UNCOVERING SOVIET DISASTERS James Oberg
Chapter 12: **REACTORS FROM THE SKY** Random House 1988

Those who circulate absurd rumors about the Kosmos-954 and who are trying to cash in on them undermine the basic principles of international cooperation in the exploration and use of outer space and are doing serious harm to the cause of strengthening mutual trust and understanding between peoples. -- — Leonid Sedov, USSR Academy of Sciences, 1978

At the dawn of the space age, as Sputniks and Explorers and Vanguards orbited the Earth, some humorists had joked that the saw about "what goes up" no longer deserved its mandatory ending of "must come down."

For many cases, this turned out to be true. There are satellites in high orbits that will take millions of years to fall back to Earth, and there are probes which have forever escaped Earth's own gravity and even that of the Sun itself.

But for several glaring counterexamples in recent years, the proverb has reasserted itself with a vengeance. Smaller satellites fell frequently but flared harmlessly in the atmosphere as they disintegrated. In 1979 the giant plummeting hulk of the derelict American Skylab space station delivered the lesson as it landed in fragments large and small on Australia. Of even more concern, falling Soviet RORSATs (the term, invented by U.S. military intelligence analysts, stands for "Radar Ocean Reconnaissance Satellites," or all-weather naval space spies powered by nuclear reactors) ignited worldwide anxiety during unpredictable but unavoidable death plunges.

The fall of Skylab became a world media event, as planet- wide anxiety followed its final weeks, days, and hours. But when the significantly more dangerous Soviet satellites fell, Moscow remained silent for as long as it could and then issued only bland and baseless assertions that there was nothing to worry about. But the realities of space operations make it a safe bet that such a radioactive satellite fall will happen yet again, and if Moscow's lack of warning and cooperation is repeated, the dangers may be even higher.

Since 1967 about four dozen Soviet satellites of the RORSA'I' class have been launched into orbit. As a first approximation, such vehicles can be identified by their distinctive orbital path and subsequent maneuver sequences. Reliance on these characteristics is necessary since Moscow consistently and innaccurately labels them "routine Kosmos payloads" for "scientific exploration of outer space" and has always insisted that the satellites were devoted to purely peaceful purposes.

The only two satellites which were ever explicitly admitted to carry reactors, and then only after the fact, were Kosmos 954 (the one that crashed onto Canada in January 1978) and Kosmos 1402 (which dropped pieces onto the South Atlantic and Indian Oceans in early 1983). But all the other nuclear-powered ROR- SATs share the distinctive orbital flight paths of the ill-fated Kosmos 954 and 1402. Their initial orbit is only about 150 miles high, inclined to the equator at sixty-five degrees. Backtracking the flight path shows their launch site to have been Tyuratam, east of the Aral Sea in Soviet Central Asia.

Normally, after several days or weeks, each satellite suddenly separates into sections, with some pieces burning up quickly and another piece (the one with the reactor on board rocketing 500 miles higher into space, where it goes dead and begins a slow derelict tumble in an almost permanent graveyard orbit. This has happened nearly all the time whenever such a satellite has been launched.

The explanation for these puzzling maneuvers lies in the nature of the mission. The satellites are using active radar pulses to seek and track naval forces on the world's oceans. Each transmits a radio pulse, then listens for the returning echoes and picks targets out of the patterns. Since both outgoing and returning pulses dissipate at the famous inverse squared law (twice as far means only a quarter as powerful), the combined efficiency of such a passive search radar system follows an inverse fourth power law: At twice the range the signal would be only one sixteenth as strong. Since effective range is so limited, the satellite must fly as low as possible, and the satellite almost has to graze the upper atmosphere. A powerful electrical source is needed. Large wings of solar cells would vastly increase the satellite's air drag and hasten its already precipitous decay rate, so the Soviets chose to use a small nuclear reactor called the "Topaz." It puts out up to 100 kilowatts of heat, which is converted into about 10 to 20 kilowatts of electricity. But the reactor, fueled with 100 pounds of uranium dioxide pellets (more than 90 percent of which consists of the U-235 isotope), also produces highly radioactive isotopes (the "daughter products" in the reaction). These isotopes, if dropped back into the atmosphere, could endanger anyone coming in contact with the debris.

These dangerous isotopes are the motivation for the boost at the end of the mission. The reactor portion is parked in an orbit sufficiently high that it will not fill back to Earth for many, many centuries. By that time the "daughter products" will have cooked down to much lower levels of radioactivity; well before then some sort of orbital tow truck service may have been able to recover them safely anyway.

The two spectacular failures in this flight plan (at least the two we found out about) were due to problems with this last, "parking" phase. Kosmos 954 was launched on September 18, 1977, but after about ten weeks the satellite suddenly and unexpectedly "died" for no apparent reason. Soviet ground controllers repeatedly radioed commands to fire the final boost rocket motor; but this sequence never occurred, and the whole satellite fell back into the atmosphere within a few weeks. Kosmos 1402 was launched on August 30, 1982, and it per- formed properly up until the final boost phase, which was commanded to occur on December 26. The satellite separated into the appropriate sections; but the reactor section's rocket motor never fired, and the unit rapidly slipped back into the atmosphere. Both occasions were similar in that the Soviets remained mum about their problems until American officials made discreet diplomatic inquiries. In 1978 the Carter administration made a high-level decision not to go public with its knowledge of the impending fall, allegedly out of altruistic concern over worldwide public panic. More probably State Department officials realized that the Soviets might use public disclosure as a pretense to refuse any cooperation at all (such as privately passing on crucial data on the satellite design), whereas they might show their appreciation for American cooperation in the cover-up by dribbling out technical details useful in any possible recovery or cleanup operation. But they didn't; their disclosures consisted almost entirely of data which Western experts already knew or had guessed. Long after the satellites had broken down in space, Soviet spokesmen (including top scientists from the prestigious Academy of Sciences in Moscow) were still faithfully assuring the world that "all is normal' in orbit — and it wasn't. Leonid Sedov, a leading space scientist with the Soviet Academy of Sciences, insisted the Kosmos 954 satellite had been launched "in accordance with our program for the exploration and use of outer space," not even hinting the "use" was as a military spy vehicle. The fall to Earth wasn't even the USSR's fault, Sedov claimed. "It may be assumed that the satellite collided in flight with some other object [on January 6]." The official Soviet sequence of events, as chronicled by Sedov and others, was grossly deceptive. The satellite, launched on September 18, had completed its low orbit mission by the end of October. But instead of being boosted to a safe higher orbit, the satellite began slipping closer to the atmosphere. It was still under ground control, so it remained "horizon stable" in a low-drag orientation. At that rate, reentry was not expected until April. But on January 6 the satellite went out of control, probably because of some internal breakdown or exhaustion of consumable supplies (Sedov's collision excuse is preposterous; the satellite was already doomed two months before), and as it tumbled occasionally sideways along its orbit, its air drag soared and its decay rate increased by five or ten times. Instead of a mid-April reentry, three months away, American analysts in mid-January saw that the satellite was coining in within ten days! On January 12 White House National Security Adviser Zbigniew Brzezinski contacted Soviet Ambassador Anatoly Dobrynin. Only at that point, months after they had known that the reentry was unavoidable, did the Soviets acknowledge the problem. Even in the last days of the satellite's fall, predictions of its final target were uncertain. In the hours prior to its actual impact, Kosmos 954 had crossed Mexico, central North America, Iceland, Scotland, central Europe, Greece, Egypt, West Africa, the Indian and Pacific oceans, California and central Canada, the North Atlantic, Spain, Algeria, the length of central Africa to Johannesburg, then the Indian and Pacific oceans again (including right over Hawaii) before it finally plunged into northern Canada. Had the satellite survived for another few hours its path would have taken it over the North Atlantic, West Africa, the Indian Ocean, eastern Australia, the Pacific, across northern Canada again, and so forth. It could as easily have come down anywhere along that line.

Fortunately the RORSAT hit a lightly populated region with white snow cover, making the detection of debris relatively easy. But even in such a sparsely inhabited area people were accidentally exposed. Two adventurers on a cross-country trek spotted a large tangled piece of plumbing from the satellite lying on a frozen creek, walked over, and picked it up. Luckily it was later determined that this particular piece was not radioactive. Shortly after the crash, Sedov discussed the whole affair on Radio Moscow and sincerely assured his Soviet listeners that "the termination of the existence of the Kosmos 954 over the northern part of Canada did not create any danger for the population of the area." That was patently untrue. The worst pieces, which could deliver fatal doses within hours if anyone had picked them up, had not even been located at that point. Sedov inaccurately asserted that the reactor "was designed in such a way as to ensure its destruction and burning up on entry in the dense layers of the atmosphere." This, too, was untrue, but the Soviet press never informed its public that the Canadians were recovering many substantial pieces on the ground.

Over the subsequent several months a joint U.S. and Canadian exercise named Operation Morning Light combed the entire search area, between Yellowknife and Baker Lake. Using highly sensitive airborne radiation detectors, the searchers located debris down to fingernail size and smaller. Everything was picked up. The teams recovered basketfuls of debris, some the size of pepper flakes but some many feet in length. Most pieces were dangerously radioactive because of contamination from the reactor core's isotopes (the virulently radioactive daughter products, not the much more gently decaying U-235, were the culprits) and could have posed genuine health hazards if they had fallen over a more populated area.

The search would have been greatly facilitated if the searchers had known what to look for and what sort of radioactive isotope might be out there waiting for them. The Canadians officially asked Moscow for specific details. What were the full nature and amount of the fuel, and the type of reactor, and its construction? What was the chemical and alloy composition of the components of the reactor? What kind of shielding had been employed? Most particularly, what particular items and indications would the Soviets have looked for if the satellite had landed in the USSR (that is, what had they already prepared to look for, in their own undisclosed contingency recovery plans? There were many questions, but even only a few answers would have been helpful.

The Soviet responses were useless for the search. They essentially said “nothing.” The Soviets did allow that there had been 100 pounds of U-235 on board but blandly assured the Canadians that “there is no danger of an explosion” (the last thing anybody was afraid of). Moscow expressed regret that its offer to send technical teams had allegedly been refused (the Canadians didn’t know what this remark referred to) and also expressed annoyance that the Canadians had taken so long to notify them officially that the satellite had hit Canada (as if the Soviet embassy in Ottawa didn’t get newspapers). They waived all rights to the return of the pieces and allowed Canada to “continue to dispose of them at its own discretion.”

Months later the Soviets did respond to Canadian lists of recovered debris with assurances that all had been found and the searchers could stop looking. On May 31 they belatedly stated, “The beryllium reflector included six moving elements that already have been found by you, and several tens of rods of cylindrical form, most of which were discovered.” It was a waste of time to keep looking for the rest, they said. “The probability of all those rods in the reflector reaching the surface [intact] after the reactor’s core disintegrated is excluded.” But these assurances no longer carried any credibility.

The Canadian historian of the recovery operations, C. A. (“Dick”) Morrison, had this succinct description of the value of Soviet inputs to the problem: “The lack of specific technical information, both before and after impact, was a serious problem. In this regard the Soviets were being, and would continue to be, singularly uncooperative.” The official Canadian damage claim later used much the same wording: The “clear and immediate apprehension of damage was not ameliorated by the Soviet failure “to provide timely and complete answers to the Canadian questions. . .”   Yet Sedov had told the Soviet public on February 4 that “the Canadian government was informed about the satellite, its power unit, as well as measures that might have to be taken in case the remnants of the satellite were discovered. Sedov was departing from the truth; to put it most charitably, he was grossly exaggerating the value of meager information which Moscow did release.

With his misunderstanding (or misrepresentation) of events, Sedov expressed outrage at some Western reactions to the fall. He denounced “absurd accusations that the satellite was a flying bomb or carried a laser gun (nobody to my knowledge had ever seriously suggested these). He scrupulously (and arguably not by accident) avoided addressing the most common Western accusation: that the satellite was a naval spy platform.

Article II of the 1972 United Nations treaty entitled “Convention on International Liability for Damage Caused by Space Objects” states that “a launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth.” The Canadian government filed a claim for $6,041,174.70 with the Soviet ambassador in Ottawa. Negotiations were held throughout 1980, and on November 22 the Soviets agreed to pay fifty cents on the dollar, Canadian.

The 1978 failure had cost the Soviets much more than just the damage claims. They surely spent at least ten times as much in redesigning, rebuilding, and requalifying the RORSAT hardware. But the military mission to locate Western naval fleets was important enough that they spent the necessary time and money, and two years later, without any fanfare or even discreet diplomatic warnings, they quietly resumed launching RORSATs.

While there was some minimal press coverage of the resumption based on analyses by Western experts on Soviet space activities (the Soviets refused to comment), nobody in the West took much notice, and nobody complained (who wanted to question Soviet intentions and he branded an enemy of world peace by Sedov?).

Although Western experts didn't know it at the time, the Soviets had implemented an additional safety feature in their reactor disposal procedure. In the gap of more than two years between the Kosmos 954 debacle and the resumption of the RORSAT program, with Kosmos 1176 on April 29, 1980, two modifications were made in the standard flight program: The low-orbit active mission duration was almost doubled, to more than four months, and the high-orbit parking phase included the reactor section's jettisoning a small package after reaching its final high orbit. The increased lifetime was evidently due to use of a more advanced model of the reactor and to larger supplies of rocket fuel to counteract the mile-a-day orbital decay induced by atmospheric drag. The jettisoning turned out to be the ejection of the reactor core itself from its surrounding structure, an additional safety feature which proved to be crucially important.

After two years of routine operations (consisting of eight launchings), disaster struck again. Kosmos 1402 was launched on August 30, 1982, and it completed its operational mission on December 28. But the boost to high orbit failed. The news came out from private sources, since the governments involved apparently again had intended to keep it secret to "avoid panic." Noted the highly critical New York Times: "One failure is bad luck, two is bad management. . . . The Soviet Union is playing Russian roulette with the world. That the odds are long is no excuse for exposing others to some danger. The rain may full on the just and the unjust alike, but no one should have to expect being showered with radioactive space junk from a bungled military spy mission."

The news of an impending RORSAT crash again swept the world, even as far as Moscow. At a press conference on other space activities, held on January 6, 1983, academician Vladimir Kotelnikov (director of numerous international cooperative space projects) was asked about the rumors. "Programmed operations are being conducted with the satellite," he assured his audience (a week after it had gone dead). "At present there are no dangers at all regarding the destiny of this satellite." Again, the official Soviet assurances were patently phony.

However, the new safety features implemented after the Kosmos 954 incident had already been activated aboard the doomed Kosmos 1402. The isotope package was automatically jettisoned from the reactor (probably by a "dead man timer, which would not even need ground command). Hence the isotopes were not going to be protected by the satellite's structure during the fiery atmospheric reentry. They could be expected to pulverize completely, and the most radioactive material would thus be safely dispersed in the upper atom- sphere at concentrations well within safety levels. The large reactor structure's debris, which could be expected to survive passage through the atmosphere, would also therefore not be badly contaminated.

After the Kosmos 1402 troubles had become public, Soviet spokesmen (after belatedly admitting the satellite was indeed falling back to Earth out of control) bravely asserted that this new improved design was "perfectly safe." But cynics would not let them forget that five years earlier a similar coterie of reassuring officials had been piously proclaiming, even after the Canadians had begun gingerly to retrieve the “hot” remains of Kosmos 954, that the “brilliant design” of that satellite had “absolutely ruled out any possibility of ground contamination.” If the new design really was so perfectly safe, the cynics asked, why did the primary Soviet flight plan even bother to boost the reactor into the high graveyard orbit? That maneuver required many times as much fuel as would be needed for a controlled reentry over the USSR itself. Surely such confidence in the safety of the backup system should lead to a decision to use it all the time, since it was so much more fuel-efficient.

In counterattack on this new group of Western complaints, the Soviet press began a campaign of ridicule for precautions being taken. Such Western concern, reported the Soviet news media, had more ominous implications. “In the West they launched a noisy propaganda campaign around the ‘fall of the Soviet satellite,’ “ TASS said. “It is not difficult to guess who needed that provocative hullabaloo and why. The militarists from Washington and NATO use it as a smoke screen to cover up their own aggressive preparations.”

A leading Soviet space Scientist provided some unusually candid insights on January 16 (shortly before the satellite plunged back into the atmosphere). In a long interview in Pravda, Dr. Oleg Belotserkovskiy, rector of the Moscow Physico- Technical Institute, hinted broadly and for the first time that Kosmos 1402 wasn’t doing precisely what had been planned for it from the beginning. “There can be factors preventing the transfer to a high orbit from occurring,” he admitted, “and therefore additional measures are envisaged in order to guarantee safety from radiation.” The one chosen for this case (the Soviets never admitted having launched dozens of similar reactors) was dispersal in the atmosphere. “The withdrawal of the fuel core with its radioactive fission products from the reactor ensures guaranteed conditions for it to burn up in the dense strata of the atmosphere and for the materials to be dispersed into finely divided particles.”

That apparently was exactly what happened. The main body of Kosmos 1402 burned tip over the Indian Ocean on January 23, 1983, after passing across Central America, the Appalachian Mountains, Iceland, Scandinavia, Estonia, the Ukraine, the Caucasus, and Iran; the smaller core itself flamed out over the South Atlantic a few weeks later. In both cases searching American aircraft found no trace of radioactivity above back- ground levels.

The Soviets must have been satisfied with the safety of their modified RORSAT hardware. Only a year and a half later, on June 29, 1984, they launched Kosmos 1579, allegedly just another “scientific research satellite.” It was a new RORSAT, and it was followed by others in the subsequent years. Until one falls out of the sky again, it’s likely public concern won’t be aroused.

There are different ways the world could find out, and an official Soviet announcement is not a leading candidate. Perhaps the reactor jettison safety system will work again, and a Kosmos 1402 replay will result. Or perhaps next time the satellite will go dead before this ejection can occur, and a Kosmos 954 replay, with the dangerous isotopes shielded through reentry by the satellite’s structure, will occur. Or perhaps there will be some new variation of “the reactor in the sky is falling.”

Meanwhile, the actual safety of the “reactor graveyard,” the high orbits where the dead RORSATs are parked, has been questioned recently by space experts. They have pointed out that the growing belt of space junk circling Earth is thickest just at the altitude chosen by the Soviets to dump their reactors. Also, expended rocket stages from various Soviet programs crisscross that region of space, raising the distinct probability that one or more of the reactor vessels could be ruptured by a collision. The debris could even he knocked closer to Earth. In any case, the smaller fragments, once formed, would tend to decay much more quickly than expected and could be hitting the atmosphere within decades instead of centuries. So far none of the reactors being tracked shows any sign of giving off pieces, but the statistics of space junk say it is only a matter of time.

The Soviets have already been the apparent victim of one orbital “hit and run.” In 1982 one of their navigation satellites suddenly disintegrated. Exploding satellites are not at all rare, but their destruction usually results when leftover on-board fuel mixes, boils, or otherwise goes unstable. This satellite had no such fuel, and the dispersal pattern of the fragments was more characteristic of impact with a piece of space junk than of internal explosion. The Soviet government never acknowledged the disintegration (it was probably a piece of an old Soviet satellite or rocket that had hit the new spacecraft) but reportedly professed even more interest in international efforts to control space pollution by junk and debris. Meanwhile, Western space experts were reassured that their statistical projections of space collisions had been verified.

A late-1986 report by Soviet-spacecraft expert Nicholas Johnson of the Teledyne-Brown Corporation office in Colorado Springs, Colorado, expressed anxiety that the existing expended reactors could suffer the same fate as the navigation satellite. “‘The threat posed by these [reactorsJ extends not only to contamination during eventual reentry into Earth’s atmosphere, but also to other Earth orbiting satellites, including manned spacecraft,” Johnson wrote. “Current space storage practices, particularly by the Soviet Union, are insufficient to ensure the protection of the Earth’s biosphere from unnecessary radioactive elements in both the near term and the fur term.”

Officially the Soviets refuse to acknowledge their responsibility for the dozens of radioactive hulks in orbit. All inquiries have been rebuffed. The only two nuclear reactors ever launched aboard Soviet spacecraft, according to the official view, were aboard Kosmos 954 and Kosmos 1402. The orbiting reactor graveyard, in Moscow’s eyes, does not exist, and therefore, there can be no danger from it, nor any Soviet responsibility for it.

The Soviet safety record on RORSATs is probably much worse than even the two reentry events and the careless orbital storage of dead reactors suggest. On several other occasions trouble seems to have developed with such satellites. On a few occasions additional radioactive contamination probably occurred.

The earliest test flights were the most troubled, as is hardly surprising in any space program. On the first six flights, between 1967 and 1973, only one payload exceeded ten days in its operational orbit before being boosted and parked. A few were hurriedly retired after only a day or two in space, suggesting immediate massive control failures. On April 25, 1973, a launch attempt failed when the booster rocket fell back into the atmosphere west of Hawaii; another launching attempt reportedly failed in January 1969, when the rocket blew up on the launch pad.

The accident near Hawaii reportedly resulted in significant radioactive contamination of the atmosphere, as detected by dust-collecting American research aircraft. The mix of isotopes revealed a startling and dangerous Soviet practice: The nuclear reactor was apparently turned on — that is, it was made to “go critical” — on the launch pad, prior to blast-off. Standard safety practices endorsed by the United Nations now call for all reactors to be launched “cool” — that is, not generating the highly dangerous “daughter isotopes”— and subsequently commanded on by remote control only after they have reached a safe, stable orbit. The Soviets did not start out following this UN-approved procedure, possibly because the Topaz design requires a very precise alignment of control hardware to avoid an unstable meltdown, and such a ticklish operation could not be remote-controlled. There is no evidence if they have subsequently adopted it.

Soviet publicity behavior with the RORSAT accidents shows variations on typical themes. The Soviets never volunteered information about accidents without strong Western prodding, and even then they responded only occasionally and with minimal information. No acknowledgment of the true purposes of the RORSATs, or technological explanations of the likely causes of their failures, was ever made. The charade about the RORSATs being “peaceful scientific satellites” was steadfastly maintained. To their own people, the Soviet officials posed as cooperating fully with Western nations yet routinely withheld data which could have been useful to Western monitoring and cleanup activities. The continued existence in space of dozens of other still-radioactive Soviet space reactors was ignored.

Anyone questioning any aspect of the Soviet line was attacked with paranoid vigor as an enemy of’ international understanding and goodwill. To object to the Soviet endangerment of the whole world was, in Moscow’s view, to play into the hands of “aggressive NATO circles.”

Even the Kosmos 954 and Kosmos 1402 accidents are in the process of being wished out of existence by Soviet space historians. The latest edition of the massive Encylopedia of Cosmonautics mentions the fall of Skylab but not of the radioactive Soviet counterparts. Discussing the dangers of falling satellites, one Soviet scientist in 1986 wrote, “We all remember Skylab!” Another, denouncing American “Star Wars” plans to put nuclear reactors in space, wrote: “The dangers in such a move are obvious -- look at Skylab, for example.” People in the West, fortunately, remember a lot more about falling satellites than just Skylab, and they don’t have to be enemies of international understanding at all — just the opposite.

A third nuclear reactor space accident in 1988 postscript added in March 2004: http://www.nuclearspace.com/past_accidents.htm describes a third RORSAT radiation scare, with Kosmos-1900, launched on Dec 12, 1987. “In April 1988 the Soviet radar reconnaissance satellite Cosmos 1900 failed to separate and boost the reactor core into a storage orbit. This failure of the basic system raised the possibility that the reactor could re-enter the Earth's atmosphere some time in late summer or early fall. The Soviet Union announced that the satellite was equipped with both a basic system for radiological protection and a redundant system. The redundant system apparently succeeded in separating the nuclear core of Cosmos-1900 on Sept. 30 at which time the reactor core was boosted into a ‘stable’ storage orbit at about 720 km altitude. The intended storage orbit, however, was to have been at more than 800 km altitude.” The payload had been slipping back to the edge of the upper atmosphere when, literally within days of an accidental entry, the backup control system fired the boost engine. The last RORSAT mission was on 14 March 1988 with Cosmos 1932, and after the Cosmos 1900 scare, the project was cancelled by Gorbachev.

http://www.russianspaceweb.com/us.html and http://www.astronautix.com/craft/usa.htm have good technical descriptions of the payload, code name ‘US-A’, with several good illustrations.