~~TOP SECRET~~

ELECTRONIC EQUIPMENT - U-2 PROGRAM

1955 - 1966

System I. (Ramo-Wooldridge, 1955-56)

Originally designed as an S-Band Elint receiver to pick up GCI and air defense signals, the system was changed to include half X-Band receivers to pick up air intercept communications, blind bombing and missile control signals. The system was designed to receive and record on magnetic tape pulsed microwave signals emanating from regions within line-of-sight range of the receiving antennas in the U-2. Up to the end of 1957, System I had been the source of the Project's greatest pay-off in Elint collection. It was replaced in 1959 by System VI.

System II. (Ramo-Wooldridge, 1955-59)

The original communications and navigation system for the U-2 did not work out (see Chapter V, Development and Procurement, p. 12).

System III. (Ramo-Wooldridge, 1955-57)(S. T. L., 1963)

This VHF recorder, developed as the original COMINT collection package for the U-2, was designed to detect automatically and record a sample of all radio signals in the frequency band between 95 and 145 megacycles, including continuous test carrier, CW transmission and AM broadcast, and to record the frequency of the signal and the time of recording. The building of a prototype was authorized in June 1955 and an order for six receivers plus spares and test sets was given in April 1956.

In August 1957 the Project Director advised the Chairman of the Requirements Committee that it was the opinion of the principal customer for System III that, at least as it had been employed to date, this system yielded a product not even of marginal intelligence value. It was suggested that the equipment, rather than operating in a search-and-lock-on mode be pre-set to frequencies on which valuable take might be anticipated, in order to obtain longer and more continuous samples. The system at that point was only carried on experimental

missions in order to establish its value by positive evidence. On 16 September 1957, the Project Director instructed the Director of Development and Procurement to eliminate System III, and on 26 March 1958, the Contracting Officer instructed Ramo-Wooldridge to transfer System III surplus material to the Navy.

In 1963 System III was resurrected and updated and several OEL personnel were trained by Systems Technology Laboratories of TRW in order to provide for emergency installation and maintenance of the system in case of need. The system has been deleted from the IDEALIST configuration a number of times, the latest date being 1 June 1967. (System XXI will replace.)

System IV. (Ramo-Wooldridge, 1955-58)

This unattended airborne FERRET system was designed to receive and record automatically electromagnetic energy radiation in the general frequency spectrum between 150 and 40,000 megacycles. A very complex system requiring more than two years development and testing, its basic units included 8 frequency-sweeping superheterodyne receivers, 2 crystal video wide open receivers, a 14-channel magnetic tape recorder, an oscilloscope and a film recorder. The engineering study was begun in July 1955 and an acceptable plan with technical exhibit was finally presented by Ramo-Wooldridge in May 1956. The Agency Elint Staff Officer [redacted] recommended acceptance and simultaneous work on the system, read-out equipment and test equipment to avoid any further delay. In October 1956, permission was given for a delay in delivery of the prototype in order to realize a savings of $150,000 in overtime pay. The prototype was finally delivered to the test site in February 1957. Arrangements were made with the Navy to flight test the system against equipment at Point Mugu Navy Missile Test Center. Testing and rework continued through the summer of 1957 and in September an urgent requirement hastened the final testing for a special mission which was run by Detachment A on 11 October 1957 over the Barents Sea with good results. System IV was used during the next two years on approximately 16 overflight or peripheral missions with fair to excellent results.

The responsibility for operation and maintenance of the equipment was taken over by Project Communications Staff in August 1958. In March 1962 all System IV equipment, valued at $805,355, was transferred to the Air Force U-2 group since the system was incompatible with the J-75 Project U-2's.

System V. (Ramo-Wooldridge, 1956)

This crystal video system consisted of nine System I units using different antennas tuned to selected bands to permit coverage over the entire frequency range of the equipment, i.e., from 60 to 10,750 megacycles. It received only pulse type signals with moderate sensitivity and the information received was recorded on a 14-channel, 1-inch tape recorder, and two 3-channel, 1/4 inch tape recorders. The disadvantage of this system was that it weighed in excess of 400 pounds leaving no space for any other payload than the tracker camera. A special hatch cover contained all of the antennas.

System V was flown with good results on two missions over the Caspian and Black Seas, one each in 1956 and 1957, and one over the China Coast in 1958. System VI replaced the System V capability.

System VI. (Ramo-Wooldridge, 1958-59)

This system, intended to replace Systems I, III and V, and using cannibalized parts from existing components, received and recorded pulse type data in the frequency range from 50 to 14,000 megacycles in four bands as follows:

P Band	50-300 MC
L Band	300-1000 MC
S Band	1000-8000 MC
X Band	8000-14,000 MC

It consisted of four separate channels to receive and record signals from each of the four frequency bands, using high gain, broadband video amplifiers preceded by antennas designed for each band. Information was recorded on two 3-channel, 1/4 inch tape recorders with each unit receiving and recording signals from two of the four bands. An automatic switching arrangement was incorporated in each channel of the system to permit time sharing of the channel for right and left antenna.

The advantage of this system was that it could be carried along with either the A-2 or B camera. Special A-2 or B hatch covers provided windows, brackets and cabling for System VI components and 20 different configurations of the system were possible. Once System VI was tested

and available for operational use, it was decided that System IV could be retired and the funds thus saved be used for increasing the collection capabilities of System VI. A total of 18 systems were procured and nine remained in the inventory at the end of 1966. The system was updated to configuration VI-A in 1963, and in 1967 planning was underway to update it again to configuration VI-C.

System VII. (Haller-Raymond-Brown, 1959-60)

This system was proposed by OSI in December 1958 and was designed to intercept and record missile telemetry signals of the pulse position modulation type during the pre-burnout stage of missile launching. The signals to be intercepted were believed to be less than four and certainly less than six simultaneous transmission frequencies; therefore the system envisioned the use of six pick-up heads of high accuracy and high fidelity. The need for the system was immediate and so available equipment was employed throughout. The Ampex 814 Recorder running at 60 ips with a recording time of 12 minutes was selected for the system.

Approval to proceed with System VII was given by the Critical Collections Problems Committee and the Elint Committee of USIB on 10 December 1958, and Haller-Raymond-Brown was authorized to proceed with fabrication of one complete system and spares. The system was delivered to Edwards North Base and tested there in April and May 1959.

Headquarters USAF and CHALICE personnel jointly planned a telemetry mission for 9 June 1959 through Iran which included use of a SAC RB-47 aircraft with manned telemetry collection equipment, and a CHALICE U-2 aircraft with System VII automatic collection equipment. The purpose of the joint planning was to coordinate both efforts and ensure that the aircraft would be on station at the proper time with respect to optimum operation of each equipment. By virtue of the higher altitude of the U-2 (65,000 feet) System VII was able to pick up missile telemetry approximately 80 seconds after missile launch time. This intercept provided 30 seconds of telemetry prior to first stage burn-out and was the first such intercept from a Soviet ICBM launching recorded by the U.S. intelligence community. The RB-47 at

a lower altitude with manned equipment able to search for and detect new telemetry frequencies, was able to get second stage telemetry which provided confirmatory information for the U-2 intercept. This mutually confirmed information ensured greater precision to analysts determining the size, type and other characteristics of engines used in the missiles.

A third partner in this effort was NSA, who advised the alerted CHALICE and SAC crews at Adana six hours prior to shot time. Take-off timing and flight planning was such that both aircraft were at optimum positions at blast-off time as was planned.

System VII was flown operationally for a year by Detachment B between June 1959 and 1 May 1960 with one excellent, eleven good, two fair and nine poor missions.

System VIII. (Haller-Raymond-Brown)(Procured for U.S. Navy)

This system was a modification of System VII to be installed in a Navy A3D aircraft to obtain telemetry signals from Soviet ICBM impact area in the Pacific. Contractual relationships were handled by DPD with Douglas Aircraft, acting as subcontractor to HRB for installation. DPD and OSI monitored development of the system and DPD Security monitored security aspects of the project, but operational use was the responsibility of the Navy.

System IX. (Granger Associates, 1958)

Early in 1958 an Agency requirement was generated for an electronic countermeasures device, for the P2V program and for the U-2. Investigation by OSI determined that the S-441 Deception Repeater (designed by Dr. Rambo under Air Force/Navy contract in 1956-57) could be repackaged to fulfill the DPD requirement. Responsibility for development was delegated to DPD/Development and Procurement Staff and the initial contract with Granger Associates was written 26 June 1958 for a prototype article, Granger Model 504. The purpose of the system was to provide false angle information to X-Band conical scan airborne intercept radars, which was achieved through the use of

inverse gain techniques. OSI continued to act as technical adviser on this development and upon completion of the testing of the prototype in May 1959 it was recommended by [redacted] that the Model 504 be produced in limited quantities in a production version capable of operating at maximum altitude of the U-2. System IX was aboard the U-2 which was shot down over Sverdlovsk on 1 May 1960.

Subsequent to the loss of that aircraft and the compromise of the Granger Black Box, it was decided to update or redesign the equipment and a contract was let with Applied Technology Inc. (a new company set up by Dr. William Ayer, who had designed the Granger 504) in December 1961 for a prototype and 14 production units of a new higher-powered model. The first sets were completed in April 1963. Configurations X-B, IX-C (Air Force), and IX-D represent improved models. System IX-B is still in operational status.

System X. (Haller-Raymond-Brown, 1962)

System X was a modification of System VII engineered specifically for Elint coverage of the Soviet missile site at Sary Shagan. Two sets were ordered in August 1962 in advance of the overflight approval and OSA funded the work conducted by HRB and Lockheed to progress System X toward eventual installation in the U-2. This funding was undertaken with the expectation that the engineering work would be applicable to other aircraft systems such as the RB-57F, if it were decided to use that vehicle on political grounds for collection against the Soviet ABM effort.

In May 1962 with the approval of USIB Chairman (Mr. McCone) OSA tried to get the British to sponsor a U-2 with System X to fly over Sary Shagan from Pakistan. While political efforts were being made by the British with Pakistan for approval, the Air Force was making an effort to adapt System X to an improved version of the RB-57D. Dr. Charyk favored use of the RB-57 rather than the U-2 for this mission, and this was agreed at a USIB meeting in late August of 1962, and the British were disengaged from their efforts. At the same time OSA discontinued contractual responsibility for System X and the Air Force took over.

System XII. (Haller-Raymond-Brown, 1962-64)

System XII was developed as an airborne warning receiver against the SA-2, Soviet surface-to-air missile (SAM). It alerts the pilot with visual and aural signals when a threat radar illuminates his aircraft and instantaneously indicates the azimuth bearing of the illuminating radar. Threat radar signals are discriminated from non-threat signals and if several threat radars illuminate the aircraft simultaneously, the system indicates the direction to each without serious interaction.

Configuration XII-B was developed in 1965 by Applied Technology, Inc. In addition to previous characteristics, it senses and provides proper sector coverage for System 9B and enables System 13C (S and C Band jammer) against SAM TWS guidance radar threats. In December 1966 the system was modified to include a LORO capability by installing a 2500 PRF counter which bypasses the scan rate detector and allows the system to unblank on receipt of a 2500-PRF (± 10 percent) signal in the receiver pass band. This modified system is designated XII-B-1. Systems XII-B-2 and XII-C are in development by American Electronic Labs.

Systems XIII, XIV, and XV. (Sanders Associates, 1963)

A countermeasures system effective against the FAN SONG radar was developed by combining the ALQ-19 (System XIII) with parts of the ALQ-49 (System XIV) and the ALQ-51 (System XV). This S-Band and C-Band jammer with improved techniques was renamed System XIII-A. This development was undertaken to provide a jammer completely different electrically and mechanically from any known military system in design or inventory. With the initial reluctance of the Joint Chiefs to approve the operational use of System XIII because of the microwave frequency memory loop, a contract was let to design a system which would delete that feature. The goal originally set for this equipment was achieved and a contract was let in August 1964 to develop the new package. Tests were conducted in October-December 1964 against FAN SONG simulation. A request for authorization to replace System XIII with XIII-A in the U-2 operational systems inventory was made to D/NRO on 25 February 1965. This was approved and by the end of May 1965 the first operationally ready unit was installed at Detachment H. Configuration XIII-C was developed by Sanders Associates beginning in September

1965 (code name MAD MOTH). It included the addition of a 3-tube traveling wave tube transmit chain, LORO recognition circuitry, inverse linear gain capability, and amplitude modulation output techniques, as well as weight-saving features. Nine production units were acquired beginning delivery in July 1966 and an additional seven sets of System XIII-A were subsequently retrofitted to the XIII-C configuration. (The Air Force also procured units for their U-2's, B-57's, and SR-71's.) A configuration XIII-D is being developed by Sanders with greater jamming power and other features.

System XVI.

System XVI was projected as a lightweight, passive Elint collection system to replace Systems III and VI, using many of the components and subsystems already in operational use in Project STSPIN and other programs. For a variety of reasons this system was not developed for operational use in the U-2, the principal problems being size and weight. In July 1964 the decision was made to postpone consideration until the U-2R procurement question was settled.

System XVII. (Haller-Raymond-Brown-Singer, 1964-65)

In October 1963, the USIB concluded with respect to its long-standing requirement for information on the Soviet ABM program that there was a sufficiently high possibility of collecting ground radar emissions from Soviet tests of such systems as to justify development and employment of an effective airborne Elint capability. Such a system would be used to collect against Sary Shagan from over China near the Soviet border. NRO was asked to work toward development of such a capability as soon as possible. On 29 October 1963, the Acting DD/S&T, Col. Giller, instructed OSA to develop a System X type of collection equipment for use in the U-2, working with OEL to develop specifications and configuration.

The new system, designated System XVII, is an unattended specialized receiving system for collection of telemetry and other missile-associated signals from the launch site at distances from 340 to 420 miles. The system continuously searches the frequency

spectrum between 50 and 8000 megacycles with ten sweep-lock receivers. Known telemetry and other missile-associated signals are monitored using 14 fixed tuned receivers.

Development of the system was authorized in July 1964 and HRB-Singer was awarded a contract on 1 September 1964 for production of two prototypes and some ground support equipment. By the time the system was operationally ready for a mission against Sary Shagan, the tip-off time before an impending launch had been cut to such an extent that it would be practically impossible to prepare and launch a U-2 mission in time to intercept meaningful signals. The only operational use made thus far has been by Detachment H along the China Coast against SAM sites.

BIRDWATCHER (HRB-Singer, 1962-63)

This system is an inhouse Agency design developed by [redacted] of OEL, the purpose being to provide an automatic means of relaying from the airborne vehicle information concerning the status of various aircraft systems during emergency situations. The data transmitted to the ground station is then analyzed to determine the cause and effects of the emergency situation. The system for the U-2C consists of up to 40 input sensors of 20 single channels and 10 dual channels sampling the status of various systems functioning, and a keyer modulator for driving the onboard 618-T-3 HF transmitter. The system can be activated by any one of designated critical sensors, by the pilot of the aircraft, or by the ground site's interrogation signal. The system has been proven operationally and has successfully fulfilled its design purpose.

OSCAR SIERRA. (HRB-Singer, 1965)

This system, designed to augment System XII, is a passive electronic countermeasures system with a broad band receiver operating in the L Band frequency range. The system receives and recognizes a missile guidance signal within a 40-mile radius and provides an alarm which consists of turning on a red light in the pilot's compartment, providing an input to BIRDWATCHER, and turning on System XIII. Three prototypes were deployed after successful tests in February 1965, and six production units were ordered. The Mark III configuration was

ini tated by HRB-Singer in December 1965 and the first prototype flight tes ed in June 1966 did not perform satisfactorily. At the end of 1966 co tinued rework and development was being performed on this version.

Sy tem XX. (Aerojet General Corp., 1967-68)

- An infra-red sensor which detects the after-burner of a pursuing fig ter aircraft is in the development stage.

Sy tem XXI. (HRB-Singer and Sylvania Electronics Systems, West, Inc.) (1966-67-68)

An airborne VHF COMINT collecting system designed as a re lacement of the obsolete System III is in the development stage.

Sin le-Side-Band Radio. (Collins Radio, 1960)

The Collins Model 618T radio was chosen to meet the requirement of light weight communications set to be used principally in the event of eed to recall the U-2 during an operational mission.

SPECIAL ELINT PROJECTS

NIGHTLATCH. [redacted]

In late 1958 a new Soviet GCI set was reported by the Air Force. This set was nicknamed BAR LOCK. It was similar to previous Soviet GCI sets in that it utilized two search dishes fixed on a rotating trailer, and multiple transmitters. It differed in having six transmitters instead of the usual five and in persistent reports that the signals were extremely strong.

In view of the excellent performance which the known characteristics should provide, interest in more detailed knowledge of the parameters of this radar was quite high. The major unknowns were (1) peak pulse power; (2) vertical coverage pattern; (3) horizontal antenna patterns and technical competence of the antenna design.

A specialized Elint collection program was initiated in March 1959, testing of the airborne equipment began in June, and field operations commenced in mid-August. During the following three months data was obtained on a number of BAR LOCK and BIG MESH sites in Eastern Europe and about 80% of the necessary data reduction was accomplished. The remainder of the data reduction took place after field operations had terminated.

The development, testing and employment of the special electronic package was provided under contract by [redacted] and the final cost, plus fixed fee, for this work was $165,427.60. The aircraft and crew to support the operational phase were supplied by the Air Force.

CHAPLAIN. (Joint CIA [redacted] Program)

The purpose of this project was to deploy to a field site location in Pakistan and operate special back scatter radar equipment which was developed for the collection of intelligence concerning missile launchings in the Soviet Union.

A survey team composed of [redacted] officers and [redacted] DPD Communications Officer, visited Pakistan arriving 8 April

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1960 and in meetings with the Pakistan Intelligence Service reached agreement on the location of the antenna for Project CHAPLAIN in the Malir Cantonment just outside Karachi.

Withheld under statutory authority of the Central Intelligence Agency Act of 1949 (50 U.S.C., section 403g)

Deployment to the field began 1 October 1960 as a joint enterprise between CIA [redacted] Total complement was composed of 17 field service techreps (ACF Industries), 5 USAF officers and men, and 1 CIA Staff employee for a total of 23. An Air Force Major commanded the group and the CIA technician was deputy and technical director for the project.

The equipment was developed jointly by OSI and TSD. DPD participation was principally with budgeting for the deployment phase for FY 1961-62, and in obtaining political approval from the Pakistan Government. DPD recommended that either TSD or the Office of Communications furnish the team leader. The man chosen was [redacted] of TSD. Chief, NE Division wished the team to report through the [redacted] although the DD/P felt he should report directly to Headquarters, DPD.

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By mid-July no degree of operational success had been achieved and DPD was in the position of having full responsibility for operational support overseas but with little or no direct responsibility for the technical operation or exploitation of the end product.

In September 1961, [redacted] proposed that the joint project become a fully military one. Ambassador Rountree in Karachi turned down the request of [redacted] for militarization of the project.

In August 1962, it was recommended and agreed that Agency participation be transferred to OEL.

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