DRAFT
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5-25-60

CLASSIFICATION

TO: Colonel A. Smith

FROM: Y. H. Katz

SUBJECT: SOME CONSIDERATIONS OF THE WEATHER FACTOR IN THE SAMOS PROGRAM

Given sufficient illumination, the number of satellite days required to obtain 95% photographic cover of any given area is a function of:

1) The number of satellite passes made over an area during a given period of time (itself a function of orbital inclination) and

2) The cloudiness on successive passes over the area.

These factors are related in this fashion: If we let n = the number of successive cloud cover observation values, C_1, C_2, C_3 ...C_n, (coinciding with successive Satellite passage times) that yield a product value of 0.05, and if N = the number of passes per day over the area (a function of latitude for a given orbital inclination), then the number of satellite days so required to get 95% cover is:

$$SD = \frac{n}{N} \quad \text{- - - - - - - - - - - - - - - - - - -} \quad (1)$$

(1) assumes that the areal placement of cloud cover is an independent variable -- that is, cloud cover is distributed in random fashion over any given area, so that probability theory can be applied to determine the number of "looks" needed to provide a given % photocover. The above assumption is good in the general case, but in specific areas and for certain seasons of the year, the assumption is invalid, owing to

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topographical and orographical influences. Examples of this situation can be found in the persistent areally placed cloud cover on the windward sides of mountain ranges, land-water interfaces, etc.

For planning purposes, a rough estimate of the <u>average</u> number of satellite days required to provide 95% cover for a given area must incorporate the historically observed cloud-cover data for that area. For most of Europe and Asia, a 5-year period of data is sufficient to draw reasonable estimates.

As of this date, little work along this line has been done. However, studies utilizing <u>mean monthly cloud cover data</u> do allow some estimates to be made. The use of mean monthly cloud data in equation (1) assumes that the individual daily and hourly cloud cover values making up the mean value are the same. This assumption yields estimates which are not readily amenable to error analysis. To illustrate this point, a mean value of 0.50 may well arise from two individual observations of clear (0.00) and overcast (1.00). Probability theory tells us that 4.3 passes would be necessary to get 95% photo cover, yet it can be seen that either 1 or 2 passes will actually give 100% cover.

In view of the lack of more meaningful data at this time, and with this deficiency in mind, mean cloud cover values must be substituted in equation (1), as follows:

Mean monthly % cloud cover ($\bar{C}$)	10	20	30	40	50	60	70	80	85
Mean # of passes/ area to give 95% cover	1.3	1.4	2.5	3.3	4.3	5.9	8.4	13.4	18.4

The following table is a derivative of mean monthly cloud data and frequency of satellite passes for specific target areas, from two orbital inclinations, two mid-season months and for varying photo widths (where the case for computing frequency of passes is based on a 300-mile width). For the most part it is based on 5 years of recent meteorological observations and ~~[illegible]~~/does not incorporate degradation effects owing to darkness. The reason for this stems from arbitrary launch times of day and date of month. If we weee to optimize launchings in January, then all January values in the table should be multiplied by a factor of 2. Optimum launch dates in July will require no factoring of the tabular values.

Memo

Number of Satellite Days for coverage probability of 0.95 for fixed (17 mile wide)
and trainable (75, 100, 200 & 300 mile wide swath) cameras for specific locations,
for a winter month (Jan) and a summer month (July) for
4. orbital inclinations of 83° & 70° (without illumination degradation effects) and given 15¼ rev/day

[redacted]

License is taken in including values for 31-day months. The need for multiple satellites indicated by these values if needed/coverage is to be had. Too, the short period of available illumination in northern areas, coupled with the number of days required to obtain cover indicates that sufficient information cannot be obtained in many areas over a relatively short period of time.

The tabular data should be used in a comparative sense only. They cannot be viewed as being either optimistic or pessimistic. In terms of cloud data input to the calculations, much needs to be resolved. For example:

(1) How good are darkness-obtained cloud observations?

(2) What is the relationship of ground-observed cloud cover to satellite observed cover? My feeling is that most observations with cloud cover greater than 50% at heights less than 2-3,000 feet above the ground will yield satellite-observed cloud cover that is somewhat less. A program to correlate ground observed and satellite observed cloud cover based on the TIROS program may help to establish the necessary relationships with regard to cloud type, amount, and height as seen from the ground.

Reliable estimates of time required to obtain cover will require a more sophisticated approach to the use of presently available climatological data. The first step here would be to simulate what the satellite would actually see based on individual cloud observations rather than grouped values by time-of-day and by season. Programming a computer program for this effort should not be too difficult a task.

Investigations into the persistencies of good weather may also yield valuable planning information for optimizing satellite scheduling times and dates.

At the present time our forecast capability (even short-range) over much of the USSR and China leaves much to be desired. A vigorous program of research to develop forecasting tools as applied to reconnaissance requirements may yield large payoffs in such plans as will demand "on-off" operations, as well as short-term operations where a "veto" to "go-nogo" can be effective.

Above all else, meteorological [illegible] considerations must be employed early in all planning, otherwise flexibility in planning and operations is lost and weather data pumped in as an afterthought becomes meaningless, and oftentimes misleading. A good example of this can be found in the <u>Supplement to WSEG Report No. 39</u>.

Attachment 1

* Obviously, these and other high satellite-day numbers are meaningless with reference to single month-single vehicle operations. Furthermore, time-spacing multiple vehicles on the same (or different orbits) does not necessarily reduce the number of days required, since there are optimum launch times and dates within each month that correspond to maximum numbers of passes over the targets in daylight.

It is more than distinctly possible to develop short-range weather forecasting capabilities that will, with a high degree of confidence allow the picking of launch dates several days in advance, so as to get complete or nearly complete photo cover on a single pass. Application of this capability to "turn on-turn off" operations of satellites already in orbit at the time might also be considered. In other words, we must take full advantage of the little good weather that is available.

To illustrate the point further, the following table indicates the % frequency of occurrence of .. 3/10 cloud cover over the northern half of the Kola Peninsula, which is a heavily clouded-over region (e.g., July mean cloudiness ~ 80%.)

[redacted]