[redacted] CORONA
TOP SECRET

CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D.C. 20505

[redacted]
Copy [redacted]
16 DEC 1969

MEMORANDUM FOR : Director, Satellite Operations Center

SUBJECT : [redacted] and CORONA System Resolution Performance

1. Attached is Technical Memorandum No. 28A. This memorandum has been prepared in order to provide a definitive Office of Special Projects position on the resolution performance of both the [redacted] and CORONA systems. As you know, many factors impact the resolution performance of any satellite reconnaissance system. However, the attached memorandum should serve as a good overall guide to the performance of these systems, and I think will serve to answer the majority of questions on this subject.

2. This resolution data included for the CORONA system in Technical Memorandum No. 28A is identical to that in Technical Memorandum No. 39 which has also been forwarded to you under separate cover. Any further questions you may have on this matter should be addressed to the Design and Analysis Division of OSP which prepared this Technical Memorandum, or the Photographic Reconnaissance Systems Program Office, as appropriate.

[redacted]
Director of Special Projects
DD/S&T

Attachment: As Stated
[redacted]

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SUBJECT: [redacted] and CORONA System Resolution Performance

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16 December 1969

TECHNICAL MEMORANDUM #28-A

SUBJECT : Sensitivity of Ground Resolution to Altitude and Location in the Ground Frame

PREPARED BY: [redacted] and [redacted]

I. INTRODUCTION

1. This paper examines the sensitivity of KH-4 and [redacted] ground resolved distance (GRD) to location in the ground frame and variation in perigee altitude for a typical orbit. In particular, GRD variation for two KH-4 orbits with perigee altitudes of 85 n.m. and 100 n.m. is discussed. The latitude of perigee is 50 degrees North for each KH-4 orbit. A [redacted] orbit with a perigee altitude of 82 n.m. at 45 degrees North is also presented.

2. Examples of KH-4 and [redacted] resolution data are included. These plots are presented with resolution contours expressed in feet.

II. RESOLUTION CONTOURS

1. The resolution performance of a panoramic system is influenced by such factors as:

(a) Film quality
(b) Lens performance
(c) Film focus position
(d) Image smear
(e) Atmosphere

2. Components of GRD are defined in the direction of image motion and in the direction of scan motion. In this paper GRD is expressed as the geometric mean of these components.

3. Figures 1(a) and 1(b) display resolution contours of

the KH-4 system at altitudes of 100 n.m. and 85 n.m. respectively. Data of the latter figure were derived from an instrument used on one of the KH-4 Missions, and its performance was considered representative of good photography.

4. To generate the resolution contours associated with an altitude of 100 n.m., two assumptions were made:

(a) Target illumination and contrast are independent of altitude,
(b) Image angular smear rate remains constant as altitude varies.

5. The apparent asymmetry of contours in Figures 1(a) and 1(b) results from a 20 mil offset from the optical node. The purpose of this offset is to paritally correct for cross-track smear.

6. At an altitude of 100 n.m. the resolution varies from 6.8 feet near the center of the imaged area to a maximum of 19 feet at one edge. This represents a resolution degredation of about 18% when compared with the resolution at 85 n.m., which varies from 5.8 feet near the center to over 16 feet at one edge.

7. Figure 1(c) displays resolution contours of [redacted] at 82 n.m., based on performance prediction results of line pairs per millimeter plotted as a function of scan angle and slit position. These contours are nearly symmetrical and indicate a resolution of from [redacted] feet near the center to over 9 feet at the edges. Because of overlap, however, the extreme edges of any frame will contain area covered close to the cross-track centerline of an adjacent frame. Therefore, all targets can be acquired with a resolution of about six feet or better. These values are based on engineering studies and are 96% reliable, as indicated in Figure 1.

III. KH-4 SYSTEM

1. The increase in GRD for the KH-4 orbits as a function of latitude is shown in Figure 2. Figure 3 presents the altitude profiles which were utilized to calculate the resolution data.

2. For convenience, this change in ground resolution for each orbit is expressed relative to 85 n.m. which is perigee altitude for the lower orbit.

3. Over the Sino-Soviet area (70 degrees North to 20 degrees North), the average increase in GRD for the 100 n.m. orbit is seventeen percent. The minimum and maximum increase of fifteen and eighteen percent occur at 20 degrees North and 50 degrees North (latitude of perigee), respectively. This increase in GRD is the difference of the percent increase of the two orbits at a given latitude.

4. Figure 2 indicates an improvement of ground resolution South of the latitude of perigee for both orbits. An average improvement of three percent, relative to perigee, occurs from 35 degrees North to 20 degrees North for the 100 n.m. orbit. The 85 n.m. orbit exhibits an improvement of better than one and one-half percent from 40 degrees North to 25 degrees North. At the same time, the average degradation North of perigee to 70 degrees is two percent for the 100 n.m. orbit and three percent for the 85 n.m. orbit. A slight improvement in resolution for the more northern latitudes, 50 to 60 degrees North, is possible by moving the latitude of perigee to the North. For this reason, the latitude of perigee should be located as far North as possible within system constraints such as drag makeup capability to assure a high reliability of RV recovery.

5. The descriptions of the [redacted] and KH-4 orbits considered in this paper are summarized in Table 1. Figure 4 presents the orbital geometry and definition of perigee altitude as well as latitude of perigee. Perigee is located along the semimajor axis and perigee altitude is defined as a normal to the earth's surface. The latitude of perigee is defined as the latitude at which this normal intersects the earth model. Minimum altitude is less than perigee altitude and occurs at a lower latitude due to the oblateness of the earth.

6. Nominal parameters for a KH-4 orbit are considered to be a 7.5 day synchronons period, 85 n.m. perigee altitude at 50 degrees North, 80 degree inclination, and the LOW orbital period which satisfies the synchronous period condition. Only the first of six KH-4B systems utilized the HIGH orbital period which is considered atypical of the KH-4 missions. The GRD increase for HIGH vs. HIGH orbits with different perigee altitudes is essentially equivalent to that of the LOW vs. LOW orbits.

7. A second KH-4 orbit with a perigee of 100 n.m. was selected for comparison of GRD. This orbit has the same synchronous period and latitude of perigee as the nominal case. A point of interest is the latitude of complete coverage in one synchronous period for these orbits, 46.5 degrees North for the 85 n.m. case and 37.0 degrees North for the 100 n.m. case. The 100 n.m. orbit is nearly equivalent to a circular orbit of that altitude over the Sino-Soviet area as Figure 3 indicates.

IV. [redacted]

1. [redacted]

2. [redacted]

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FIGURE 2

INCREASE IN GRD VS. LATITUDE

(KH-4)

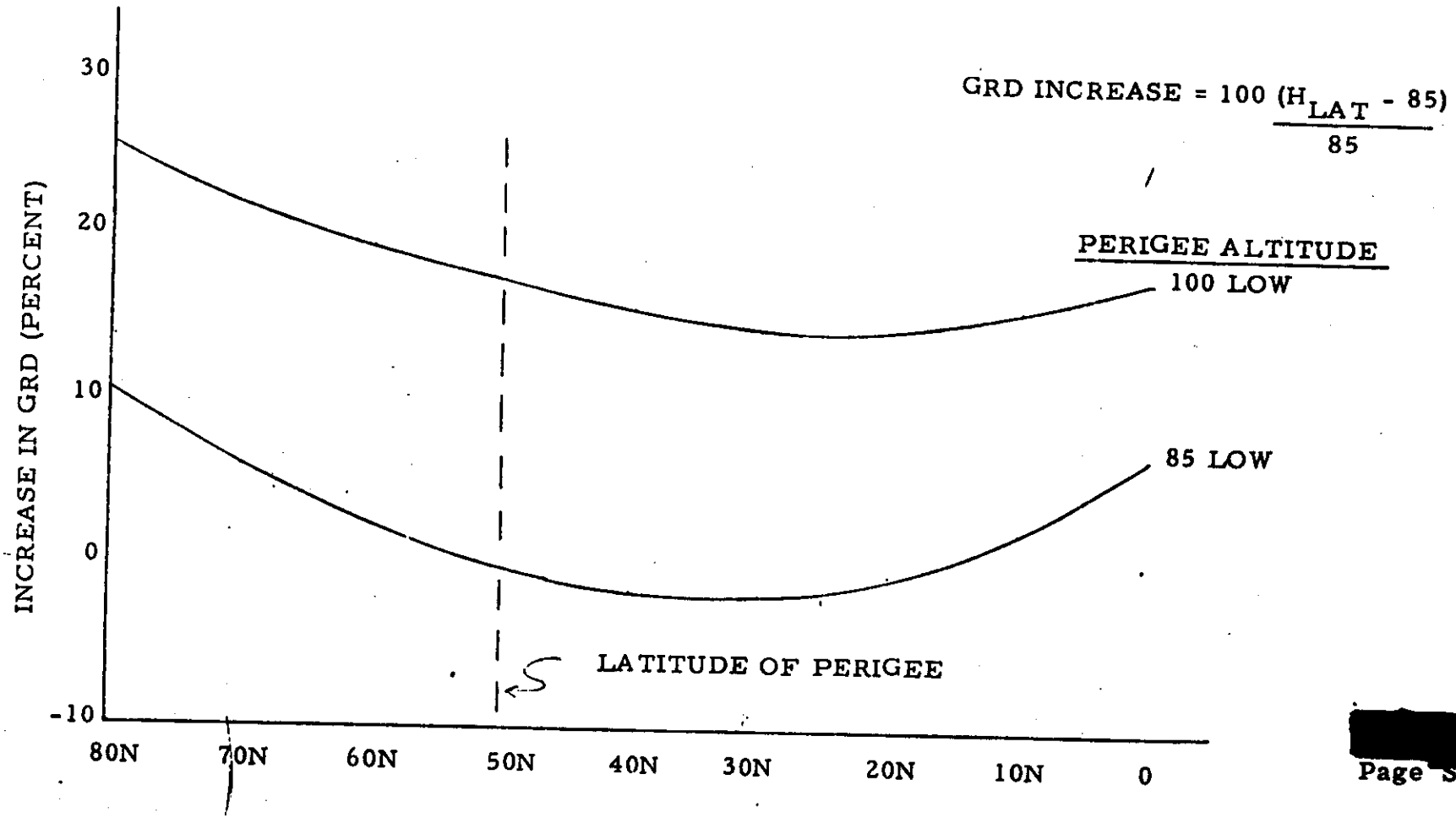


FIGURE 3

ALTITUDE VS. LATITUDE

(KH-4)

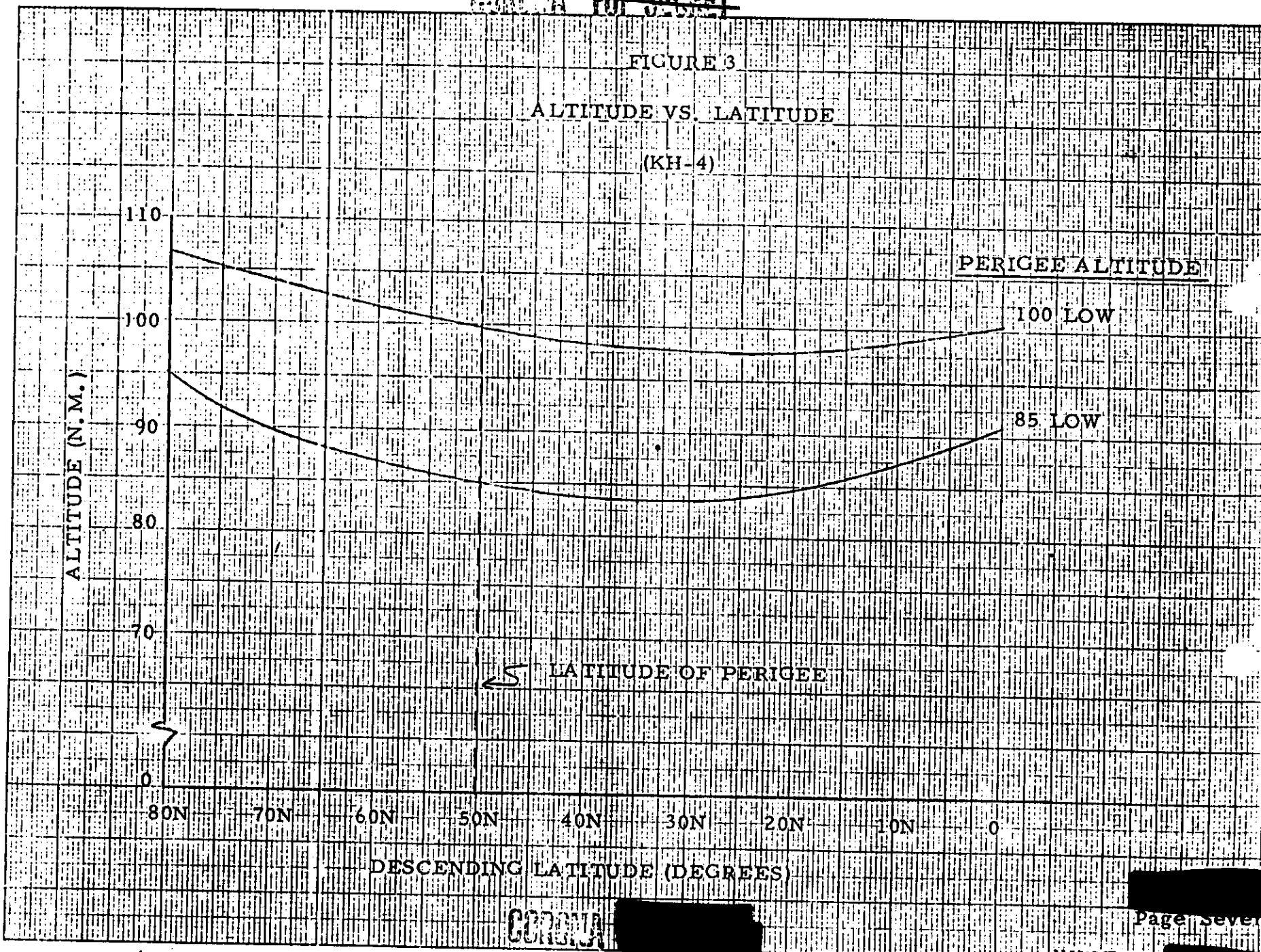
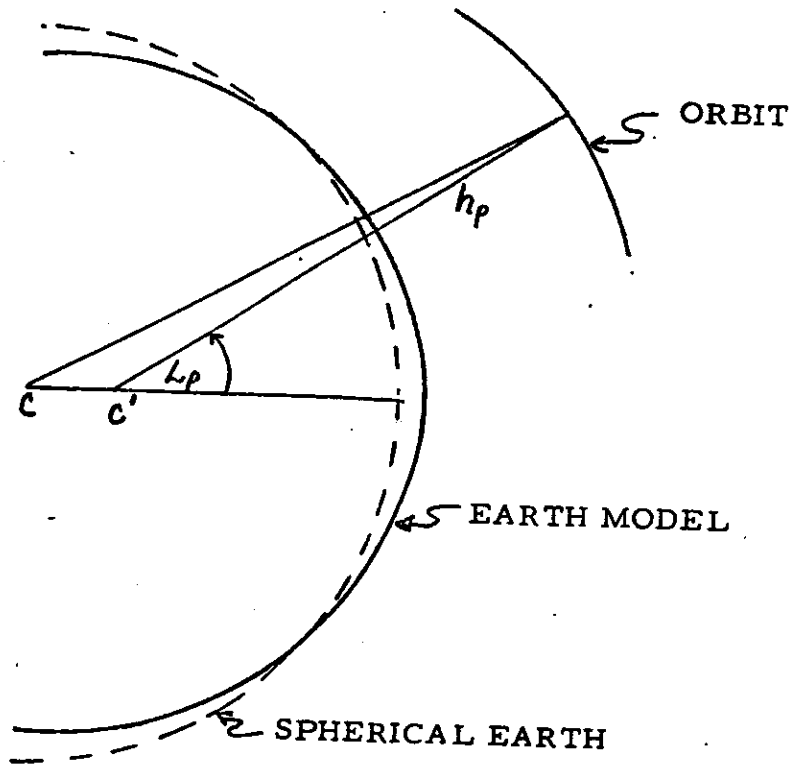


FIGURE 4

ORBITAL GEOMETRY



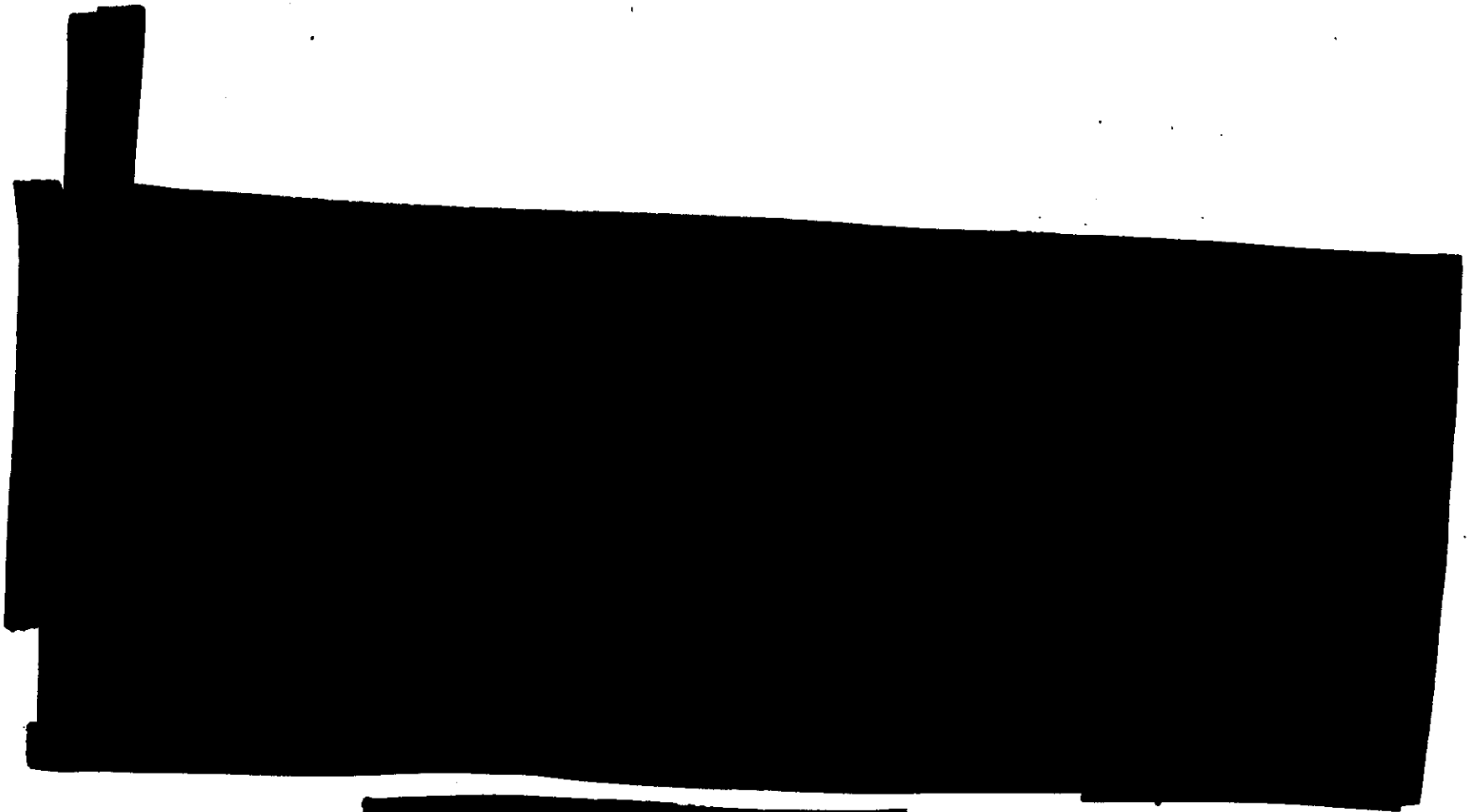
C Center of Spherical Earth
C' Center of Earth (Geodetic)
L_p Latitude of Perigee
h_p Altitude of Perigee

FIGURE 5

[redacted]

FIGURE 6

[redacted]



[redacted]

TABLE 1

ORBITAL DESCRIPTIONS

	KH-4		[redacted]
	85 n.m.	100 n.m.	
Perigee Altitude	85 n.m.	100 n.m.	[redacted]
Perigee Latitude	50 Degrees North	50 Degrees North	
Apogee Altitude	150 n.m.	135 n.m.	
Inclination	80 Degrees	80 Degrees	
Synchronous Period	7.5 Days	7.5 Days	
Orbital Period	88.63 Minutes	88.63 Minutes	
Simulated Launch	WTR	WTR	[redacted]
Comments	LOW Period	LOW Period	[redacted]
Complete Coverage In Sync Period	46.5 Degrees North	37.0 Degrees North	[redacted]