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REQUIREMENTS FOR SATELLITE ELINT RECONNAISSANCE

by

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INTRODUCTION

This is written hurriedly on a March 1962 weekend by the author to fill a particular need. It is strongly believed that some clear, valid, written requirements should be delineated at this time before too many more hundred million dollars are expended. The author does not consider himself any paragon of authority on the subject. He is, however, a consumer of ELINT and has been for many years. He is one of the prime National users of ELINT in producing finished intelligence. As such, he ought to be gently heard as to what may be needed. The author is neither a hardware-monger or representative of any commercial interest involved in the program. He is not a processor of intercept data alone, either, although his office for years has been intimately involved in processing and collecting of ELINT from many platforms and techniques. ELINT is not a sole means of collection, it is only one of our many sources employed in our end product. Due to politics, it seems to take an inordinate amount of administrative energy, however, from our end task. This is written in part to make our own job easier as producer of intelligence on foreign electronics development.

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GENERAL AIMS OF SATELLITE ELINT

1. Obtain Information on New Equipments

The most urgent requirement is to search for vital new-purpose equipment over the Sino-Soviet complex. Today the most urgent requirement undoubtedly is to determine the parameters of the ABM or/and space-associated family of radars near Lake Balkash in the heart of the USSR. There are undoubtedly other areas of either current or future concern. Interesting new installations are in construction in the Leningrad area, in the Arctic, in Kamchatca, which undoubtedly involve electronics. Other than "TOKEN" and probable [redacted] we know virtually nothing about any radar in use on many missile ranges and involved in the Soviet space program. We know nothing specifically involving radar on the Chinese missile ranges. Our coverage of research and development establishments in Moscow is limited to a splendid but limited effort of project [redacted] We see many interesting devices in the Moscow area from time-to-time. For example, what are the parameters of the most interesting [redacted] device seen at Odintsovo as early as 1958, a 50-foot paraboloid? Other centers of development (where there should be developmental equipment of interest which should radiate before reaching the field) are Novosibirsk, Krasnoyarsk, Leningrad, Gorkyy, Serpukhov, and Saratov. For ECM planning it is best to get warning as soon as an equipment reaches testing stage. To attack the developmental radar appearance problem requires long-time surveillance.

If there is one thing that past ELINT has taught us historically (from General Martini's Zeppelin in the Irish Sea through Harold Jordan's success after hundreds of failures to get the German AI, to the present day) it is that: A SINGLE MISSION WITH NEGATIVE RESULTS IS COMPLETELY OR NEARLY WORTHLESS. YOU MUST TRY, TRY, AGAIN AND AGAIN! I cannot stress this point enough.

Other than the areas, and long time-frame of search required, one other factor must be stressed. We vitally need to know PROMPTLY when the Soviets begin to occupy new portions of the electromagnetic spectrum at very-high frequencies and above with transmitters of high power. Any new band of usage, with high power in particular, is to the Soviets a new division in their Army of electronic warfare. This is particularly true at frequencies higher than about 1000 Mcs where it is so difficult to make critical components work over any significant band-width. Knowledge of Soviet occupancy of any new and previously unused part of the spectrum is a continuing and urgent intelligence requirement.

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2. Obtain Data on Radar Order of Battle

We need timely and current information further on previously-known equipments. This requirement differs from the above in that the parameters of the equipment are generally rather well known. We do need coverage of areas technically inaccessible by any other sensor due to physical, political or safety restrictions. Today this includes the greater part of the Soviet heartland, the Arctic, the soft under-belly, and the western reaches of China.

The types of Sino-Soviet equipment upon which we need data most urgently are their most significant defense and weapon-control radars. These include those that give the longest range (such as [redacted] at present), those that cover targets at highest altitude, and those that measure altitude most accurately (the nodders followed by the [redacted]. Of the weapons systems currently deployed in operation, the surface-to-air missile systems GB would appear most urgent.

It seems unreasonable to ask a satellite system to locate targets more accurately than current peripheral ELINT does, or to measure any of the technical parameters more accurately. In the opinion of the author, which is shared widely in NSA and AF, FTD, current quality of our terrestrial collection from a technical viewpoint has many deficiencies which require improvement such as r-f accuracy, beam patterns, power measurements, pulse interval accuracy and stability measurements. It is unreasonable to expect an unmanned satellite to do technically what our ferrets and submarines and Project [redacted] is not doing.

3. Other Requirements

I know the national lists and formal ELINT briefings make much of many factors such a providing "indications of hostile action", "strategic EW", etc. Honestly, ELINT can not be sold on this basis today, although it has been thus peddled. I do believe the satellite, if the system is simple, and readily interpretable at ground sites by ordinary operators of average ELINT training, due to its wide "gross" look can help on this score. (An example, of course, is GRAB II's initial intercept of [redacted] showing naval manuevers in the Norwegian Sea.) Data can and should be collected on activity versus times of day and days of week to give some clue to alertness of Soviet defenses, etc. In general all these things are bonuses or long-term goals of the ELINT program. They should not be stressed over and above 1 and 2, despite what any NATIONAL ELINT REQUIREMENTS or any other paper may glibly state in its glorious generalities.

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SPECIFIC REQUIREMENTS IN ACCOMPLISHING THESE AIMS

1. Frequency Coverage

The radio-frequency of an electronic equipment is its "ID Card". Nothing else is as important. What sort of coverage do we desire? In the long run we want coverage from the maximum-useable-frequency in the HF band (from 10 - 50 Mcs) up to millimeter waves (current needs beyond 40 Gc/s appear unnecessary). Naturally, there are practical limits further. Also there are varying priorities within these limits.

At the upper end of the spectrum atmospheric absorption (water vapor, CO_2 etc.) severely limits the frequencies necessary to probe. Further down (in the upper portion of the microwave region) C- to X-band, radars and other devices at present are more often used for shorter range detection purposes and on mobile platforms. HOWEVER (and this should be stressed) there is a definite trend in the U. S. to higher and higher frequencies for even long range work. And let us not forget that for over a decade we have been using in our own defenses important X-band height-finders. Although Soviet practice at present limits satellite utility at these frequencies, any agressive broad-band search should certainly include the higher frequencies in its ultimate program.

At 50 - 70 Mcs and below it would appear that long range technical search from land sites, particularly when the sunspot cycle finally changes around again in five years or so would be more attractive means of attacking the problem. Experiences with other means of long range propagation at the lower band TV frequencies indicates great hopes as well as amateur experience. It is unfortunate that only [redacted] of the free world intelligence groups has really done anything from long range in these bands.

In summary the priority of coverage at present would appear to be about as follows (with view to Sino-Soviet frequency usage and the general requirements delineated above):

a. 72 - 5100 Mcs, especially 100 - 4000 Mcs

b. 5100 - 9500 Mcs

c. Above 9500 Mcs at atmospheric windows only and where there may be evidence of suitable Soviet component work.

d. From the UHF to 72 mcs. [redacted]

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One other point is worth stressing. The spectrum should be covered as rapidly as possible. Also, in keeping with the prior warning-continuity is required over a significant time period.

2. Frequency Resolution

For the second general aim, radar OB, we generally need resolution only to about 20%. The fact is we know the r-f quite accurately on familiar equipment involved (although not accurately enough, a horrible deficiency of terrestial collection which we should not solve in a satellite first) already. The main problem is to separate and locate signals in bands where large numbers of radars exist. We know now that this can be done in our worse case S-band.

For the first general aim initially we need wide-band coverage at the expense of resolution. If we find a new frequency band in Sino Soviet use, or a new equipment on the first few intercepts we would be most happy to have 10% resolution. Eventually, we would like to narrow it down (assuming we cannot reach the target by any other means) to accuracy in the order of 1%. Also we would like to see if such new equipments or any old equipments have the ability to jum or move in frequency. This is a most important current and future requirement - neglected all to often today by our other collectors.

3. Non-Ambiguity in Frequency Region

I am capitalizing this factor, because it has never clearly been appreciated by our collectors or equipment designers. On this, more than any single failure, does much ELINT become simply worthless. Unless it is a most simple ROB problem, if we are not SURE, and I mean really SURE of the frequency-even within broad limits defined above - the data is worthless. Frequency ambiguity in conventional ELINT is produced by images, local oscillator spurious responses to harmonics, etc., intermediate frequency break-through, and general break-through receiver selectivity. Most receivers have inadequate selectivity (particularly the sensitive superhetrodyne) to reject sufficiently all off-frequency or even-off-band emissions. A skilled operator, if he has the time, can remove some of this ambiguity, but in the satellite (VET) we have no operator nor certainly the time to do such validity-of-signal checks. With detector-video systems often filtering is inadquate to give more than a minimal moniel protection (against L-band signals crashing through to an S-band crystal for example). In automatic unattended systems which are sequentially switched we have had trouble with the switching and connection ambiguity repeatedly. With TWT preamplifiers we have overloaded them so they become non-linear generators of spurious

signals themselves. Whatever system is developed IF IT IS UP THERE UNATTENDED WE MUST KNOW AND REALLY KNOW that the signal is in a given band AND BEYOND ALL DOUBT NOTHING ELSE. Otherwise the data is far worse than no data, it wastes precious analysis time, and may give vitally wrong answers.

4. Pulse Repetition Rate or Interval

The accuracy here in our opinion is required to be reasonably high, except for routine ROB data where signal density is very low. In such low density cases accuracy as poor as 2 or 3 percent might be tolerated. For the really useful search tool we would like to see accuracy (at least short-term accuracy, not necessarily absolute) in the order of one part in 1000 achieved. On an initial intercept in a new band much less accuracy may be permitted initially, as long as identification is certain.

5. Antenna Scan Rate or Interval

Beyond frequency and prf this parameter, by all odds, is the best means of distinguishing signals (and with microwave signals is often the best means). About 5 milliseconds at present seems to be a suitable figure, which on an average sort of radar again gives a comparative accuracy of at least one part in 1000. On the first signal of a type again less accuracy is needed.

6. Irregularities in Pulsing

Next to the above in any pulsed signals this is most important. We need to know if the beam nutates (i.e., conical or spiral scan) and the rate. Pulsed f-m and a-m should at least be recognized if possible. Skipped or omitted pulses should certainly be detectable and recognizable. The pulsed f-m should be detectable if the more rigorous standards of paragraph 4 are achieved. Nutation or beam displacement should be possible of recognition and at least gross measurement. Although other types of pulse modulation, are of interest they may well be placed in the categories of things "nice to know".

7. "Nice to Know" Parameters

The following things would be very nice additional technical data to measure with comments as appropriate:

a. Indication of power level

This is probably the most important. Since we have never had a really reliable such measurement from terrestial ELINT,

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although notable efforts have been made by CIA, it seems a little unjust to require it of a satellite. Also any such data is so much a function of many things, especially antenna beam pattern, which we seldom know well.

b. Measurement of beam-width or antenna lobe structure

From conventional ELINT we have measured horizontal beam-width with success a fair fraction of the time. Although notable efforts have been made in efforts to measure vertical beam structure and side lobes by FTD (Air Force) and CIA, results have been a little uncertain. Therefore, it is considered reasonable to desire the satellite to give data on beam structure in the horizontal plane to about 2:1 accuracy, (100%), a rather coarse requirement, but useful.

c. Polarization of beam or change therein

Although this is sometimes measured with significant success in terrestial ELINT, and is useful at times, it would appear to drop into the categories of esteric parameters that would be "nice to do" in a few cases.

d. Pulse width

Fat less important, although so often stressed, is pulse duration. The author has found it useful in relatively lower percentages of critical cases than any of the above factors. In case any pulse-width variations which might have significance occur, of course it might be important (but the author knows of no radar system yet in the Sino-Soviet bloc, other than possibly IFF where this was a factor, then only on a very gross scale). [redacted] provided they are dependable.

e. Location of Equipment

This is a critical factor. Like so many of the above factors, the accuracy criterion varies completely with the specific problem. For example, on new equipments, the vital new equipments, it would initially suffice to confirm its existence and verify that it is SOVIET. The latter verification implies a certain gross location depending upon precise geography and/or a very precise knowledge of friendly equipment. After this determination it might suffice to locate radar to within 300 nm. [redacted]

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With radar order of battle on familiar equipments in the interior it would seem desirable to seek a goal of about 50 nm on the more important radars.

9. Modulation other than pulse

Virtually all of the above is written with only consideration of pulsing equipment. Thus far, as Sino-Soviet radar is concerned this has sufficed. It probably will not indefinitely. It should be added that we are not doing very well on this requirement from terrestial ELINT. Basically the most urgent requirement in the immediate future seems to be the cw system. Our own HAWK and other systems use such techniques, and there is some current concern about at least a small part of the Soviet SAM situation. The latest radar on the [redacted] in the Soviet Navy for SAM work resembles a cw array greatly. It would appear that cw is a greater threat at frequencies above 1000 Mcs. This requirement is exclusive of any communications systems. CW should be done after complete pulse search is accomplished however.

10. Satellite Must Not Generate Its Own Noise Artifacts

Another plague of ELINT and acoustic intercept efforts today is the self-generated noise energy from the collection vehicle that subsequently looks just like a valid signal. Sometimes an alert operator, given the time, can track signal down to an ice cream freezer or another electrical or mechanical device. But in the satellite we have neither time nor the operator (yet). This is an argument for a minimum of complexity, switches, rotating devices, etc., within the satellite. Furthermore, the analysis personnel should be subsequently intimately familiar or have immediate access to those familiar with the every detail of the satellite to interpret odd occurences. Ninety-nine percent of our "odd ball" signals prove to be due to either this or to the defect outlined in paragraph 3. It seems possible this might be true in complex satellites. And no operator is available to debrief.

11. Reliability

This is paramount. Although this does not of necessity require simplicity it certainly does suggest as few frills as possible.

12. Must Give Valid Data Against Friendly Radars

Unless a system gives also valid data against "benchmarks" we are likely to suspect data in all other areas. The data must

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not only be recognizeable; it must be consistent and repeatable.

A concomitant of this which plagues our peripheral terrestial reconnaissance is a completely inadequate knowledge of full radiation parameters and location of friendly equipments around the Sino-Soviet bloc. Although some work is being done, its urgency in support for many long-range ELINT programs must be recognized.

13. Security of System

We appropriately use this paragraph number for this item. We must not let the Soviets know what we are doing, even indirectly or by implication. We wish to see an environment in its normal state not effected by the collector itself. If we want a troubled state measurement, let something else create the change in environment, but let our collector remain dark or inferative to the enemy.

14. Data Timeliness

We would prefer data to be collected in real time. If not, as soon as possible should be the goal. The processing should not involve undue delays.

15. Make system Compatible with Consumer's Desires

Our targets are primarily military systems. It would seem paramount that developments should at least broadly reflect the desires of the service intelligence agencies and/or DIA. If possible, a qualified technical consumer should be in on the planning of the device.

16. Make System Compatible With Processor

Under current arrangements NSA is charged with the greatest ELINT processing function. Certainly, again, a qualified technical person from that agency should at least be consulted in any planning. Virtually all of our experience in processing, and thus far all our success, has involved analogue collectors. It would be reactionary to reject digital collection and read-out, but until confidence and competence can be developed with such techniques it is recommended that all systems have at least analogue back-up if possible.

17. Negative data Can be Important

Presuming the negative is truly valid, it may be more important than positive results. This is a fact not truly appreciated at the top level in governme

13. Continuity and Persistency of Effort

The negative can only be valid if reliable, trustworthy data has been collected over a long time period. We repeat that history shows us that only persistence pays.

The need for surveillance is so constant and the ELINT requirements so steadily increasing and changing that we need long life satellite collectors or a steady stream of short life vehicles or possibly a combination of the two.

POSTLOGUE

The author has a very serious suggestion. For the more esoteric collection with complicated receivers and collection systems, it is strongly recommended that the project MERCURY type project be expanded to include a satellite cruising astronaut (and preferably ELINT trained) at the controls of an equipment equivalent to current ferret collection devices. The human being as a device to do things intelligently is still not out of vogue, as [redacted] demonstrated so vividly.

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