SPECULAR REFLECTANCE

and

FRONT LIGHTING

HEXAGON 1208-3

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Specular Reflections and Front Lighting on HEXAGON 1208-3

Introduction

Specular reflections and front lighting (SR/FL) occur in the Northern Hemisphere during HEXAGON summer missions. Because of the wide scan range and high inclination orbit, the possibility of SR/FL is present when the geometry of the vehicle, target, and sun is proper. However, by carefully selecting the orbit, the effects of SR/FL can be minimized. PFA evaluation of 1208-3 indicate that a certain amount of the imagery is degraded by SR/FL.

Specular Reflection/Target Lighting

The evaluation of HEXAGON 1206 indicated that SR/FL was a problem, especially in the early part of the flight. The main problem was that SR/FL occurred at nadir thus compounding the effect since a target so located would be doubly degraded. The nature of the target determines if specular reflections will be present. Specular reflections are generally associated with water though any highly reflective surface will produce specular reflections. Front lighting is essentially independent of the target; solution is to choose an orbit which places SR/FL out in scan so that no target suffers from both effects.

High sun angles are also undesirable. Photographs taken at high sun angles have small shadows causing difficulty in mensuration. Sun angles are a function of the latitude, orbit, launch time, and time of year. Again, the effect of high sun can be minimized by proper orbit selection.

NPIC Preferences

Based upon meetings held at the SOC with representatives of NPIC, [redacted] and data contained in a report by R. Kohler, two basic photo interpreter preferences were stated. First, the optimum sun angle for mensuration is 45 degrees with a desired range between 30 to 70 degrees. Second, it is desired that SR/FL not occur so as to be located at the same point on the ground in both the forward and aft cameras.

Weather Support

The HEXAGON program receives the support of a complex weather forecasting system. The system employs satellites which observe the area of interest. The timing of the weather satellites determine the optimum weather forecast for HEXAGON. To reduce the time between observation, forecast, and HEXAGON operation, the weather satellites are in daylight ascending orbits. The optimum delta nodal time between the weather satellite and HEXAGON is four hours. Since the present weather satellite has a nodal crossing time of 0830 local time, HEXAGON should cross the equator at 1230 local time. If the time difference is shortened, the data from the MetSat may not be in the data base to support the forecast. If the difference is lengthened, forecasts become less accurate.

Selection of the 1208 orbit.

Three main candidate orbits were considered for 1208. One was 1100 PST (1900 GMT) sun synchronous, the second 1230 PST (2030 GMT) sun synchronous, and the third 1230 PST non-sunsynchronous. The first was eliminated because it suffered from poor weather support throughout the entire mission. The second was eliminated because it produced high sun angles. The third was selected because it gave the best mix of trade-offs between SR/FL, high sun angles and weather support. Specifically, weather support was optimum for the first portion of the mission. As the sun subpoint moved north, the mission moved earlier in the day thus reducing the high sun problem as the flight progressed. And finally, during the course of the mission, the SR/FL moved out in scan and to separate locations.

1208 Launch Delay

The selected orbit was based upon a launch date of 13 March 1974. The launch was delayed until 10 April 1974. Since solar conditions are rapidly changing at this time of year, by the time lift off occurred, the benefits of the selected orbit had been diminished. The main effect was that the maximum sun angle the mission would encounter had increased by five degrees.

SR/FL and Sun Angles through 1208-3

As had been expected and planned, prior to launch, the effects of SR/FL have increased during the course of the mission. The specular reflection and front lighting locations have separated and do not occur at the same points on the ground. This had been a prime desire of NPIC. While a significant number of frames are effected by SR/FL, the actual amount of film affected is as low as can be accomplished by selection of orbits. A further reduction can be accomplished by operational changes such as deletion of ops. The accompanying table lists the portion of product affected by number of frames and number of feet degraded. The number of feet degraded is a worst case. This is because speculars were counted on the basis of geometry only and not on the nature of the target. In addition, that portion of the scan which fell between -10 to -20 and =10 to =20 was considered degraded. It would appear that the more realistic measurand of the quantity of degraded photography would be feet of film rather than number of frames.

Conclusions

HEXAGON Mission 1208 is performing exactly as expected in relation to solar geometry. The delay in launch did result in higher solar elevations and cause the SR/FL to move northward with respect to system time. A more accurate reporting measurand is feet of film degraded rather than number of frames degraded.

ESTIMATE OF SR/FL DEGRADATION ON 1208-3

Ops	Total Frames	SR/FL Frames	Percent	Total Film	SR/FL Film	Percent
375-399 (24)	1102	624	56.6	5904.27	841.81	14.3
400-421 (21)	767	286	37.3	4615.40	457.38	9.9
422-445 (23)	932	479	51.4	5724.77	985.42	17.2
TOTAL	2801	1389	49.6	16,244.44	2284.62	14.1