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[redacted] Comments on Syracuse University Research Corporation - Report on Impact of Exotic Radars on ASD-1 and Project 102 Data Processing from an Intelligence Viewpoint

It has been the philosophy of this office that it is unreasonable to demand of a satellite collection system at this time identification of systems that terrestial intercept systems do not currently accomplish. The first priority should be to cover the spectrum, both known to be in Sino-Soviet use and those frequencies thus far unused. In every collector so far we have intercepted new systems. It is true that it will not be possible to identify each of the variants under development in the U. S. by our current system IF the modified Soviet radar has the same prf, rough rf, and scan rate of conventional models. However, this assumption is by no means certain.

Prior to this time NO peripheral or other collection system has thus far identified any pulse-to-pulse frequency-jumping Soviet radars. As far as is known none are in actual operational use. When they are being developed ., best means of initial intercept and recognition at this time will be by the Army-sponsored operation PORTRAY. It is of interest to note that the first intercepts on frequency "shifting" not PP jumping (never seen yet) from a Soviet radar [redacted] were from PORTRAY and apparently quite early in the development process as verified from subsequent intelligence. The next verification from "operationally deployed" radars were from the Swedish land-based intercept operations in the Baltic.

We agree that future Soviet systems are likely to incorporate more of the [redacted] type frequency shifts. Whether or not they will operationally employ any of the more sophisticated systems described herein immediately or soon is debatable. In general, it is many years before such systems reach the field from laboratory stage, and few of the many reach operational stages. We think the best equipment for the checking of these most sophisticated PP techniques et al, should be turned over to PORTRAY, the Swedes and similar type collection operations. The satellites should concentrate first on known shift techniques to be used by the Soviets such as employed in the S-band [redacted]. As far as is known no satellite has ever intercepted a [redacted] thus far.

It is interesting to note that the Soviets were very early in providing ordinary frequency shift in their radars. There has been no increase in such usage over the last two years, interestingly enough. Such critical radars as the [redacted] radar have not been observed shifting r-f's.

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On the other hand, Soviet occupancy of new microwave radar frequency bands has been demonstratedly alarming. It is against this demonstrated threat that we wish to protect the nation first; only subsequently to be followed by the checking of the jumping, etc., techniques. We must work first against the most likely threats.

It is strongly recommended that any systems demonstratingly effective against "exotic" techniques be first considered for terrestial employment in operations such as PORTRAY, Sweden, Finland or the like. It is patently unfair to ask a satellite system to analyze, identify and process signals of a type more sophisticated than any of our intercept systems currently can achieve in and around the Soviet Union on ground, sea and conventional aircraft. Furthermore, the USSR traditionally has shown a penchant for reasonably uncomplicated approaches to their radar equipment in contrast to the U. S.

Meanwhile, we trust that NRL will study means of improving frequency resolution etc., eventually in our collection system AFTER WE HAVE COVERED THE SPECTRUM ENTIRELY for these signals as well as more conventional radars, which are more probable in our opinion.

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Brief Comments by Mr. Lorenzen

Coherent Carrier

1. Would hear it. Detect signal but we do not have the stability overall to determine Coherent Carrier.

2. Frequency Jump: Will receive the system unless the jump is outside our wide-band system which is not likely. Probably the best system for detecting the signal initially. Indications of frequency jumping is not likely. Fairly simple modification of the system would provide data on the frequency jumping.

3. Modulation-on-Pulse: Would not indicate the modulations on the pulse (Chirp). It would detect the system and probably would be the simplest and best for this type signal.

4. Modulated Pulse Repetition Frequency: The system will give indications of Modulated Pulse Repetition Frequency. Very effective on this type system.

5. Multi-Beam: If the system is rotating the system will detect this type Radar. If it is off-set in frequency we would detect the system if it is in our pass band.

6. Scan Agility: If all pulses are at a given rep-rate then indications of the scan pattern will be present.

7. Multi-Static: We will be as well off as any other system to detect this radar. If two transmitters are used we should be able to resolve this and if spacing is sufficient we could position fix with the [redacted] system.

8. Ionospheric Propagation: Most of these systems are in the HF band, if they were in the UHF and higher we would detect them.

9. Noise Modulation: We would detect any reasonable amount of PRF modulation in any system in our band.

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INTRODUCTION

This is the final report on Contract AF 30(602)-2293, "Advanced ELINT Data Processing Study." The purpose of this study was to predict the ELINT data-processing problems which will arise in the 1965-1970 time period because of unusual radar signals and to suggest solutions to these problems.

This report invokes much detail which has been reported in technical memoranda prepared during the course of the study, and utilizes "probability of coincidence" formulas derived in Syracuse University Research Corporation Technical Report No. 9, also prepared during the course of the study. These supporting documents are listed in the Bibliography.

The AN/ASD-1 and Project 102 systems were singled out for specific consideration because these are the two most advanced ELINT systems scheduled for use in the 1965-1970 period. Other systems no doubt will also be in use: the ALD-4 will probably still be gathering information at that time, and it is probable that some systems using analog and mixed-base receiver techniques, as in Pirate III, will appear in an operational form

The exotic or advanced types of radar systems are divided for consideration in this report into nine types, as outlined below

1. Coherent Carrier (CC): A term applied to a radar set, either pulsed, CW, or CW/FM, in which functional importance is attached to the short-term phase or frequency stability of the transmitted signal. The pulsed CC radar exhibits a high degree of pulse-to-pulse frequency or phase stability.
2. Frequency Jump (FJ): A term applied to the pulse-radar technique in which the transmitted frequency is deliberately changed from pulse to pulse or from pulse group to pulse group in either a programmed or random fashion.
3. Modulation-on-Pulse (MOP): A term applied to the pulse-radar technique in which the radio-frequency carrier is frequency or phase modulated during the pulse, either in discrete or continuous

fashion; also referred to as "coded-pulse," pulse compression, or intrapulse modulation.

4. Modulated Pulse Repetition Frequency (MPRF): A term applied to the pulse-radar technique in which the interpulse interval (pulse repetition frequency) is intentionally modulated in some manner.

5. Multi-Beam (MB): A term applied to radar systems in which two or more beams are simultaneously radiated. Beams may be distinct in position, frequency, or both.

6. Scan Agility (SA): A term applied to a radar in which the beam or beams can be shifted rather freely, without the conventional mechanical constraint, in direction in any desired manner from pulse to pulse or from pulse group to pulse group.

7. Multi-Static (MS): A term applied to a radar system which has associated transmitters and/or receivers displaced physically from each other by a large distance relative to the range resolution capability of the system, and which makes some functional use of this long "baseline."

8. Ionospheric Propagation (IP): A term applied to a radar system which employs the properties of the ionosphere to detect the back-scattered energy from the target itself, from a "scar" left by a target passage through the ionosphere, or from target exhaust gases.

9. Noise Modulation (NM): A term applied to a radar system which emits a signal with pseudo-random modulation characteristics.

These radar techniques and reasons for their use are described in the first two references in the Bibliography. A concise tabulation of parameters of all known advanced radars using these techniques under development by the U. S. or its allies is found in Reference 3.

In this report, attention is focused on the frequency-jump (FJ) and scan-agility (SA) radars. There is evidence that signals from these types will be found in the unfriendly signal environment since, if the Soviets do not turn to the

FJ technique for anti-jam reasons, they are likely to turn to it or to phased array techniques to obtain scan agility. Signals from these radar types present special problems (as described in this report) to Project 102 and the ASD-1; but, if the problems are recognized, ground-based data-processing techniques can nevertheless provide for recovery of a large amount of information concerning such systems.

This report is organized in the following manner: Part I, the Summary, presents briefly the results obtained in the study of the response of the ASD-1 and Project 102 receiving systems to exotic radar signals, describes data processing techniques to detect and analyze unusual radars, and lists problems which require further study. Following the Summary, Parts II and III of the report treat in detail the ASD-1 and Project 102 F-2, respectively, in relation to advanced type radar signals. Much of the detail of these sections is summarized in Figures 13, 14, 15, 16, and 18 (Part II) and 32, 33, and 34 (Part III). The reader interested in pursuing the basis for statements made in the Summary may wish to read Part II or III. Appendix I presents the important parameters of U. S. and allied FJ radars for easy reference to the reader. Similar charts for all exotic radars appear in Bibliography Reference 3. Appendix II lists, in chart form, some of the important parameters of the various versions of Project 102.