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EKIT REPORT NO.7 (FLIGHT NO.8)

EFFECTS OF DIFFERENT EXPOSURE LEVELS ON TYPE 3404

31 MAY 1967

CONTRIBUTORS: [redacted]

APPROVED BY: [redacted]

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1. SUMMARY

This report is the seventh in the EKIT series and contains the analysis of Eastman Kodak type 3404 at various exposure levels. Although type 3404 has been used for many years, there is still not complete agreement on the manner in which to best expose the material. It was the purpose of this test to obtain imagery at various exposure levels and to see just what effects occur in similar scenes at these levels. The analysis was extended from the aircraft to the satellite system with a study of two past KH-4 missions.

1.1 SCOPE OF THE TEST

A high flying aircraft using the 112B camera system was used to gather the flight material. The exposure times (seconds) were 1/200, 1/250, and 1/400; 1/500 for EKIT flight no. 8; and 1/325 and 1/600 for EKIT flight no. 3. The weather was partially cloudy on EKIT flight no. 8, although clear weather was encountered over the CORN targets. The analysis consisted of a subjective evaluation, a tone reproduction analysis, and a system considerations section. The subjective evaluation is an analysis of the imagery by a photointerpreter. The tone reproduction analysis consists of describing the tonal aspects of the imagery. The system considerations section ties these two sections together and applies this information to the satellite system.

1.2 CONCLUSIONS

The conclusions from this test are: (1) that overexposure does cause a system resolution loss of at least 10 percent for one stop over, and (2) that optimum exposure is not a simple function of the sensitometric characteristic but is directly related to the type of target being photographed and its general reflectivity. In addition, it is suggested that the criterion for exposure of strategically important targets be re-evaluated. The present method of measuring "average terrain D_{min}" is believed to be inadequate for judging the best exposure level.

2. TEST PLAN

EKIT report no. 7 contains the exposure analysis that was performed on type 3404 film. Originally only EKIT flight no. 8 [redacted] was intended for use in the exposure analysis test. In the analysis stage, it became necessary to draw upon other imagery, which was the material used in EKIT report no. 5 (EKIT flight no. 3). This section describes the basic camera configuration and the specific details of the camera settings that were used for these two tests.

2.1 112B CAMERA SYSTEM

Though discussed in previous EKIT reports, a description of this camera system will be again presented to familiarize the new reader with the system employed in this test series. The camera is a pan scanning type that has been designed around the diffraction-limited Petzval type lens of 24-inch focal length, with an f/3.5 aperture that covers a 6-degree field angle. To obtain stereo, a pair of these cameras is tilted from the nadir at 13 degrees each, and set face to face so that each camera scans in opposing directions. The lens is continuously rotated about its operational nodal point scanning across the line of flight, and is translated against the flight direction for image motion compensation.

During approximately 70 degrees of the lens rotation, a capping shutter is opened to permit the aerial image to expose the 70-millimeter film through a slit. This slit controls the exposure time, e.g., at a 20-inch-per-second scan rate, a 0.40-inch slit produces an effective exposure time of 1/500 second. At the completion of the photographic scan, the capping shutter is closed.

The film is continuously being transported in from the supply spool and out to the takeup spool. A frame-metering roller controls the frame length (the correct amount of film placed in the format area), and clamps at each end of the format hold the film stable in the approximate focus position. The excess film is accounted for by a shuttle assembly that gives or takes according to demand.

A focal position is determined by a scan head assembly mounted on a precise arm from the nodal point to the focus. This scan head gently lifts the film from the rails to the image plane during exposure and returns it to the rails after exposure. The rails are required only to hold the film at the approximate focus and to guide the film during transport.

Recorded on the film edge outside of the format area on each frame are the frame number, binary time, and timing pips of 125 cps. These timing pips are scanned on the film across the 70-degree format length with one pip blanked out to indicate when the binary time data block is printed. Three scanning rates are built in to match the V/h requirements while maintaining approximately 10 percent overlap at the format center. Increased overlap is acquired on both sides of nadir as the off-vertical scan angle increases.

2.2 CAMERA MODIFICATIONS

One of the considerations for all of the EKIT tests is that no modification be made to the 112B system that would be incompatible with the normal operation of the KH-4b system. Since the slit width can be changed by about $1\frac{1}{3}$ stops in the KH-4b system, a set of split slits that covered this range was fabricated for use in the 112B tests. Though this is contrary to the normal use of the 112B system itself, it was necessary in order to simulate the KH-4b system capabilities. Figs. 2-1 and 2-2 show the slit configuration used in EKIT flight test nos. 3 and 8.

2.3 FLIGHT TEST PLAN DETAILS

The two flights necessary for this test were flown over the Fresno-Bakersfield areas in early August 1966. One flight also included two passes over Los Angeles. Repeated coverage of each city was used in order to obtain images of all target areas on each half of the film with both cameras. A summary of the camera settings is given in Table 2-1.

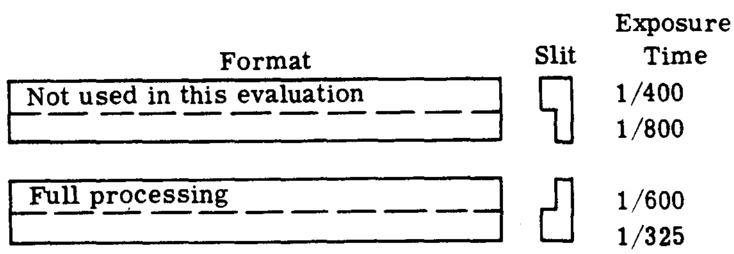


Fig. 2-1 — Slit configuration and processing level for EKIT flight test no. 3

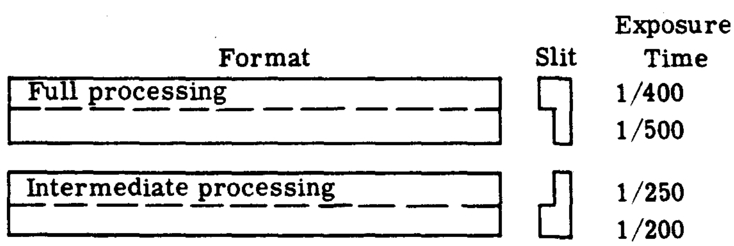
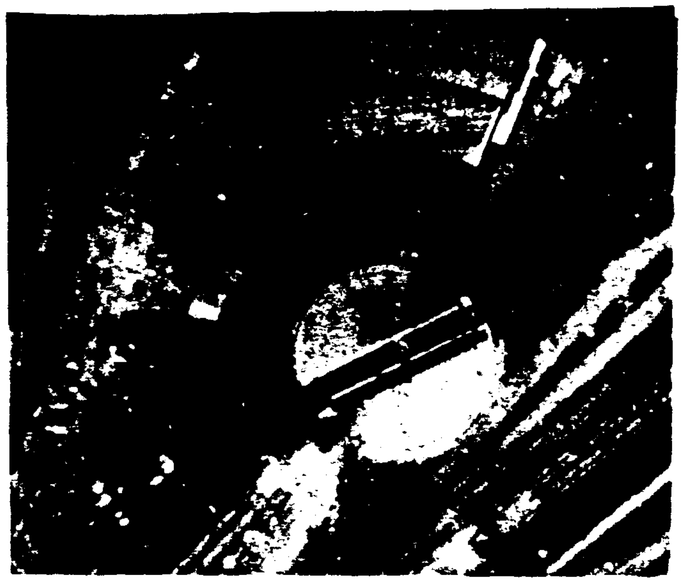


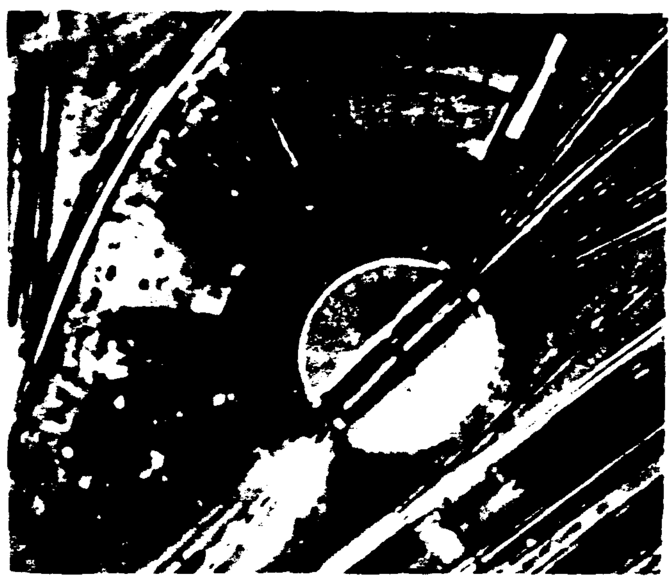
Fig. 2-2 — Slit configuration and processing level for EKIT flight test no. 8

Table 2-1 — Specific Camera Details for EKIT Flight Nos. 3 and 8

	GT-265-66 EKIT Flight No. 3		GT-273-66 EKIT Flight No. 8	
Film	3404	3404	3404	3404
Exposure time	1/800 and 1/400	1/600 and 1/325	1/500 and 1/400	1/250 and 1/200
Haze filter	W21	W21	W21	W21
Scan mode	II	II	II	II
f/no.	3.5	3.5	3.5	3.5
Processing	Full	Full	Full	Intermediate
Area covered	Fresno and Bakersfield		Fresno, Bakersfield, and Los Angeles	
Time of photography	1800 to 2205Z		1745 to 2150Z	
Flight date	2 August 1966		9 August 1966	

(a) Railroad turntable—1/250-second exposure

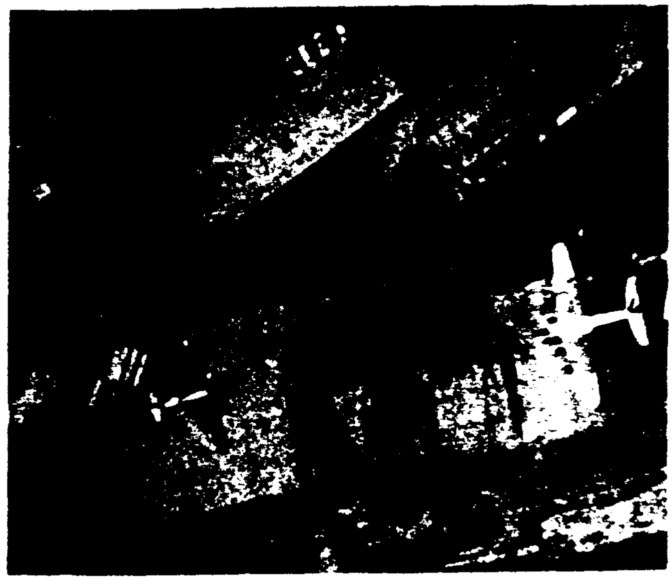




(b) Railroad turntable—1/500-second exposure

Fig. 3-2 — Comparative photomicrographs of different exposure levels of a dark toned subject, 60× enlargement

(a) Engine test chamber—1/200-second exposure

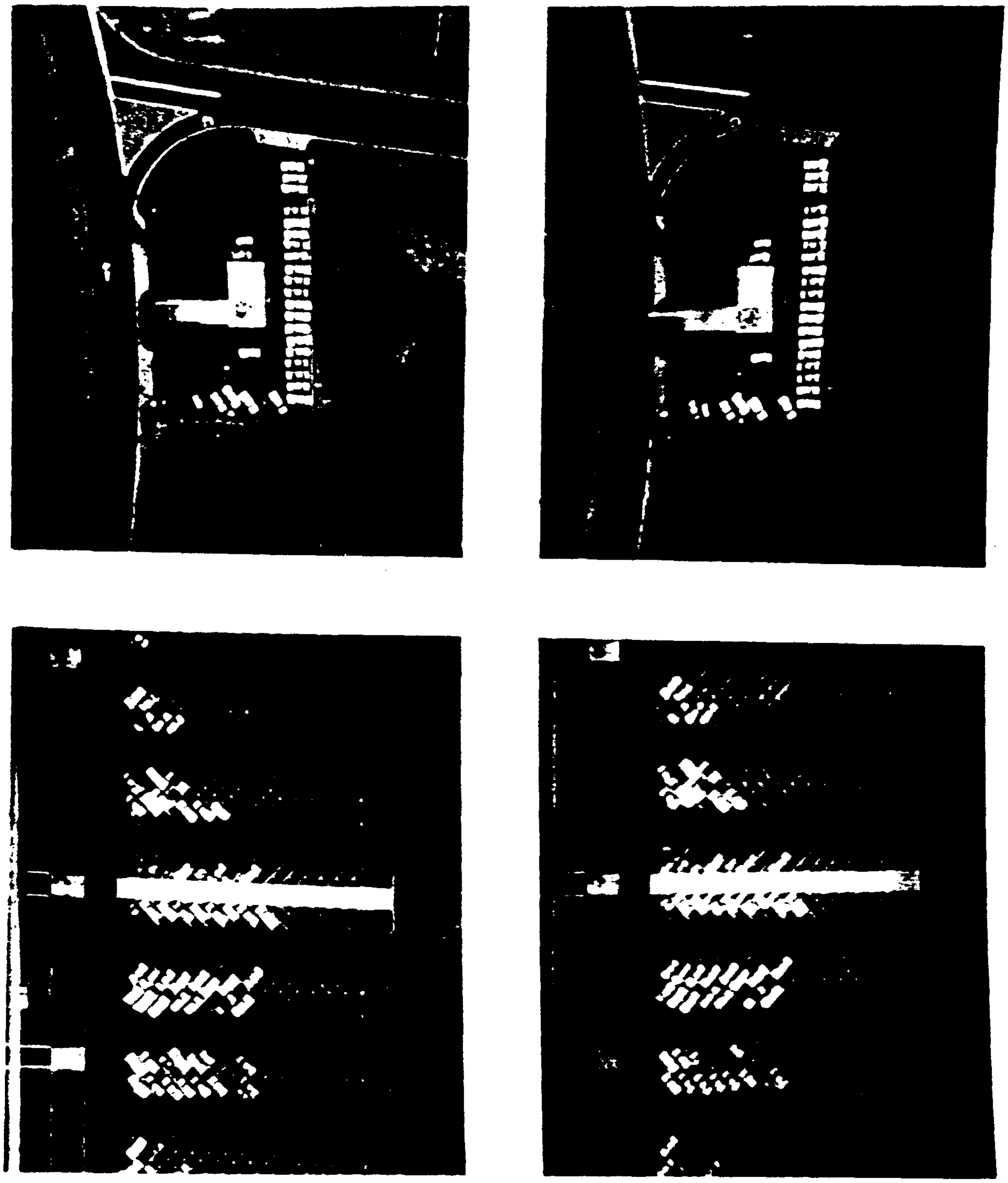


(b) Engine test chamber—1/400-second exposure

Fig. 3-1 — Comparative photomicrographs of different exposure levels on EKIT flight test no. 8, 60× enlargement

(a) Parking lot—1/600-second exposure (frame 030)

(b) Parking lot—1/600-second exposure (frame 012)



(c) Parking lot—1/600-second exposure (frame 030)

(d) Parking lot—1/325-second exposure (frame 012)

Fig. 3-3 — Comparative photomicrographs of different exposure levels on EKIT flight no. 3, 60× enlargement

3.2 PHOTOINTERPRETER'S COMMENTS ON MODEL PHOTOGRAPHY

Since the exposure in the flight photography covered a range of only one stop, the model photography* was re-examined. The Itek model is an HO-scale, three-dimensional model of a typical New England landscape. It contains a small suburban area, a superhighway, mountain terrain, and house construction. It is a very useful test bed for systems that must be examined under as real a photographic situation as possible, without the atmospheric and camera perturbations that occur in an actual flight. The imagery available covered a range of four stops; two stops underexposed, one stop underexposed, normal, one stop overexposed, two stops overexposed. The photomicrograph of the positive images from these negatives for the normal exposure is shown in Fig. 3-4; the poor exposures are shown in Figs. 3-5(a) through 3-5(d).

Five negatives at each level of exposure were made and the best of each selected for evaluation. Positive transparencies were made of each to obtain optimum results as a fixed processing gradient and a subjective comparative evaluation was made.

Two stops underexposure [Fig. 3-5(a)] produces a record of low contrast with loss of vegetation separation and shadow detail. Highlight areas are well depicted as would be expected. Resolution of the joist pattern in the house under construction is virtually nonexistent and the general lack of contrast affects acuity adversely.

One stop underexposure [Fig. 3-5(b)] produces some blocking of vegetation but considerably less than the two-stop underexposure record shows. Generally the exposure is quite good with a rather wide tonal scale. Edge sharpness appears to be slightly better than in the normal exposure, probably due to a decrease of development effects and an acceptable contrast range. Joist detail is improved though not well defined.

Normal exposure (Fig. 3-4) produces a record with good tonal range. Vegetation is well defined, shadows are more open and delineate some detail but the highlight areas are somewhat washed out. The overall appearance is generally pleasing and resolution is at its peak. The joist in the building under construction is well defined and the highlight portion shows texture.

One stop overexposure [Fig. 3-5(c)] increases the information content of the darker areas—woods and bridge shadows. Highlight areas tend to block up somewhat. Generally, this exposure compares favorably with the normal exposure; however, some increase in graininess and a decrease in acuity are present. In this particular image, the joist detail is better than in the normal exposure.

Two stops overexposure [Fig. 3-5(d)] renders the shadows and vegetation details the best of all. Highlights are well blocked, graininess is at its highest, and acuity suffers. The joist detail is absent and resolution has fallen off considerably.

3.3 PHOTOINTERPRETER'S CONCLUSIONS

The following conclusions are drawn from these tests. There is a noticeable difference in the tonal rendition on the original negatives with as small an exposure difference as 20 percent. Over the exposure levels covered in this test, however, this difference caused no loss or gain in information when the positive prints were printed for the best reproduction that each negative could give. There is a significant difference in the image quality when the exposures are different

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*Originally obtained from EKIT report no. 5.

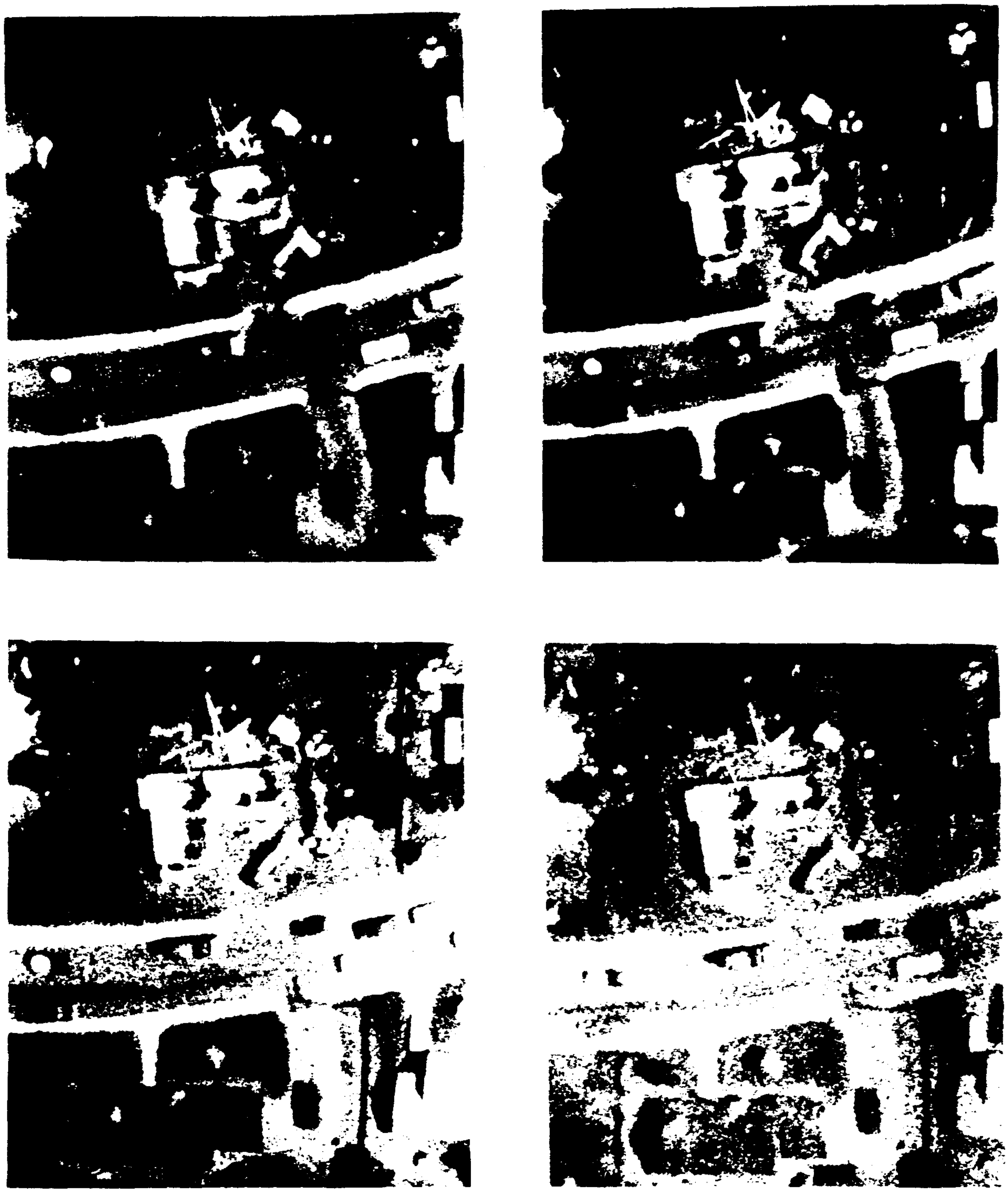
by a stop, overexposure causing a loss in quality. The flight test does not allow a resolution number to be fixed to this difference, although since it is visually evident, there must be a minimum of 10 to 15 percent difference in resolution. Although the shorter exposure time generally results in increased image quality (due in part by less image motion), there is a point beyond which no further information is gained due to the loss in subject tones that are to be reproduced. The line is not clear cut as to the level of exposure at which this occurs since it is a function of the subject's reflectance. Darker objects, such as the railroad turntable and yard to require a significantly higher exposure level to be reproduced well. The reverse may also be stated, i.e., if the reflectance of a subject is very high, a lower exposure level would be warranted.

In the model test, the graininess significantly increased in the overexposure. This test also showed a serious loss in tonal quality (particularly low reflectance objects) with one and two stops underexposure. There were some areas, such as high reflectance objects, that are improved by a stop underexposure.

Fig. 3-4 — Model photograph—normal exposure, 60× enlargement

(a) Model photograph—2 stops underexposed

(b) Model photograph—1 stop underexposed



(c) Model photograph—1 stop overexposed

(d) Model photograph—2 stops overexposed

Fig. 3-5 — Model photography at four different exposure levels, 60× enlargements

4. TONE REPRODUCTION ANALYSIS

Mobile CORN targets were displayed at Bakersfield, California. For this analysis, the image of a five-step gray scale on the negative and the 8430 dupe was used. These images were available for all four exposure levels from EKIT flight no. 8. The procedure involved making high quality dupes on type 8430 and coordinating with the photointerpreter for judgment of the quality from a subjective viewpoint. The densities were then read on a microdensitometer and these values converted to "effective diffuse density" readings by using the Collier coefficient for this film-microdensitometer combination.

The tone reproduction scheme used consists basically of four quadrants, each related to the two bounding it by the particular curve it represents. The first quadrant (Fig. 4-1) represents the transfer of subject tones through the atmosphere to form their effective log exposures in the negative. This is the graphical analogy of

$$B_a = B_o t + H$$

where B_a = brightness at the film plane
B_o = original ground brightness
t = atmospheric transmittance
H = atmospheric hazelight

Although this information is not actually known, the curve for Quadrant I can be obtained by plotting the gray scale (log) reflectance values versus the effective log exposure that they form. This is determined by relating the densities formed to the log exposure that was necessary for their formation. The second quadrant is the negative characteristic curve. Its density axis becomes a relative log exposure axis for the duplicating material in Quadrant III. The final quadrant represents the reproduction of tones for the system and is obtained by plotting the densities of the gray scale in the positive image versus the original gray scale log reflectance. If the reproduction had been theoretically ideal,* it would have been a straight line at a 45-degree angle as indicated by the dotted line in Quadrant IV of this figure. However, due to the low slopes of some portions of the three curves that make up this reproduction system, the reproductions are generally far from ideal.

Fig. 4-1 represents the tone reproduction cycle at exposure values of the 1/200-second image for intermediate processing conditions. Under this exposure and these processing conditions, the luminance differences of the original scene were placed on the upper part of the straight line and shoulder of the negative D-log E curve. The duplication of these values on 8430 film

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* Theoretically ideal is not necessarily the best from a subject standpoint.

processed in D-19 for gamma values of 1.4, 1.5, and 1.6 placed these values on the lower part of the positive curve. The tone reproduction indicates that the original exposure was too great (overexposed) to be properly reproduced.

Because of this overexposure it was necessary to process the 8430 to a higher contrast to expand the density values. The results of this printing, Fig. 4-2, now show a scene with acceptable tone reproduction of the original subject.

Fig. 4-3 represents the tone reproduction for the 1/500-second image. The same three positive characteristic curves were used for this reproduction as were originally used (Fig. 4-1) for the 1/200-second exposure. Note that since the majority of the scene has been reproduced on the midtone regions of the negative (Quadrant II), the final reproduction with these positive characteristic curves has considerable contrast. A very good reproduction is obtained with a normal duplication process.

The shortest exposure time (1/500) still produced a negative that is considerably above the minimum exposure that could be recorded. For the next tone reproduction cycle, it was assumed that a 1/1,000-second exposure had been used. When these three duplicating curves are used, the same problem of low contrast has occurred. This time, however, the reproduction would be quite dark. By adjusting the exposure slightly, a much better reproduction would be obtained as shown in Fig. 4-4. Since these pictures were not actually taken by the system, only the theoretical tone reproduction graphs were available. It does illustrate, however, that good tonal reproduction of the five-step gray scale can be obtained with a shorter exposure time.

Tone Reproduction Conclusions

It is concluded that the difference in exposure levels on the original material has a significant effect on the duplication necessary for good reproduction. With exposure levels so great that the scene is essentially almost all the way on the shoulder, a serious contrast loss results. It can be regained, for the most part, through proper duplication. An exposure of 1/1,000 second could have been used in this test and a good reproduction of the scene could have been obtained. It would have been driven further into the toe regions of the curve, though slight adjustments in printing could again have given a good image.

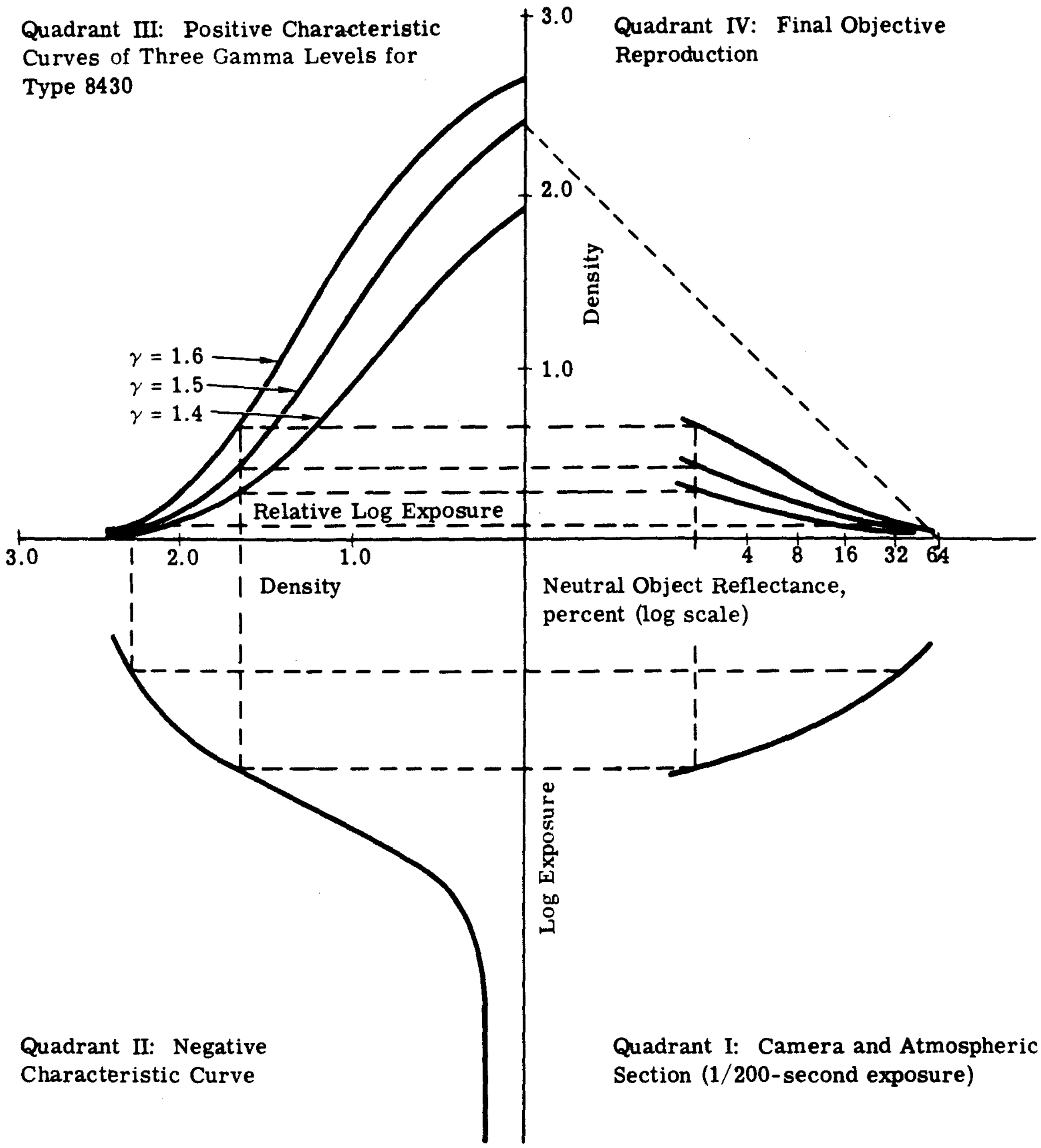

Fig. 4-1 — Tone reproduction cycle for the negative exposed at 1/200-second exposure time

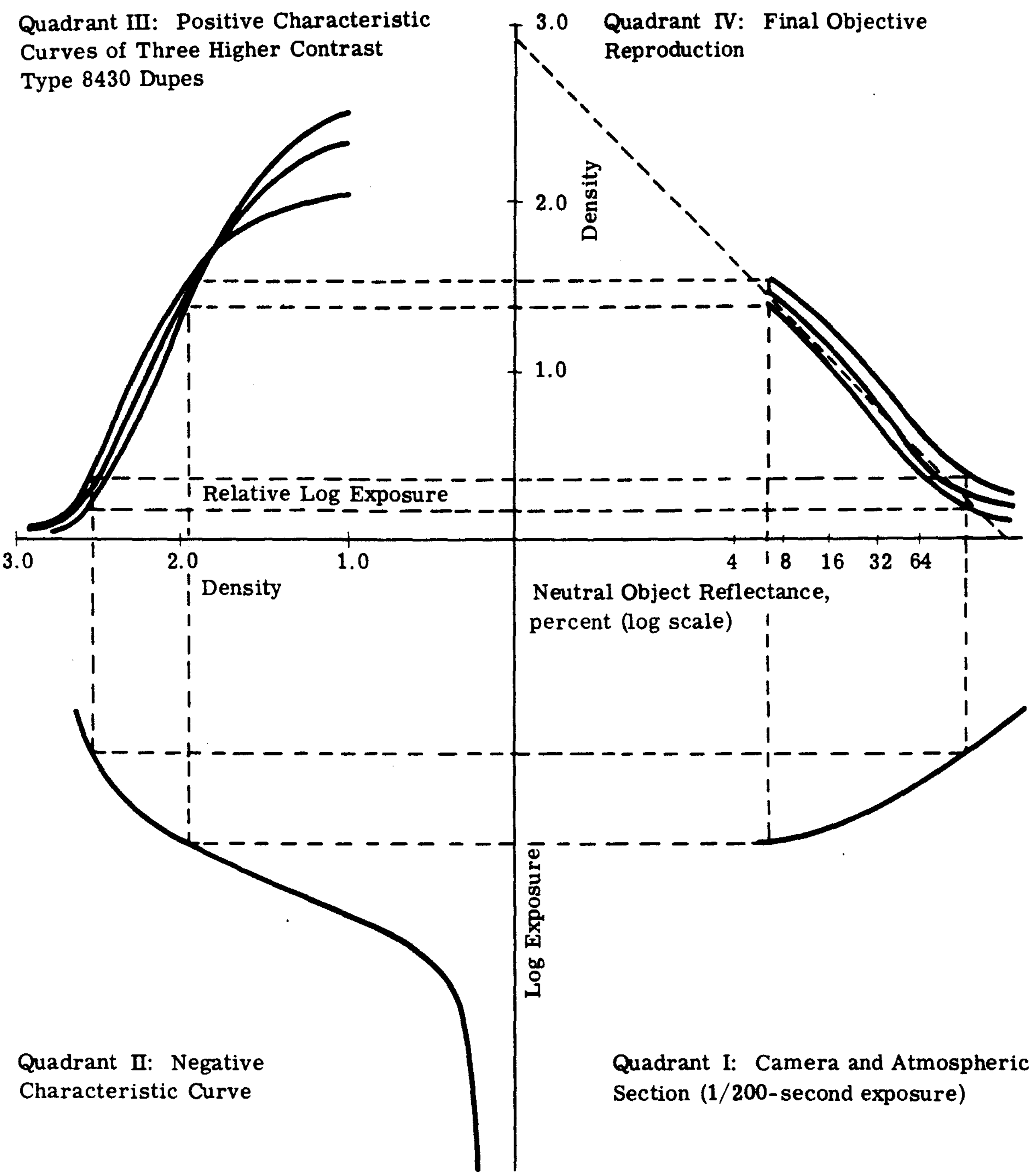

Fig. 4-2 — Tone reproduction cycle for the negative exposed at 1/200-second exposure time. (Duplication control has been increased for a better reproduction.)

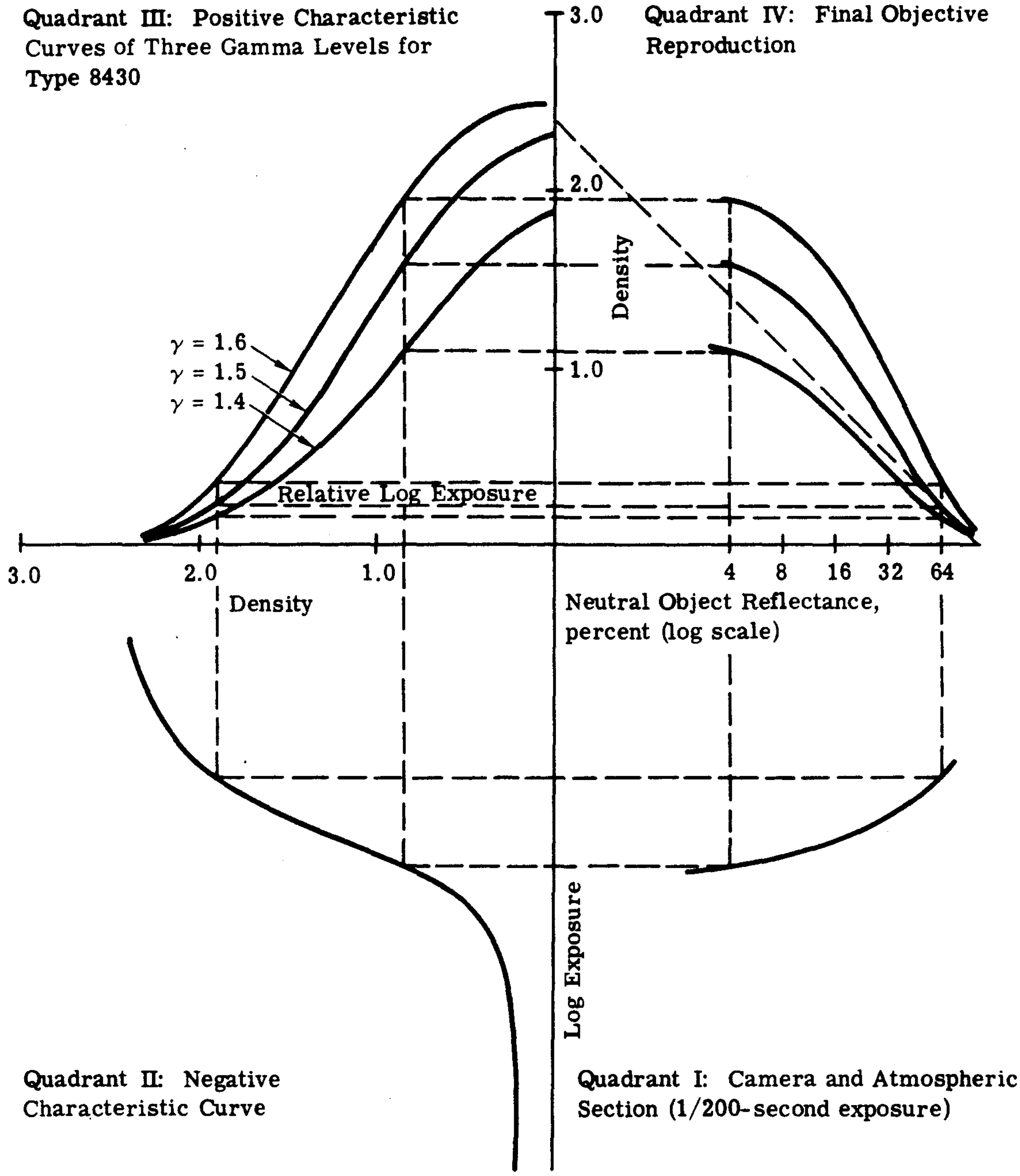

Fig. 4-3 — Tone reproduction cycle for the negative exposed at 1/500 second

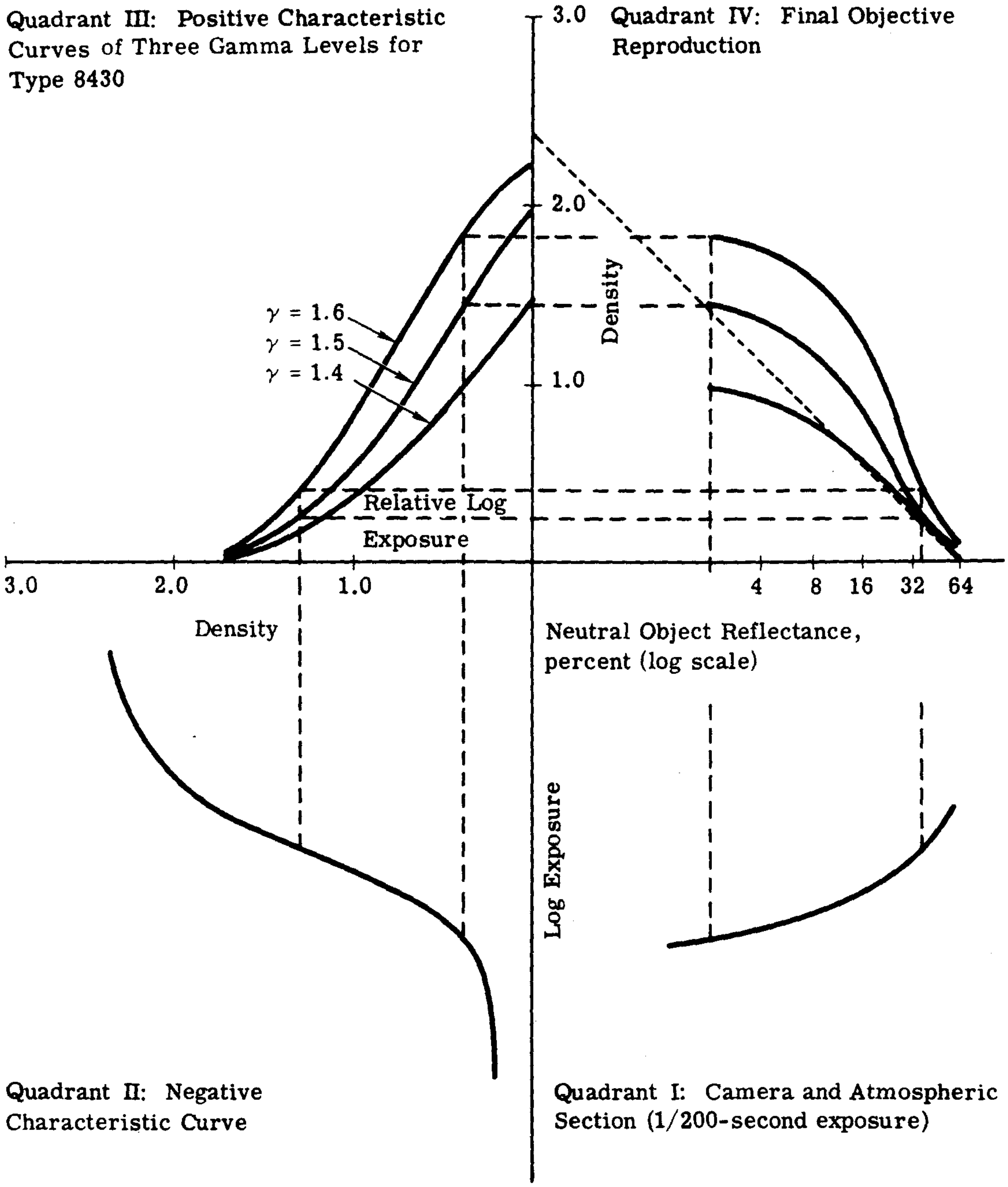

Fig. 4-4 — Theoretical tone reproduction cycle for a simulated 1/1,000-second exposure

5. KH-4b SYSTEM CONSIDERATIONS

In this section some of the results of the previous two sections will be expanded in an effort to extend these conclusions to the KH-4b satellite system. The density analysis discussed in this section will be related to the tone reproduction of mission 1034. A comparison will be made between the microdensitometer readings of COMOR priority targets and the diffuse density values of the AFSPPF reports.

5.1 DENSITY ANALYSIS

Some work has been done in conjunction with NPIC to evaluate the relationships between target and terrain minimum and maximum deviation. This work was done on missions 1023 and 1034. The basic analysis procedure of both missions was to make microdensitometer traces (using a 10- × 10-micron aperture) of operational COMOR priority targets. These targets were selected and scanned by NPIC. The peaks and valleys on the traces were chosen as the D_{max} and D_{min} respectively for the target. The result of these analyses are discussed below.

<u>Mission 1023-1</u>

Mission 1023-1 was initially selected for analysis since it was reputed to be significantly underexposed by the processing contractor, while the photointerpreter reputed that it was an excellent mission. The processor was basing his conclusions on the terrain density measurements.

One of NPIC's analysts randomly selected COMOR priority targets and these were measured on the microdensitometer. The results are shown in Table 5-1 where they are compared with the AFSPPF terrain measurements. For a fair comparison the microdensity measurements were converted to equivalent diffuse density readings by applying the Collier coefficient (in this case, 0.89). This comparison provides some interesting observations.

First, in general, the target D_{min} values are higher than those of the terrain D_{min}. This is verified by the higher average D_{min} value for the targets.

Second, the lower levels of the target D_{max} values are higher than those for terrain values. The upper limit of the D_{max} values for the targets are, however, lower than those for the terrain areas. What is significant, however, is that the average density level of the targets is higher than that of the terrain areas for the FWD camera and only lower than the terrain measurements by a few percent in the AFT camera.

Third, it is most significant that three of the four comparisons have density values of the target areas higher (from 0.2 to 0.3 density units higher) than their comparable terrain values. What this suggests is that, in fact, the target areas are more heavily exposed than the terrain areas. This fact could explain why the photointerpreters thought this was a good mission whereas the processing contractor thought it was underexposed. They were making observations on different things, the photointerpreters on targets, and the processing contractor on terrain areas.

Fourth, what is particularly interesting is that the target density analysis seems to agree more with the photointerpreters even though the sampling was considerably smaller than the terrain density analysis.

Mission 1034

It was realized that the mission 1023-1 analysis was somewhat limited in its scope, hence, a further study was undertaken. NPIC made similar measurements (mission 1034) on more than 50 operational target airfields. Again the targets were selected by an NPIC analyst. The results of this evaluation are shown in Table 5-2. In this case the comparison is against Eastman Kodak's measured density values. As with mission 1023-1, some interesting observations are possible.

First, and again in general, the target D_{min} values are higher than the terrain D_{min} values. In fact, on the 1034-2 portion, the target average D_{min} values were over 0.80 (0.82 and 1.12), whereas the terrain measured values were relatively less being 0.50. It is interesting to note here that, by the analysis of terrain density data, the exposure/processing is in specification (i.e., D_{min} between 0.48 and 0.90). The target D_{min} information says we are out of specification, being either overexposed or overprocessed for the targets.

Second, on the target D_{max} analysis, targets on three of the four portions of the mission went to absolute D_{max} (2.38). The target average D_{max} values were considerably higher than the terrain D_{max} values by an average of about 0.4 density units.

Third, and again as with 1023-1, the analysis of target densities yields a different picture of the exposure given the material as compared to the terrain density analysis. The analysis in general illustrates what many have claimed, that target areas are overexposed, or at least of a higher density than the typical terrain areas.

This initial work tends to confirm the original hypothesis that exposure analysis should be made from target areas and not typical terrain areas.

A fundamental question raised in the previous two sections is, "What is the reflectance of the targets of interest?". It was suggested in the subjective analysis that there is a gain to an overexposed negative if dark toned objects are being photographed.

Two airfields were chosen, one with white concrete of generally high reflectance and one which represents the darkest airfield covered (with black runways). Both scans included aircraft, in one case on the white concrete, and in the other, on the black asphalt. The characteristic curves for the negatives were obtained from the AFSPPF report on mission 1034. In addition, the average D_{min} and D_{max} were computed from the bar graphs of the density analysis reported in that text.

Fig. 5-1 is the data available for a tone reproduction display of the mission 1034 photography. The negative characteristic curve (Quadrant II) is from AFSPPF; the positive characteristic curve (Quadrant III) is from 8430 and was determined in our laboratory, since the atmospheric data is not available. However they are not really needed in order to study the basics of where, on the D-log E curves, certain objects fall. The average D_{max} and D_{min} (from AFSPPF data) have been indicated on the negative characteristic curve. The duplication curve has been placed in Quadrant III so that the average D_{max} on the negative is printed so that it produces a density of 0.4 in the highlights of the dupe positive. Superimposed on the characteristic curve is the microdensitometer scan of the darker airfield. The densities have been converted to equivalent diffuse density with the specular/diffuse constant (Collier's Q) for the film-microdensitometer combination. The distance scale for this trace is relative, being about 2 millimeters on the film for the trace represented on this graph. In this airfield, there is very good separation between the aircraft (arrows) and the black runway. This airport will be well reproduced with the normal duplication. On the graph in Fig. 5-2 is a scan of another airfield from the same mission. The densities from this scan are much higher on the characteristic curve. The subject scanned was a row of aircraft on a white (probably concrete) runway. Though there are density differences to indicate the presence of these aircraft, they are at a very high density level and would be difficult to see. When this negative is printed for the same criteria as the previous example, the subject of interest is almost "washed-out." There is only a little information remaining.

These two scans represent the extremes in density ranges of all the scans made. It is unfortunate, though, that most of the 50 scans that were made were not in between these two but closer to the high density sample.

In fact, only 26 of the 50 scans had any minimum density below 0.8, and of those, only 14 had more than just a fraction of the entire scan below 0.8.

A similar analysis was performed on mission 1023. This mission was seriously underexposed by the standard control limit criteria. It is interesting to note that it was claimed to be of significantly better quality by the photointerpreter than any of its recent predecessors. The scans of this mission included other strategic targets than airfields. The majority of these scans were very similar in density range and level as that of Fig. 5-1.

It is concluded from this analysis that airports can be given significantly less exposure than they presently are, i.e., about a stop less. It may cause a slight loss in other areas such as mountain terrain and vegetation, however, a gain will be experienced in the quality of airfield and similar targets.

Table 5-1 — Density Analysis for Mission 1023

Mission 1023-1 D_{min} Density Analysis

Camera	Measurement	D_{min} Range	Average D_{min}	Standard Deviation D_{min} (σ)	Number of Samples
FWD	AFSPPF—Terrain	0.15 - 1.26	0.39	0.17	278
	NPIC—Target	0.16 - 1.26	0.67	0.33	16
AFT	AFSPPF—Terrain	0.20 - 1.40	0.53	0.21	269
	NPIC—Target	0.68 - 0.87	0.75	0.09	5

Mission 1023-1 D_{max} Density Analysis

Camera	Measurement	D_{max} Range	Average D_{max}	Standard Deviation D_{max} (σ)	Number of Samples
FWD	AFSPPF—Terrain	0.43 - 2.41	1.22	0.36	278
	NPIC—Target	1.08 - 1.81	1.43	0.24	16
AFT	AFSPPF—Terrain	0.41 - 2.21	1.31	0.34	269
	NPIC—Target	1.18 - 1.43	1.27	0.11	5

Table 5-2 — Density Analysis for Mission 1034

Mission 1034-1 D_{min} Density Analysis

Camera	Measurement	D_{min} Range	Average D_{min}	Standard Deviation D_{min} (σ)	Number of Samples
FWD	EK—Terrain	0.25 - 1.45	0.53	*	
	NPIC—Target	0.43 - 1.19	0.69	0.23	12
AFT	EK—Terrain	0.38 - 1.35	0.50	*	
	NPIC—Target	0.36 - 0.71	0.48	0.14	6

Mission 1034-1 D_{max} Density Analysis

Camera	Measurement	D_{max} Range	Average D_{max}	Standard Deviation D_{max} (σ)	Number of Samples
FWD	EK—Terrain	0.55 - 2.20	1.20	*	
	NPIC—Target	1.23 - 2.38	2.14	0.41	12
AFT	EK—Terrain	0.52 - 2.25	1.30	*	
	NPIC—Target	0.65 - 1.45	1.15	0.37	6

Mission 1034-2 D_{min} Density Analysis

Camera	Measurement	D_{min} Range	Average D_{min}	Standard Deviation D_{min} (σ)	Number of Samples
FWD	EK—Terrain	0.38 - 1.25	0.50	*	
	NPIC—Target	0.65 - 1.64	1.12	0.26	34
AFT	EK—Terrain	0.35 - 1.55	0.50	*	
	NPIC—Target	0.31 - 1.23	0.82	0.28	8

Mission 1034-2 D_{max} Density Analysis

Camera	Measurement	D_{max} Range	Average D_{max}	Standard Deviation D_{max} (σ)	Number of Samples
FWD	EK—Terrain	0.60 - 2.0	1.4	*	
	NPIC—Target	1.58 - 2.38	1.90	0.19	34
AFT	EK—Terrain	0.55 - 2.30	1.30	*	
	NPIC—Target	1.35 - 2.38	1.62	0.34	8

*Data estimated from histograms, σ and number of samples not available.

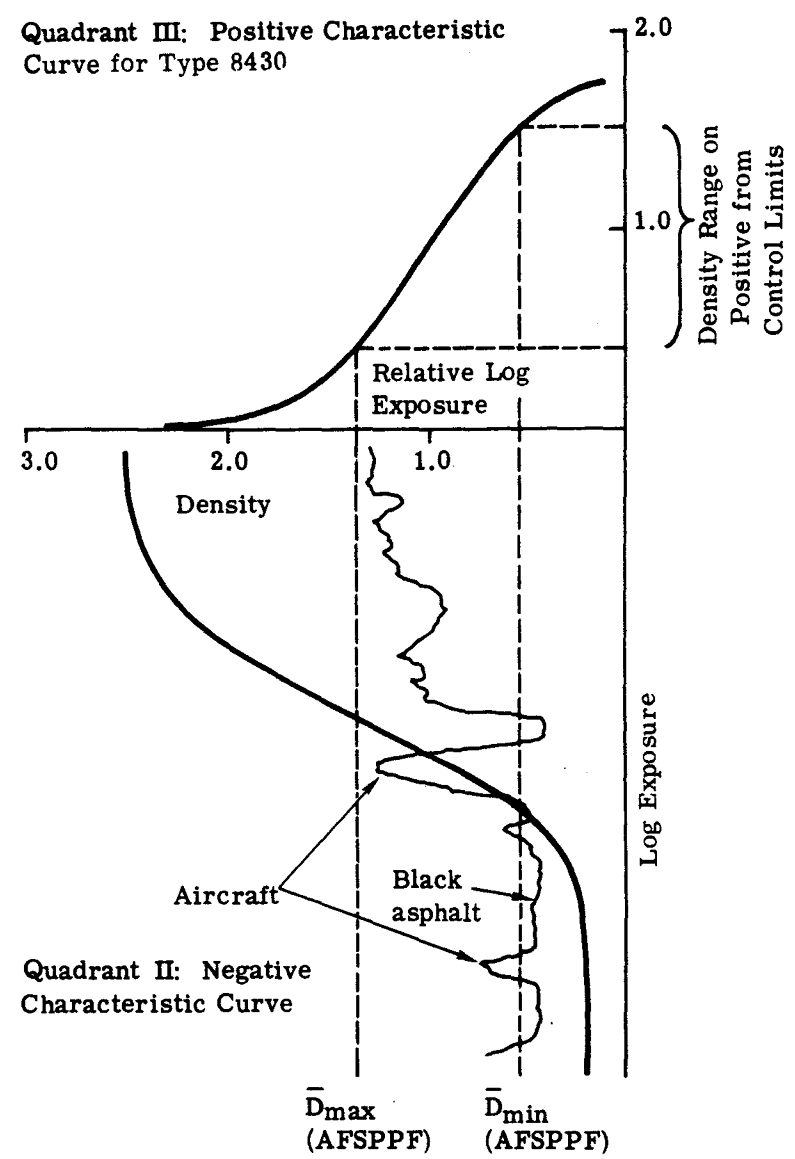

Fig. 5-1 — Portion of the tone reproduction cycle from mission 1034 with the low reflectance target superimposed on the sensitometric quadrant

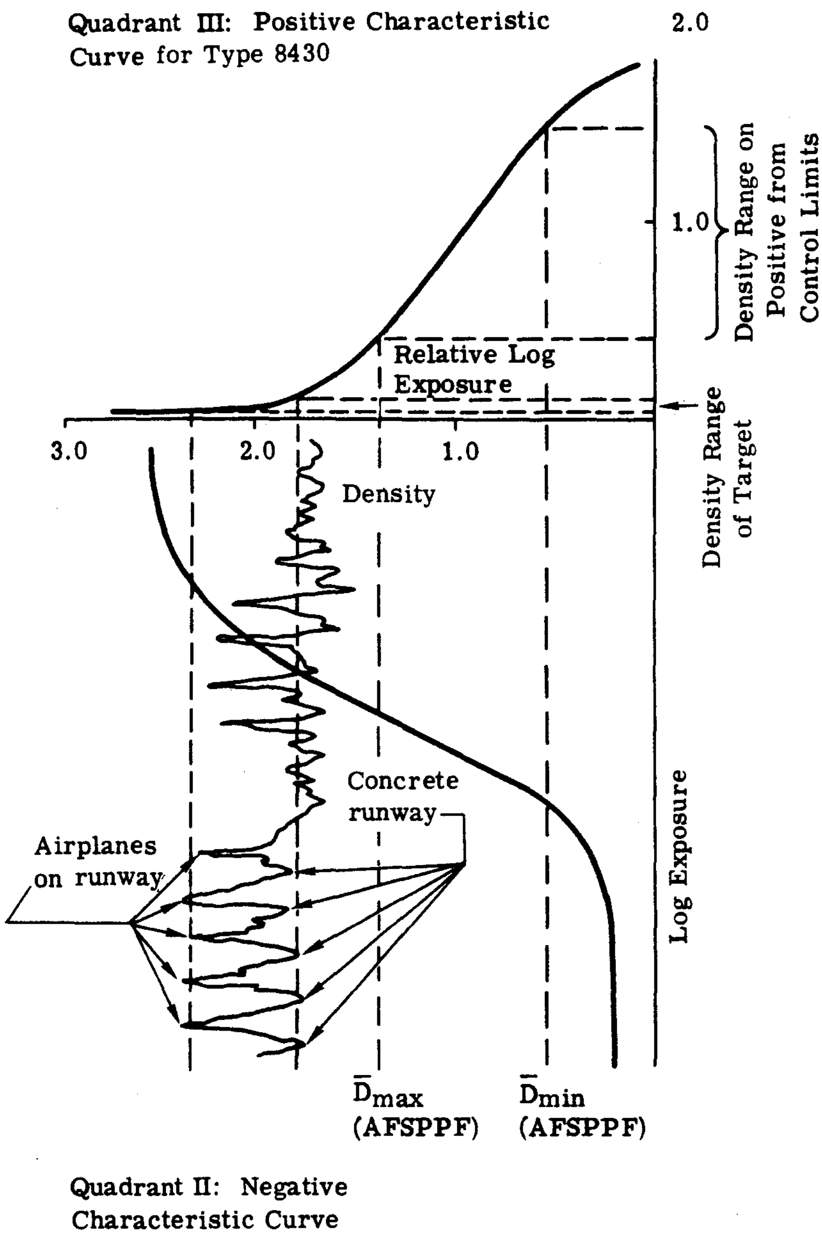

Fig. 5-2 — Portion of the tone reproduction cycle from mission 1034 with the high reflectance target superimposed on the sensitometric quadrant

6. DISCUSSION

This report, unlike previous EKIT reports, does not require a conclusions section; instead, a discussion section is warranted. The present system for evaluating the proper exposure and processing is based on average D_{min} density readings from terrain measurements. Based on the results of the previous two sections, it appears that this criterion should be re-evaluated. It has been shown that peak resolution is a function of exposure. It has also been shown that the reflectivity of the target has a bearing on the best exposure level for that particular target. Most of the examples have indicated that COMOR priority targets, airfields in particular, have been overexposed, indicating that if the exposure were to be changed, it should be reduced. However, although these particular targets have been brighter than the "terrain targets," it does not mean that all priority targets are so. The 112B flight test covered many target areas that were relatively dark, and a greater than normal exposure would have improved them. It is the purpose of this discussion to point out that the criterion for proper exposure, i.e., terrain D_{min}'s is perhaps not the best. Instead, a criterion that takes into account the average reflectivity of targets and the frequency of occurrence of these targets in any one photographic pass should be used.

At this point in time, it is impossible to set up such an exposure control system. However, with the proper analysis of past and future imagery, it will be possible to obtain enough data to put such a criterion into effect. It will require an analysis of the brightness of important targets, the frequency of occurrence of these targets, and the changes that they undergo as a function of time of year and solar altitude.