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Michał Pietkiewicz
University of Warmia and Mazury in Olsztyn, Poland
e-mail: michal.pietkiewicz@uwm.edu.pl
ORCID: 0000-0002-1119-3771

THE "LIABILITY CONVENTION" IN A CLASH WITH PRACTICE – EXAMPLE OF THE "KOSMOS 954" SATELLITE

Abstract

The article examines the settlement of international claims and disputes arising from faulty nuclear-powered satellites which fall on another state's territory. The author analyzes diplomatic relations between the USSR and Canada and the content and legal settlement of the international dispute resulting from the Soviet Cosmos-954 satellite disintegrating on Canadian territory. The author concludes that the 1971 Convention on International Liability for Damage Caused by Space Objects was adopted within the appropriate time-frame, and that it forms a reliable foundation for the settlement of conflicts between the States in this area. However, the 1981 bilateral agreement "Settlement of the Claim between Canada and the Union of Soviet Socialist Republics for Damage Caused by "Cosmos 954"" showed that it has never been utilized. This contravenes the international treaty regulating international liability for damage caused by space objects. Therefore, the biggest question of all materializes here: did the international community need space law? Even though it is the newest branch of public international law, it is almost 60 years old. This period of time (more than half a century) has only seen it in academic discussions on how states should abide by it. The lack of relevant case law is a good and bad thing at the same time. Bad – because we still do not know how international courts and tribunals will apply norms of space law. Good – because up until now we have not experienced an international conflict that states have not been able to solve by diplomatic measures.

KEY WORDS

"Cosmos-954" satellite, space crash, space damage, liability for space activities, "Morning Light" operation, international dispute resolutions

SŁOWA KLUCZOWE

satelita "Cosmos-954", katastrofa kosmiczna, szkoda kosmiczna, odpowiedzialność za szkody kosmiczne, operacja „Morning Light", rozwiązywanie sporów międzynarodowych

1. THE BACKGROUND OF THE "ЛЕГЕНДА" (LEGEND) SYSTEM

The question of artificial satellites' energy source was raised after the very first satellite launch, and it was proposed that satellites operating at low altitude should be equipped with nuclear reactors because not all devices could effectively use solar panels.

One of the most serious problems of optical reconnaissance was, and still is, the impossibility of direct observation of ground objects uninterrupted for every 24-hour period and in all weather conditions. Therefore, orbital radar systems were developed immediately after the implementation of programs to create the USSR and USA military satellite constellations.[1]

"Legend" (GRAU[2] index - 17K114) was a system of the global satellite Marine Space Reconnaissance and Target Designation (МКРЦ) for Soviet Navy operation in 1978-2006. The system enabled monitoring and subsequent prediction of tactical situations in oceans, and the transmission of information in real time to ships, submarines and ground stations.

However, the short service life of an active satellite predetermines the episodic nature of its work, and the "Legend" system was developed to replace the obsolete aviation marine radar targeting system called "Success".

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[1] I. Afanas'yev, *Kistorii razrabotki sputnikov morskoy radiorazvedki*, 'Novosti Kosmonavtiki' 2007, No. 1, p. 20, https://warspot.ru/17979-zvezda-polyn (accessed 18.01.2023).

[2] Index of the department of the Ministry of Defense. Conventional alphanumeric designation of a sample of weapons and military equipment assigned by one of the Ordering Departments of the Ministry of Defense of the USSR and Russia.

The lead developer was 'Experimental Design Bureau No. 52 (ОКБ-52)'[3] established under the leadership of Vladimir Chelomey.[4] Political upheavals and reforms in the rocket and space industry then led to the August 1965 change, when the process was newly-headed by the Leningrad Arsenal Design Bureau, named after M.V. Frunze,[5] and led by Evgeny Ivanov.

It was decided that the "Legend" had two device types: the radar reconnaissance US-A (Active Reconnaissance Satellite, GRAU: 17Ф16К) and the radio intelligence US-P (Passive Reconnaissance Satellite). The navy gave these devices the following nicknames: the first was "Thin" because of its elongated cylindrical shape, and the second was named "Flat" after its wide solar panels.[6] In the final version, the project of the Marine Space Reconnaissance and Target Designation provided a "non-stop" survey of global oceans by grouping seven vehicles: four US-As and three US-Ps. The satellites were programed to collect information on "probable enemy" fleet movements, and transmit it to the ground station and directly to warships and submarines on duty in the ocean.[7] This surveillance was used to target the Cruise-missile submarine projects (SSGN) armed with P-700 "Granit" missiles with a flight range far exceeding the range of their own detection and target capabilities.

The US-P spacecraft searched and identified surface targets without radar irradiation, and registered them only by intercepted signals characteristic for a particular type of ship. The US-P equipment was then operated by solar power plants with buffer batteries.[8]

In contrast, an important feature of the US-A spacecraft was that it used the "Chaika-seagull" one-way-side-view radar station to detect enemy fleets. This required a lot of energy, and solar panels were difficult to use because the radar required more efficient operation. Therefore, it had to be in a relatively low 240-270 km orbit. In addition, the atmospheric influence still imposed on the panels would slow down the satellite and take it out of orbit too early.[9] The radar would also have to be turned off in the earth's "shadow". These combined prob-

[3] Joint Stock Company ""Military-Industrial Corporation" Scientific and Production Association of Mashinostroeniya".

[4] S. Gorove, *Cosmos 954: Issues of Law and Policy*, 'Journal of Space Law' 1978, No. 6(137); N.F. Krasnov, *Aerodinamika otryvnykh techeniy*, Moscow 1988, p. 113.

[5] Nowadays Russia is one of the leading developers and manufacturers of space technology, naval artillery and launchers.

[6] O. Kaptsov, *Morskaya kosmicheskaya sistema razvedki i tseleukazaniya*, Voyennoye obozreniye, 20.03.2012, https://topwar.ru/12554-morskaya-kosmicheskaya-razvedka-celey.html (accessed 18.01.2023).

[7] A. Zemlyanov, G. Kossov, V. Traube, *Sistema morskoy kosmicheskoy razvedki i tseleukazaniya (istoriya sozdaniya),* Sankt Petersburg 2002, p. 84.

[8] M. Tarasenko, *Voyennyye aspekty sovetskoy kosmonavtiki*, Moscow 1992, p. 71.

[9] See more in: V.S. Verba (ed.), *Radiolokatsionnyye Sistemy Zemleobzora Kosmicheskogo Bazirovaniya*, Moscow 2010.

lems led the designers to equip the craft with a nuclear power plant with homogeneous fast neutron reactor and thermoelectric generator.[10]

Work on the creation of a nuclear installation, which later received the designation BES-5 (Onboard Power System No. 5) and "Buk-Onboard space installation", was determined by the resolutions of the Central Committee of the CPSU and the Council of Ministers of the USSR No. 258-110 on 16 March 1961[11] and No. 702-295 of 3 July 1962.[12]

The appointed responsible executor was the Experimental Design Bureau No. 670 (OKB-670), headed by Mikhail Bondaryuk and under the scientific leadership of the Physics and Energy Institute (PEI).[13] Work on the space nuclear power plant was much more difficult than expected, and a large team of specialists were soon working on the project. This included the Moscow Design Bureau "Krasnaya Zvezda-Red Star" with part of the OKB-670 team, the "Istok-source" Scientific and Technical Center and the Institute of Atomic Energy and other enterprises.[14]

The mass of the US-A satellites was approximately 4 tons, and 1,250 kg of this was in the nuclear power plant. They had a cylindrical shape with a 1.3-m diameter and the length of 10 m, and the radiation safety was provided by two systems:

(1) the main system took the nuclear power plant into a long-term "burial" orbit at 750-1000 km height, with the help of a special solid-fuel propulsion system. Calculations determined that the lifetime of objects in the "burial" orbit is at least 250 years;[15]

(2) a duplicate system was based on the destruction of the reactor from aerodynamic heating in the upper atmosphere.

The US-A flight design tests began by launching simplified vehicles without nuclear installations or radar stations. The "Cosmos-102" (28 December 1965) and "Cosmos-125" (20 July 1966) satellites were launched using a modified two-

[10] O, Makarov, *Ye rakety i kosmicheskaya razvedka: ubiytsy avianostsev, Techinsider*, Voyennaya aviatsiya, 28.04.2020, https://www.techinsider.ru/weapon/182371-razvedchik-na-bystrykh-neytronakh/ (accessed 18.01.2023).

[11] Decree of the Central Committee of the CPSU and the Council of Ministers of the USSR on the development of work on anti-satellite defense and space exploration, No. 258-110, 16 March 1961, https://www.kosmonavtika.com/bibliographie/documents/258-110.pdf (accessed 18.01.2023).

[12] A.A. Bashlakova (ed.), *Severnyy kosmodrom Rossii*. Vol. 1., Plesieck 2007, p. 45.

[13] V. Pupko, *Istoriya rabot v FEI po razrabotke i sozdaniyu YARD i kosmicheskikh YAEU, 50 let FEI*, Obninsk 1996, p. 205.

[14] O.A. Gubeladze, R.A. Goncharov, *Zashchita vozvrashchayemoy chasti kosmicheskogo apparata, Izvestiya vuzov. Severo-Kavkazskiy region*, 'Yestestvennyye nauki. Prilozheniye' 2006, No. 1, p. 38.

[15] A.A. Kulandin, S.V. Timashev, I.V. Zaytsev, *Energeticheskiye sistemy kosmicheskikh apparatov*, Moscow 1994, p. 127.

stage launch vehicle of the "Vostok" type (11A510), with additional orbit-launch from the spacecraft's own propulsion system.

"Cosmos-954" became the 20th Soviet satellite with a nuclear power source.[16] Many accidents occurred over 10 years of use of these devices. Two "Cosmos"-line satellites returned to Earth in emergency conditions in 1969, one failed at launch in 1973 and a further incident occurred in 1975. However, the program continued, despite the risk of radioactive contamination of the territory in the event of a fall.[17]

2. LAUNCH AND CRASH OF THE "COSMOS-954" SATELLITE

The next US-A under the name "Cosmos-954" was launched by the Cyclone-2 carrier rocket at the Baikonur cosmodrome on 18 September 1977. This was in standard configuration with the Buk nuclear power plant-series No. 58, and it began working in tandem with "Cosmos-952" which launched two days earlier. However, it lost orientation in space and ground service control on 28 October 1977. The command sent to take the reactor compartment into "burial" orbit did not arrive, and uncontrolled descent began as it was breaking-up in the higher atmosphere. Although the precise causes of the accident are still unknown, the corrective propulsion system software most likely failed.[18]

The TASS Russia News Agency report on the "Cosmos-954" satellite launch in the "Pravda-truth" newspaper translates to the following: "On 18 September 1977, the next artificial satellite to orbit the Earth is "Cosmos-954". It was launched in the Soviet Union, with scientific equipment designed to continue space exploration installed on board the satellite. The satellite is put into orbit with the following parameters:

– Initial circulation period – 89.6 minutes;

– The maximum distance from the Earth's surface (at apogee) is 277 kilometres;

– Minimum distance from the Earth's surface (at apogee) is 259 kilometres;

– The inclination of the orbit is 65 degrees."

The TASS article continued, "In addition to scientific equipment, the satellite has a radio system for accurate measurement of orbital elements and a radio telemetry system for transmitting operational data on instrument and scientific

[16] A.B. Zheleznyakov, *Tayny raketnykh katastrof: plata za proryv v kosmos*, Moscow 2004, p. 239.

[17] M. Dolphin, "*Cosmos 954" and its Unlikely Journey to the NWT 35 Years Ago*, Hay River Hub, 9 April 2013, http://www.hayriverhub.com/2013/04/kosmos-954-and-its-unlikely-journey-to-the-nwt-35-years-ago2013 (accessed 28.01.2023), p. 38.

[18] A. Zheleznyakov, *Avariya sputnika "Kosmos-954",* 'Sekretnyye Materialy' 2004, No. 19, p. 33.

equipment back to Earth. The equipment installed on the satellite is working normally, and the coordination and computing centre is processing the incoming information".[19]

The situation worsened on 28 October and 6 January 1978 when the spacecraft depressurized, and this caused its accelerated fall. The Americans concluded from the changes in satellite motion that it would enter the dense atmospheric layers by the end of January 1978. Meanwhile, the Soviet experts hoped that "Cosmos-954" would be brought down somewhere in the ocean, but could not say exactly where the debris would fall. Subsequent reports compared this to the "Russian roulette".[20]

The United States then contacted the Soviet government through diplomatic channels on 12 and 17 January and requested accurate information about "Cosmos-954". The answers received were laconic: "the satellite's nuclear installation runs on uranium-235, the design provides for the complete disintegration of the reactor in the dense atmosphere layers and the pollution of the area will be minimal and require just the implementation of standard remediation measures".[21]

On 18 January, the governments of NATO countries and Australia, New Zealand, Japan and Canada received a message from the United States about the "Cosmos-954" problem, with the recommendation to be careful when detecting fragments of the Soviet apparatus. However, the American emergency specialists stressed that they considered it unnecessary to warn the population in advance because of the uncertainty of the "landing" location. Incredibly, all governments agreed to remain silent, and until the fall of Sputnik, not a single head of state ever mentioned the possibility of an atomic explosion, which politicians did not rule out, despite reassurances from the Soviet Union.[22]

On 24 January 1978, at 6:53 a.m. Ottawa time (11:53 UTC), a red-hot object appeared in the sky over south-western Canada.[23] Twenty-two minutes later, President Jimmy Carter informed the Canadian Prime Minister Pierre Elliott Trudeau that a Soviet satellite had crashed in northern Canadian territory, and he offered to help collect the wreckage. Later it became known that debris fell over a 600 km

[19] «Kosmos-954». Soobshcheniye TASS, Pravda Newspaper, 20.09.1977.

[20] A. Zheleznyakov, *Yadernoye sozvezdiye: istoriya sozdaniya i ekspluatatsii otechestvennykh kosmicheskikh apparatov s yadernymi energeticheskimi ustanovkami*, 'Atomnaya Strategiya XXI' 2004, No. 9, p. 31.

[21] I. Fedik, *Yaderno-kosmicheskaya energetika, Istoriya sovetskogo atomnogo proyekta (1940–1950)*, Vol .3, Moscow 1996, p. 90.

[22] R.L. Grasty, *The Search for COSMOS-954*, 'Search Theory and Applications' 1980, pp. 211-220; V.S. Yartsev, *Krusheniye sovetskogo sputnika «Kosmos-954» i mezhdunarodnyye posledstviya*, Moscow 2018, p. 89.

[23] C.A. Morrison, *Voyage into the Unknown: The Search for and Recovery of Cosmos 954*, 'Archivaria' 1982, No. 17, p. 58.

long section: from the Great Slave Lake to Baker Lake. The total area of "pollution" was 124,000 km^2.[24]

Information about the incident finally reached the media, and this caused a great stir. For several days the media discussed what had happened, making the wildest accusations against the United States and the Soviet Union. For example, it was claimed that American aerospace defense shot down "Cosmos-954", and the satellite was not a research or reconnaissance satellite, but carried an atomic warhead.[25] The media tried to avoid panic by hiding the accident details, but panic gradually engulfed the world.[26]

The Soviet Main Intelligence Directorate (GRU) discussed the possibility of sending several special-forces teams to Canada to secretly collect and take away "Cosmos-954" fragments. But this idea was wisely abandoned, especially since American and Canadian specialists were actively working in the fall area.[27]

3. "MORNING LIGHT" OPERATION

On 24 January, the active phase of the recovery operation called "Morning Light" began. Its headquarters was at a military base in the Edmonton suburb in Alberta, Canada. It was first necessary to outline search zones for the "Cosmos-954" wreckage, and aircraft equipped with sensitive gamma spectrometers were then deployed.[28] The U-2 reconnaissance aircraft barraged at high altitudes, trying to detect plumes of uranium-235 and its decay products. Research showed that there were no traces of air contamination, but, all parts of the reactor recovered on the ground, including the smallest ones, had to be identified and fully tested, especially for radioactivity.[29]

Four SS-130 Hercules military transport aircraft from the Royal Canadian Air Force 435th Squadron were equipped to identify areas with excess natural radioactive background. From 24 January to 25 March, the pilots made 608 sorties and

[24] H.W. Taylor, E.A. Hutchison, K.L. McInnes, J. Svoboda, *Cosmos 954: Search for Airborne Radioactivity on Lichens in the Crash Area, Northwest Territories, Canada*, 'Science' 1979, Vol. 205(4413), pp. 1383-1385.

[25] M. Yuzbashyan, *Aktual'nyye mezhdunarodno-pravovyye voprosy razresheniya sporov v oblasti kosmicheskoy deyatel'nosti*, 'Pravo i Upravleniye. XXI Vek' 2018, No. 2(47), p. 50.

[26] *The Dangers of Cosmos 954*, 'The New York Times', 27 January 1978, p. 24.

[27] O.V. Yakovlev, *Sistemnyy analiz bezopasnosti i riska kosmicheskoy yadernoy energetiki*, 'Vestnik VGU. Seriya: Sistemnyy Analiz i Informatsionnyye Tekhnologii' 2011, No 2, p. 46

[28] E. Power, A. Keeling, *Cleaning up Cosmos: Satellite Debris, Radioactive Risk, and the Politics of Knowledge in Operation Morning Light*, 'The Northern Review' 2018, No. 48, p. 89.

[29] R. Dean, P. Whitney Lackenbauer (eds), *Operation Morning Light: An Operational History,* Antigonish, NS 2018, p. 30.

located wreckage sites from an average altitude of 300 meters. Mistaken sightings occurred because of complex data processing. For example, some search teams that followed specialist advice and landed in the tundra and on the frozen lakes returned with nothing. In addition, theorists believed the reactor core elements should form craters at least one meter in depth, but all attempts to find these elements ended in vain.[30]

A further problem was that the search was conducted in the harsh Arctic winter. Gamma-ray spectrometers and computer data processing constantly failed in the low temperatures, and ground teams experienced serious physical symptoms and psychological stress aggravated by radiophobia.[31]

The "Morning Light" Operation was suspended at the end of March, after more than a hundred fragments of radiating materials with a total mass of 65 kg were collected. The fragment radioactivity ranged from several milliroentgen an hour to 200 X-rays an hour. The recovered fragments of the reactor core were only 0.1% of this 65 kg mass. The preliminary report published in September 1978 concluded that the reactor "burned-down" in the atmosphere, and particles which settled in the desert Arctic regions had a diameter of less than a millimetre. These were then carried away by meltwater in April and May.[32]

The summary of the operations is divided into two temporal phases. The first phase was from 24 January 1978 to 20 April 1978 and the second from 21 April 1978 to 15 October 1978. The total costs were CAD 12,048,239.11 for the first phase and CAD 1,921,904.55 for the second

4. LIABILITY CONVENTION AND DIPLOMATIC MEASURES

The Soviet Union had to react in some way to what was happening, but high-ranking politicians remained silent. The scientists' comments supported politician demands to ban space research, quietly rebuke the Russians and impose sanctions on the USSR. The Soviet Union actions were discussed and condemned, and it was obvious that anti-Soviet hysteria had spiralled out of control. Moreover, it should have been clear to all scientists that the satellite would burn almost com-

[30] E.J.J. Power, *Memories of Mistrust and Contamination: The Legacies of Cosmos 954 and Operation Morning Light in Denendeh*, Master Thesis, Department of Geography and Planning, University of Toronto, 2019, https://tspace.library.utoronto.ca/bitstream/1807/98549/1/Power_Ellen_201911_MA_thesis.pdf (accessed 28.01.2023), pp. 15-16; G.A. Orlova, *Fiziki-yadershchiki v bor'be za pravo na kosmos,* 'Apokrif, Tekhnologos' 2018, No. 2, p. 120.

[31] Radiophobia – a fear of ionizing radiation.

[32] R.L. Grasty, *The Search for COSMOS-954*, (in:) K.B. Haley, L.D. Stone (eds), *Search Theory and Applications*, NATO Conference Series 1980, Vol. 8, p. 217.

pletely in the upper atmosphere without appropriate installation protection, and that only fragments would return to earth.[33]

The Canadian Department of External Affairs contacted the USSR Ambassador in Ottawa, in accordance with Article 5 in the 1968 Agreement on the Rescue of Astronauts, and the Return of Astronauts and Return of Objects Launched into Outer Space. The first Canadian diplomatic document stipulated that space-object components believed to be part of Cosmos 954 had been discovered on Canadian soil. They also notified the United Nations Secretary-General that Canada reserved its rights on liability and compensation for this incident under international law.[34]

The USSR remained silent on further Canadian communications on the 24 and 27 January 1978, and the Canadian Government therefore issued an Aide-Memoire requiring answers to technical questions about the Cosmos 954 debris. These included: (1) What was the amount and nature of the fuel's chemical and alloy composition?; (2) What was the reactor-fuel half-life?; (3) What shielding was used, and was there an alternative container which would have offered greater protection?; (4) What types of material, energy level and ionizing radiation spectrum would the Soviet authorities have expected if the remnants had landed on Soviet territory?; (5) Over what sized-area would debris have been distributed?, and (6) Is the reactor the same, or essentially similar to the "ROMASHKA-chamomile" reactor described by Pushkarsky and Okhotik in 'Review' 1971, Vol. 9, No. 2?[35]

The first official USSR Embassy reply to Canadian authorities was dated 20 February 1978. The Soviet regime regretted in it only that the search and removal of Cosmos-954 debris had occurred without their specialists' participation. This was quite illuminating, because the Canadian government had sent three queries which remained unanswered. Moreover, that Soviet communication illustrated that the USSR had no interest in any space objects discovered on Canadian territory - regardless of commitment to the above-mentioned Article 5 of the 1968 agreement.[36]

The next Canadian communique to the Soviet Embassy in Canada was sent one week later. This missive stressed Canada's concern about the risk of harmful effects from the satellite fragments, because some were highly radioactive. It also listed all the official communications sent to the Soviet Embassy, addressed the accusation of not inviting Soviet specialists to the search and informed the USSR of their intention to submit a claim for damages. This claim would include the search and recovery costs incurred by Canada for hazardous Soviet satellite components present on Canadian territory, and it would be filed in accordance with

[33] I. Fedik, 1996, *op.cit*., p. 88.

[34] Canadian Department of External Affairs Note of 8 February 1978.

[35] Canadian Aide-Memoire to Soviet Embassy in Ottawa of 8 February 1978.

[36] Note from the Embassy of the USSR at Ottawa – 20 February 1978.

international law and relevant international agreements. This included the 1972 Liability Convention, wherein Canada and the USSR are both parties.[37] A following Canadian government communication advised the Soviets that new spacecraft fragments had been discovered,[38] but the USSR Embassy stated again that they were not interested in anything found on Canadian soil, and Canada could deal with it as they wished.[39]

A further Canadian communique of 13 April 1978 requested additional technical information because the satellite weighed several tons and the reactor core was tens-of-kilograms. The sheer size posed problems about the amount and spread of subsequent radiation over Canadian territory.[40] Canada received an involved answer on the 31 of May. The Soviets answered those questions, but most importantly they added that Soviet specialists estimated that the level of external radiation would generally be safe for the Canadian population. They based this on Canada's transmitted information, and then advised that all searches would be immediately discontinued if a similar situation occurred on USSR soil.[41]

5. CLAIM AND SETTLEMENT

Canada presented its log of claims for USSR compensation for Cosmos 954 damages on the 23 January 1979. It is most important here that the Canadian Government did not file its claim under any particular legal norm. Instead, it vaguely conveyed that the claim was filed on the following basis: (1) the relevant international agreements, (2) the 1972 Convention on International Liability for Damage caused by Space Objects and (3) on general principles of international law.[42]

Canada's compensation claim was for CAD 6,041,174.70. This was presented without prejudice to Canada's right to additional claims for currently unidentified or undetermined damage, and for future population and ecological radiation from nuclear contamination.[43] It is quite strange, and therefore important, that this

[37] Note from the Department of External Affairs, 28 February 1978 (No. FLO-0497).

[38] Note from Department of External Affairs – 3 March 1978 (No. FLO-0532).

[39] Note from the Embassy of the Union of Soviet Socialist Republics at Ottawa of 21 March 1978.

[40] Note from the Department of External Affairs of 13 April 1978 (No. FLO-0840).

[41] Note of 31 May 1978 from the Embassy of the Union of Soviet Socialist Republics at Ottawa.

[42] J.A.B Note, *Convention on International Liability for Damage Caused by Space Objects: Definition and Determination of Damages After the Cosmos 954 Incident*, 'Fordham International Law Journal' 1984, No. 8, pp. 255-285.

[43] Claim Against The Union Of Soviet Socialist Republics For Damage Caused By Soviet Cosmos 954 (No. FLA-268), 23 January 1979.

claim presented to the USSR was 40% less than the actual 13,970,143.66 Canadian-dollar-cost for the two Morning Light recovery stages.

The international law stipulations relevant to compensation for damages starts with the Outer Space Treaty.[44] The essence of Treaty Article VII is that "each State Party to the Treaty that launches or procures the launching of an object into outer space is internationally liable for damage to another State Party to the Treaty". The Liability Convention[45] provides more detailed information on compensation. Article II 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 or to aircraft flight".

Moreover, the Canadian claim was also based on the general principles of international law. The principle of absolute liability applies to fields of activities with a common high degree of risk, and this is repeated in numerous international agreements and is one of "the general principles of law recognized by civilized nations" under ICJ Statute Article 38. This is accepted as a general principle of international law.[46] The Canadian damages calculation applied relevant criteria established by the general principles of international law, according to which fair compensation is to be paid. Therefore, its claim included only costs deemed reasonable, "proximately caused by the intrusion of the satellite and deposit of debris, and capable of being calculated with a reasonable degree of certainty".[47]

Canada and the USSR reached a compromise and signed a Claim Settlement on 2 April 1981 after very lengthy negotiations.[48] The Protocol was signed in Moscow by Canada's Ambassador to the USSR, Geoffrey Pearson and, on behalf of the USSR by N.S. Ryzhov, Deputy Minister of the Ministry of Foreign Affairs. This formal Protocol settled Canada's claim for damages caused by the "Cosmos 954" Soviet satellite disintegration over Canadian territory, and interestingly, the parties to the protocol used the term "disintegration", rather than "crash", "catastrophe" or "disaster".

The entire document had a very short text, consisting only of a preamble and 3 articles. The main stipulation was that the USSR pay three million Canadian dollars to the Canadian Government. This registered the payment in full, and the final settlement of all matters connected with the disintegration of the Cosmos 954 Soviet satellite in January 1978. It further registered that the Canadian Government accept this payment.

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[44] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967, Res. 2222 (XXI).

[45] Convention on International Liability for Damage Caused by Space Objects, 1971, Res. 2777 (XXVI).

[46] Annex A of the Claim.

[47] *Ibid.*

[48] B. Schwartz, M.L. Berlin, *After the Fall: An Analysis of Canadian Legal Claims for Damage Caused by Cosmos 954*, 'McGill Law Journal' 1981, No. 27, p. 676.

6. THE END OF THE "LEGEND"

The "Cosmos-954" disintegration and subsequent international scandal forced the US-A device developers to initiate additional security measures. A further system was introduced into the Buk installation. This was intended to separate the core from the reactor vessel if removal in the "burial" orbit failed. The core was to be destroyed by a "piston-type powder pressure accumulator". This would disintegrate radioactive materials into tiny fragments, so that larger particles could not return to Earth.[49]

The US-A launches resumed in April 1980. However, all eventualities could not be covered, and the "Cosmos-1266" on-board equipment failed on 28 April 1981 with the threat of uncontrolled descent from orbit. Fortunately, it was possible to transfer the reactor to the "burial" orbit on this occasion, but the device worked for only eight days. Similar problems occurred for the next "Cosmos-1299" satellite which was launched on 24 August 1981. This operation lasted only thirteen days, and therefore proved unacceptable to the space industry.[50]

The two launches of "Cosmos-1365" in May 1982 and "Cosmos-1372" in June the same year proved so successful that the USSR military considered deploying the "Legend" system full-time. This success, however, was over-shadowed by a further calamity. The "Cosmos-1402" satellite launched at the end of August 1982 failed on the 28 December that year. Attempts to transfer the Number-70 series nuclear power plant reactor to the "burial" orbit were unsuccessful, and uncontrolled descent began.

Fortunately, an additional radiation safety system worked perfectly, and this destroyed the active zone, so that the "Cosmos-1402" remnants entered the atmosphere over Ascension Island in the Atlantic Ocean on the 7 February 1983. The American space services recorded only a slight increase in natural background radiation in that area. Although no one was injured, this accident again forced the Soviet Union to suspend US-A launches for a year and a half. Launches then resumed on 29 June 1984 with "Cosmos-1579", and they continued regularly for four years.

The fully modernized US-AM "Cosmos-1900" spacecraft equipped with 5 kW electric power and the latest "Topaz-1" nuclear power plant (TEU-5, "Topol") was put into orbit in December 1987.[51] Its subsequent disaster initiated the end of the

[49] E. Galloway, *Nuclear Powered Satellites: The U.S.S.R. Cosmos 954 and the Canadian Claim,* 'Akron Law Review' 1979, Vol. 12(3), p. 414.

[50] R.V. Borodin, *Osobennosti sverkhzvukovogo obtekaniya povrezhdennoy poverkhnosti vozvrashchayemoy chasti kosmicheskogo apparata*, 'Materialy VIII Mezhdunarodnogo Foruma «Vysokiye tekhnologii KHKHI»', Moscow 2007, p. 51.

[51] D. Harland, R. Lorenz, *Space Systems Failures. Disasters and Rescues of Satellites, Rockets, and Space Probes*, Berlin/Heidelberg/New York 2005, pp. 92-93.

"Legend" missions. Ground communication with the spacecraft was suddenly interrupted on 16 April 1988, and it began descending uncontrollably in the following months. All attempts to transfer the command to withdraw the reactor or to separate the core were unsuccessful. However, the designers were determined not to introduce radioactive substances into the atmosphere, so they activated the reactor's automatic withdrawal system five days before the predicted fall on 30 September 1988. This was successfully turned on after the fuel reserves in the orientation system were exhausted.[52]

Launching of the final "Cosmos-1932" US-A on 14 March 1988 prompted international outcries of "space pollution". Although the flight lasted sixty-eight days and ended normally, it was wisely decided to abandon the use of devices with nuclear reactors.[53] Strong political pressure from the United States and international organizations demanded that the Soviet Union stop space pollution.

A further important factor in terminating "Legend" was the reactor's low technical abilities which failed to meet expectations. However, thirty-one Buk nuclear installations and one "Topaz-1" were launched in the US-A spacecraft missions. Twenty-eight of these remain in high orbits, as only one "Buk" did not reach space and two returned to Earth in emergency.

7. CONCLUSION

This article analysed the causal relationships and international legal consequences of the Soviet "Cosmos-954" satellite crash on Canadian territory. Canada is a NATO member state, and the presence of Soviet military satellite fragments on its soil became one of the most serious international incidents at the end of the Brezhnev "détente" period. However, the analysis has clearly indicated that it is possible even for oppositional states to cooperate under international law and bilateral agreements which provide compensation for the damage caused.

This outcome is possible because all parties involved in space technology are aware that unforeseen situations may be inevitable during testing processes, and that these form an indispensable condition for the development of advanced technology. The 1971 Convention on International Liability for Damage Caused by Space Objects was adopted expeditiously and, in this instance, it formed a reliable foundation for settlement of the "Cosmos 954" conflict between the oppositional States. Moreover, the 1981 bilateral agreement entitled "Settlement of the Claim

[52] O.A. Gubeladze, *Vliyaniye defektov poverkhnosti korpusa letatel'nogo apparata na teplovoy pogranichnyy sloy*, 'Yestestvennyye Nauki' 2008, No. 1, p. 29.

[53] M. Tyrrell, *Making Sense of Contaminants: A Case Study of Arviat, Nunavut*, 'Arctic' 2006, Vol. 59(4), p. 374.

between Canada and the Union of Soviet Socialist Republics for Damage Caused by "Cosmos 954" provides the precedent that negotiations and agreement between conflicting parties enable the details of the order and the content of the damage to be systematically addressed and settled. This legal process ably resolved the injured party's claims.

The legal process has thus created a reliable foundation for future settlement of complex disputes between nations. Moreover, it is important to maintain this process throughout the development of the present stage of space activity, because this will help negate escalating conflicts and disputed claims for damage during the exploration of outer space.

Most interestingly, this important example of Cosmos-954 remediation became an accepted academic example of the practical use of the Liability Convention – but is it really? The previous points made in this article identify that the claim was based on the above-mentioned convention, but what is important here is not the claim - but its settlement. In direct contrast to academic acceptance, this entire situation was actually resolved through diplomatic channels.

While everyone is congratulating the legal process for settlement of the Canada-USSR claim, this article concludes that there is not one word about "legal basis" in the document, and therefore the remediation grounds were never based on the Liability Convention. Moreover, the Claims Commission cited in Article XIV was not established.

In conclusion, the political manner in which this Cosmos-954 conundrum was settled leads the author to presume that "the provisions of the Liability Convention are dead", because it has not been used since its ratification. The remaining queries are if the space law was enacted before essential use and, most controversially, do we really need space law?

REFERENCES

Afanas'yev I., *Kistorii razrabotki sputnikov morskoy radiorazvedki*, 'Novosti Kosmonavtiki' 2007, No. 1, https://warspot.ru/17979-zvezda-polyn (accessed 18.01.2023)

Bashlakova A.A. (ed.), *Severnyy kosmodrom Rossii*. Vol. 1., Plesieck 2007

Borodin R.V., *Osobennosti sverkhzvukovogo obtekaniya povrezhdennoy poverkhnosti vozvrashchayemoy chasti kosmicheskogo apparata*, 'Materialy VIII Mezhdunarodnogo Foruma «Vysokiye tekhnologii KHKHI»', Moscow 2007

Dean R., Whitney Lackenbauer P. (eds), *Operation Morning Light: An Operational History,* Antigonish, NS 2018

Dolphin M., "*Cosmos 954" and its Unlikely Journey to the NWT 35 Years Ago*, Hay River Hub, 9 April 2013, http://www.hayriverhub.com/2013/04/kosmos-954-and-its-unlikely-journey-to-the-nwt-35-years-ago2013 (accessed 28.01.2023)

Fedik I., *Yaderno-kosmicheskaya energetika, Istoriya sovetskogo atomnogo proyekta (1940–1950),* Vol. 3, Moscow 1996

Galloway E., *Nuclear Powered Satellites: The U.S.S.R. Cosmos 954 and the Canadian Claim,* 'Akron Law Review' 1979, Vol. 12(3)

Gorove S., *Cosmos 954: Issues of Law and Policy*, 'Journal of Space Law' 1978, No. 137 Krasnov N.F., *Aerodinamika otryvnykh techeniy*, Moscow 1988

Grasty R.L., *The Search for COSMOS-954*, 'Search Theory and Applications' 1980

Grasty R.L., *The Search for COSMOS-954*, (in:) K.B. Haley, L.D. Stone, L.D. (eds), *Search Theory and Applications*, 'NATO Conference Series' 1980, Vol. 8

Gubeladze O.A., Goncharov R.A., *Zashchita vozvrashchayemoy chasti kosmicheskogo apparata, Izvestiya vuzov. Severo-Kavkazskiy region*, 'Yestestvennyye Nauki. Prilozheniye' 2006, No. 1

Gubeladze O.A., *Vliyaniye defektov poverkhnosti korpusa letatel'nogo apparata na teplovoy pogranichnyy sloy*, 'Yestestvennyye Nauki' 2008, No. 1

Harland D., Lorenz R., *Space Systems Failures. Disasters and Rescues of Satellites, Rockets, and Space Probes*, Berlin/Heidelberg/New York 2005

Kaptsov O., *Morskaya kosmicheskaya sistema razvedki i tseleukazaniya*, Voyennoye obozreniye, 20.03.2012, https://topwar.ru/12554-morskaya-kosmicheskaya-razvedka-celey.html (accessed 18.01.2023)

Kulandin A.A., Timashev S.V., Zaytsev I.V., *Energeticheskiye sistemy kosmicheskikh apparatov*, Moscow 1994

Makarov O., *Krylatyye rakety i kosmicheskaya razvedka: ubiytsy avianostsev, Techinsider*, Voyennaya aviatsiya, 28.04.2020, https://www.techinsider.ru/weapon/182371--razvedchik-na-bystrykh-neytronakh/ (accessed 18.01.2023)

Morrison C.A., *Voyage into the Unknown: The Search for and Recovery of Cosmos 954*, 'Archivaria' 1982, No. 17

Note J.A.B., *Convention on International Liability for Damage Caused by Space Objects: Definition and Determination of Damages After the Cosmos 954 Incident*, 'Fordham International Law Journal' 1984, No. 8

Orlova G.A., *Fiziki-yadershchiki v bor'be za pravo na kosmos,* 'Apokrif, Tekhnologos' 2018, No. 2

Power E.J.J., Keeling, A., *Cleaning up Cosmos: Satellite Debris, Radioactive Risk, and the Politics of Knowledge in Operation Morning Light*, 'The Northern Review' 2018, No. 48

Power E.J.J., *Memories of Mistrust and Contamination: The Legacies of Cosmos 954 and Operation Morning Light in Denendeh*, Master Thesis, Department of Geography and Planning, University of Toronto, 2019, https://tspace.library.utoronto.ca/bitstream/1807/98549/1/Power_Ellen_201911_MA_thesis.pdf (accessed 28.01.2023)

Pupko V., *Istoriya rabot v FEI po razrabotke i sozdaniyu YARD i kosmicheskikh YAEU, 50 let FEI*, Obninsk 1996

Schwartz B., Berlin M.L., *After the Fall: An Analysis of Canadian Legal Claims for Damage Caused by Cosmos-954*, 'McGill Law Journal' 1981, No. 27

Tarasenko M., *Voyennyye aspekty sovetskoy kosmonavtiki*, Moscow 1992

Taylor H.W., Hutchison E.A., McInnes K.L., Svoboda J., *Cosmos 954: Search for Airborne Radioactivity on Lichens in the Crash Area, Northwest Territories, Canada*, 'Science' 1979, Vol. 205(4413)

Tyrrell, M. *Making Sense of Contaminants: A Case Study of Arviat, Nunavut*, 'Arctic' 2006, Vol. 59(4)

Verba V.S. (ed.), *Radiolokatsionnyye Sistemy Zemleobzora Kosmicheskogo Bazirovaniya*, Moscow 2010

Yakovlev O.V., *Sistemnyy analiz bezopasnosti i riska kosmicheskoy yadernoy energetiki*, 'Vestnik VGU. Seriya: Sistemnyy Analiz i Informatsionnyye Tekhnologii' 2011, No. 2

Yartsev V.S., *Krusheniye sovetskogo sputnika «Kosmos-954» i mezhdunarodnyye posledstviya*, Moscow 2018

Yuzbashyan M., *Aktual'nyye mezhdunarodno-pravovyye voprosy razresheniya sporov v oblasti kosmicheskoy deyatel'nosti*, 'Pravo i Upravleniye. XXI Vek' 2018, No. 2(47)

Zemlyanov A., Kossov G., Traube V., *Sistema morskoy kosmicheskoy razvedki i tseleukazaniya (istoriya sozdaniya),* Sankt Petersburg 2002

Zheleznyakov A., *Avariya sputnika "Kosmos-954"*, 'Sekretnyye Materialy' 2004, No. 19

Zheleznyakov A., *Yadernoye sozvezdiye: istoriya sozdaniya i ekspluatatsii otechestvennykh kosmicheskikh apparatov s yadernymi energeticheskimi ustanovkami*, 'Atomnaya Strategiya XXI' 2004, No. 9

Zheleznyakov A.B., *Tayny raketnykh katastrof: plata za proryv v kosmos*, Moscow 2004