereas the technical judgments indicated severe anomalies.

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* The ranking of these three is somewhat arbitrary since the PET does not assign any quality number.

[redacted]

An analogy is, perhaps, useful. The camera system on Mission 1101 was out-of-focus. Yet this fact was not dramatically reflected in the PI assessments. This does not mean, of course, that all efforts should not be expended to improve focus. In like manner, there is consistent technical agreement that the film (SO-380) in Mission 1105-1 was not lying flat (nor stationary) during exposure. This is an undesirable system anomaly. Irregardless of PI ratings, it must be corrected.

The history of UTB testing with the J-3 system (see TAB B) is replete with occurrences of failures--film pulling out of rails, mistracking causing system shut-down and severe focus problems. These are only a few of the difficulties that have been encountered with UTB. There is by no means an overwhelming history of success in UTB testing with the J-3 camera; in fact, the opposite is true.

The decision to cancel the December 1106 Mission was the correct one. Three items remain as fact:

1. The history of UTB testing with the J-3 system is replete with failures.

2. Mission 1105-1 did exhibit image quality variability greater than is normal, or than is expected. This quality variation is due to the film not lying flat nor still in the rails.

3. Failures are still being experienced in system testing of UTB, even with later versions (i.e. CR-10). With the history of failures attendant to UTB testing and our lack of understanding of all the problems involved, our confidence is low that UTB on CR-6 would have been trouble-free. TAB B notes that the most prevalent failure with UTB has been failure to transport a full load. A failure such as this, in flight, could be catastrophic.

[redacted]

TAB A

SUMMARY OF QUALITY ASSESSMENTS

System	Flight Information	NPIC [redacted]	OAK PI's	PET	Comments
CR-1	Up - 15 Sep 67 1 Down - 21 Sep 67 2 Down - 29 Sep 67	MIP - 95 Good-comparable to better J-1's	About same as J-1 Good 14% Fair 57% Poor 29%	Equal to or better than previous C photography.	Even though lenses noticeably out of focus, PI ratings did not dramatically show this.
CR-2	Up -- 9 Dec 68 1 Down - 15 Dec 68 2 Down - 23 Dec 68	MIP - 100 Good - better than 1101	Better than best J-1 Good 27% Fair 58% Poor 15%	Better than any previous CORONA photography.	Free of any significant anomalies.
CR-3	Up -- 1 May 68 1 Down -- 8 May 68 2 Down - 15 May 68	MIP - 95 Comparable to 1101. Out-of-focus spots.	Very Poor Good 5% Fair 63% Poor 32%	Fair, not as good as 1102 Greater than normal variability. Focus problems.	Soft spots and Focus problems again produce anomaly.

Attachment to
[redacted]
A-1

[redacted]

System	Flight Information	NPIC [redacted]	OAK PI's	PET	Comments
CR-4	Up -- 7 Aug 68 1 Down - 14 Aug 68 2 Down - 22 Aug 68	MIP - 115 Better than 1102	Not as good as best J-1, slightly better than average J-1's. Not as good as 1102 Good 18% Fair 48% Poor 34%	Best yet obtained from CORONA system	No significant anomalies. Significant atmospherics noted by both PET and PI's.
CR-5	Up -- 2 Nov 68 1 Down - 12 Nov 68	MIP - 100 Degraded due to variable focus and smear.	Best Ever Good 41% Fair 33% Poor 26%	Not yet convened. However, camera contractor agrees with "31"	Anomaly due to UTB evident. However, technical & PI's judgment of quality obviously based on different criteria.

Attachment to [redacted]
A-2

[redacted]

TAB B

HISTORY OF UTB TESTING

Date	System	Test	Remarks
Jun 67	Qual Model	First UTB tested in the CORONA system.	Limited to slow cycle rate.
Jul 67	CR-3	Set up for full load of UTB; however, not fully accomplished due to delivery schedule.	Problem: Tracking, Dr. A, pulling out of rails, poor resolution test, motion during scan. Action: Raised drum roller & added 7 additional rollers.
Sep 67	CR-4	Attempted run with full load--also not completed due to delivery schedule.	Problem: Tracking. Action: Used Qual Model to identify source of scan motion--made drum roller mods. to reduce motion. Tension tests to evaluate Dr. A and to evaluate new steering rollers.
Jan-Feb 68	CR-5	Incorporated mechanical mods--steering rollers; ran full load.	Steering rollers increased frame length by 5/8" on each end. Problem: Unexplained tracking failure. Cut & wrap failure. Many failures remained unresolved at time of delivery.

Attachment to [redacted]
B-1
[redacted]

Date	System	Test	Remarks
----------	CR-5 (CONTINUED)	----------	Resolution test good. Dr. A varied good & bad. Action: Third generation lens required tighter Dr. A tolerance. Separated rails to improve tracking.
Mar-May 68	CR-6	A. Modified to include tri-undercut steering rollers; ran full load.	A. Strain sensitivity observed. Reduced tension to relieve strain. Action: Increased tension during start-up to prevent slack loops. Decreased supply dewrap tension on shut-down. Rail hole presentation improved. Cut & wrap failure remained unresolved. At this point, saw need for extended film path (first implemented on CR-8).
		B. Full load of UTB.	B. Problem: Unexplained tracking failure. New Procedure: Pinned output rollers prior to shipment.
Concurrent with CR-6	CR-7	A. Platen end rollers further modified--single undercut. Made block and Dr. A runs.	A. Result: Test suggested tension increase to 36 ounces. Problem: Increased strain sensitivity noted.
		B. Second full load test.	B. Unexplained tracking failure.

Date	System	Test	Remarks
Jun-Aug 68	CR-8	Extended film path.	Improved tracking and reduced strain sensitivity.
Jun-Jul 68 (Problems: CR-9 advanced ahead of CR-8)	CR-9	A. Drum access cover rollers raised and retrofitted to CR-5 to reduce tendency to pull out of rails. B. Vacuum chamber Dr. A test.	B. Dr. A good and bad depending on condition of film, i.e. how many times film had previously experienced vacuum conditions. New film was better.
Aug 68	CR-10	Raised trailing drum rollers.	Lower film lift during Dr. A on supply side. Retro-fitted to CR-5.
Current-- In test now	CR-11	UTB test with raised drum rollers.	Problem: Scan motion re-occurred on one instrument. Installed STB and found motion reduced significantly. Action: New problem and where we are today.

Attachment to [redacted]
B-3

[redacted]