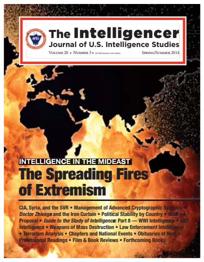

From AFIO's THE INTELLIGENCER
JOURNAL OF U.S. INTELLIGENCE STUDIES
Volume 20 • Number 3 • $15 single copy price
Spring/Summer 2014 ©2014, AFIO

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Guide to the Study of Intelligence

Scientific and Technical Intelligence

A Memoir by a S&T Intelligence Officer

by S. Eugene Poteat, LLD(Hon.)

EDITOR'S INTRODUCTION

The first Soviet atomic bomb test on 29 August 1949 caught the US by surprise. Aided by a long term and successful espionage operation against the Manhattan Project, the detonation highlighted the lack of US intelligence on the USSR. The next year, UN forces in Korea began encountering advanced Soviet-made fighters (MIG-15, some flown sub rosa by Russian pilots) that were superior to America's aircraft. Clearly the US needed more and better intelligence about its adversaries and their weapons capabilities in order to develop appropriate countermeasures and its own weapons systems. Existing SIGINT and technical sensors proved inadequate, calling for a new generation of scientific and technical collection systems to support the development of ever more sophisticated US countermeasures and advanced weapons systems.

The CIA took the lead in the development of new, highly sophisticated approaches to scientific and technical intelligence collection. While much of what CIA undertook remains cloaked behind a curtain of secrecy, the following reminiscences of a senior CIA scientific and technical intelligence officer gives insight into how the CIA responded to the challenge.

A Memoir

Long before I joined CIA its analysts had been unable to answer President Eisenhower's critical "bomber and missile gap" questions. The president called in the nation's leading scientists for advice on what technology might be brought to bear on the issues. This advisory group became known as the "Land Panel" after one the group's more innovative and active members, Edwin "Den" H. Land, president of the Polaroid Corporation. The panel quickly came up with solutions to the "bomber and missile gap" and other intelligence questions as well: 1) Get spies inside the Soviet Union, 2) Use high-altitude aerial reconnaissance to see what missiles and bombers the Soviets have, and 3) begin the development of reconnaissance satellites since aerial reconnaissance will eventually be vulnerable to improving Soviet antiaircraft missile defenses. Surprisingly, Eisenhower directed the CIA to take the lead in developing and operating both the U-2 aerial reconnaissance and the reconnaissance satellite efforts with support from the Air Force. Then Director of Central Intelligence Allen Dulles objected, saying the CIA was not in the business of developing such high-technology systems. Eisenhower's response was, "Well, you are in that business now, because it has to be done in secret."[1]

I was recruited into the CIA from Cape Canaveral, Florida in 1959 and initially underwent the requisite indoctrination into the principals of intelligence and espionage. Contrary to the widely held perception that intelligence is the purloining of secret information from foreign countries, which is then used for advantage in wartime and as an aid to diplomacy, and the catching of foreign spies, or counterintelligence, I learned that intelligence serves a number of other purposes, such as technology development in support of other intelligence programs, support to

1. The Land Panel findings were approved by President Eisenhower in November 1954. The U-2 flew its first mission over the USSR on July 4, 1956 and continued until the May 1, 1960 shootdown of Francis Gary Powers. As a testament to the developers of the U-2 it is still in service with the US Air Force and NASA today. The first successful photographic reconnaissance satellite mission occurred on August 10, 1960. See Richard Garwin, *CORONA: America's First Reconnaissance Satellite System. A View from the Land Panel, Notes for Presentation* George Washington University, May 23, 1995, at *http://www.fas.org/rlg/052295CRNA%20CORONA%201-7.pdf*; Gregory Pedlow and Donald Welzenbach, The CIA and the U2 Program, 1998, at *https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/the-cia-and-the-u-2-program-1954-1974/*; and David Robarge, *Archangel: CIA's Supersonic A-12 Reconnaissance Aircraft*, 2012, at *https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/a-12/index.html.*

treaty negotiations and monitoring, arms control, and more. Until the recent scholarly literature on the subject, published materials on intelligence primarily focused on intelligence disasters, such as the Bay of Pigs or the shoot-down of Gary Powers' U-2 over the Soviet city of Sverdlovsk. The story of American intelligence is much fuller. Recounted here are some of the challenges and successes CIA faced to answer critical national security questions.

Americans were shocked when Khrushchev publicly humiliated President Eisenhower over the U-2 affair. Not widely known was that the U-2's photographs had disproved Khrushchev's boast that Russian missiles were "being cranked out like sausages." that American fears of a severe bomber and ballistic missile gap with the Soviets were unfounded, or that its intelligence was a key ingredient in American diplomacy that permitted President Kennedy to call Khrushchev's bluffs during the Berlin crisis of 1961 and the Cuban missile crisis of 1962.

At the time of the U-2 shoot-down, the CIA already was well along in developing the U-2's replacement, the A-11 OXCART reconnaissance aircraft, at Lockheed's Skunk Works in Burbank, California. The OXCART was to fly at over 90,000 feet at Mach 3.3.[2] The CIA and Air Force jointly had the CORONA photographic satellite well under way in a parallel development that would eventually replace all aircraft over-flights of the Soviet Union.

Concerns about the vulnerability of the yet-to-fly OXCART to the Soviet air defense radar network were the basis for the most sensitive aspect of the project. The OXCART was to be invisible to the Soviet radars—the first-ever stealth aircraft.[3] But how small a radar target was stealthy enough? That depended on how good the Soviet air defense radars were. But for policy makers there were more questions about the Soviet air defense radars than there were answers. President Eisenhower, having been badly burned over the U-2 incident, nonetheless endorsed continued development of OXCART, but made it clear that there would be no over flights of the Soviet Union unless the CIA could prove, absolutely, that it would be invisible to their air defense radars.

The Intelligence Community had no hard information about the transmitter power of Soviet radars, their receiver sensitivity, the spatial coverage of their beams, or even how widespread they were deployed, much less anything about their counter stealth capabilities. The CIA's Clandestine Service could offer no help since it did not have a single case officer inside the Soviet Union at the time.[4]

American electronic intelligence, or ELINT, had virtually nothing to offer about Soviet radar capabilities against stealth. The only option seemed to fall back on making the best possible intelligence estimate with regard to Soviet radar capabilities for dealing with a high and fast airplane with a very small radar cross section. In the words of other intelligence veterans, 'Estimating is what you do when you don't know and cannot find out.'

But there were several problems with the Intelligence Community's estimates. There was often insufficient information available to produce even a guess, much less a reasonable estimate, on such esoteric topics as a radar's ability to detect stealthy aircraft. When available, COMINT and photography were considered the most credible sources of relevant intelligence, and provided the bulk of the technical contributions to National Intelligence estimates (NIEs). ELINT's contribution was virtually nil, and intelligence analysts considered it next to useless. One prominent CIA operations officer said that his Clandestine Service considered ELINT the only five-letter cuss word, that he viewed ELINT as worthless, and that only his agents could be relied on for worthwhile information. He was right in that ELINT provided little information about Soviet radars other than their identification and general location—even when they were within line-of-sight of our ELINT receivers. Most Soviet radars, however, were well beyond the line-of-sight of ELINT.

This was the scene when I joined the CIA's Office of Scientific Intelligence as a new engineer. I was soon cleared into the OXCART project and into its stealth aspect. The OXCART mission planners were especially concerned about just how widespread the Soviet early warning radars were and where they were located. It seemed impossible, however, to determine the number, exact location, or any other technical information on those radars. I recalled an occasion at Cape

2. The original aircraft was designated the A-11 and later the A-12. It would become the predecessor to the Air Force's better-known SR-71 Blackbird.

3. The engineering approach to stealth was to create an airplane that would result in a deceptively small blip on enemy radar screens by shaping the airplane with razor-sharp edges, or chines, by tilting the rudders inboard to reduce radar reflections, and by using as much composite radar-absorbing material as possible.

4. This was because Llewellyn Thompson, the US Ambassador in Moscow, would not permit such risky, 'dirty' business as intelligence to jeopardize his sensitive diplomatic position during his initial term (1955-57). He again served in Moscow from 1967-69.

Canaveral in the early 1950s, when the signal from a ground-based radar located a thousand miles beyond our horizon was picked up at the Cape—the signal had been reflected off a Thor missile during a test flight. A plan was made to exploit this same phenomenon (later called "bi-static intercept") to intercept high-powered radars well over the horizon by pointing ELINT antennas at Soviet ballistic missiles during their flight testing and using the missile's radio beacon for pointing, or simply programming the ELINT antennas to follow the missile's predicted trajectory.[5]

Project MELODY

CIA management approved and Project MELODY was born.[6] MELODY was installed at a CIA monitoring site on the shores of the Caspian Sea in northern Iran in late 1960. Over the ensuing years, MELODY produced bi-static intercepts of virtually all the Soviet missile tracking radars, including some located at a test range nearly a thousand miles away. The fixed location of MELODY and limited trajectories of the Soviet missiles being tracked, however, still did not provide the locations of all the air defense radars throughout the Soviet Union that were needed by the OXCART mission planners.

A new powerful Soviet air defense early warning radar, called the TALL KING, began to appear about this time, which, if deployed widely, appeared to improve significantly the Soviets' air defenses. TALL KING radar quickly became the OXCART's nemesis. MELODY's success with the high-powered, missile-related radars led to the idea of using the moon as a distant bi-static reflector to locate the Soviet TALL KING radars deployed in the Soviet Union.

Stretching the bi-static concept as far as we could, we attached sensitive ELINT receivers, tuned to the TALL KING frequency, to the giant 60-foot RCA radar antenna just off the New Jersey Turnpike near Moorestown, and pointed at the moon. Over time, as the Earth and moon revolved and rotated, all the Soviet radars came into view one at a time and their precise geographic locations plotted. The extremely large number of radars that were found and their extensive coverage of the Soviet Union was disturbing news for the OXCART Program Office—and for the US Air Force's Strategic Air Command, which had to plan wartime bomber penetrations routes.

Now assigned to the OXCART Program Office, I was given the job of trying to obtain the hard technical data needed to resolve the stealth vulnerability issue. In looking at the Soviet air defense radars, particularly the TALL KING, and, to a lesser degree the radars associated with anti-aircraft missile systems, we knew we had to get answers that could stand the most stringent scrutiny from the policy makers that would be involved in approving future OXCART over flights. I assembled a small group of engineers and scientists who were known for their innovation, their understanding of the Soviet air defense system, and a nose for running one-of-a-kind field operations anywhere in the world. We outfitted a C-97 cargo aircraft that operated in the air corridors from West Germany to Berlin—which had line-of-sight access to East German-based Soviet radars—with laboratory precision measurement instruments. There was a similarly equipped Air Force RB-47 reconnaissance aircraft that operated around the periphery of the Soviet Union. This effort led to a series of airborne ELINT systems that could measure a radar's spatial coverage and radiated power with extreme precision.[7]

The precise dimensions of the TALL KING's antenna were also needed for our calculations. One US Army military attaché got close-in ground photographs of the radar in East Germany. The antenna was mounted on a small brick base, and we asked for the dimensions of one of the bricks. It turned out the bricks were from the nearby Pritzwalk Brick Factory and easily acquired. When we asked our Clandestine Service to filch a Pritzwalk brick, we dared not admit it was for an ELINT project. We were happy with their impression that it was to be hollowed out and used for an agent's dead drop.

Our special systems were installed in a series of Air Force planes, starting with the C-97 and RB-47, then C-130s, and finally ever more modern aircraft.[8] Missions were flown around the world, along the periphery of all Communist countries and in the Berlin air corridors. Technical reports on the mission results were published by CIA and distributed throughout defense and intelligence communities, as well as to

5. Previously, the common practice had been to point the antennas at the horizon, in the direction of the target radars. There was little wonder no distant signals were ever intercepted.

6. There were no computers in those days, so our feasibility studies and engineering calculations involved solving spherical trigonometry equations using slide rules, tables of logarithms, and hand-cranked calculators.

7. The system could also measure other important radar signal parameters, including radio frequency coherence, polarization and internal and external signal structure—details that provided even further insight into a radar's performance that would be vital to designers and builders of electronic jammers.

8. The US Air Force now operates two specialized RC-135 Combat Sent airborne technical ELINT collectors to obtain precise measurements on radars of interest in many countries.

the defense industry's electronic countermeasures designers. These reports were eventually distributed to allied countries as well.

One revelation of this accurately measured air defense coverage was that the Soviet's low-altitude radar coverage was far better than our analysts' earlier estimates, and the Strategic Air Command quickly changed its wartime plans to penetrate at much lower and survivable altitudes. The projects also answered the analysts' question of whether the TALL KING radar also had a height-finding capability for determining an aircraft's altitude as well as its bearing and range. One of our RB-47s over the Sea of Japan, towing a special antenna nearly a mile behind the aircraft abruptly descended 5,000 feet and then quickly climbed back to cruise altitude. A nearby National Security Agency monitoring site confirmed that the Soviets' had in fact observed and reported the change in altitude.

Project PALLADIUM

We now knew the Soviet air defense radars' power and spatial coverage, but that was only half the answer to the OXCART's stealth—and health. We also needed to know the sensitivity of the Soviets' radar receivers and the proficiency of their operators. The CIA had a stable of top outside scientists to draw on, and with their help and suggestions, I came up with an electronic scheme to generate and inject carefully calibrated false targets into the Soviet radars, deceiving them into seeing and tracking "ghost" aircraft.

We could simulate a false target including its range and speed.[9] Our project was dubbed PALLADIUM. The real trick was to find some way of discovering which of our blips the Soviets could see on their radar screens—the smallest size blip being a measure of the sensitivity of the Soviets' radars and the skill of their operators. We began looking at a number of possible Soviet reactions that might give us clues as to whether our ghost aircraft was seen. We finally discovered that certain Soviet communications links could be monitored to reveal Soviet detection and tracking of our ghost.

Every PALLADIUM operation consisted of a CIA team with its ghost aircraft system, a NSA team to monitor the communications links, and a military operational support team. Covert PALLADIUM operations were carried out against a variety of Soviet radars around the world, from ground bases, naval ships, and submarines.

When the Soviets covertly moved into Cuba in an attempt to checkmate US military superiority it presented a golden opportunity to measure the system sensitivity of their SA-2 anti-aircraft missile radar. One memorable operation, conducted during the Cuban Missile Crisis, had the PALLADIUM system mounted on a Navy destroyer out of Key West. The destroyer lay well off the Cuban coast, out of sight of the Soviet radars near Havana, but with our PALLADIUM antenna just breaking the horizon. A false aircraft was made to appear to be a US fighter plane about to overfly Cuba. The idea was for the early warning radar to track our electronic aircraft and then for a Navy submarine, that had covertly slipped into Havana Bay, to surface and release a series of calibrated metallic balloon-borne spheres of different sizes that would rise into the path of the oncoming false aircraft. It took a bit of coordination and timing to keep the destroyer, submarine, and false aircraft all in line between the Havana radar and Key West. We expected the Soviets would track and report the intruding aircraft and then switch on their SA-2 radars in preparation for firing their missiles—and would also report seeing the other strange targets, our spheres, as well. The NSA team, with its skilled team of Russian and Spanish linguists and their monitoring systems on board the destroyer, would provide feedback. The smallest spheres reported seen by the SA-2 radar operators would correspond to the size, or smallest radar cross section aircraft, that could be detected and tracked.

While we got the answers we went after, it was not without some excitement—and entertainment. Cuban fighter planes had fired on a Liberian registered freighter the day before. This led us to expect that the Cubans and Soviets would not hesitate to attack a US-flagged vessel. In the middle of the operation, Cuban fighter planes were dispatched to intercept the intruder. We had no trouble in manipulating the PALLADIUM system to keep our ghost aircraft just ahead of the pursuing Cuban fighters. When the NSA team heard the Cuban pilot radio his controllers that he had the intruding aircraft in sight and was about to make a firing pass to shoot it down, we all had the same idea at the same instant. The engineer moved his finger to the switch, I nodded yes, and he switched off the PALLADIUM system.

9. Basically, we received the radar's signal and fed it into a variable delay line before transmitting the signal back to the radar. By smoothly varying the length of the delay line, Knowing the radar's power and spatial coverage from the aircraft precision measurements, we could now simulate an aircraft of any radar cross section, from an invisible stealth airplane to one that made a large blip on Soviet radar screens—and anything in between, at any speed and altitude, and fly it along any prescribed path.

Important Achievements

By now, we felt we knew at least as much about the Soviets' radars as they did. We also knew that their radars were excellent, state of the art, and their operators were proficient. We had finished our special mission, concluding that as soon as the OXCART came over the horizon, Soviet air defense radars would immediately see and track it. At the same time, however, we had established realistic stealth radar cross section goals that, if met by the next generation of stealth aircraft, would allow the aircraft to fly with impunity right through the Soviet radar beams. The F-117 stealth fighter would eventually be the first aircraft to meet these goals—with the help of other CIA engineers and scientists.

Even before we had finished our projects, it had become obvious that, if the OXCART could not fly stealthily, it could in the meantime fly safely, relying on its superior performance to out-fly anti-aircraft missiles. But we would need a stable of effective electronic countermeasures systems in the future. Our small group had already spun off two other groups, one to take on the job of developing electronic jammers and warning receivers for the OXCART, SR-71 and the U-2s that were still flying, and a second group to continue investigating revolutionary techniques to improve stealth technology.[10]

President Eisenhower had personally approved the initial development of the OXCART program, and Kennedy had supported its continued secret development—but made it clear there would be no over flights of the Soviet Union unless its stealthiness and invulnerability were guaranteed, which was not to be. In one of President Johnson's first speeches, he announced the existence of this unique aircraft, effectively declassifying the project. Shortly thereafter the Soviets began development and testing a new surface-to-air missile, the SA-5, clearly designed to intercept such extremely high-altitude, high-speed aircraft as the OXCART.

During the years that our small group of engineers was in existence, we would occasionally discuss just how far we could go in terms of probing, spoofing, and injecting false targets, signals and information into an enemy's electronic or communications networks to covertly learn more about his hidden, concealed or secret capabilities and intentions. We also brainstormed about what responses or secondary reactions, observables or seemingly unrelated responses to our probing we might look for when radiation security, encryption and deception were used. The process had no name at that time, but in retrospect, we were unwitting participants in the beginnings of what is now known as information warfare.

Caught Cheating

One of MELODY's more significant contributions would come about during negotiations with the Soviets on the 1972 Anti-ballistic Missile (ABM) treaty—which included an obligation not to give non-ABM systems, such as the new Soviet SA-5 anti-aircraft missile, capabilities to counter strategic ballistic missiles—and not to test them in an ABM mode. In preparing a National Intelligence Estimate (NIE) intelligence analysts were debating whether the SA-5 anti-aircraft missile could be upgraded to become an ABM and whether the Soviets might try to so test it covertly.

After nearly a year of trying to come up with an estimate of SA-5 capabilities and Soviet intentions, many analysts believed that the Soviets would never dare cheat on such an important treaty. I suggested that we assume that the Soviets, based on their history, should be expected to cheat by testing their SA-5 against one of their own ballistic missiles, and that we need only find a way to catch them at it. Much to the chagrin of the some analysts, MELODY answered the question within a few weeks. MELODY was modified by adding a special ELINT receiver tuned to the SA-5's ground-based target-tracking radar frequency—which was known by then. We relied on an Air Force's surveillance radar in another country for a tip-off of Soviet missile launches. MELODY, pointing its antenna at the Soviet missiles in flight from the Sary Shagan missile test range nearly 1,000 miles away, readily intercepted the SA-5 target tracking radar signals in the forbidden ABM role. During one of the ensuing Geneva negotiating sessions, Dr. Henry Kissinger, using intelligence derived from the MELODY intercepts, looked his Soviet counterpart in the eye and read him the dates and time

10. The CIA's electronic countermeasures expertise would eventually benefit the Air Force. One of the U-2 missile warning receivers developed was modified and installed in an Air force fighter plane and became the basis of a later system called WILD WEASEL, used to locate and destroy SA-2 missile sites in North Vietnam. WILD WEASEL became the stuff of great stories and legends about the derring-do of the pilots who hunted down the SA-2 sites, launched their radar-killing missiles in close, and dodged the missiles fired at them during these encounters. Mike Nastasi, *The Wild Weasels: Daredevils in the Sky, Military History* Online at *http://www.militaryhistoryonline.com/vietnam/airpower/wildweasel.aspx* and W. A. Hewitt, *Planting the Seeds of SEAD: The Wild Weasels in Vietnam*, School of Advanced Airpower Studies, Air University, Maxwell Air Force Base, Alabama, PhD Thesis. May 1992. *http://www.au.af.mil*.

they had cheated on the treaty. The cheating immediately ceased, and the Soviets began a mole-hunt for the spy in their midst that most surely had tipped us off.

Counting Enemy Troops

During the Vietnam War CIA's special task force engaged in a heated debate with the Army and Secretary of Defense McNamara's office over the infiltration rate of North Vietnamese soldiers. CIA estimates were much larger than those of the Department of Defense, and if they could be validated, did not bode well for the outcome of the war. A quick study revealed that the Air Force had airdropped acoustic sensors along the Ho Chi Minh Trail in an attempt to detect and count infiltrators.[11] Both the Air Force and Navy also had SIGINT aircraft, EC-47s, EC-130s and EC-121s, orbiting off the Vietnamese coast to intercept and count the number of small radios carried by the infiltrating groups, always traveling in fixed numbers, on their trek south on the trail. A good estimate was obtained by multiplying the radios by the number of men per group. The problem was that the orbiting SIGINT airplanes could not fly high enough to intercept all the radios on the very long trail.

Our solution was simply to get an airplane that could fly high enough to intercept all the radios simultaneously for an accurate count. The Air Force quickly found a special radio receiver, installed it in a U-2, and had the operation underway in about a month. A U-2 could stay aloft for 12 hours; two could provide 24-hour coverage. The infiltration rate turned out to be more like a flood. The Defense Department would finally accede to the higher CIA numbers.

Looking Back Over a Career Some Thoughts

Presidents turned to CIA to answer vital questions. CIA evolved and invested in its technical capabilities to respond as required. President Eisenhower valued and understood intelligence from his wartime experiences, supported the U-2 program and used its intelligence effectively. Kennedy, new to his office, while badly burned by the Bay of Pigs debacle, was always a quick learner, and effectively used U-2 collected intelligence in defusing both the Berlin and Cuban Missile Crises. Other presidents were not so friendly to intelligence. President Reagan had a predilection for using intelligence to counter the Communists. He encouraged many high technology programs, such as the Strategic Defense Initiative—disparagingly labeled Star Wars by the media—against which the Soviets had no hope of competing. Reagan's intelligence services, with his personal knowledge, would then foil the KGB's extensive efforts to steal American computers and communications know-how, which the USSR needed to match the SDI technology and improve its lethargic industries. [12]

Having learned the value of intelligence from his job as Nixon's National Security Advisor, Secretary of State Dr. Henry Kissinger became a voracious consumer and user of intelligence. Not only did he use it effectively to reduce Soviet cheating on the ABM treaty, he cut off the supply of CIA satellite photography to an ally, Britain, until he gained their agreement allowing the U-2 to operate from the British air base in Cyprus during the cease fire in the Arab-Israeli war in 1974. On those occasions when we were briefing a high-level panel on a planned CIA operation, to obtain the requisite approval before proceeding, Kissinger was, more often than not, the panel member that thoroughly grilled us on every detail of the planned operation, including background, ramifications if things went wrong, and whether other options were considered.

History is replete with examples of the use, and abuse, of intelligence and intelligence organizations. Strong willed leaders often think they know best, especially if the intelligence is soft or only an imprecise estimate. Even if the intelligence is hard, they still may choose to ignore it, depending on their own political agendas. Presidents and other policy makers seem more likely to use, abuse, or ignore intelligence, depending on their predilection or prejudice toward the subject. Intelligence is an esoteric and often misunderstood subject, and a busy president or other policy maker, if he has no prior reading or understanding of the subject, will find difficulty in acquiring it. A policy maker with an unreasoned prejudice against intelligence, along with a lack of understanding of its historical value, can do as much, if not more harm to the national interest as can one with a predilection

11. For a history of the Igloo White sensor program see Philip D. Caine, *Igloo White*, July 1968 to December 1969, Headquarters PACAF, January 1970, declassified and available via *http://en.wikipedia.org/wiki/Operation_Igloo_White*. The Vietnam order of battle controversy is examined by Naval Postgraduate School professor James Wirtz, "Intelligence to Please? The order of battle controversy during the Vietnam War," *Political Science Quarterly*, Vol. 106, No. 2 (Summer 1991), pp 239-263. *http://www.jstor.org/stable/2152228*.

12. The fascinating story of the covert action to respond to the extensive Soviet pilfering of US and western technologies is told by Gus W. Weiss, "The Farewell Dossier," *Studies in Intelligence*, at *https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/csi-studies/studies/96unclass/farewell.htm*.

toward intelligence and a belief that it can do more than it actually can?

The CIA's ever-more advanced high-tech intelligence collection systems, with a new generation of ultra-high tech satellites, the operation to recover a Soviet missile submarine from the floor of the Pacific Ocean, and the many other classified collection systems, has led to CIA's reputation as one of the nation's leading R&D establishments.[13]

READINGS FOR INSTRUCTORS

Each year more and more materials are declassified and released about US intelligence efforts to obtain the information needed for policymaking and defense planning. Recommended are the following:

Richard Garwin, *CORONA: America's First Reconnaissance Satellite System*. A View from the Land Panel, Notes for Presentation George Washington University, May 23, 1995, at *http://www.fas.org/rlg/052295CRNA%20 CORONA%201-7.pdf*.

Gregory Pedlow and Donald Welzenbach, *The CIA and the U2 Program*, 1998, at *https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/the-cia-and-the-u-2-program-1954-1974/*.

David Robarge, *Archangel: CIA's Supersonic A-12 Reconnaissance Aircraft*, 2012, at *https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/a-12/index.html*.

For a summary of Project AZORIAN, the attempt to raise the sunken Soviet missile submarine in the Pacific see *Project Azorian: The CIA's Declassified History of the Glomar Explorer* at *http://www2.gwu.edu/~nsarchiv/nukevault/ebb305/*

For the story of how CIA tapped a vital cable in Moscow (Project GTTAW) see Milt Bearden and James Risen, *The Main Enemy: The Inside Story of the CIA's Final Showdown with the KGB*, Ballentine Books: New York, 2003.

In *The Wizards of Langley: Inside the CIA's Directorate of Science and Technology*, (Boulder, CO: Westview Press, 2002) researcher Jeffrey T. Richelson writes "Several of the most important collection systems the United States operates today are direct descendents of earlier CIA programs."

Many CIA technical efforts are discussed in *Spycraft: The Secret History of CIA's Spytechs, from Communism to Al-Qaida* by Robert Wallace and H. Keith Melton. (London: Penguin Books, 2008). Wallace was the former chief of CIA's Office of Technical Services.

Gene Poteat is President of the Association of Former Intelligence Officers and a retired CIA senior scientific intelligence officer. He presently writes and lectures on intelligence and national security issues.

13. Besides development of pioneering aircraft such as the U-2 and A-11 OXCART, CIA scientists and engineers have developed space-based systems for imagery and SIGINT collection, and digital systems which formed the foundations for today's GEOINT capabilities. Project AZORIAN was a multi-year effort to recover the Soviet submarine K-129, which sank in April 1968. In the summer of 1974, the specially built ship, Glomar Explorer, recovered part of the submarine. Project GTTAW was a covert tap on an underground cable in Moscow that connected the Soviet nuclear weapons R&D complex with the Ministry of Defense. For six years CIA officers accessed the recorders on the cable revealing much about Soviet weapons capabilities and developments.