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TITLE: The Life And Death Of Cosmos 954

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The satellite that came into the cold.

THE LIFE AND DEATH OF COSMOS 954

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Cosmos 954 was launched in the Soviet Union on 18 September 1977. By November, U.S. tracking radars had observed an unusual decay in its orbit. On 6 January 1978 the satellite lost its attitude stabilization system, a terminal ailment. On 24 January Cosmos 954 crashed in the ice and snow near Great Slave Lake, Northwest Territories, Canada.

This satellite was one of a series scanning the oceans by radar, seeking out large surface ships. Such satellites use a small nuclear reactor to power a radar and the equipment needed to report to a ground station. CIA and DIA judged the reactor to be of the so-called *Romashka* variety, but no one could say for certain that it *was* this type; this was surmise, nicely done, but still circumstantial. Fuel for *Romashka* is 90 percent enriched Uranium-235, embedded in carbide and surrounded by graphite moderator, yielding a compound considered distinctly unhealthy to fondle. Throughout 954's decay and reentry, its reactor (of whatever type) was alive and hot.

One virtue of 954's life and death is the simplicity of describing the problem it posed, namely: what does one *do* about a live nuclear reactor reentering the earth's atmosphere aboard a Soviet surveillance satellite? A quick scan of literature showed no textbook answer, nor even a textbook question. It remained for the National Security Council Staff to put together a group to cope with the problem, and this article is some of that group's story. It contains elements of tension, humor, self-satisfaction, and some demonstration of the timely use of intelligence.

For those enamored of methodology, permit me to suggest two problem-solving approaches:

Type One: Crisis Management. This scheme suggests that untoward circumstances can be contained, that reasoned information can be made available and used, and that calculated risks are there to be taken. Objectives can be set and means for those objectives spelled out, and out of that array a decision can be reached.

Type Two: Muddling. This implies making up responses as a problem progresses, and coping as events and information unfold over time. Muddling is very much the label for a process, and is to be distinguised from "muddling through," which is a conclusion. Muddling occurs when the decision maker is not sure where he is headed, but has a good idea where he would *not* like to end up. A fancy word is "heuristic," meaning figuring out how to figure it out as time yields its clues.

Those bloodied by the real world recognize that both types apply—the issue of which scheme dominates a problem is determined by the properties of the problem itself. In theory, it would seem necessary to divine the characteristics of a situation before launching into its resolution (nobody in modern history has ever done this, given the resolute dominance of the demand for answers over processes needed to obtain them). In the Instance of Cosmos 954, two properties dominated: the NSC group had some time to think the problem through, and second, the "opposition" was Newton's Law of Gravitation, later compounded by Bernoulli and the physical effects of aerodynamic drag on the satellite. The game was against nature rather than against conscious intelligence. This in turn became reckoning the time and place of 954's

reentry and the likely consequences of that reentry. To the group, "likely consequences" was the probability that one human might be injured (the judgment was one chance in 10,000). For the time and place of reentry, United States tracking experts produced the correct date—24 January—with a spread of two days that narrowed as the 24th approached. For the place, one might cautiously describe this estimate as night baseball with the lights out.

One precondition to problem-solving is in fact to deduce that a problem exists and to move the issue to a forum where it can be worked. The Air Defense Command inferred decay in November, and by formal and random ways sufficient interest boiled up so that by early December DIA had its own interagency group in session. At that time reentry was judged to be for the late spring or summer of 1978, given that the satellite maintained its attitude stabilization. Loss of stabilization would produce tumbling and early reentry, a process which indeed began on 6 January. But an open question in December was the existence of a fail-safe system on 954: if one was on board, it would sense an abnormal condition and automatically boost the reactor portion of the vehicle to a higher altitude parking orbit, where the reactor would cool harmlessly. Judgments varied over this issue, and prudence dictated that the analysis proceed without any presumption of a fail-safe system (note that the eventual crash of 954 still did not preclude the presence of such a system, as it could itself have failed).

DIA's group concluded there was a small chance of a very serious problem. It recognized that the issues posed by 954 spread across many agencies, a circumstance anticipated by the Department of State representative who had already drafted a letter to NSC suggesting that the problem be taken over by the NSC Staff. It was sent. The Department of Energy representative had nearly finished his statistical study of the outcomes and their probabilities; this study proved to be the key analytic piece and upon it was premised the one-in-10,000 chance of harm to a human. The tone of the DIA group was stoic in that we felt captured by a no-win situation (i.e., a negative sum game to theorists). A colleague suggested the outcome of 954 would be akin to determining the winner of a train wreck.

The NSC group formed on 19 December, fetchingly calling itself the *Ad Hoc* Committee on Space Debris. It was put together by active recruiting on the part of its chairman from the NSC Staff, rather than the usual procedure of agency nominations. The facts were recounted, and NSC directed the preparation of, if you will, pre-contingency plans. These included the availability of tracking resources and the assurance that the proper agencies and representatives were receiving information from collection resources. Operation MORNING LIGHT was born.

By 6 January the NSC representative and the respective members of MORNING LIGHT had briefed their principals, and the prospective reentry date was judged to be April. Then, on the 6th, the Air Defense Command reported 954 out of control. The telephones of MORNING LIGHT members summoned them to NSC, and what had been pre-contingencies became an inexorable fact: the satellite was coming down carrying a live reactor, with the best reentry guess 24 January. (This again validated the policy maker's rule of probability, i.e., the simple fact that an event is unlikely does not stop it from happening. For instance, Cosmos 954 landed on its 2,060th revolution, one that had only an 8 percent chance of any land impact.)

NSC gave responsibility to the Department of Energy for domestic contingencies, and assigned it to State in the event of a foreign reentry. Defense was to provide support as required, and I found myself promising airplanes, reconnaissance, and all manner of gadgets to these agencies, should they be needed. At the time, I was not sure I had the authority to do this, but such was the sticky wicket of MORNING LIGHT members.

Arrangements for contingencies are easy; handling the world after the contingency is yet another proposition. Although the risk of harm was judged low, still, the possible harm to populated places could be so severe that its low probability could not allow one just to hope that the satellite could be ignored. And it was here that MORNING LIGHT became a sobering experience for those navigating the problem. This wrenching was not at all helped by worry that a sensationalized leak would disturb the public in unforeseeable ways.

The MORNING LIGHT group had to cope with a set of arrangements and decisions:

Contingency Plans for Cleanup of Radioactive Materials: This estimable task entails finding radioactive sources, decontaminating land areas, and attending to persons found within a harmful distance. It turns out that locating active materiel on the ground is far from a simple mission. The hunt for radioactive pieces surviving reentry has to begin with large search areas, prompted by reentry plots furnished from tracking radar, backed up by any visual sightings. Sensor aircraft would patiently refine the ground search, while high altitude U-2s would seek out the debris cloud left by burned and dispersed uranium. The Departments of Energy and Defense shared this unappealing assignment, but the planning was such that the men and equipment could be launched when the President said to do so.

Ask the Soviets for Information: Because MORNING LIGHT had to infer the type of reactor on 954, we were in some measure presuming our design to the Soviet reactor, substantially complemented by CIA and DIA details about *Romashka*. Little seemed to be at risk in our asking the Soviets for information, and it was the general view that no good answer could be formulated to a postmortem inquiry asking why the United States did not seek data from the owners of the satellite. These are the questions posed to the Soviets, and a paraphrase of their response:

— According to information available to us, Cosmos 954 appears to be quickly decaying into the earth's atmosphere. We estimate that it will reenter the atmosphere any time within the next month.

— We are concerned that Cosmos 954 may be powered by a nuclear reactor and that its reentry into the atmosphere thus may represent a potential for nuclear contamination. If the debris falls on or near a populated area, there is the obvious possibility of a serious hazard to the public.

— In view of these serious possibilities and in the spirit of cooperation called for by the Outer Space Treaty, we would like to hear your view of the problem, as well as any additional information you can give us.

— In particular, if there is a nuclear reactor on board Cosmos 954, we would like to know whether it is designed to disintegrate during reentry or whether there is a significant probability of impact of the nuclear fuel. We need this information to assist in determining what steps to take in the United States to protect our public.

— Given the urgency of this question, we request an expeditious answer.

The Soviets replied that:

> The small power plant at the satellite "Cosmos 954" operates only on U-235 fuel. As we have already said, it is explosive-proof because the accumulation of a critical mass is ruled out. Besides that, the design of the plant provides for its destruction and burning upon entering denser layers of atmosphere.

~~NOT RELEASABLE TO FOREIGN NATIONALS~~

~~SECRET~~

> However, in view of the accident aboad the satellite [depressurization], it cannot be ruled out that some destroyed parts of the plant still would reach the surface of the earth. In that case an insignificant local contamination may occur in the places of impact with earth which would require limited usual measures of cleaning up.

A colleague remarked that he wasn't too sure what "usual measures of cleaning up" a reactor crashing in from outer space might be, and there was also some ambiguity in the meaning of "explosive-proof".* But some considerable relief was expressed when MORNING LIGHT was told the reactor had been designed to burn up during reentry. (I observed that any seemingly hard information is gratefully received during a crisis, and also noted how vulnerable one can be to that information.)

Notification of Other Countries: The Soviets had not told anybody of 954's impending reentry. The United States had the information, a sensitive problem was nearing full brew, we had no idea where 954 would come down, a lurid leak seemed inevitable, and the satellite belonged to the Soviets.

Who should be informed by the United States, if anybody? What were our responsibilities to our allies and to the world for a problem which was not of our making but about which we knew? Skipping pros and cons, lists of countries, and the imponderable factor that the more nations informed, the greater the chance of a leak, the notification problem was surely disturbing. Mortals, with notorious shortcomings, should not have to make these judgments. But it had to be done, and we went at it on the general approach of notifying our allies and some other countries with which we share such special relationships as tracking facilities. From those countries notified, State received uniform gratitude, but some governments were intensely upset over the slightest prospect that Cosmos 954 might land on their soil.

Notification of U.S. Citizens: Another scrimmage. Congressional leadership was briefed. In MORNING LIGHT contingency planning, the Federal Preparedness Agency was primed to provide state and local civil defense officials with pertinent information *after* a reentry in the United States. At issue again was what to say before anything happened. Judging the imponderables, the plan was to notify local authorities if there was something tangible to notify them about. In retrospect, the steps taken proved right, but 16 hours before reentry, the MORNING LIGHT group was still debating public announcement; we argued through the circumstances pertinent at that late hour and decided to stay on our original approach. The effort had come nearly to reentry time without a break in security, and the United States had been encouraging other countries to contain public comment. A reversal at that hour would have been, at best, awkward.

As the Day of Reentry neared, computers plotted the predicted ground trace. Gazing at the traces, a colleague observed that only one pass would cut across the Soviet Union and that a number of ascending and descending paths traversed Canada (after it was all over, we noted the marvels of retrospective clarity). At 0500 on the 24th, the DIA Current Operations Center called to announce imminent reentry, with a window equal to one complete orbit. At 0653 EST the satellite was down in Canada.

The Center has its complement of maps, red and green telephones, TV monitors, and flashing lights: I didn't have all the right badges (two were required, and at one point some earnest young officer asked why I didn't have all the right badges; at a

* Three senior government officials when briefed wondered if the reactor could detonate like a nuclear weapon. The lesson applies to those who live so close to technical matters that they tend to presume widespread knowledge of engineering or physics to officials trained or experienced in other fields.

moment of high crisis, his inquiry about badges proved most helpful). The CRITIC message failed to reach the responsible State Department officer; he called to find out what had happened. Another officer from State inquired about the satellite impact in the Azores. The computer connecting the DIA center and NSA went down, so a backup system had to be brought up. Later on, a commercial power reactor in Colorado experienced a valve malfunction and some release of radioactivity; at first the release was reported as very dangerous, so intense that it would require the diversion of a nuclear emergency team from the Canadian mission to Colorado. Because of a mix-up, the first report never reached me; by the time the mix-up was repaired, it had been discovered that someone in Colorado misread the radiation sensors and that there was never a problem in the first place. Despite these tiny upsets, the necessary airplanes and search teams were ordered to Canada by the President and did their job.

Later a well-known television journalist called, breathlessly announcing that his network management in New York was "about to be tipped off" that the mysterious East Coast sonic booms were really American ABM attempts to shoot down the errant satellite. Could I confirm before the story went on the air? With an effort worthy of Zeus, I resisted the temptation to respond that the booms were really the Navy's X-25 hypersonic underwater earthquake generator. (Isn't it strange that a reporter might ask for verification of a story about which he was *about to be* tipped off? But then, one can't bother too much about logical sequences.)

The Use of Intelligence in Operation MORNING LIGHT: A pet definition of intelligence is simply information that helps people making decisions think ahead. But "information" is a loaded word. There are facts or data, but then there is creeping interpretation (opinions about facts), followed by hypothesis, conjecture, and theory. Hard work must be done to keep from scrambling these terms and acting on one when it is in the guise of another. Facts and data are observational (at least some of the time), while information is a testing of observation and an arranging of data by some thoughtful procedure. Information gets at the question, "what do the data mean?" and so must lend itself to creeping interpretation. This sets up a dilemma, in that there are too many pieces of data for any decision maker to handle, but going beyond raw data requires the use of judgment by the person doing the organizing. The First Rule of Intelligence is—forgive me—if you want to know something, ask, but be careful whom you ask and how you do it. Hear and listen, see and observe, and go back and do it again, while trying mightily to diversify sources of both data and meaning.

The ear should be tuned to the uncertainty latent in any interpretation, and special efforts have to be made to isolate the variance of a projection, extrapolation beyond known facts, and, perhaps most of all, the compound or aggregate consequences of the separate unknowns bearing on a particular problem. For the re-entry of Cosmos 954, the MORNING LIGHT group had to contend with its fair allotment of queasy questions (some of which could not be termed intelligence issues):

— Did 954 have a fail-safe system?

— What sort of power supply?

— Health hazard?

— Landing when and where?

— Could the Soviet response be believed? Were they conjuring up some rococo scheme to throw us off?

— Consequences of a leak on public psychology?

— Response of foreign governments to our telling them, and responses of those governments not cut in?

For instance, the conviction about the fail-safe device weakened about in proportion to the length of time 954 was in orbit decay. References to the system shifted from "the system," to "if there is a system," to 50-50 odds. Cross-checking suggested that one observation and the notion of sound engineering practice, that is, our own American perspectives, were the premises of the first judgment. Uncertainties became more apparent as time went on, but early checking among sources had made it clear that this would probably happen. This experience underscores the Second Principle of Analysis, that is, carefully observe the difference between the second estimate and the first, for that difference gives a good clue to emerging uncertainty. Surely there must be an epistemology of variable constants, and a price, that is, the longer the waiting period for information, the more circumstances constrain the range of response.

As for public reaction, one reporter said, "What I could have done with that story if I had it a day early!" You can visualize the headline, and the MORNING LIGHT working group took it for granted that any publicity before impact would produce florid reporting and a tense public response. After it was over, a social psychologist at the Center for Disaster Research observed that "people prepare" for earthquakes, floods, fires, and hurricanes, and in general make do. One would surely like to see the research footnotes on public reaction to the first live nuclear object (spewing deadly nuclear radiation) tumbling in from the cold depths of outer space. Intelligence was not asked to judge likely public response or that of governments to notification, but a compilation of post-event reactions was put together.

In retrospect, intelligence stuck to its knitting. The MORNING LIGHT team had a good grasp for that which was known and that which was conjecture. Creeping interpretation never became a problem: the CIA representative gave his reports by way of what we knew, what we did not know, followed by this or that could happen. By 24 January the compound uncertainties had become an almost agreeable way of life; there is some comfort in knowing what is in the realm of the factual and what resides in the realm of pure chance. MORNING LIGHT knew what it couldn't know and prepared accordingly.

Of the two decision approaches, Crisis Management and Muddling, it is clear both were used, however unconsciously they may have been incorporated in the proceedings. Policy work requires the use of any procedure that helps lead to sound decisions, and only the unwise lock themselves into any single approach. The 954 project was blessed with perceptive leadership from the NSC (get a strong team together, listen and fight the issues, but force decisions and get those to officials who can put them into effect). The inexorable approach of 24 January surely provided an incentive not to dawdle over methodological niceties, but the deadly deadline was not by itself the reason MORNING LIGHT worked well.

Early on, the fate of Cosmos 954 was largely of statistical interest, but after tumbling, arithmetic calculation gave way to more intense considerations. Surprises, when they arrive, are usually unpleasant (this may be especially true in technology). History has shown there is a vast market for oracles, but vision is not a gift nature dispenses generously, so mortals are left to ponder what-ifs and prepare for them as best they can. When 954 tumbled out of control, MORNING LIGHT was able to move quickly, mainly because much of its homework had been done, this thanks in good measure to timely and persuasive intelligence work.

OPERATION MORNING LIGHT

CHRONOLOGY OF EVENTS, COSMOS 954

—September 18, 1977 Soviets launched Cosmos 954.

—November 1977 Intelligence sources determined Soviets experiencing difficulties.

—December 1, 1977 Deputy Under Secretary of Defense for Policy (Admiral Murphy) alerted by his staff.

—December 19, 1977 NSC interagency task force on space debris established (State, Defense, NASA, CIA, Energy and OSTP).

—January 6, 1978 Through intelligence sources, determined Soviets had lost control of satellite; reentry date established January 23 or 24, 1978.

—January 12, 1978 Approached Soviets on the issue.

—January 14, 1978 Soviets' response confirmed that nuclear power source was on board and that they had lost control of satellite. Projected reentry on January 24, 1978.

—January 17, 18, 1978 Informed key Congressional leaders (Byrd, O'Neill, Baker, Rhodes, Inouye and Boland) of problem and steps we were taking in event the satellite landed in the United States.

—January 17, 1978 Dr. Brzezinski memorandum making Energy responsible for clean-up and other safety considerations relating to possible reentry in the United States, receiving support from Defense and from other agencies as appropriate. State was made responsible for foreign requests for assistance, calling on Energy and Defense as appropriate.

—January 17, 1978 Approached Soviets for clarification.

—January 18, 1978 Informed our allies and other countries with which we have a special relationship, e.g., tracking facilities.

—January 19, 1978 Soviets responded, indicating the reactor would not go critical and that it was designed to disintegrate during reentry.

—January 20, 1978 The Department Energy Task Force went into operation.

—January 22, 1978 Approached the Soviets and asked if there were any new developments.

—January 23, 1978 Soviet response indicated that reentry was projected for January 24, 1978.

—January 24, 1978 Satellite reentered atmosphere at 6:53 a.m. EST over Queen Charlotte Island and impacted last at Great Slave Lake.

—January 24, 1978 Prime Minister Trudeau was immediately informed that the satellite had landed in Canada. United States offered assistance in locating fallen debris and in cleanup. Trudeau accepted by a return telephone call to the President.

—January 24, 1978 Dr. Brzezinski informed the Soviets that the satellite had landed in Canada.

—January 24, 1978 AFTAC/MAC aircraft and Nuclear Energy Search Teams dispatched to Canada.