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NPIC/P&DS-231/64
11 December 1964

MEMORANDUM FOR: See Distribution

SUBJECT : Project HI-C, High Altitude Color Photography

Attached for your information is a copy of a summary of the subject project to 1 December 1964.





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Assistant for Plans and Development

Attachment (TCS#10926-A-64)

Distribution:

- Copy 1 - Director, NPIC
- 2 - Exec. Dir., NPIC
- 3 - Asst. for Ops
- 4 - Asst. for Admin.
- 5 - Chief, TID
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1 December 1964

MEMORANDUM FOR: Assistant for Plans and Development

SUBJECT : Summary of Project HI-C, An Evaluation of
Color Photography Taken from High Altitude
Aircraft

I. Background

In early Spring, 1964, [redacted] of (S)NRO convinced Dr. McMillan that it should be determined if high altitude color photography could be developed to the degree that it would be of definite value to photo interpretation. Subsequently in August 1964, the (S)NRO in conjunction with OSA/CIA and Eastman Kodak flew test missions at nominal altitude over California with the 112-B System. The camera system carried a new color emulsion film (SO-121) in the forward camera and panchromatic film (4404) in the aft camera giving convergent stereo imagery of black and white and color combined. This test mission was given the designation of GT 64-148 and was followed by a similar mission using the "B" configuration camera. This test mission was designated as GT 64-149. The color imagery from these two missions was the best obtained to date by reconnaissance systems.

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II. Exploitation Evaluations

A. In mid-September the (S)NRO distributed the materials from GT 64-148 to the NPIC, DIA, SAC, NRTSC, FTD and AMS with the requirement that "each recipient conduct a comprehensive analysis of this mission material." The undersigned requested of [redacted] a further clarification of the requirement and was told that (S)NRO wanted a PI-oriented evaluation to determine subjectively if the color in mono gained values or lost values in comparison with the 4404 B&W imagery in mono. He also wanted an evaluation of the combination of B&W and color together in stereo. [redacted] stated that he was not particularly interested in technical evaluations at this time.

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B. The NPIC received the coverage for the entire mission which included 10 different formats or variations of prints of color and B&W of the San Francisco Bay area. The NPIC evaluation centered on these 10 formats. The Assistant for Operations issued a work project with P&DS/Plans Branch coordinating the evaluation and results. TID/TSB made a comprehensive technical evaluation. Even though it was not required by (S)NRO at the time, we reasoned that it would be required eventually and the evaluation would probably be of value to PI evaluations. The PAG was requested to perform a PI evaluation, and after the testing techniques had been decided upon, with the aid of [redacted] two senior, experienced photo interpreters from PAG, [redacted] set up the tests and refined the techniques. The evaluation tests were carried out by PAG PI's ranging in experience from 2 to 20 years and including the several specialized fields. The results and conclusions have been submitted to Plans Branch in a written report. PID is currently carrying out the same test while TID/TAB is conducting a mensuration evaluation. Reports from all evaluations will be combined and summarized in a final report which will include conclusions and recommendations. [redacted] requests that the report be submitted to the (S)NRO and OSA over the signature of the Director/NPIC with copies sent to the other agencies conducting the tests. It is hoped this will be concluded by 12 December 1964.

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III. Evaluation Meeting

On 24 November 1964, [redacted] held a meeting in [redacted] in order to determine from the PI community whether or not GT 64-148 produced sufficient information values to photo interpreters to warrant continuing with color testing and perhaps include it in aircraft operational missions. [redacted] realizes that all testing has not been concluded but felt that he could get a general consensus from which he could recommend to Dr. McMillan whether or not more test missions should be flown. Twenty-nine persons were present representing; NPIC, CIA/PID, CIA/OSA, DIA, SAC, NRTSC, AMS, EK, FTD, GIMRADA and Tactical Support Command. The NPIC was represented by [redacted]

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P&DS. The following summarizes the pertinent points for general appraisal. For specific reference, detailed reports are being prepared by the NPIC representatives present.

A. Characteristics of SO-121 Film

1. Type Film

Original material is SO-121, Aerial Ektochrome.
Speed rated at EI-13.
Color duplicates printed on SO-121.

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2. Theoretical Resolution:

125 1/mm at 1000:1 contrast
70 1/mm at 1.6:1 contrast

3. Measured Resolution - as measured on B&W bar chart at Edwards Air Force Base.

- a. EK measurements on SO-121, original negative:
53 1/mm in one direction
60 1/mm in other direction
- b. EK measurements on 4404, original negative:
90 1/mm in one direction
120 1/mm in other direction
- c. TID measurements:
SO-121 on dupe positive - 40 1/mm
4404 on dupe positive - 80 1/mm

4. Duplicating Film Thicknesses:

SO-121 Estar base thickness - 2.5 mils
SO-121 Total thickness - 3.5 mils
SO-121 Thickness at mylor splice - 8.6 mils
4404 - Total thickness - 4 mils

5. Miscellaneous

- a. Emulsion is softer than 4404; subject to digs and scratches. Have not tried protective coating yet but believe lacquer will give protection.
- b. Flimsy film, does not track well on spools and rollers.
- c. Film has a latent image shift if kept at ambient temperatures between time of exposure and the time of processing, if the elapsed time is more than 6 hours. Therefore, it must be refrigerated during this period. EK has designed special containers in which the film is packed with dry ice until it reaches the processing point where it is thawed (takes 3 hours before processing). EK is trying to develop a coating to overcome the image shift problem and eliminate refrigeration.

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d. Since this type film is new, there is no experience history on, post-processing storage life, so stability of material is unknown.

e. Fiducials and data block are not readable because of black borders. No solution for this problem has been found yet.

B. Film Processing and Duplication

This information is based on GT 64-148 consisting of 2700 ft. of SO-121 color film.

1. Processing of SO-121

a. Done at EK on a Grafton processor.

b. Rate of processing is 5 ft. per minute as compared with 25 ft. per minute for B&W.

2. Duplication

a. Duped onto SO-121 film in order to hold resolution. Duplicating was done with the Niagara Printer.

b. Duped by two methods.

(1) Use of conventional white light with tungsten lamp.

(2) By triple beam printing.

c. Rate is 5 ft. per minute on 70 mm film. Can print 3 color dupes simultaneously on 9 $\frac{1}{2}$ " film at the rate of 15 ft. per minute.

3. Titling

The present method of titling B&W is impractical for the color ON since the titling does not show through the black borders. Titling must now be done separately on each duped copy using white titling tape. However, EK believes that an edge flasher can be used to title on the color ON and thus eliminate this problem.

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4. Color Enlargements, Processing (EK)

a. Method #1 (best method). Use of ON in reversal process. Enlarging to 5X directly onto SO-121 material. This gives the best resolution.

b. Method #2. Use of ON to type 6110 internegative at 5X enlargement then contact print onto Kodak Ektocolor film. This produces a reduction in contrast but better tone.

c. Selection of above methods. Selection depends upon requirements for:

(1) Best resolution - Method #1

(2) Best tonal rendition - Method #2

5. Cost Comparison - Color with B&W (According to EK)

a. Processing of SO-121 original cost 4 times that of 4404 B&W original. This is due mostly to slower processing speed (more man-hours). The chemical cost is about twice as much for B&W.

b. SO-121 duplicating cost is 12X that of 8430 B&W duplicating material.

c. Color processing and duplicating of this type materials will always be considerably higher than for B&W (no less than 8 times for duplicating)

6. EK Proposal to Reduce Processing Cost

a. First, produce a B&W dupe from the original color negative and sent to the user for quick scan.

b. The user scans the B&W dupe and selects areas of interest.

c. The selected areas are then transmitted back to the processor for color duplicating of these areas in chips or rolls which are then sent back to the user.

d. Many feet of color duplication can be eliminated by the selection of areas of interest.

NOTE: If coverage is to be made in both color and B&W simultaneously as planned, the first step will be unnecessary since a dupe of the B&W will already be in the hands of the interpreter and an additional one would be unnecessary.

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7. Elapse Time of Delivery of Color Copy

The elapsed times are calculated from the time of receipt of 400 ft., of the processed color ON at EK. These figures represent total EK production for one mission.

- a. / 4 days - delivery of B&W copy from original color.
- b. / 6 days - first color copy delivered.
- c. / 10 days - total of 3 color copies delivered.
- d. / 14 days - 4 additional color copies (total of 7).
- e. / 1½ days - elapsed time for each additional color dupe.

C. Viewing

- 1. Light tables should be equipped with daylight fluorescent tubes which are balanced for color (EK).
- 2. Ambient lighting should match (in color temperature) viewer lighting. (EK).

D. Summary of Reports Made at 24 November Meeting

- 1. NRTSC - Findings based on white light color dupes only.
 - a. Conclusion - Color has specific advantages and disadvantages to each type of target or area of interest.
 - b. Recommendations
 - (1) Use color operationally
 - (2) Promote an R&D program in color films and emulsions
 - (3) Conduct ground resolution tests
 - (4) Conduct interpretability tests
 - (5) Conduct format investigations
 - (6) Conduct additional flight tests over a variety of targets.
 - (7) Conduct R&D and Color processing and equipment.
 - (8) Add camouflage detection film to the system.

2. SAC Report

a. Comments

- (1) Under high magnification the color layers separate giving a sense of false stereo.

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(2) Color should always be used as a supplement - the multi-sensor approach.

(3) Ideally, SAC would like stereo color in addition to stereo B&W.

b. Recommendations

(1) It is recommended that B&W always be flown with color.

(2) Recommend further color test missions.

3. DIA - AP Report

a. Comments

(1) Color in combination with B&W is ideal for military geography and geology. Color has limited value in interpretation of urban areas, underground installations and detail targets.

(2) Color has good values for interpretation of construction materials, new construction and materials stored in the open.

(3) Evaluations of color should be subjective.

4. GIMRADA Report

a. Comments

Primary interest is to use color in military geography studies and in a rapid combat mapping system which is currently being developed in conjunction with AMS.

5. NPIC Report

a. Comments

(1) Color has a definite advantage over B&W for scanning.

(2) If a camera system is capable of high system resolution B&W is preferred for detailed readout. However, if a camera system produces a color resolution that approximates the B&W resolution, color is preferred since more is to be gained.

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b. Recommendations

(1) That more test missions be flown but test flights be planned to simulate more of operational conditions rather than the optimum conditions (good sun angle, clear atmosphere, etc.) under which the GT 64-148 was flown.

(2) That the NPIC be permitted to submit a list of targets to be covered in order that the NPIC evaluations will be based more on national requirements.

(3) That in the event it is decided to use color operationally the Community be informed as far in advance as possible in order that equipments can be obtained or modified and laboratories can be prepared to handle color material.

E. Conclusions

1. will publish a summary of the meeting. 50X1
2. For the time being color should be considered operational only for atmospheric reconnaissance.
3. A narrow band printing of color material is preferred for interpretation and is superior for photo lab work.
4. The increased cost of color is not considered highly significant when the cost of the entire mission and exploitation is considered.
5. The delayed delivery time of color materials may be a serious factor.
6. Color presents many problems for the photo laboratories located at exploitation installations. Planning for the equipping of these laboratories should be begun early.
7. An edge flasher should be developed so that titling can be done on the original color negative.
8. Consideration must be given to reducing the number of generations of color materials produced and distributed.
9. If the camera - lens system does not limit B&W film resolution, B&W should be flown in conjunction with color. On the other hand if the camera limits the B&W resolution to say 50 1/mm, using color in both cameras may be desirable.

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F. Requirements

1. That OSA plan for at least one more flight test of color.
2. That [redacted] (DIA) compile a target list for OSA to use in planning flight missions. 50X1
3. That future tests simulate operational conditions and include the factors of sun angle, ground environment, photogrammetrically controlled areas, and varying ground coverage and vegetation.
4. That R&D be continued in color films and processing and in the development of viewing equipments, etc., for color materials.

NOTE: Subsequent to the meeting [redacted] told the undersigned that he was going to recommend to Dr. McMillan that one or two more color test flights be flown and that consideration be given to using color operationally some time next Spring. 50X1

IV. Actions to be Taken

It is recommended that subsequent to the distribution of this summary to the NPIC components, the conclusion of the NPIC evaluation report and the receipt of the evaluations of the other agencies by NPIC, that the NPIC Staff study these reports and then hold a conference in order that apparent problems can be identified and that advanced planning can be started early enough for the Center to be prepared to receive color materials when the time comes.

[redacted]

Plans Branch, P&DS

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