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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON 25, D.C.

REPLY TO ATTN OF: AFCIN

SUBJECT: COMINT Intercept Task for SAMOS Sub System F-2 (S)

27 MAY 1960

TO: AFDAT (General Boushey)

1. Reference is made to the attached letter from the National Security Agency Serial N 1797, subject as above, dated 10 May 1960.

2. The requirement for a COMINT intercept capability for SAMOS is recognized and adequately documented in GOR 80-2. It is believed that the NSA suggestion to incorporate the Airborne Instrument Laboratory proposal for R&D tests of the COMINT capability of SAMOS in Sub System F-2 vehicles is a valid approach to the problem.

3. It is recommended that AFBMD be directed to implement the proposal outlined by the National Security Agency, as an R&D test to demonstrate the feasibility of COMINT collection from ESV's. It should be emphasized that such a program should be accomplished with no degradation of the programmed ELINT capability for SAMOS and without slippage of the present development schedule.

JHWalsh

JAMES H. WALSH
MAJOR GENERAL, USAF
ASSISTANT CHIEF OF STAFF,
INTELLIGENCE

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NATIONAL SECURITY AGENCY
FORT GEORGE G. MEADE, MARYLAND

SS 0 05318

Serial: N 1737

10 MAY 1960

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SUBJECT: COMINT Intercept Test for SAMOS Sub-System F-2 (S)

TO: Assistant Chief of Staff, Intelligence
U. S. Air Force
The Pentagon
Washington 25, D. C.

1. Reference is made to AFBMD letter to DIRNSA, Subject: R and D Feasibility Package for SAMOS, dated 20 April 1960 (copy attached) and Exhibit A Proposal J-7564 by Airborne Instruments Laboratory (copy furnished to Col Poe, AFCIN-1, by Maj Copley, AFBMD). It is recommended that, with the alterations outlined below, AFBMD be instructed to proceed to implement the proposal as an R/D test of the COMINT capability of SAMOS.

2. It is conceded that such a preliminary experiment is necessarily a compromise. First, it is limited by the possible modifications that are possible to make to the SAMOS F-2 payload and can be done within its time schedule and funding. Secondly, it is a compromise on the expected COMINT product since there are few communications targets which are amenable to intercept from a satellite with the minimal equipment available for F-2. Thus, this test should be considered to be mainly an R/D "field operation" to verify theoretical calculations.

3. The feasibility of using satellite vehicles for COMINT collection platforms was shown in NSA R/D Technical Document 33.144, dated Aug 59 (copy furnished Col Poe). This document was sent to AFBMD with a request for cost estimates on the various COMINT tasks suggested therein. The above referenced AFBMD letter is considered an interim reply to the requested estimate. The cost figure on the order of $600,000 for four F-2 units of the special experiment is considered justified for an initial effort to demonstrate the feasibility of using ESV's for COMINT. It is assumed that currently available Air Force funds would be used. Much of the receiver and detector development would be applicable for more advanced operational intercept equipment when such a requirement for COMINT collection is developed.

4. The Proposal J-7564 for recognizing Russian air communications, particularly the [redacted] data transmission, has been studied in detail. 50X1

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There are some weaknesses in the proposed equipment which result from the compromises mentioned above. The most serious weakness is the poor location information expected. The F-2 antennas in the VHF band cannot, without major redesign, perform location fixing. Also, the slow data rate of the [redacted] signal leads to a slow receiver frequency scan. Modification of either the antennas or the scan rate to improve location finding would reduce the probability of intercept. It is felt that R/D objectives of this first experiment would be better met by keeping the probability of intercept as high as possible, at least on the very first flights. Then based on the success of that test for sensitivity signal recognition, etc., later flights, possibly still on the F-2 program, could be modified to improve the location fixing capability. In fact, the proposed location accuracy (± 1300 nautical miles by ± 300 nautical miles) is considered so deficient that the inhibit receiver might be better used for recognizing a second COMINT signal type than to attempt so poorly to locate the Russian air signals. It is recommended, therefore, that an FM discriminator and wider band (800 kc) IF amplifier be incorporated into the basic VHF scanning receiver and signal antenna system, and that a simple detector be utilized to recognize the presence of a single, or several, sideband channels of VHF multi-channel FM communication signals such as the [redacted] or the [redacted] link [redacted]. It is believed that this modification to the proposal would lower the cost from that for the double channel inhibit receiver for the air communication signal alone. 50X1

5. The second serious weakness of the proposed equipment is its frequency accuracy. Although not specifically stated, it is probably of the order of 1% which would be 1 mc at 100 mc. This is not sufficient to resolve the [redacted] channel separation used by USSR on air communications. It is therefore recommended that a more accurate receiver frequency control be used, specifically that its oscillator be calibrated when over the track station (as is planned for F-2) and that a few crystal controlled frequencies be incorporated in the F-2 special receiver. These could be sequentially switched-in under real time or stored program commands in accordance with COMINT derived frequency operating schedules as was tried recently on System III. Thus, at times, the scan mode of the receiver could be stopped and the feasibility of controlled intercept could be verified. These features would undoubtedly increase the cost of the device somewhat.

6. As indicated above, the intelligence resulting from this R/D test would be expected to be confined to producing background information. Only the existence of VHF [redacted] VHF air-voice and VHF-FM multichannel would be detected, counted, and identified by time and radio frequency. The problem of false identification or of alarms from undesired signals

has been considered and should be emphasized in developing the test package. Very rough location information would be available but other parameters, such as the combination of detector alarms and their variation with time, should help in sorting out spurious signals. It should be specified that preliminary data processing be done on SAMOS processing equipment, but that any intelligence data be analyzed in COMINT channels only.

7. It is not intended that this action shall constitute an NSA requirement for COMINT operations using satellite vehicles. Specifically, only this preliminary R/D experiment proposed by AFBMD, as modified herein, is endorsed. The R/D test and evaluation could be done by AFBMD and LMSD with the cooperation of the COMINT community. If the project is approved, NSA will continue to provide technical guidance to the Air Force through the R/D test. Any usable breadboards resulting from the development work of the contractor would be expected to be made available for COMINT R/D testing and one of the final models should be tested in an actual signal environment, preferably in an aircraft, prior to launching F-2. It is concluded that, with the above interpretation, the AFBMD proposal is definitely worth the investment and will point the way toward future development in space platform equipment for COMINT collection.

FOR THE DIRECTOR:

S Kullback

S. KULLBACK
Associate Director

Incl:
a/s

Copy Furnished:
AFBMD (SAMOS Project Officer) (Less Incl)
AFSS (OPD) (Less Incl)

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EXHIBIT A OF PROPOSAL J-7564

SPECIAL INTERCEPT EQUIPMENT FOR WS-117L

I. SUMMARY

It is the purpose of this exhibit to propose COMINT intercept equipment for the WS-117L program and to describe the proposed equipment. The equipment proposed is capable of intercepting the Soviet air defense voice communications and data transmission system signals in the 100 to 150 mc range. The equipment will continuously scan this band and record the frequency and time of intercept of each desired signal and be capable of providing coarse emitter location information. Maximum use of components developed for the F-1 and F-2 systems is proposed. The equipment is proposed for F-2 flights.

II. GENERAL

The objectives of the proposed equipment are:

a. To verify the feasibility and evaluate the utility of COMINT intercept in the VHF frequency range from a satellite.

b. To provide this capability with moderate budget requirements.

c. To fly this equipment at the earliest possible date in the WS-117L program.

To meet these objectives, a relatively simple receiving-recording equipment is proposed. This equipment has the capability of obtaining useful information concerning one particular signal type of COMINT interest. The scope has been limited to this single signal type to [illegible] simplicity and costs. The advanced state of development

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of suitable F-2 antennas and receiver components in the 60 to 300 mc range dictated the choice of intercepting a signal in this band. On the basis of intelligence interest and intercept feasibility, the type selected was the Soviet air defense, voice communications and data transmission system signals in the 100 to 150 mc band. Although the proposed equipment is specifically designed for the intercept of this signal, many of the proposed components are suitable for the intercept of other signal types in the VHF frequency range. Therefore, if intelligence interest in this signal decreases during the development of the proposed equipment, it will be possible to modify the existing equipment for the intercept of a higher priority signal.

III. PROPOSED EQUIPMENT CAPABILITY

The proposed equipment will utilize a scanning receiver to cover the 100 to 150 mcs range. The receiver will continuously scan this band in approximately 200 seconds. Upon recognition of the data transmission or voice signal, the equipment will record digitally the following data on magnetic tape:

1- radio frequency (12 bits including 3 bits for band identification)

2- vehicle time of intercept (13 bits)

3- signal-inhibit difference amplitude (3 bits)

4- identification of side tone or voice frequencies in transmission (3 bits)

5- parity check (1 bit)

The digital data will be recorded on the F-2 tape recorder with the special equipment intercept words interspersed with ELINT intercept words. The length of the special intercept words will be lengthened to that of the ELINT words by the addition of selected bits (18 bits for flights 1 and 2 and 36 bits for flights 3 and 4). (During ground processing special words will be identified by the frequency band code). Digital storage is provided in the special intercept equipment to hold its word until such time as the F-2 recorder is available for use in recording the special word.

Following an ELINT intercept in the F-2 system for flights 1 and 2 there is always sufficient time to insert an additional 50 bit word prior to the next possible ELINT intercept word. However, in the F-2 system for flights 3 and 4 during the scanning of band 1, there is not sufficient time to insert the special word between successive ELINT words when these occur at peak rate. Therefore when the proposed equipment is used in flights 3 and 4, a special intercept word will have to be stored until recording time is available, i.e., until no intercept is received in a channel of band 1, at which time the special word will be recorded. However, if 12 successive channels in band 1 contain valid intercepts, a special word cannot be written on the tape unless an ELINT word is blanked. It is proposed therefore, that the special word be stored up to 200 milliseconds (corresponding to the channel time of the special equipment) if necessary, and then, if no recorder time was available, an ELINT word would be blanked out and the special word inserted. This mode of operation would be required only when the special equipment is being used in flights 3 and 4 and then only while band 1 is being scanned.

The antenna-receiver system proposed for use in the special equipment is the so-called modified inhibit scheme which is utilized in bands 3b (130 to 290 mc) and 3a (59 to 130 mc). The resulting coverage pattern obtained by the use of this scheme is shown in figure 1. The patterns shown are approximate since actual measurements on a 100-150 mc antenna have not been made. In flights 1 and 2 the special equipment will utilize a band 3a antenna scaled down to the 100-150 mc range, while in flights 3 and 4 the special equipment will utilize a band 3b antenna modified to perform in the 100-150 mcs range. These differences are necessitated by the differences in F-2 antenna configurations for these flights.

The single intercept emitter location characteristics of this system are such as to produce positional uncertainities of approximately $\pm$ 1300 nautical miles along the ground track of the vehicle and approximately $\pm$ 75 nautical miles orthogonal to the ground track. The orthogonal uncertainty is further reduced by the measurement and recording of signal amplitude difference between the two receiver channels resulting in regions of location uncertainty of an approximate width of 25 nautical miles with left-right ambiguity unresolved.

The positional uncertainty along the ground track of the vehicle can be considerably improved if several intercepts of the <u>same emitter</u> can be identified, particularly, on successive receiver scans. For example, as indicated in figure 1, if three successive intercepts are made, the uncertainty along the ground track may be reduced to approximately ± 750 nautical miles. Some further improvement for the multiple intercept case may be obtained by reorienting the coverage pattern with respect to the ground track.

The proposed receiver will have a 14 db noise figure and a 50 kc IF bandwidth. Therefore the 6 watt, Soviet airborne transmitter (assume f = 150 mc) located directly below the satellite will produce a 21 db IF signal-to-noise ratio. This assumes a satellite altitude of 291 nautical miles and isotropic gain for the transmitting and receiving antennas. However, further signal-to-noise improvement of about 10 db is obtained through narrowband post-detector characteristics and further signal integration. The signal detection threshold referred to the I-F amplifier output will be set at approximately 10 db to minimize "false alarm" intercepts due to noise triggering.

Soviet signals other than those intended to be intercepted in the [redacted] region of the spectrum may result in false alarms. 50X1 These are the [redacted] runway localizer and the [redacted] communications transmitter. It is, however, believed that because of the limited frequency allocations and the relatively low density of these "interfering" signals that the interference effects will not be serious.

IV. EQUIPMENT DESCRIPTION

Figure 2 is a block diagram of the proposed equipment. Many of the units shown are components that have been developed for the F-1 or F-2 equipments and can be used either directly or with modifications for this application. The two channel receiving system proposed for this equipment is similar to that used in the ELINT receivers.

The proposed antenna is a dipole similar to the Band 3b antenna used in the F-2 equipment. The two elements of the dipole, which is oriented orthogonally to the vehicle ground track, are fed to a hybrid network to obtain sum and difference pattern outputs for the signal and inhibit receiver channels, respectively.

The preselector is a fixed-tuned 100 to 150 mc filter providing rejection of image and other spurious responses. The first mixer is conventional and converts the received frequencies to 60 mc. A signal from the scanning local oscillator is also coupled to this mixer. This local oscillator will be either voltage tuned or mechanically tuned. In the latter case the design would be similar to that used in the band 3b receiver in the F-2 equipment. The output from the first mixer is connected to the first i-f amplifier tuned to 60 mc and having a bandwidth of approximately 2 mcs. This amplifier is similar to the preamplifier used in the F-2 receivers. The output from the first i-f amplifier is connected to the second mixer which converts 60 mc signals to 5 mc signals. The second local oscillator is fixed-tuned at 55 mc and feeds the second mixer. This second conversion is used to obtain a narrow i-f bandwidth of about 50 kcs. An automatic gain control (AGC) circuit is utilized to provide sufficient receiver dynamic range. The gains of both signal and inhibit channels are controlled by the signal channel amplitude. The sidetone and voice detectors operate from the output of the 5 mc i-f amplifier. These detectors demodulate the i-f signal, separate, by means of filters, the sidetone and voice frequencies, and detect the presence of each of the sidetones or the voice frequencies. The sidetone frequency can be used to differentiate between Soviet ground and airborne transmissions. Signal integration following the sidetone and voice detectors may be desirable to further improve the signal-to-noise ratio. The decision to provide additional signal integration would require further information not presently available concerning signal characteristics such as:

a. percentage of voice modulation

b. range of voice frequencies transmitted

c. percentage of sidetone modulation

d. range of sidetone variability

e. shape of sidetone keyed pulses

f. whether sidetone and voice may be present simultaneously on the same carrier.

The output of the detectors is fed to the amplitude comparator which provides the decision making capability for accepting signals within the desired coverage area (see figure 1) and rejecting all others. It is expected that the same amplitude comparator can be used on voice or sidetone keyed signals.

The presence of either sidetone or voice on any frequency within the desired coverage area of the system will result in outputs of the amplitude comparator, and the sidetone and voice logic circuits which indicate which sidetone was transmitted or whether voice was transmitted. The appropriate recongition pulse is stored in the register of the digital data handler.

The receipt of a recognition pulse results in the reading into the data register, the quantized difference amplitude, the vehicle time and frequency of intercept. The data is stored in the register until recording time is available on the F-2 tape recorder unit. Various timing pulses must be recived from the F-2 system data handler to permit the special word to be properly inserted on the tape. When the special equipment is used with the F-2 system, flights 3 and 4, provision is also made to blank one ELINT word from the record and insert a special intercept word in its place, if necessary, to avoid loss of COMINT intercept data. The digital data handler is designed to operate with either F-2, flights 1 and 2 ferret equipments, or flights 3 and 4 ferret equipments, by simple switching or wiring changes.

The special intercept equipment will be programmed and controlled from the F-2 system commands but will generate its own regulated d-c power.

V. F-2 SYSTEM MODIFICATIONS REQUIRED

The F-2 equipment for flights 1 and 2 must have the following modifications to accommodate the special intercept equipment:

1- inclusion of band 3a modified inhibit antenna (modified to cover 100 to 150 mcs range).

2- provide interconnections of timing pulses, primary power, command controls, tape actuator pulse, and data pulses, as required, between the special equipment and the F-2 system (a minimum of internal F-2 changes are required).

The F-2 equipment for flights 3 and 4 must have the following modifications to accommodate the special intercept equipments

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1- inclusion of band 3a modified inhibit antenna (modified to cover 100 to 150 mcs range).

2- provide interconnections of timing pulses, primary power, command controls, tape actuator pulse, and data pulses, as required, between the special equipment and the F-2 system (aminimum of internal F-2 changes are required).

The F-2 equipment for flights 3 and 4 must have the following modifications to accommodate the special intercept equipment:

1- removal of band 3b receiving system (retain 3b antenna with modification to permit operation in the 100-150 mc range).

2- provide interconnections of timing pulses, primary power, command controls, tape actuator pulse, blanking pulses, and data pulses, as required, between the special equipment and F-2 system (some minor internal modifications of the F-2 data handler are required.

VI. PHYSICAL CHARACTERISTICS AND MISCELLANEOUS CONSIDERATIONS

The proposed special intercept equipment will have the following characteristics, exclusive of the antenna:

Volume:	approximately 2.0 cubic feet
Weight:	approximately 100 pounds
Power Consumption:	150 watts

It is recommended that this equipment be provided with at least 12 test points for system performance telemetry. These telemetered signals will all be d-c values. The availability of telemetry channels will have to be coordinated with AFBMD and Lockheed.

The data format of COMINT data can be handled by the T and A stations as well as SS/I in the same manner as ELINT data.

VII. POSSIBLE EXTENSIONS OF EQUIPMENT CAPABILITY

The equipment proposed above does not obtain message content. It is felt that the inclusion of such capability on F-2 flights is not feasible because of schedule requirements equipment proposed is adaptable for modification for use in future flights to obtain message content.

In such an extension the data transmission signal could readily be recorded by digital measurements of pulse position or by analog recording, and voice transmissions could be recorded on tape if desired. This additional capability could be obtained by the addition of a suitable tape recorder unit and by modifications to the local oscillator circuitry to provide for stop-scan operation on selected signals.

Improved emitter location accuracy could be obtained, at the cost of some reduction of intercept probability, by the addition of an another signal-inhibit antenna receiving system having a coverage pattern orthogonal to that shown in figure 1. Within the approximately 150 mile square area common to the two patterns emitter location could probably be refined to about $\pm$ 25 miles accuracy. The wide coverage necessary to obtain continuity of intelligence and high intercept probability would still be retained in a single channel of such a direction finding receiver.