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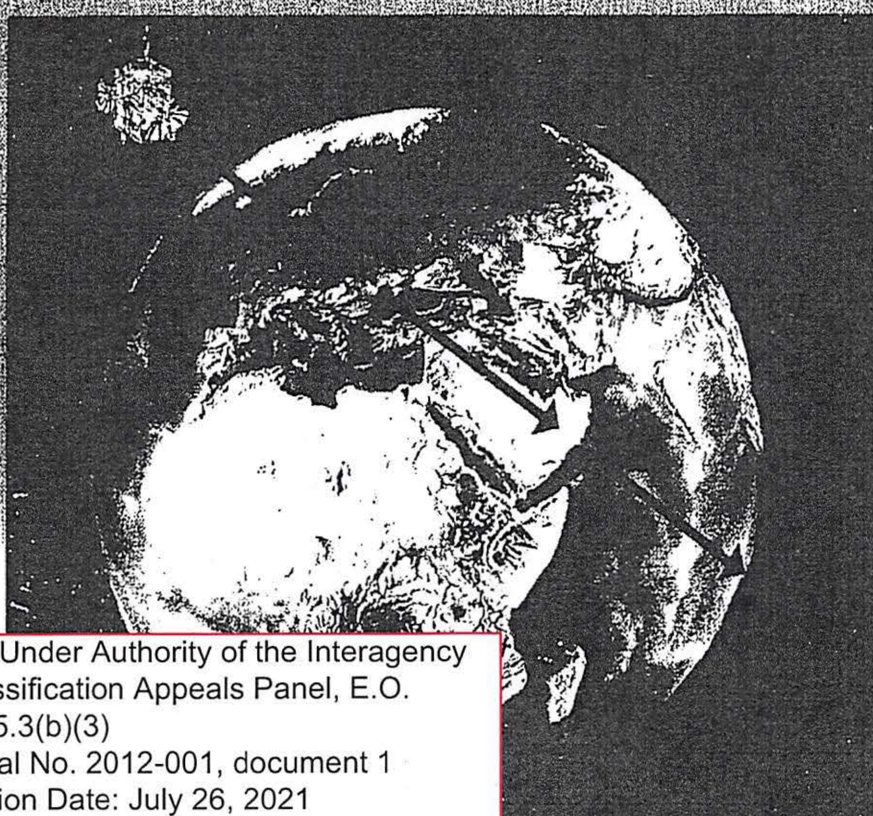
Series VI
Volume 5

The Foreign Missile and Space TELEMETRY Collection Story - The First 50 Years

Part One: The 1950s and 1960s



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UNITED STATES CRYPTOLOGIC HISTORY

Special Series
Volume 8

The Foreign Missile and Space TELEMETRY Collection Story - The First 50 Years

Part One: The 1950s and 1960s

Richard L. Bernard

CENTER FOR CRYPTOLOGIC HISTORY

NATIONAL SECURITY AGENCY

2004

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November 29, 1999

Richard Bernard
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Dear Dick,

I'm writing to commend and congratulate you on completion of the first volume of "The Foreign Missile and Space Telemetry Collection Story – the First Fifty Years," even though I think you have overly credited my personal contributions compared to so many of our talented associates. In particular, you do not give yourself sufficient credit for your leadership role for so many years.

As I reflect on the early period of telemetry collection before today's National Technical Means capabilities, you've made it easy to recall the primitive but growing capabilities of those early days, when so much of the problem involved the difficult military logistics of remote ground sites and the risky flight operations of airborne systems. We owe a lot to those military teams – soldiers, sailors and aircrews – for the success of the collection systems this history chronicles. The pictorial history you collected and included, which are priceless memories for members of the early TELINT community, is an important part of the history and helps to bring the story alive. Your research to identify the many individuals who made critical and remarkable contributions with limited funds, but using the advanced technology of those times, is especially valuable for giving them a long-overdue recognition for their contributions to our nation's security during those Cold War years. Finally I'd like to urge the readers of this history to study the "lessons learned" sections carefully – Dick has skillfully written them in a way that the lesson core is relevant to today's complex projects.

Sincerely,

William J. Perry

(U) Introduction

(U//FOUO) This history project was undertaken under the sponsorship and guidance of the National Security Agency Center for Cryptologic History (CCH). Working space and a considerable amount of reference material provided by the Defense Special Missile and Astronautics Center (DEFSMAC). The author specifically wishes to thank Dr. David Hatch, Dr. Thomas Johnson, and Mr. Barry Carleen of the CCH for their advice and guidance. The document has also benefited by a number of photos of TELINT field systems and locations provided by GTE, the current parent of Sylvania-EDL, where much of the original contractor work was performed. It has also benefited from background information provided by Raytheon, the current parent of HRB, another key contractor in the 1950s and 1960s. The key documents and personnel interviews that were used in developing the material are listed, but the author takes full responsibility for any errors of fact or interpretation that may appear in the document.

(U//FOUO) The primary topic of this document is telemetry collection against foreign missiles, satellites, and space vehicles. All chapters in the document contain information on telemetry collection systems planning, operational targeting, and collection coordination, with some discussion of field processing, national-level processing and analysis, and intelligence results. Emphasis is on Telemetry Intelligence (TELINT), now called Foreign Instrumentation Signals Intelligence (FISINT) collection, with limited mentions of activities in other interrelated "INT's" as necessary to put the TELINT information into proper context. Each chapter (usually a 10-year period has a table showing significant events, a photograph of each collection site/asset the first time it is discussed, and selected geographic portrayals.

(U//FOUO) Throughout this document the reader may be confused by the fact that identical projects, locations, or missions will have several names. Primarily as a security measure, but often to assign short titles or covernames consistent within a participating organization, different names were assigned to the same effort. For example, as a matter of NSA policy, any contractor project was assigned a different name by the contractor than the one used by NSA. Within the U.S. DoD, each military service agency often had its own name for an NSA project. Also, operational missions, particularly those controlled by the JCS had a separate name, and often a different one for each deployment. Likewise any project that had foreign participation was often given a separate name by the foreign partner. I have tried to minimize this confusion by showing alternate names within the text and on several of the charts and tables within the document.

(U) Endnotes are provided at the end of each chapter.

(U) A chart showing all of the project names/and a summary of information on each telemetry collection (or coordination) project mentioned in the text for the 1950s and 1960s are provided in Appendix A.

(U) Additional detailed information on selected telemetry collection projects and facilities that were started in the 1950s and 1960s is presented in Appendix B.

(U) There were two outstanding leaders in the U.S. who had significant influence on early telemetry collection projects, the coordination of collection efforts, and the thought-provoking analysis and conclusions that were reached during that period. They were Dr. William J. Perry, more often known as "Bill" Perry, and Mr. Charles C. Tevis, more often known as "Charlie" Tevis. In large measure these two individuals shaped the successes that were achieved during the 1950s and 1960s. Charlie Tevis died in 1994, and among other recognition he received for his lifelong interest in foreign weapons systems intelligence was that the new DEFSMAC operations center at NSA was dedicated to his honor in 1999. The commemoration plaque reads, "His vision is our reality today and our inspiration for tomorrow." Dr. Perry now holds several positions at Stanford University and has contributed information and ideas that have been included in the document, and he has graciously provided the forward for the document.

(U) This monograph, which covers the 1950s and 1960s, is Part One of a fifty-year history of telemetry collection. Part Two, to be published at a later date, will deal with collection from 1970 up to 2003.

(U) Chapter 1
In the Beginning (1950s)

(U) Arguably, the Space Age began with the experiments in rocketry by Robert Goddard in the 1920s. The military Space Age began during World War II with the launch of V1 and V2 rockets by Nazi Germany against London in 1945.

(U) The clear demonstration of the military power of even uncontrolled rockets motivated the major powers in the postwar period to begin conducting research to turn rockets from the crude, uncontrolled flying bombs used by the Germans into longer-range weapons with precise control. In addition to their use as weapons, rockets were developed to launch earth-orbiting satellites and other space vehicles.

(U) The United States conducted its own experiments in rocketry, and was at the same time concerned with the rate of development of missiles in the Soviet Union As the Cold War intensified, the American intelligence community looked for ways to collect information about Soviet progress in missile and space vehicles.

(U) TELINT (Telemetry Intelligence) or, in its more modern terminology, FISINT (Foreign Instrumentation Signals Intelligence), was an important asset in understanding Soviet development in long-range weaponry. This document will use the terms "telemetry" and "TELINT" since those were the terms in use in the 1950s and 1960s, the period under consideration.

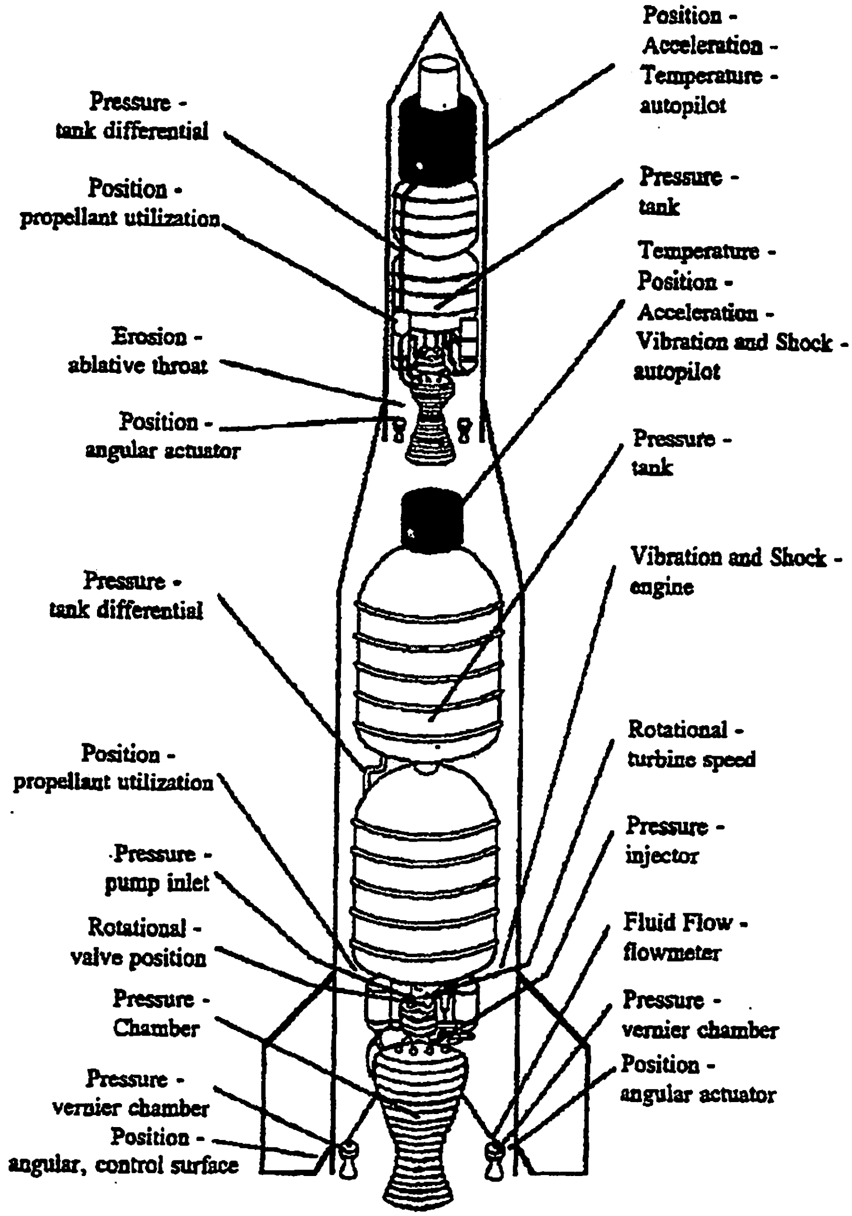
(U) Why Telemetry Is Important

(U//FOUO) There are engineering, and sometimes operational, requirements for designers and operators of missile and satellite systems to know how the vehicle is performing. Typically during development and test firings of all types of missiles or space vehicle launches, the sponsor wants to know the performance of propulsion components and the directional guidance system. This information is almost always acquired through telemetry, and performed in real time both for testing decisions (e.g., missile destruction if it is off course) and for later performance evaluations.

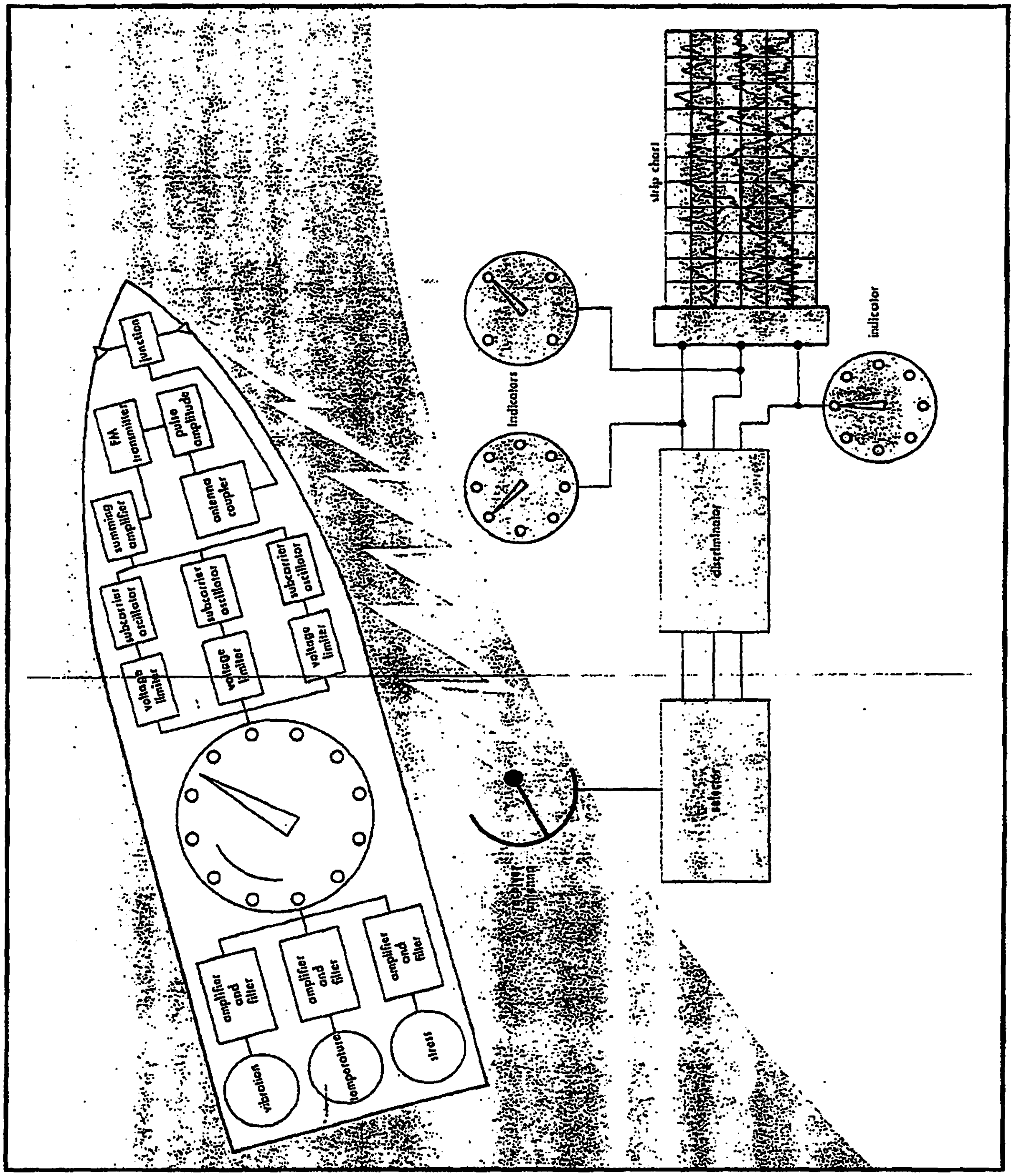
(U//FOUO) "Telemetry" is an electromagnetic signal(s) emanating from a missile or spacecraft and intended to convey data to selected users, usually at ground stations. "Tele" is the Greek word meaning "far off" and "meter" is Greek for "to measure."

(U//FOUO) A corollary signal is "beaconry," here defined as an electromagnetic signal emanating from an object intended to allow ground sites to determine the position and/or trajectory of a missile or spacecraft. Test range instrumentation is also an intelligence target.

(U//FOUO) Through intercept of foreign telemetry, one country may find it possible to determine how another country's missiles, satellites, and space probes are functioning; it is also possible in this way to receive the information the vehicles may be collecting on behalf of their own country. In short, TELINT collects, processes, and analyzes information from foreign missiles and satellites. (Telemetry was also often available from aircraft test flights in the development phase, but this document will concentrate on telemetry intelligence from foreign missile and space events.)

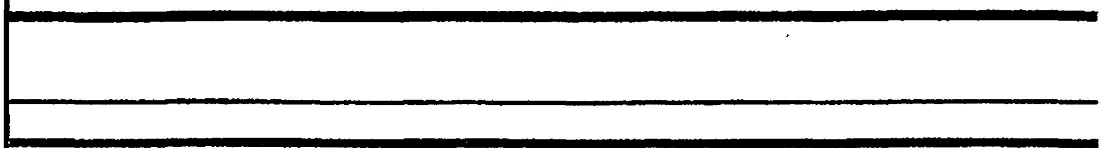


(U) Fig. 1. Missile functions that may be measured by telemetry

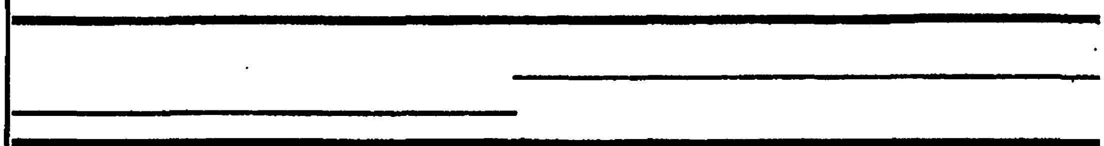


(U) Fig. 2. Transducer information is combined into a telemetry signal that is transmitted to the ground to be received, recorded, and displayed; different parameters are transformed from measurements using "transducers" and sent back to earth using radio telemetry.

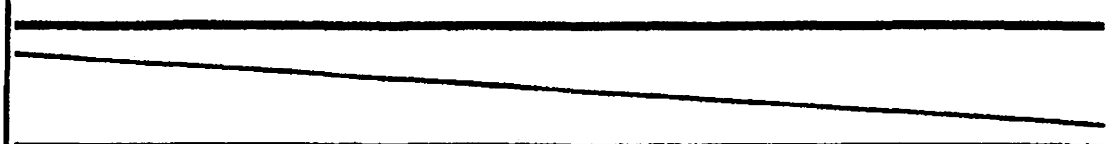
Typical Telemetry Displays



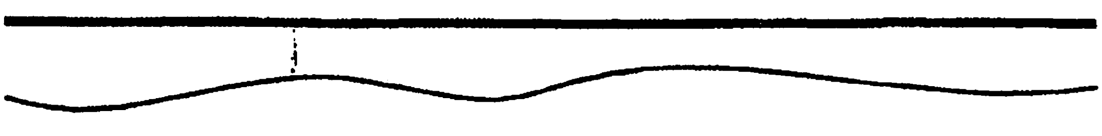
This trace shows an invariant channel - one that has not changed during this measurement interval. This is typical of a fuel level when no fuel has been used.



This trace shows a discrete step change that is typical of an "off/on" event such as turning on a camera or heater.



This trace shows a ramp change that represents something changing slowly over time. This could be the steady discharge of a battery at a continuous rate.



This trace shows a continuously changing curve which could represent the movement of an elevator on an airplane.

(U) Fig. 3. Selected "channels" of measurements from a missile test firing after the information has been received and converted back to data

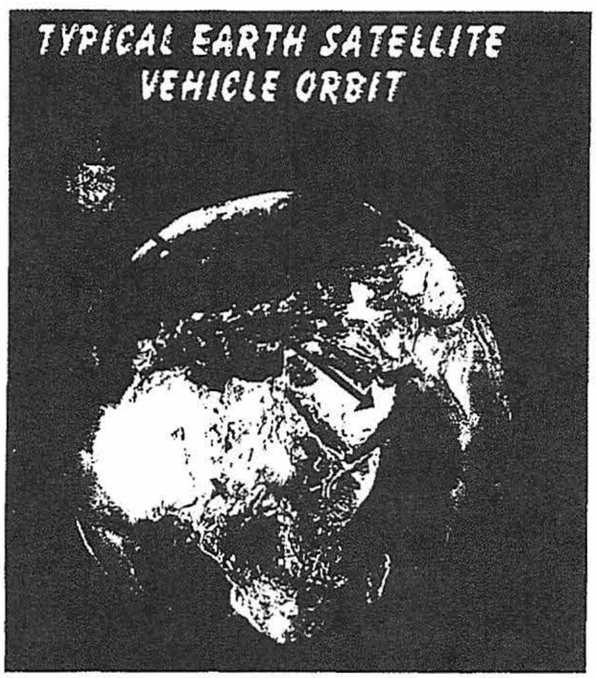
1.4(c)

[redacted]

(U//FOUO) Guidance functions are measured for satellite launches and propulsion; in addition, telemetry and beacons are used to evaluate the activities of a satellite once it is injected into orbit. Mission and satellite health data, particularly for scientific and reconnaissance satellites, are usually sent back to earth via radio telemetry or specialized data links.

~~(S)~~ A member of NSA's research organization, PL 86-36/50 USC 3605 [redacted] has described TELINT this way:

> **The raw telemetry data is noisy, degraded, incomplete, and imperfectly instrumented, and from this uninviting material it is necessary to extract the particulars of the rocket flight, the characteristics and performance of the missile, and the implications of the missile operation.[1]**



(U) Fig. 5. A typical satellite orbit

1.4(c) [redacted]

(U) Fig. 6. Different types of earth orbits typically used by satellites – 1.4(c) 1.4(c) [redacted]

(U) The First Telemetry Intercepts

(U//FOUO) As might be expected, the earliest technique used by the U.S. to track Soviet missiles and space launches in the 1950s was radar. The U.S. Air Force created the Distant Early Warning (DEW) system to detect missile and space launches that came into the system's view, primarily over Alaska, Canada, and Greenland.

(U//FOUO) Later, air, land and sea-based radars were developed specifically to track foreign missiles. For example, the first FPS-17 radar was designed specifically to detect Russian missiles launched from the Kapustin Yar test launch area. One was installed in 1955 at Diyarbakir, Turkey, and a second was installed on Shemya Island, Alaska, in the late 1950s. Later, higher precision tracking radars were added to those locations. The U.S. Navy had an HF radar system for tracking satellites that passed over the U.S. starting in 1957. This became the Naval Space Surveillance "fence," which came into full operation in 1961.[2]

(U//FOUO) Optical tracking was also used by the U.S. and the Soviets, starting with Baker-Nunn camera systems and developing into precision optical (and eventually laser) tracking systems.

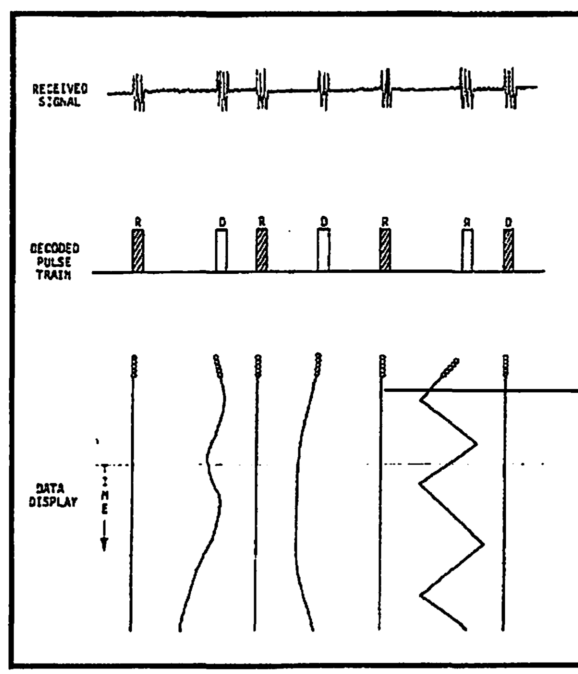
(C) At the end of World War II, both the United States and the Soviet Union captured German scientists who had worked to develop weapons systems for Nazi Germany. In the early 1950s German scientists who had been taken forcibly to the USSR after WWII were repatriated to Germany. These returnees reported that the Soviets were working on ballistic missiles based on the German war efforts. The Soviets had acquired some V-2 rockets, and it is believed they started test firing them from Kapustin Yar in 1947, with assistance from the captured and relocated German scientists.[3]

(C) This was important information for Western intelligence agencies. Also important for future collection of information about Soviet missile developments, the scientists reported that the Soviets may have been using the German "Messina I" nine-channel telemetry system originally used on the V-2 rocket weapons.

(S) [redacted] of CIA's ELINT (Electronic Intelligence) Branch, at a U.S./U.K. Guided Missile Intelligence Conference held in the U.K. in late 1954, argued that existing [redacted] sites in Turkey could probably obtain TELINT from Soviet guided missile tests at the Kapustin Yar launch site. He repeated his arguments, supported by mathematical calculations, in a memo on January 10, 1955.[4]

(C) In the summer of 1955 and into 1956, the U.S. Army Security Agency (ASA) searched for Soviet missile-related communications at Sinop, Turkey, under a project codenamed BRIMFULL. Their tasking was not to collect VHF missile telemetry but to collect the signal, believed to be transponded at the UHF frequency of 605 MHz, from the missile radio guidance system. The ASA site installed special receivers, with the operators told to set them for frequency modulated (FM) signals. Dr. William Perry (then a systems engineer at the Electronic Defense Laboratories in California), after studying data obtained from the repatriated German rocket engineers, believed the signal was more likely to be amplitude modulated (AM).

(S) The U.S. telemetry collection efforts against Soviet missile telemetry signals culminated on June 20, 1956, when the first successful telemetry was recorded from a Soviet SS-1 short-range missile launched from the Kapustin Yar Missile Test Range (KYMTR). The signal, a 16-channel pulse position modulated (PPM) and amplitude modulated (AM) signal at the VHF frequency of 61 MHz, was designated Type A by the Army-Navy Electronic Evaluation Group (ANEEG), a U.S. DoD joint service ELINT coordinating group.[5] It is believed that later in 1957 the Sinop site intercepted the first "S-Band" beacon from a missile at 2800 MHz.[6]



(U) Fig. 7. Diagram of how a PPM/AM signal is received and displayed

(S) On 20 July 1956, a second telemetry signal; which was 48 channels, called Type B, was intercepted under the guidance of Henry DeCourt, another ANEEG engineer who later become an NSA senior manager. (This signal was later designated S302 in the NSA ELTEX designation series and was used in the 1960s for both early Soviet ballistic missile launches and space vehicle applications.) The Type A and Type B telemetry signals used by the Soviets were both based on telemetry systems Germany had developed during WWII. Later Soviet telemetry systems (Types C, D, and E) were their own designs.[7] Table 1-1 below summarizes these signals.

(S) Search continued for the R-10 guidance transponder signal. It was never intercepted, possibly because of line-of-sight limitations based on the missile trajectories, the low power of the signal, or possibly because the Soviets were not using that guidance system.[8]

(S) From 1956 until early 1958, the only useful telemetry was being collected from three land-based sites (Sinop, Samsun, and Trabzon) and two aircraft platforms (the Navy P4M [redacted] and Army/Navy A3D [redacted] in Turkey. In 1958 EGGSHELL in Iran became operational, and Shemya began collecting reentry data from TTMTR ICBM missiles impacting into the Kamchatka impact area. In 1959 sites at Peshawar, Pakistan, and Wakkanai, Japan, began producing useful data.

(S) By early 1957, the U.S. Army Security Agency (ASA) had established a telemetry analysis capability and a major collection site at Sinop and had established a telemetry collection facility on Shemya, assisted by Haller, Raymond and Brown (HRB), and Electronic Defense Laboratories (EDL). ASA also had a transportable van deployed to Wakkanai, Japan.[9]

(S) By 1958 the USAF Security Service had established several collection sites on the Black Sea in Turkey, near the southern USSR border. A Security Service collection system codenamed [redacted] had been installed at Samsun, Turkey, which emphasized coverage of KYMTR, and at Trabzon, Turkey, for coverage of TTMTR, the Tyuratam Missile Test Range. Other Security Service collection sites were at Wakkanai, Japan, Peshawar, and Shemya.

(S) The U.S. Air Force Security Service (AFSS) produced a comprehensive handbook, "ELINT Collection of Space Vehicle Signals," that provided an overview of Soviet test range operations, the target signals, and procedures for signal collection for field collection activities (as well as processing activities). This gave an excellent

(S) Table 1-1 Early Soviet Missile Telemetry Signals

Initial U.S. Names	Signal Type	Telemetry Channels	Primary Use	[redacted]
Type A AT01	PPM/AM	16	MRBMs	
Type B AT02	PPM/AM	48	ICBMs & ESVs	
Type C [redacted]	PPM/AM	[redacted]	MRBMs &ICBMS	
Type D [redacted]	PPM/AM		various	
Type E [redacted]	PPM/AM		several	

overview of what was known about the Soviet missile and space program in 1958, including COMINT aspects.[10]

(S) Activity at TTMTR was considered of such importance that all field sites were to report activity at EMERGENCY Precedence using a special series of reports called [redacted] An initial report would be issued three hours after Soviet launches, when that information was available.[11]

(U) Bing Crosby (Unknowingly) Helps

(S) A typical telemetry collection system used VHF Yagi antennas, NEMS-Clarke 1302 receivers, and Ampex FR1104 recorders — a 4-channel 100-KHz bandwidth recorder with fifteen minutes running time. Modified records with seven channels were provided in the late 1950s. Magnetic tapes used at ELINT field sites in those times were generally two to four channels and had a recording bandwidth of 100 kHz. This was somewhat improved by running a then conventional 1/4-inch two-track recorder that normally recorded at 100 MHz bandwidth at double speed in order to get 200 MHz.[12]

(U) The magnetic tape recorders eventually used for high fidelity recordings — both by the U.S. broadcasting and the U.S. intelligence communities – had a surprising start.

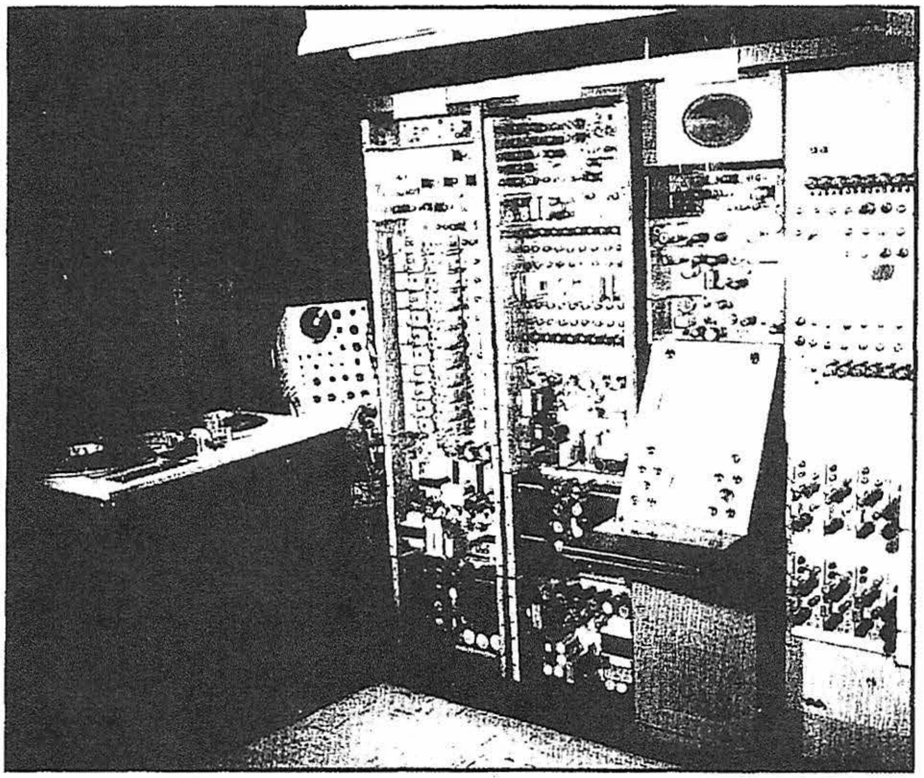
(U) In 1946 singer Bing Crosby wanted to shift his weekly radio show from "live" to recorded, but found significant disadvantages to all the recording mediums then available for his use. In June 1947, his production company became aware of some wartime German recording technology that a man named Jack Mullin had brought back to the United States. Mullin, then working for a film company, was hired to record the Crosby show with this new technology. Using magnetic tape rather than wax disk records allowed editing, by cutting and splicing the tape, as well as significantly improving audio quality.

(U) Crosby hired Mullin in 1950 to head a small — twenty-five person — organization to do recorder development; it was called the Crosby Enterprises Research Laboratory. Crosby also guided and underwrote Ampex (an acronym for Alexander M. Poniatoff plus the initial letters of "excellence"), which was also making improvements to the German technology. By 1950 the Crosby group, working with Ampex, modified an Ampex 300 recorder to operate at 60 ips, which allowed 100-kHz telemetry recordings to be made on a single track of 1/2-inch tape on fourteen-inch reels.

(U) The U.S. government became interested in this technology and used it to record telemetry from its Pacific Missile Test Range firings. It was later adopted by the intelligence community for various purposes, including TELINT collection.[13]

(U) In 1951 Crosby encouraged the development of video recording by his group, and Ampex also began a parallel development. By 1953 Ampex had developed a rotary head recorder for television. The Crosby Enterprises recorder efforts, spearheaded by Mullin, evolved into a broadband recorder that could record 1,000-kHz signals on fourteen tracks of one-inch tape at 120 ips on fourteen-inch reels, which allowed for about fifteen to twenty minutes of recording on one reel.

(U) In 1957 Crosby sold his recorder development interests to the 3M Corporation, which was then into the magnetic tape business; this evolved into the MINCOM series of recorders. By the end of the 1950s, both Ampex and MINCOM were well established in providing tape recorders for instrumentation signals, usually on one-inch-wide tape with fourteen recording tracks, with each track capable of recording 1,000-kHz (1 MHz) signals. Ampex and MINCOM became the primary providers of instrumentation tape recorders for TELINT use for the next twenty-five years.[14]



(U) Fig. 8.
The early (1951) development model of Crosby Ampex 200 video recorder and its associated electronics. Note the use of vacuum tubes and that the video "monitor" is a console in itself.

(U) Fig. 9
Bing Crosby viewing the video recorder. Jack Mullin is shown on the left, and Wayne Johnson, another Crosby Enterprises engineer, is on the right.

(U) The Management (or lack thereof) Approach

(U//FOUO) During the early 1950s the U.S. Air Force, along with the U.S. Army, had the most interest in the developing Soviet missile threat. The threat was addressed independently by many organizations, but coordination among U.S. military departments, CIA, and NSA was minimal at best, competitive at worst.

(U//FOUO) However, in the summer of 1955 a Joint Intelligence Community Task Force, PL 86-36/50 USC 3605 [redacted] was set up for a summer study in Landsberg, Germany, and became known as the RETRIBUTOR LANDSBERG GROUP (RLG). (RETRIBUTOR PL 86-36/50 USC 3605 [redacted]

(U//FOUO) The task force concluded that plans for Soviet ballistic missile testing were probably under way. The USAF started follow-up actions in its Security Service, then under Major General John Samford, USAF, later to become director of NSA, and at ATIC (Air Technical Intelligence Center) under Brigadier General "Hal" Watson, USAF, at Dayton, Ohio. The USAF also established the Soviet Missile Technical Intelligence Group (SMITIG) at San Antonio, Texas. SMITIG activities involved reviewing and reporting on COMINT traffic as well as such collateral information as additional interrogation of German rocket scientists repatriated by the Soviets. There were no Army, Navy or NSA representatives at SMITIG.[15]

(U//FOUO) When SMITIG reports came out, DIRNSA (then Lieutenant General Ralph Canine, USA) objected to the USAF release of the report, which contained a lot of COMINT information that had not been subject to proper NSA reviews. However, he then had an intensive COMINT analysis effort commence at NSA, initially under Dr. Leslie Rutledge and then under CIA Statute CIA Statute [redacted] who later became associate deputy director for science and technology (ADDS&T) at CIA.

(U//FOUO) SMITIG continued its efforts until 1958 when it was disestablished. It was probably put out of operations because NSA was finally becoming heavily involved, and, ATIC wanted better control of the intelligence studies effort and moved that function to Wright-Patterson Air Force Base at Dayton, Ohio. Also, at the time, the Guided Missile and Astronautics Intelligence Committee was being activated under the United States Intelligence Board to provide top-level policy and analysis on intelligence efforts against foreign missile and space activities.[16]

(U//FOUO) The U.S. Army started parallel efforts at Redstone Arsenal under Carl Duckett, who later became deputy director for science and technology (DDS&T) at CIA. The Army effort involved contract assistance from a young electronics engineer/analyst named Dr. William Perry at the Sylvania Electronics Defense Laboratory (EDL) in Mountain View, California. Sylvania was selected by the Army as a "captive" R&D organization to focus on its growing need for electronic countermeasures (ECM), a more technologically complex activity than Army Laboratories could handle at that time. Dr. Perry had joined EDL in 1954 and headed it from 1960 to 1963. He left GTE and founded Electromagnetic Systems Laboratories (ESL), Inc., but in the late 1970s left ESL to become director of defense research (DDR&E) in the Pentagon. "Bill" Perry continued his interest in foreign missile and space intelligence throughout his career, which included being under secretary of defense, research and engineering, from 1977 to 1981 and secretary of defense from 1994 to 1997.

(U//FOUO) The processing and analysis of collected telemetry data were also done by several organizations, often in an uncoordinated manner, and often under contract with companies like Sylvania-EDL, HRB-Singer, Jet Propulsion Laboratory (JPL), Lockheed Missile and Space Division, General Electric, and the Space Technology Laboratory (STL) of Ramo-Woldridge.

(C) NSCID 17, promulgated in 1955, established ELINT policy and provided for a National Technical Processing Center (NTPC); it was established in mid-1956 at the Naval Security Group Nebraska Avenue facility and replaced the Army-Navy Electronic Evaluation Group (ANEEG) that had been started in 1952. NSCID 17 still allowed for separate management of CIA and DoD ELINT activities; CIA had formed its own ELINT collection and processing program in 1954.[17]

(C) In 1956 the NTPC was given the added responsibility of processing telemetry from Soviet missiles. Initially NTPC had about 100 people, none from NSA. However, in 1958 NTPC was transferred to NSA when NSCID 6 was rewritten to centralize management of DoD and military ELINT management at NSA.[18]

(C) NSA began collection coordination and analysis in force in 1958 when the Soviet Missile and Astronautics Center (SMAC), the forerunner of Defense/SMAC, was formed to provide an around-the-clock watch center. Later, elements of the Office of General Studies (GENS), GENS-1 (Soviet Ground Forces Division), GENS-4 (Russian Technical Services Division), and GENS-6 (Advanced Weaponry and Astronautics Division), were combined as A4, the Office of Advanced Weaponry and Astronautics. At that time the SMAC (now called the SIGINT Missile and Astronautics Center) was designated as A41. When the NSA mission was expanded to include ELINT (bringing TELINT - Telemetry Intelligence - as part of the responsibilities), the SMAC center became the focal point for all SIGINT collection coordination against foreign missile targets.[19] Table 1-2 summarizes the missile targets.

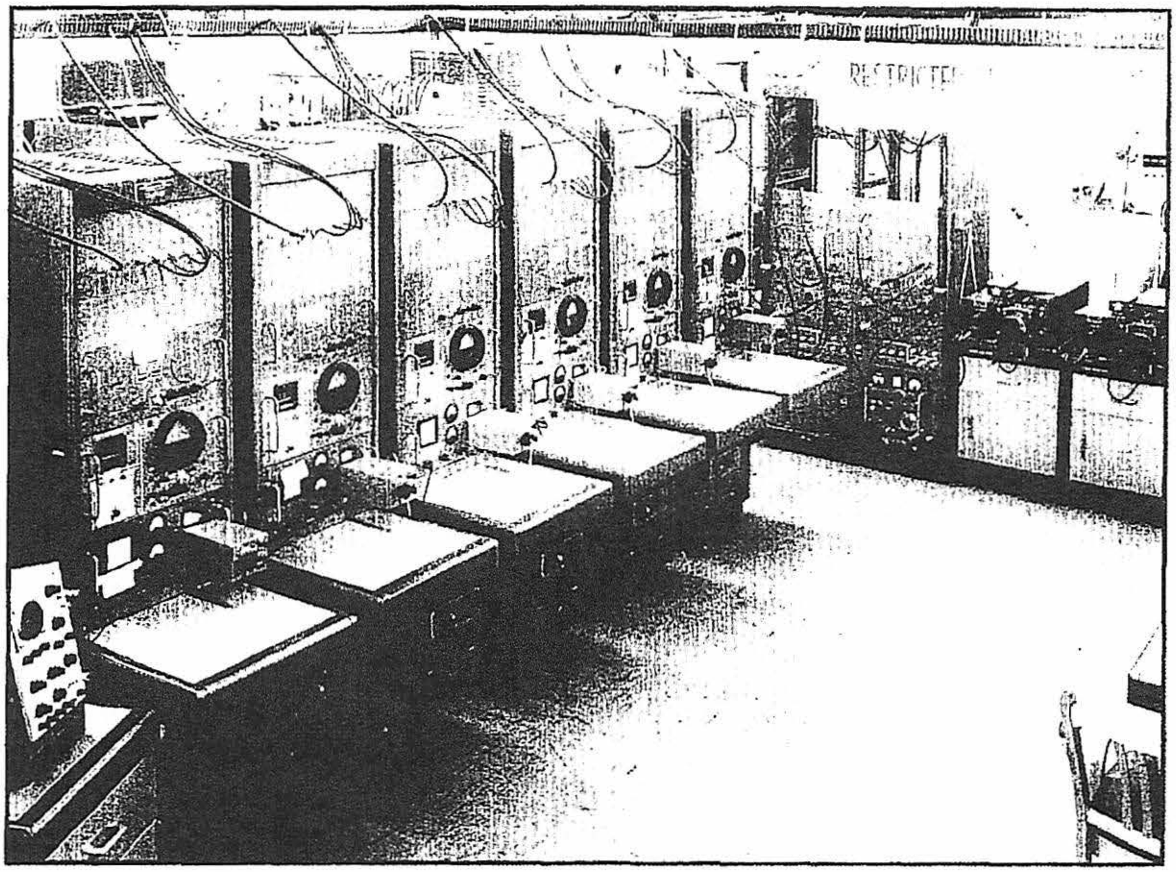
(C) When Defense/SMAC was established in 1964, selected Defense Intelligence Agency (DIA) responsibilities for Department of Defense non-SIGINT collection coordination and the DIA responsibility for initial all-source reporting against foreign missile and space events were added to the SMAC SIGINT activities. Thus, U.S. Department of Defense operational actions and early reporting became focused in one operations center, which remains in place today, albeit updated and modernized several times. (The formation of Defense/SMAC is covered more fully in Chapter 2 of this document.)

(U) New Signals

(S) By the late 1950s the Soviets had started using Type C, D, and E telemetry signals for their missile tests. 1.4(c) 1.4(c) [redacted] became the workhorse signals for the Soviet missile and space program in the late 1960s and on into the 1970s.

(U//FOUO) Based on what was known in 1956, EDL began construction of several systems to go after missile telemetry. Lewis Franklin, a Senior Engineer at EDL, credits Ray Franks, an antenna design engineer, as the first to build a broadband log periodic antenna for use in the VHF band that was able to receive a broad frequency range of signals at a higher signal gain than a Yagi antenna. A second key technical element was the NEMS-Clarke 1302 motor-driven sweeping broadband receiver, which was instrumental in successful collections of early Soviet and Chinese missile and space telemetry where the U.S. did not know the exact frequencies ahead of time and had to search frequency bands.[20]

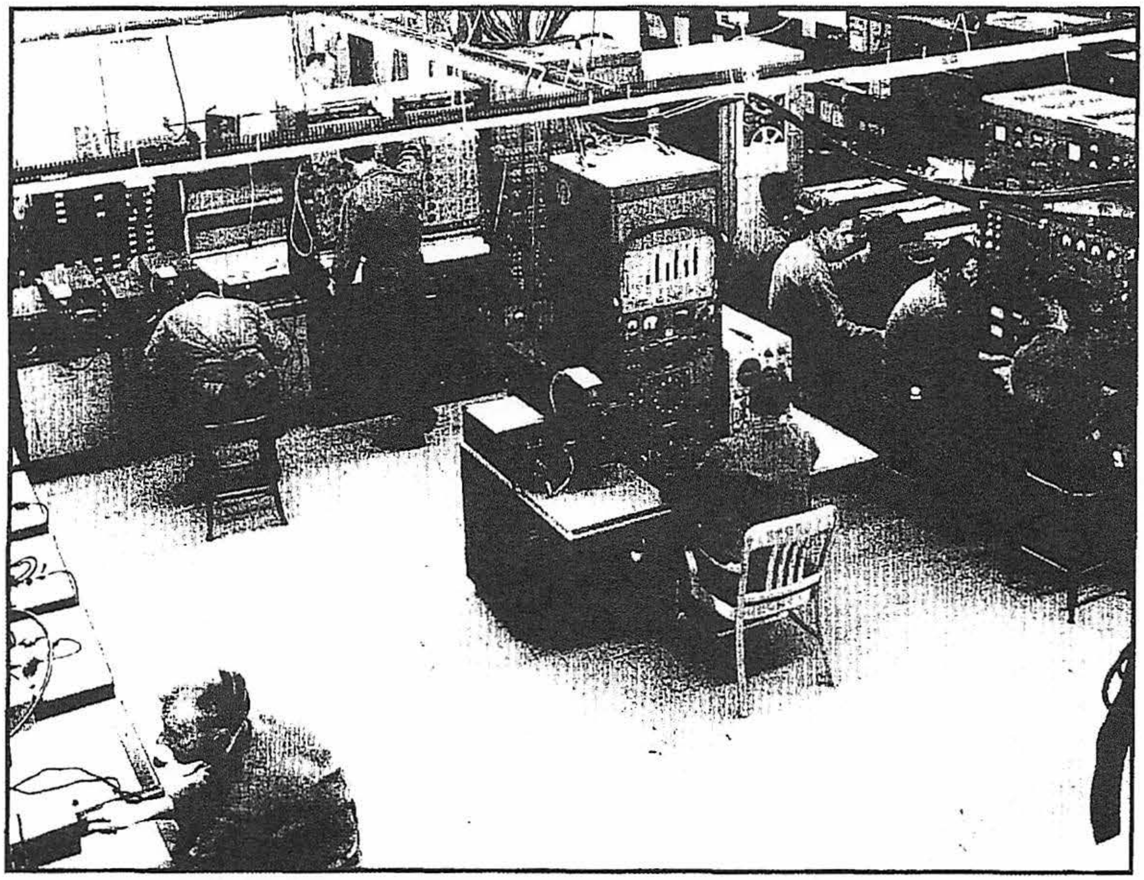
(U//FOUO) One of the first of the early EDL collection systems was Project 5110 in 1956/57 for Sinop, Turkey.



(U//FOUO) Fig. 10. The VHF search positions using the NEMS Clarke motor driven receivers used for the 5100 system (on the right)

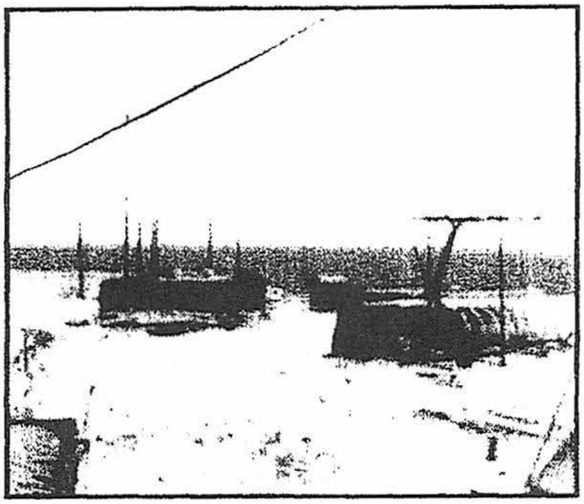
(S) Other efforts were implemented at the Army Security Agency facility at Shemya, Alaska, to look for Soviet ICBM missile reentry telemetry at the impact area on Kamchatka. Using his ingenuity for finding resources, an Army sergeant named Clampett put together a "system" in an unused "Jamesway" building. This was respectfully called "Fort Clampett." The "Fort Clampett" equipment was operated from 1956 until early 1959. The first successful collection of ICBM reentry telemetry from a Soviet ICBM fired into the Kamchatka impact area came on 30 January 1958 from the ASA site at Shemya.[21]

(C) Based on this initial interception of missile reentry telemetry, EDL was tasked to build two systems called ESGM, "Earth Satellite Vehicle and Guided Missile." Originally, ESGMs were to be installed at Wakkanai, Japan, and Shemya, Alaska, but, because of difficulties in obtaining approval from the Japanese government for the Wakkanai installation, the second system was modified to be transportable and was delivered to Helemano, Hawaii.[22]



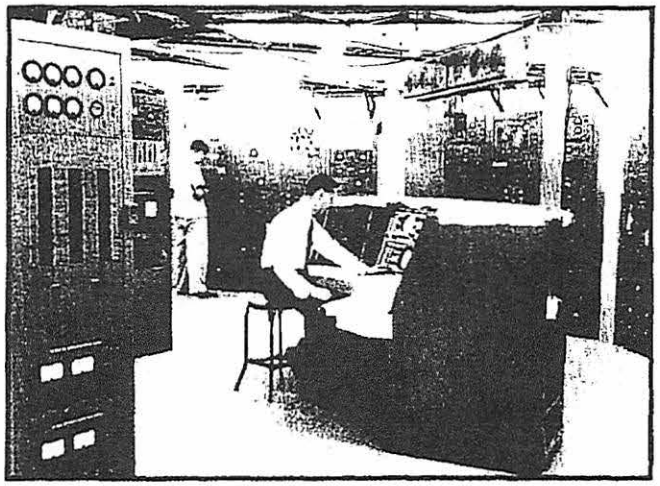
(U//FOUO) Fig. 11. The EDL Project 5110 antenna control console with VHF receivers and 1.4(c) [redacted] receivers on the left. The system was installed at Sinop in 1957.

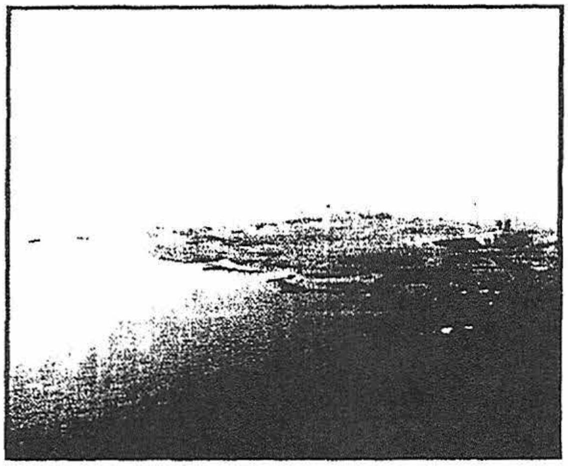
(S) By 1958 a set of equipment called System 5110 (VHF) and 5113 (SHF) was deployed to Sinop, Turkey, along with a modified SCR-584 based 1.4(c) [redacted] 1.4(c) [redacted] 1.4(c) [redacted] 1.4(c) [redacted] It is worthy of note that USASA fully integrated civilian contractor tech reps into the workforce, both at ground sites and in airborne operations, and this often provided a valuable additional source of engineering and systems analysis experience.



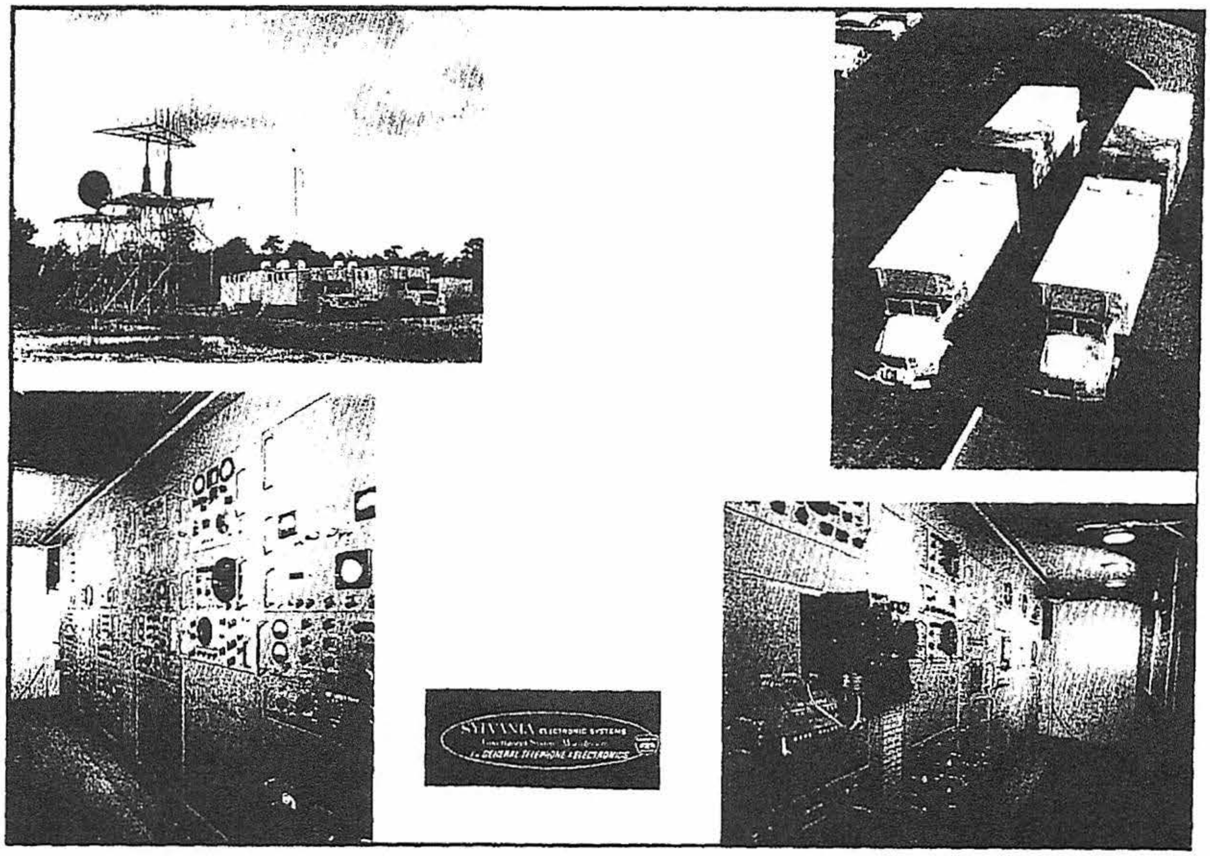
(U//FOUO) Fig. 12. "Fort Clampett" on Shemya. The building and antennas (on the left) and some supply "Quonset" huts that literally blew away into the ocean during a storm in late 1959. The same storm, with winds over 100 knots, damaged beyond repair two U.S. Navy telemetry collection planes that were on Shemya at the time, and it severely damaged the Navy aircraft hangar.

(U//FOUO) Fig. 13. The ESGM antenna control tracking console for the system while it was being staged in Mountain View, CA, by EDL. The VHF receiving positions, using manually tuned NEMS Clarke receivers, are behind and to the left of the antenna control operator, and the SHF receivers are behind and to the right of the operator.

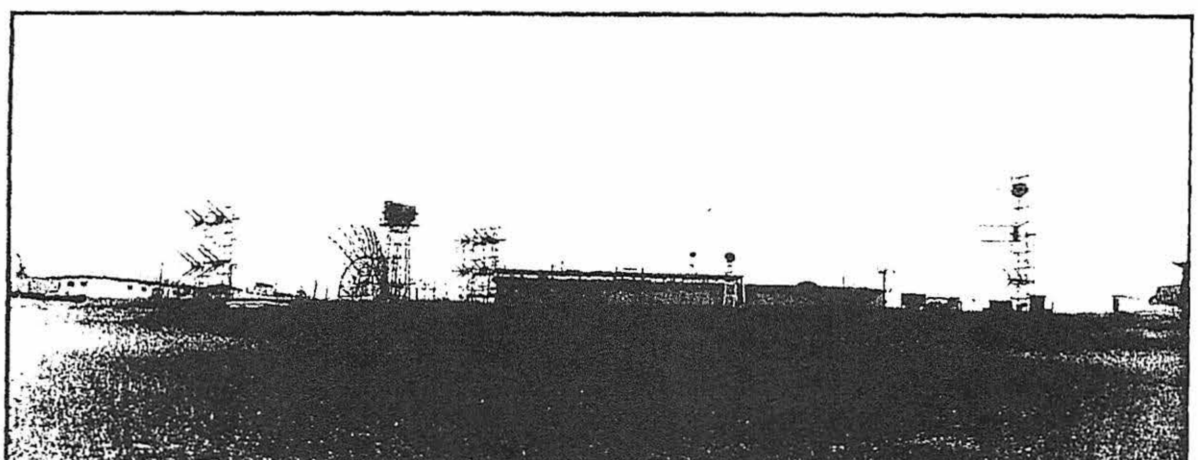




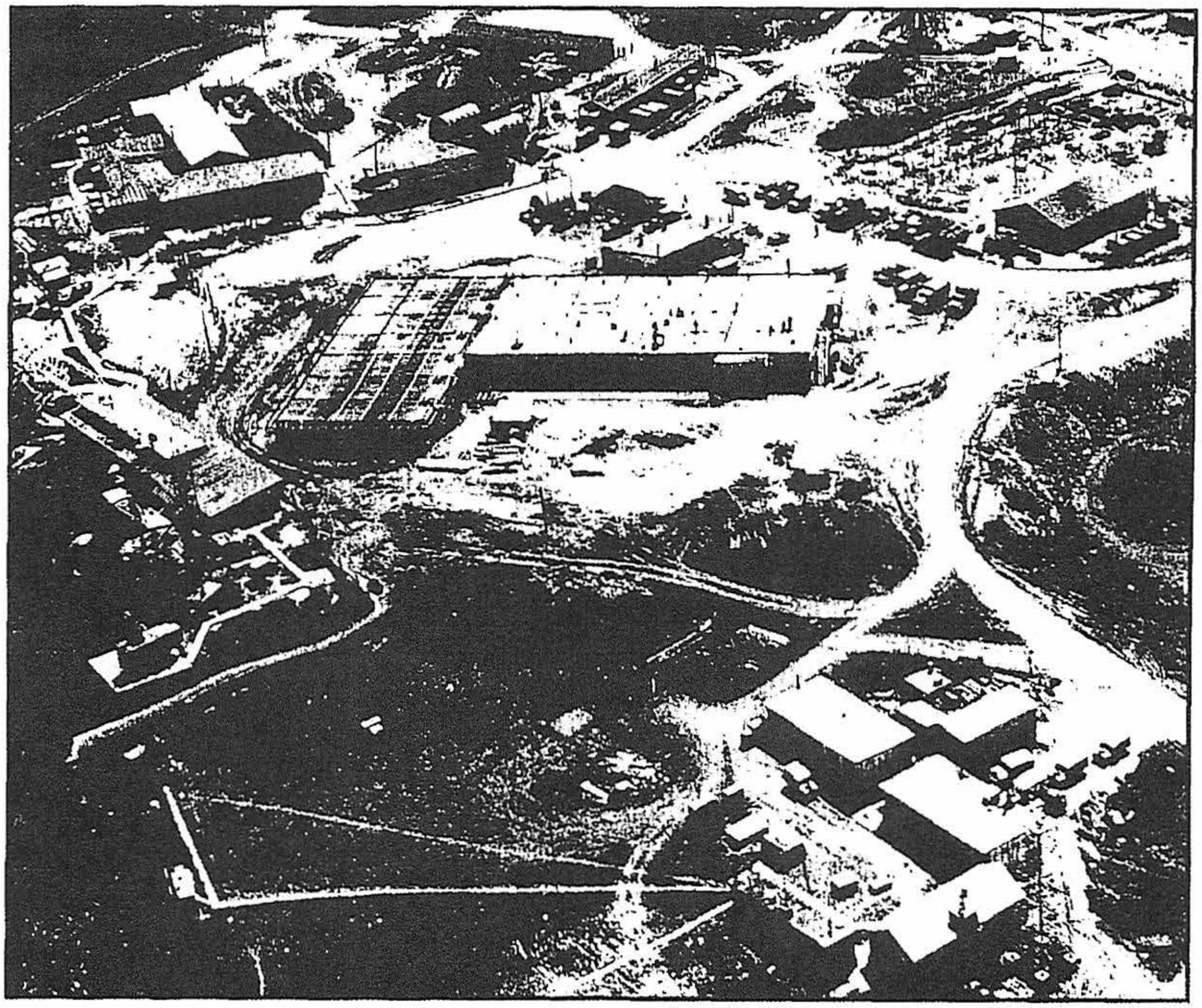
(U//FOUO) Fig. 14. Shemya Island in 1959 with ESGM; and AN/FPS 17 radar (top right)



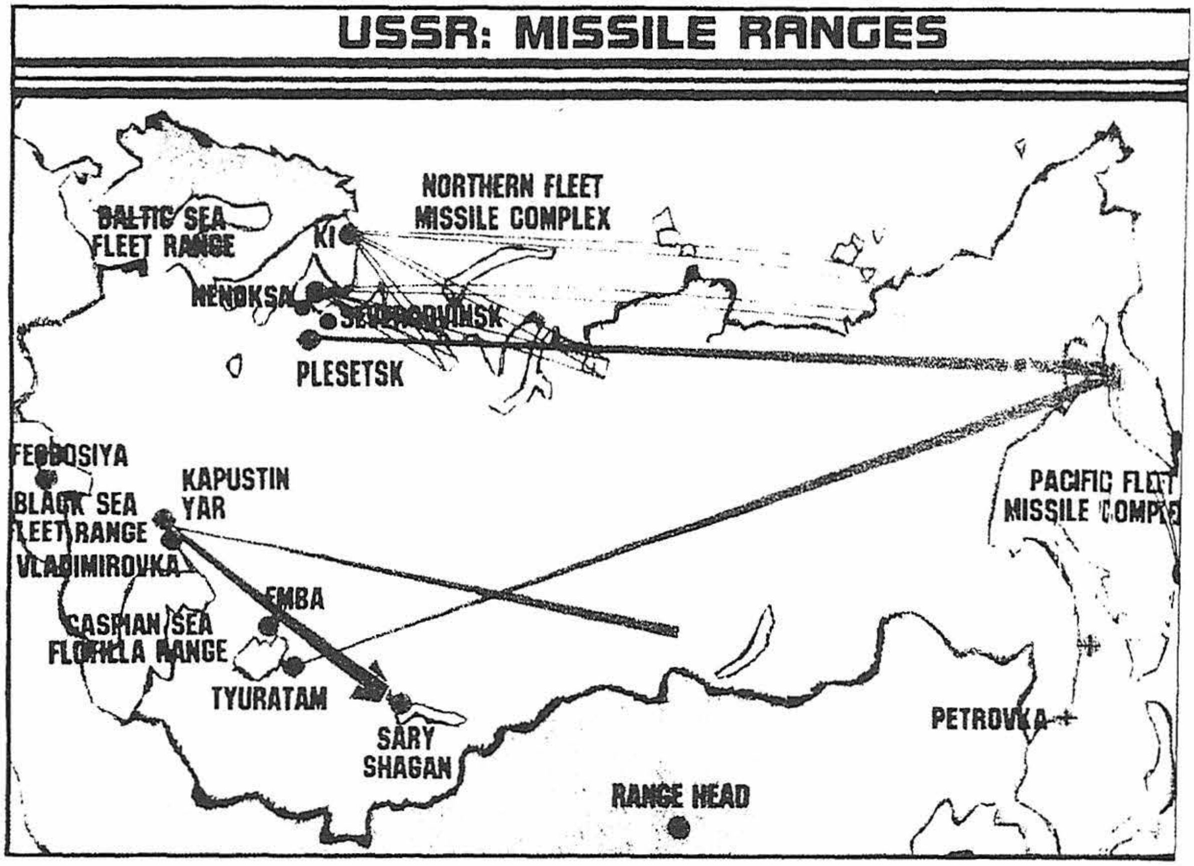
(U//FOUO) Fig. 15. A montage of the EPL 5110/5115 system that was deployed to Sinop, with the equipment in v
since there was not enough space for the equipment in the small operations building available at that time. Person
facilities were in such short supply that some ASA enlisted personnel were still living in tents at that time.



(U) Fig. 16. The broad array of COMINT and ELINT antennas operated at Sinop in 1959



(S//NF) Fig. 17. Most of the Sinop facility in 1959/60 with the one of the [redacted] PL 86-36/50 USC 3605 [redacted] PL 86-36/50 USC 3605 antenna vans at the left of the photo about halfway down the side. [redacted] 1.4(c)



~~(S)~~ *Fig. 18. Soviet primary missile launch sites (Kapustin Yar and Tyuratam at that time) as well as other Soviet launch and impact facilities that developed later. Kapustin Yar was primarily involved in short range ballistic missiles (SRBM), medium range ballistic missiles (MRBM), and intermediate range missile (IRBM) testing. Tyuratam was involved in intercontinental ballistic missile (ICBM) launches and space vehicle launches.*

(U) Table 1-2 Missile Designators and Ranges

Missile Abbreviation	Range Designation	Range Distance
SRBM	Short Range	under 1,000 km
MRBM	Medium Range	1,000-3,000 km
IRBM	Intermediate Range	3,000-5,500 km
ICBM	Intercontinental Range	over 5,500 km

~~(S)~~ By the late 1950s the major U.S. Army ground sites were at Shemya and Sinop, with a smaller site at Soya Point, Japan. The U.S. Navy had several "patrol" aircraft configured for missile radar, optics, and telemetry collection. The U.S. Air Force had ground sites at Samsun, Diyarbakir, and Trabzon, Turkey; Wakkanai, Japan; and Peshawar. It also flew and operated the [redacted] RB-47 aircraft from Incirlik AFB near Adana, Turkey. Even the ASA ground station at Teufelsberg in Berlin, which had many taskings, had an adjunct mission to search for telemetry.

(U) CIA Involved from the Beginning

~~(S)~~ In 1956 CIA determined that COMINT, and perhaps telemetry, from the Kapustin Yar missile/space launch site could be collected from locations in northern Iran. Therefore, it set up a temporary "clandestine" facility at the Shah's hunting palace outside the city of Behshahr and called it EGGSHELL, initially manned on a TDY basis by CIA Office of Communications personnel. The "temporary" site soon expanded and in 1959 began to collect telemetry from newly operational Tyuratam Missile Test Range (TTMTR). It eventually became a permanent location, soon to be called TACKSMAN I. PCS personnel, with family accommodations and amenities would staff it as the operations expanded over the years.

~~(S)~~ 1.4(c) 1.4(c) [redacted] 1.4(c) CIA also had a telemetry collection package configured for the U-2 flights from Turkey and Pakistan.[24]

(U) Contractors in Collection and Analysis

(U//FOUO) Much of the technical work and some of the analysis were done by a number of companies under contract to one of the military services in the 1950s.

(U//FOUO) Electronics Defense Laboratory (EDL), under the guidance of Dr. William Perry in the late 1950s, was formed by the U.S. Army Signal Corps R&D Laboratories in 1953, with fifty employees, as an industrial source of Electronic Countermeasures (ECM) studies and systems. By 1959, as a result of its mission to develop countermeasures equipment and techniques for the Army, EDL was a prime contractor in preparing concepts, developing technology, providing equipment, integrating systems, analyzing results, and supporting operations for foreign telemetry.[25]

(U//FOUO) A report prepared by EDL in February 1959, with Bill Perry as author, shows EDL's comprehensive activities. The booklet provided a summary of ELINT R&D applicable to the foreign missile and satellite problem and recommended approaches and/or projects — almost all of which were pursued, although not necessarily contracted to EDL. The document discussed requirements for increased frequency coverage, twenty-four-hour ELINT signal search, and the need for obtaining pre-burnout and ground guidance signals.[26]

(U//FOUO) Another key company was Haller, Raymond and Brown (HRB), formed in 1947 by Dr. George Haller, Dr. Richard Raymond, and Dr. Walter Brown. HRB was an outgrowth of early ELINT work done by Haller and Raymond during WWII. One of HRB's early contracts, in 1958, was as subcontractor to RCA for one of the first uses of a "modern" computer (Burroughs 101-E) to analyze telemetry. By 1958 the company was part of Singer and was known as HRB-Singer for many years; it was later acquired by E-Systems, and is now part of Northrop-Grumman.[27]

(U//FOUO) EDL and HRB remained heavily involved in studies, signal analysis, and collection system development for the next forty years, with emphasis on field collection systems and intelligence studies using the results of the collected telemetry data.

(U//FOUO) Other contractors who participated in the final processing and substantive analysis of the data included the Missile and Space Division of the Lockheed Corporation, the Jet Propulsion Laboratory, and the Space Technology Laboratory of the Ramo-Woldridge Corporation.

(U) NSA Gets an Expanded Role

(C) While collection resources increased during the late 1950s, telemetry and beacon analysis (and the intelligence conclusions resulting therefrom) was still somewhat fragmented, and there were still a lot of unknown factors.

(C) In May 1959, the Air Force Air Technical Intelligence Center (ATIC) convened a seminar at Inglewood, California, to discuss the status of ballistic missile intelligence. Almost fifty missile and space telemetry and analytic experts from all participating intelligence analysis organizations were assembled. The group concentrated on powered flight telemetry data; one key question was whether the Soviet IRBMs and ICBMs were using radio or inertial guidance. Key participants included Bill Perry (from EDL), Albert "Bud" Wheelon (from STL), Eberhardt Rechtin (from JPL), Carl Duckett (from ABMA), and David S. Brandwein (from STL), all of whom rose to senior management positions in the intelligence and defense community in later years. [redacted] CIA Statute CIA Statute attended from CIA. NSA representatives included Major Roger Stubblefield, USAF, (COSA-5); [redacted] PL 86-36/50 USC 3605 (COSA-5); and [redacted] PL 86-36/50 USC 3605 (GENS-6).

(C) The conference concluded that a great deal of additional COMINT, ELINT, and RADINT data and analysis were needed on Soviet ballistic missile and space launch programs. This seminar led, if indirectly, to the formation of the NSA-managed Telemetry and Beacon Analysis Committee in 1960.[28]

(C) U.S. collection of telemetry signals from foreign missiles and — after the Soviet Union launched SPUTNIK in 1957 — satellites was difficult, since almost all signals were VHF or higher line-of-sight signals, and had to be "tracked" as the target moved along its trajectory or orbit.

(C) Technical challenges were compounded by management challenges. Some U.S. organizations, primarily NSA, considered the signals COMINT, but most other organizations considered telemetry as ELINT. This brought on classification policies and procedures to resolve. The question was settled in 1959, when the United States Intelligence Board (USIB) declared that telemetry was to be treated as ELINT, not COMINT.

(C) The signals themselves did not easily pass through either configuration of existing receivers, COMINT or ELINT, nor were existing SIGINT antennas normally configured to follow, much less "track," signal targets moving as fast as missiles and satellites. In the 1950s the U.S. was fortunate just to obtain the signals, usually VHF PPM, and record them on ¼-inch "wide-band" magnetic tapes in the field for display and analysis at NSA or other U.S. analysis centers. (100 kHz and 200 kHz bandwidth was considered wideband in those days.)

(C) By the end of the 1950s, it was clear that the intelligence community had a major problem on its hands. With customers such as the U.S. military and users who had to design countermeasures clamoring for analytic results about Soviet missile and space activities, NSA found itself right in the middle of the problem.[29] By the late 1950s, there was a growing call for coordination of activities in the light of the expansion and importance of Soviet missile and space activities.

(U//FOUO) Up until 1959, AFCIN-Z on the USAF Air Staff had been the primary DoD coordinating element for ELINT. With the new NSCID 6 of 15 September 1958, NSA became responsible for coordinating DoD ELINT, including TELINT. Some CIA personnel assigned to AFCIN-Z returned to CIA, and some integrated into NSA in January 1959.

(C) In 1959 NSA agreed to take over management of the USASA-sponsored telemetry analysis effort being done by HRB and JPL. NSA concentrated its analysis on shorter range missiles, the

Air Force on ICBMs and IRBMs, and the Army on beacon and guidance systems.

(C) At the same time, NSA created the concept for the Telemetry and Beacon Analysis Committee (TEBAC). The idea was to focus talent in government and industry to determine what signals meant in terms of technical intelligence and bring better coordination to the many technical aspects of processing. Initial TEBAC membership was NSA, USAF, USA, Lockheed Missile and Space Division, Sylvania's Electronics Defense Laboratory, HRB-Singer Inc., the Jet Propulsion Laboratory (JPL), and the Space Technology Laboratory of the Ramo-Woldridge Corporation. Membership was extended to CIA and associate membership to GCHQ — NSA's opposite number in the United Kingdom – and the U.K. Ministry of Defense.[30]

(U) Lessons Learned

(S) Joseph Burke, a long-time TELINT manager summed up NSA's view of the situation in an address to the DIRNSA, Lieutenant General Samford, and other senior NSA and CIA officials in August 1959. Burke reviewed the history of collection, processing, and analysis, then noted that signal collection results went from 54 reported intercepts in 1956 and 150 in 1957, to over 200 by August 1959. In addition to a very small cadre of analysts at NSA and at NTPC, the Army had an in-house effort supplemented by contractors, which was turned over to NSA in March 1959, and the USAF had a largely contractor-based analytic effort. Burke highlighted management and analytic difficulties encountered with such a wide variety of collection platforms and organizations, and finished by noting that NSA was already producing reports from telemetry data, integrating COMINT and Soviet radar tracking data. He said that NSA hoped to expand the Agency's role in coordinating contractor support being provided to the USAF by LMSC and STL.[31]

We might summarize the lessons of the 1950s in this way.

(U//FOUO) **Lesson 1**: When faced with a highly technical and complex problem, form an organization that has the technical competence and the charter to address at least a large part of the problem. The U.S. Army did this when they established the Electronic Defense Laboratory (EDL) to support the Army's mission to combat the growing Soviet missile threat. The Army gave EDL the flexibility to recruit the right people, and permitted them access to the intelligence information they needed to do a good job.

(U//FOUO) **Lesson 2**: With many well meaning but fragmented efforts by several organizations attacking a similar (if not common) problem, i.e., the growing threat from numerous Soviet missile developments, put someone in charge. This started with the formation of the Army-Navy Electronic Evaluation Group (ANEEG), followed by the National Technical Processing Center (NTPC), both with limited success; it culminated with the establishment of NSA as primary DoD focal point for direction or guidance for collecting, processing, and analyzing telemetry from foreign missiles and satellites.

(U//FOUO) **Lesson 3**: When several organizations tackle a complex technical problem with many unknowns, and each can contribute to improving the situation, find a management mechanism that allows all the players to participate. This was done when the separate intelligence organizations agreed to NSA leadership in the concept for the Telemetry and Beacon Analysis Committee (TEBAC) in 1959. This group shared information and exposed government and contractor conclusions to "peer group" review to an extent unprecedented at this time.

(U//FOUO) The 1950s could be characterized as a time when the U.S. intelligence community "got its act together" on a set of emerging Soviet missile and space telemetry targets. This would

(S) Table 1-3 U.S. Telemetry Collection Assets Available by 1959

Location/Name	Facility Type	Based In	Platform/Site Operator
Sinop	Ground (KY)	Turkey	USASA
Samsun	Ground (KY/TT)	Turkey	USAFSS
Diyarbakir	Ground (KY/TT)	Turkey	USAFSS
Trabzon	Ground (KY/TT)	Turkey	USAFSS
1.4(c) [redacted]	Air (KY/TT)	Turkey	Army/Navy
	Air (KY/TT)	Turkey	Air Force
Shemya	Ground (Impact)	Alaska	USASA/USAFSS
EGGSHELL	Ground (KY/TT)	Iran	CIA
Peshawar	Ground (TT)	Pakistan	USAFSS
Wakkanai	Ground (Impact)	Japan	USAFSS/USASA
1.4(c) [redacted]	Air (Impact)	Japan/Alaska	Army/Navy
1.4(c) [redacted]	Air (TT)	Pakistan	CIA

soon evolve into a cohesive and coordinated collection program spearheaded by NSA in the 1960s.

(U//FOUO) Table 1-4 shows the increase in Soviet missile and space events detected by TELINT in the late 1950s.[32] Table 1-5 shows some of the significant activities and events of the 1950s.

(U//FOUO) Despite the increase in telemetry collection shown above, it is instructive to note the conclusions reached by the United States Intelligence Board estimates prepared by the Guided Missile and Astronautics Intelligence Committee (GMAIC) in September 1959. In summary, the NIE stated:

> **Soviet programs in the development of guided missiles and in space flight have been carried forward on a wide front over the past year.... Evidence on some systems is extensive but for the most** 1.4(c) [redacted]

~~(S)~~ Table 1-4 Late 1950s Soviet Missile/Space Telemetry Intercepts

Type	1956	1957	1958	1959	Total
IRBMs and Verticals	18	43	62	71	194
Space Vehicles	0	2	1	3	6
ICBMs	0	0	4	15	19
Pacific Impacts	0	0	0	2	2
Totals	18	45	67	91	221

(C) Table 1 5 Significant TELINT Activities/Events for the 1950s

Year	Activity/Event
1950	Crosby Group and Ampex begin to develop magnetic tape recorders with sufficient bandwidth to record telemetry. Ampex 300 modified to produce 100 KHz band width
1952	Army-Navy Electronics Evaluation Group (ANEEG) established at Naval Security Station on Nebraska Avenue
1953	First use of Ampex 300 to provide 1-MHz recording capability in an RB-47 Soviet overflight
1954	CIA forms its own ELINT program
1955	NSCID-17 provides policy guidance for DoD and CIA ELINT/TELINT activities RETRIBUTOR/LANDSBERG Study Group established to review Soviet missile activity
1956	First identified intercept of Soviet missile launch telemetry (from Sinop, Turkey) National Technical Processing Center (NTPC) given TELINT processing responsibilities
1957	Crosby 1-MHz recorder installed on an RB-S7 Crosby recording group sold to MINCOM
1958	NSCID-6 assigns ELINT responsibilities to NSA. NSA Soviet Missile and Astronautics Center (SMAC) established First Soviet ICBM re-entry telemetry collected (from Shemya, Alaska)
1959	NTPC transferred to NSA to become COSA-5 Telemetry and Beacon Analysis Committee (TEBAC) concept developed by NSA Start of U-2 flights designed to collect telemetry

Notes

1 (U) [redacted] "A review of Telemetry Processing."

2 (U) Stanley G. Zabetakis and John F. Peterson, "The Diyarbakir Reader," *Studies in Intelligence*, Vol. 8, no. 4, Fall 1964.

3 (U) [redacted] "Early History of the Soviet Missile Program (1945-1953)," *Cryptologic Spectrum*, Vol. 5, No. 3, Summer 1975. James Harford, Korolev — *How One Man Masterminded the Soviet Drive to Beat America to the Moon* (John Wiley and Sons, 1997).

4 (U) [redacted] Chief, CIA ELINT Branch, memo "Coverage of Soviet Guided Missile Firings," to Chief, Electronics Branch, 10 January 1955.

5 (U) [redacted] "Sinop Revisited," *NSA Technical Journal*, Twentieth Anniversary Issue, 1975, 41. (U) Among the participants in this project were two later NSA senior officials: [redacted] then an engineer with ANEEG, and James Donnelly, then an ASA enlisted man.

6 (U) U.S. Air Force, "Report of Intelligence Community Telemetry Seminar on 18-22 May 1959," ATIC Document AT-9-4594, 55.

7 (U) Interview, Lewis Franklin, 10 September 1998.

8 (U) Thomas R. Johnson, *American Cryptology during the Cold War, 1945-1989* (Ft. Meade: Center for Cryptologic History. [redacted] Sinop Revisited."

9 Interview, January 1999, Robert Phillips, field engineer, analyst, and system planner at Sylvania-EDL in the 1950s; now on staff with the GTE Corporation.

10 (U) USAF Security Service, "ELINT Collection."

11 (U) Ibid.

12 (U) [redacted] R-412 document, "A Review of Telemetry Processing and Analysis," S-136, 23 September 1961. USAF Security Service, Air Force Communications Center, "ELINT Collection of Space Vehicle Signals," December 1958. Interview, Lewis Franklin.

13 (U) Interview, Robert Phillips.

14 (U) Steven Schoenherr, *Der Bingle Technology* (University of San Diego, 1996). "Der Bingle" was an affectionate nickname for Bing Crosby, one of the most popular entertainers of his time. "Tape Recordings: Future Boom," *Fortnight*, 6 January 1954, 21-22.

15 (U) Some of the participants in SMITIG included Joseph Amato (then an AFSS civilian, later an NSA senior), Corley Wonus (then a member of ATIC, later a key manager in Science and Technology area at CIA), and Captain Roger Stubblefield, USAF, who later came to NSA as a civilian.

16 (U) Roger Stubblefield, "The Origins of the U.S. Technical Intelligence Efforts on the Soviet Missile Development Program," unpublished Memorandum for the Record, 22 January 1997, Center for Cryptologic History, Bernard papers. Interview, James Donnelly.

17 (U) Robert S. Knapp, *The Central Intelligence Agency: the First Thirty Years* (CIA: History Staff, 1990).

18 (U) Johnson, *American Cryptology*. Potts, "Sinop Revisited."

19 (U) Frank J. Irons, "Reflections on the Soviet Strategic Missile Threat of 1960," *Cryptologic Spectrum*, vol. 11, no. 3, Summer 1981. Johnson, *American Cryptology*.

20 (U) Interview, Lewis Franklin.

21 (U) Interview, Robert Phillips.

22 (U) Interview, Robert Phillips. Johnson, *American Cryptology*.

23 (U) Interview, Lewis Franklin.

24 (U) Stubblefield, "Origins." Interview, James Donnelly. Gregory W. Pedlow & Donald E. Welzenbach, *The Central Intelligence Agency and Overhead Reconnaissance: the U-2 and OXCART Programs, 1957-1974* (CIA History Staff, 1992).

25 (U) Sylvania Electronic Systems, Electronic Defense Laboratories, circa 1966.

26 (U) William J. Perry, "Recommendations for Augmentation of Guided Missile ELINT Program," (Electronic Defense Laboratory, 6 February 1959).

27 (U) Edward W. Keller, *The History of HRB — 50 Years of Excellence* (25 April 1997.

28 (U) "Report of Intelligence Community Telemetry Seminar on 18-22 May 1959.

29 (U) Melville J. Boucher, "Talomatry and How It Grew," *Cryptologic Spectrum*, Fall 1971.

30 (U) [redacted] "TEBAC: A Unique Intelligence Community Resource," 10 November 1988.

31 (U) Joseph P. Burke, "U.S. Effort to Analyze and Interpret Soviet Telemetry Signals," GENS-6 document TSC No 007/59, enclosure C. C. Tevis memo, "GENS /AWARD -73/59," undated.

32 (U) "Annual ELINT Review — 1960," C (COSA)-51 document S-61-5700, 30 June 1962, 130.

33 (U) National Intelligence Estimate (NIE) 11-5-59, entitled "Soviet Capabilities and Guided Missiles and Space Vehicles," 8 September 1959.