Environmental and Socio-Demographic Consequences of the Chornobyl Nuclear Power Plant Accident: A Historical Retrospective after 36 Years

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Abstract

The accident at the Chornobyl Nuclear Power Plant was one of the largest in human history. It is often referred to as a global event because its effects were felt not only by Ukrainians but also by the populations of Belarus, Russia, Central Europe, the Balkans and the Scandinavian Peninsula. 2022 marked the 36th anniversary of this terrible occurrence, when the history of Ukraine in the late twentieth century was divided into two parts: before the tragedy of 26 April 1986, and after it.

Today, it is important for Ukrainian society not only to recognise the significance of the catastrophe and remember its victims but also to find ways to overcome its grave consequences. This requires comprehensive research useful for developing new approaches to minimising the environmental and socio-demographic problems caused by the Chornobyl tragedy. Thus, this research has practical scientific, humanitarian and socio-political significance.

The novelty of the obtained results lies in the study's critical rethinking of the achievements of predecessors and its analysis of historical sources concerning the environmental and socio-demographic consequences of the accident at the Chornobyl Nuclear Power Plant as they manifested from 1986 to 2022.

The methodological basis of the work is empirical cognition. The use of logical-analytical methods of grouping and typology allows us to classify homogeneous events and coherently present the material of the article. The study additionally uses comparative judgment, historical-statistical and problem-chronological methods. The principles of objectivity and impartiality also play an important role in the work.

The purpose of the study is to investigate the consequences of the Chornobyl Nuclear Power Plant accident on the environmental and socio-demographic aspects of the population of Ukraine from 1986 to 2022 based on the identified set of sources. From a historical perspective, the level of pollution in the territories of Ukraine is traced, the demographic situation is monitored, and parallels are drawn between the Chornobyl disaster and the increase in incurable diseases and mortality.

In conclusion, the authors note that although 36 years have passed, the echo of this catastrophe remains tangible for the population of Ukraine. Several issues still must be solved. The first is the return to life, namely, the safe living and management of areas that have been exposed to radiation contamination, as well as the continuation of work aimed at restoring agricultural soils. Second, purposeful work must be conducted by the state to minimise social and demographic problems resulting from the Chornobyl catastrophe. In our opinion, the government should increase expenditures aimed at providing quality medical services to the population of Ukraine, as well as conduct constant monitoring of the health of those people who are at high risk in order to better detect diseases in their early stages. These groups of people include liquidators of the consequences of the accident and migrants. Such measures can stabilise the demographic situation by increasing birth rates and reducing mortality, as well as improve the health and living standards of the population of Ukraine.

Keywords

Chornobyl, accident, radiation, evacuation, ecological disaster, demographic situation, acute radiation sickness, historical retrospective

The accident at the Chornobyl Nuclear Power Plant on 26 April, 1986, was one of the largest in the history of mankind. It is often referred to as a global event because the consequences of the disaster were felt not only by Ukrainians but also by the populations of Belarus, Russia, Central Europe, the Balkans and the Scandinavian Peninsula. 26 April, 2022, marked the 36th anniversary of this tragedy.

For modern youth, the phrase "Chornobyl disaster" does not sound scary but magical. Sightseeing trips were organised to the exclusion zone until 2022, and tourists curiously explored the ghost town of Prypiat: houses, shops, hotels, food and educational institutions, abandoned a third of a century ago, caused terrible feelings. In the 1980s, life was in full swing in Prypiat, but now everything is abandoned and dilapidated. However, almost none of the tourists thought about the consequences of the tragedy. At first glance, the consequences are invisible, but in truth, they continue to threaten people's lives and health.

A vivid confirmation of this fact is the tragic event of 24 February 2022, which divided modern history into another "before" and "after". On this day, at 5 o'clock in the morning, a full-scale war was launched by the Russian Federation, aimed at destroying Ukraine. Soon after the invasion of Ukraine, Russian troops managed to occupy the entire territory of the Chornobyl Nuclear Power Plant and took all the personnel and security of the plant hostage. The world recognised such destructive actions of the Russian aggressors as an act of nuclear terrorism, the consequences of which would be felt by the entire world. In addition, Russian soldiers began to dig trenches in the "Red Forest" and received a high dose of radiation (Radio Liverty 2022). This is clear proof that 36 years later, the dangerous consequences of the Chornobyl catastrophe still affect people's lives and health.

Therefore, after the de-occupation of the Chornobyl zone, it is important not only to recognise the catastrophe as a terrible accident and remember its victims but also to find the best ways to finally overcome its grave consequences. This will require comprehensive research to develop approaches to minimising the environmental and socio-demographic problems caused by the Chornobyl tragedy. Thus, this research has practical scientific, humanitarian and socio-political significance.

The Chornobyl disaster has been many scientists' object of research. In the historical context, this topic is reflected in the works of N. P. Baranovska. Baranovska, through a wide range of sources, highlighted the causes of the accident at the fourth power unit of the Chornobyl Nuclear Power Plant, studied the chronology of events and described the work required to minimise its consequences.

Information about the impact of the Chornobyl accident on the population is contained in the publications of such researchers as P. P. Mykhailenko, N. N. Lakiza-Sachuk, N. I. Omelianets and S. I. Pyrozhkov. However, it is worth noting that almost all of these studies were conducted in the late 20th to early 21st centuries, and, therefore, they cannot reflect the full range of negative consequences that the Ukrainian population continues to experience at the beginning of the third decade of the 21st century.

Among the unpublished sources, materials from the Central State Archive of Supreme Bodies of Power and Government of Ukraine and the Central State Archive of Public Organizations of Ukraine are of great importance for this research. They contain information on the scope of radiation contamination in the territory of Ukraine, describe the work aimed at resettling people from the exclusion zone and present data on public health in the first post-emergency years. In addition, the sources include several regulatory legislative documents that allow us to trace the state's policy aimed at ensuring social, medical and radiation protection for victims of the Chornobyl disaster.

Thus, although the historiographical and archival sources are quite representative, given the constant passage of time, it is appropriate to reconsider the tragedy's negative environmental and socio-demographic consequences for Ukrainian society over the past 36 years. The purpose of this research is therefore to study these consequences from 1986 to 2022 based on various sources and using modern methods and principles of scientific and historical knowledge. The novelty of the obtained results lies in the study's critical rethinking of the achievements of its predecessors and its analysis of historical sources concerning the environmental and socio-demographic consequences of the Chornobyl Nuclear Power Plant accident.

Research and methodology

The methodological basis of the work consists of methods of empirical cognition, as well as historical, chronological and problem-thematic methods. The use of the logical-analytical methods of grouping and typology makes it possible to classify homogeneous events and coherently present the material. The method of comparative judgment is also applied, enabling comparisons of the consequences of the Chornobyl Nuclear Power Plant accident, beginning in 1986 and ending in 2022. Historical and problem-chronological methods are additionally used to analyse the course of events during the study period. In the process of investigating the topic, the principles of objectivity and impartiality play an important role, helping to give a balanced assessment of the actions of the heads of pro-government structures and relevant ministries aimed at eliminating the power plant accident and minimising its consequences. These principles made it possible to assess the actions of both the Soviet leadership and the power structures of modern Ukraine in solving urgent problems related to the catastrophe at the Chornobyl Nuclear Power Plant from the standpoint of neutrality. In particular, both negative and positive political decisions to minimise the consequences of the disaster were analysed. Thus, the use of a wide range of research methods allows us to comprehensively and systematically examine our chosen topic.

Findings and discussion

The night between Saturday the 25th and Sunday the 26th of April, 1986, was one of the most terrible nights in the history of Ukraine. The explosion at the fourth power unit of the Chornobyl Nuclear Power Plant caused significant economic, environmental and socio-demographic consequences for Ukraine, which was part of the Soviet Union at the time. Therefore, it is not surprising that the totalitarian system, in order to avoid panic, tried to hide the scale of the accident from the public. This secrecy was manifested primarily in complete information silence: the first official announcement from the Soviet government was made on television two days later, on 28 April. Even then, the statement was made under pressure from the international community, which had learned about the accident after discovering radioactive particles on employees' clothes at the Forsmark Nuclear Power Plant in Sweden, located 1,100 kilometres from Chornobyl. Notably, the message itself was concise and contained very little information about what happened, and, therefore, the public had the impression that the threat was already localised and there was no danger to their lives or health. In addition, the leadership of Soviet Ukraine issued an order to hold May Day demonstrations in cities and villages, exposing the public to further radiation, which negatively affected the health of most Ukrainians, especially pregnant women and children, over the next 36 years.

Radioactive spread

Only in 1990 did the Verkhovna Rada of the Ukrainian SSR recognise Ukraine as an ecological disaster zone and officially approve the list of the most affected territories by radiation. The list included 81 administrative units in 12 regions of Ukraine: Vinnytsia, Volyn, Zhytomyr, Ivano-Frankivsk, Kyiv, Rivne, Sumy, Ternopil, Khmelnytskyi, Cherkasy, Chernivtsi and Chernihiv (Social, Medical and Radiation Protection of Victims in Ukraine as a Result of the Chornobyl Disaster 1998, p. 543).

The total area of the affected radioactive territories was 50,000 square kilometres. In particular, the Zhytomyr region accounted for 27.4% of the agricultural land, meadows, pastures and forests affected by radiation, the Kyiv region accounted for 23%, and the Rivne region, 22.7% (Smolii 2006, p. 585).

Emissions of radioactive isotopes of iodine, strontium, caesium and plutonium, which are recognised as the most dangerous emissions for all living organisms, emanated from the destroyed reactor of the fourth power unit of the Chornobyl Nuclear Power Plant, creating the so-called exclusion zone (2,598 square kilometres). The exclusion zone was a highly polluted territory surrounding the destroyed power unit and the plant, which became a constant source of radionuclides to the adjacent areas of the Kyiv and Zhytomyr regions (Law of Ukraine No. 3522-IV).

It is worth noting that a 3-kilometre zone around the Chornobyl Nuclear Power Plant was designed as a sanitary protection zone, according to regulatory documents concerning the process of ensuring radiation safety and sanitary control. However, after the accident at the fourth power unit, it became obvious that a much larger area was exposed to radioactive contamination. Based on research conducted during the initial stage of work responding to the tragedy, the life-threatening radiation area had a radius of 30 kilometres.

Subsequently, the situation and the impact of emissions from the "shelter" facility (built at the accident site) on the environment were more thoroughly monitored. Then, based on research conducted by specialists at the Institute of Biophysics of the Ministry of Health, the State Sanitary Epidemiological Service of Ukraine approved a 10-kilometre zone of special radiation danger.

The larger zone with a 30-kilometre radius received the official status of the Chornobyl Exclusion Zone, with a complex border determined by specific levels of pollution. At the end of 1986, its perimeter reached 223.5 kilometres, 34 of which passed along the border of Ukraine and Belarus. About 36,545 hectares of densely populated Ukrainian land fell into this disaster zone (Baranovska 1999, pp. 224–225). The most polluted areas, from which soil samples were constantly taken, were the villages around Chornobyl: Dytiatky, Mashev, Usov, Krasne, Benivka, Stara Shepelycha, Buriakivka, Zymovyshche, Kryva Hora, Strakholissia, Chystohalivka, Kopachi, Stachanka, Korohod and Ilovnytsia (Fedorenko 2014, p. 71).

Since it was deadly to live in this territory, 115,000 people were evacuated from the exclusion zone in the first year following the accident. However, the evacuation process was not completed in 1986. Since the level of pollution remained quite high in the late 1980s, and the death rate from diseases in these territories increased significantly, the process of resettling people from polluted regions continued into early 1990. As of 7 December 1990, a specially created Commission on the Chornobyl Disaster reported that "out of 12 villages of Narodychi District of Zhytomyr region in 1990, 1,203 families consisting of 3,414 persons were resettled. In addition, 18,611 persons were given special documents for resettlement to other regions of the Republic, as well as providing housing and employment. 139 families consisting of 362 persons left two villages of Podilsk District of Kyiv region" (Central State Archive… 1/22/1984). In general, the process of resettlement from these territories continued until the mid-1990s, when the resettlement of residents of the most radioactive villages of Kyiv and Zhytomyr regions was officially completed.

Ecological impacts

The consequences of radioactive contamination were devastating for the ecology of Ukraine. All objects of flora and fauna felt the maximum impact of radiation in the first 10–20 days after the disaster. However, in the summer and autumn, the radiation level decreased by about 20%, and by the end of the year, it decreased by another 10–15%.

The ecosystem was particularly damaged in the exclusion zone. The radiation effects immediately became apparent in pine forests, the death of which was recorded on the territory of about 500 hectares around the Chornobyl Nuclear Power Plant. In the first days after the accident, all the conifers simply withered, forming the infamous Red Forest through which the first evacuation buses passed. The death of entire animal populations was recorded in the same territory.

However, the greatest disaster was caused by the effects of radiation isotopes on agricultural land (4.6 million hectares), causing not only environmental but also significant economic losses (Smolii, Berenshtein and Panchenko 2000, p. 97). To rehabilitate damaged soil, a whole range of measures were carried out, including the alkalisation and re-alkalisation of pastures and meadows, as well as liming acidic soils. Soil restoration projects were carried out for 2.14 million hectares of the most polluted agricultural land (Baranovska 2011, p. 132).

Thanks to timely measures, it was possible to limit the contamination of agricultural products to permissible levels, with further positive developments toward reducing radiation. This is evidenced by the data collected from monitoring agricultural and forestry products, which has been regularly conducted since that time. In 1997, radiation contamination exceeded permissible levels in vegetables, fruits and cereals in 638 localities, and three years later, in 2000, radiation-contaminated milk from was only in 487 localities.

However, over time, the state began to curtail rehabilitation work restoring radiation-contaminated soils, purportedly due to a lack of funds. In our opinion, this was an erroneous decision, since the level of radiation was still dangerous for the life and health of people in some regions. Our conclusion is confirmed by the results of monitoring territories outside the exclusion zone that were significantly contaminated with radiation in 1986; such research was conducted in 2018 by the National Institute for Strategic Studies. Even now, some territories still have a significant level of radiation. Therefore, one of the priorities of the modern state policy concerned with minimising environmental and man-made security threats in Ukraine should be returning these territories to normal life ('Threats in the Field…').

Monitoring radiation contamination in food

An important step that saved lives was the constant monitoring of the quality of food products, including confirming the absence of radiation contamination. First, agricultural products were checked.

During the first five years after the disaster, Ukraine developed a system of radiation control for products, consisting of a network of city, district and inter-district laboratories, as well as sanitary stations. The work of these laboratories extended to all the markets of Kyiv and regional and district centres of Ukraine. All institutions were provided with radiation measuring devices manufactured by a specialized Bila Tserkva enterprise, and each institution checked their products several times, as it was indisputable that the population continued to be exposed to radiation through the consumption of agricultural products in the first years after the accident. In particular, in the Zhytomyr and Volyn regions, a dangerous level of radiation was detected in 80–95% of food consumed by the population; in some cities and villages, the contamination rate even reached 98%. Furthermore, in 70 settlements located on the border of the exclusion zone, the level of radioactive compounds in vegetables and fruits collected from household plots was three times higher than the permissible norm (Baranovska 2011, p. 131).

The situation improved only 15–17 years after the accident. In 2000–2003, specialists at the Ukrainian Academy of Agrarian Sciences analysed about 3 million samples of agricultural and forestry food products (1 million food samples in 2000, about 900,000 samples in 2001, and more than 850,000 in 2003) for radionuclides. According to the results, almost 2% of fruits, vegetables, mushrooms, berries and dairy products exceeded the maximum permissible levels of radionuclides defined by State Hygiene Standards PL-97 (National Report on the State of Technogenic and Ecological Safety in Ukraine in 2003, 2004, p. 119).

Today, all agricultural products that enter specially-built food markets are checked by laboratories (the number of which has reached 982 units), and their work is regulated by a number of documents, namely the Order of the Ministry of Agrarian Policy and Food of Ukraine (2017) "On the Regulations on the State Research Institute for Laboratory Diagnostics and Veterinary and Sanitary Expertise and the Regulations on the City, District, Inter-District State Laboratories of the State Service of Ukraine on Food Safety and Consumer Protection" ('Regulations on City…'). However, the risk of encountering products with a higher level of radiation than the permissible norms remains relevant. For example, in 2019, Volyn radioecologists took 13,973 samples of various agricultural and forestry products, and 16 were found to exceed the permissible level of radiation (3 milk products and 13 forest mushrooms and berries). Furthermore, there are many spontaneous markets in Ukraine, and their products do not pass proper verification.

Socio-demographic impact

In addition to environmental problems, the accident at the Chornobyl Nuclear Power Plant caused significant, extremely negative changes in the socio-demographic profile of Ukraine.

First, there have been noticeable changes in the geographical and demographic maps of Ukraine. As a result of the evacuation from the Chornobyl Exclusion Zone, as of the beginning of the 2020s, one city (Prypiat) and 63 rural settlements were completely depopulated (of which

more than 20 units disappeared from the state map); 11 villages were degraded and depopulated; and the city of Chornobyl was turned into a shift settlement, which now houses more than 2,000 personnel working in shifts and about 100 self-settlers who returned after the evacuation work was completed. In total, 199,000 people were evacuated from the Chornobyl district along with the city. However, as of 2018, 814 families continued to live in the zone of unconditional mandatory resettlement, including those who initially refused to move and those who returned to their native homes later.

Second, after 1986, there was a significant decrease in the birth rate in the affected areas, and the contaminated areas had the highest mortality rates of the population in comparison with other regions. Furthermore, children born between 26 April 1986 and 26 February 1987, whose parents were in the territory of the now officially designated exclusion zone at the time of the accident, had a significantly higher number of chronic diseases of the nervous system and mental disorders compared to children in other regions of Ukraine. Mortality rates remained significantly higher in radiation-contaminated areas even 10 years after the accident. For example, in eight districts of the radioactively contaminated zone of the Zhytomyr region, the death rate per 1,000 people in 1997 was 17.5, compared to 16 people per 1,000 in the region. In the most polluted districts – Narodychi, Korosten and Luhyny – the death rate per 1,000 people was 29.5, 21.9 and 21.3, respectively (Mykhailenko 1998, p. 94). This negatively impacted the demographic balance of the country. In particular, in the years following the accident, an average annual decrease in the number of people was recorded in the radioactively contaminated regions, which, since 1989, amounted to 7–13%, while in Ukraine as a whole, this indicator was 4–11% (Lakiza-Sachuk, Omelianets and Pyrozhkov 1994, p. 22).

Third, the Chornobyl disaster exposed about 4 million Ukrainians to radiation, including 2,315,900 million people (including 499,500 children) who were forced to live in a radioactively contaminated territory (Hudkov 2003, p. 22). According to medical examinations, more than 80% of patients (85% of whom were the liquidators of the accident) became disabled over the next 20 years (Poiarkov et al. 2006, p. 5). Among them, according to scientists, 60–70% lived in villages and about 30% lived in cities. Agricultural and forestry workers were the most exposed to radiation among all the demographic categories of the Ukrainian SSR, excluding liquidators and station workers. In particular, according to the All-Union Scientific Center of Medicine, which monitored radiation doses, the highest level of radiation doses was recorded in employees of rural farms, at 0.6–1.3 rem/H, and of forest estate lands, at 1.0–1.5 rem/H (Central State Archive 1/32/2671).

Health impacts

Moreover, the accident at the Chornobyl Nuclear Power Plant caused a surge in the incidence of adult and child diseases, both in the country as a whole and in the regions most affected by radiation.

The first was acute radiation sickness, with which 237 people were diagnosed in the second half of 1986 (28 of whom died). In the next two years, another 134 people were treated for the severe consequences of radiation. During the period 1987–2005, another 29 Ukrainians died from complications caused by acute radiation sickness. The most common causes of death were sudden heart failure, cancer and somato-neurological pathologies.

According to medical monitoring data, all people evacuated from the affected area showed a tendency to develop diseases of the respiratory, digestive and circulatory systems, as well as malignant neoplasms. Now, most medical scientists talk about the long-term consequences of Chornobyl, which are manifested in a triad of cancers that develop over 2 to 30 years. These are thyroid cancer, leukaemia and breast cancer.

One of the most serious consequences of the Chornobyl accident was the increase in the incidence of thyroid cancer, especially among children. From 1986 to 2002, 2,702 patients aged 0 to 18 years were treated for thyroid cancer in Ukraine. Among these patients, 1,882 were children (0–14 years old). Through 2014, the number of patients with this type of cancer continued to grow. The statistics were simply dreadful; 10,600 people fell ill with the disease, and they were those who were exposed to radiation in childhood or adolescence.

Leukaemia also began to appear mainly in the first years after the Chornobyl tragedy, and breast cancer became common in women who were exposed to a high dose of radiation while working to eliminate the consequences of the accident. According to statistics, there were 8,000 such women diagnosed with breast cancer (Radio Liberty 2016). The situation has now stabilised, but every year, doctors detect 20–30 cases of cancer in people who were exposed to a high dose of radiation in 1986.

In addition, both displaced persons and people who lived in polluted areas showed a tendency to develop mental disorders, namely, depression, insomnia and social dysfunction.

A separate category of people requiring both medical and social support is the participants in the liquidation of the Chornobyl Nuclear Power Plant accident. About 600,000 of these people are still alive today. On average, the effective radiation dose per liquidator in 1986–1987 was 163.7 mSv. In this category of people, according to the medical service, health deterioration was recorded in all classes of diseases, primary among which was oncological diseases (mainly leukaemia), as well as cardiovascular diseases and endocrine and mental disorders. As of 2021, according to the organisation Chornobyl Union, out of the 600,000 liquidators, 10% had died, and 165,000 had become disabled people of groups I, II and III (Main Directorate… 2021).

As of 2021, the total number of victims of the Chornobyl Nuclear Power Plant accident was 2.5 million ('In Ukraine 1.6 Million People…'), including 1.6 million people annually seeking help in medical institutions. Such a large figure is a clear indication that the problems associated with the terrible accident have not disappeared but still remain relevant and require concrete efforts from the modern authorities to provide financial and medical support to citizens affected by the Chornobyl disaster.

Conclusion

At the beginning of the 2010s, not all state institutions directed their efforts toward improving the social protection of these categories of Ukrainian citizens. In particular, the Cabinet of Ministers, headed by then Prime Minister Arsenii Yatseniuk, sent a number of resolutions to the Verkhovna Rada. Law 76-VIII, "On Amendments and Cancellation of Certain Legal Acts of Ukraine", was thus adopted by the Verkhovna Rada and amended Law No. 791 a-XII, "On the Legal Status of Territories Exposed to Radioactive Contamination as a Result of the Chornobyl Disaster". As a result, since 1 January 2015, the zone of enhanced radioecological control, that is, half of the contaminated territory of Ukraine, has been eliminated. This, in turn, set a precedent for depriving some Ukrainian citizens of the status of victims of the Chornobyl disaster and, therefore, of the benefits to which they are entitled. By the decision of the Supreme Court of Ukraine in January 2019, this status and related benefits remain for people who lived and worked in the former fourth zone of radioactive contamination.

Certain positive steps were taken to improve the social situation of Chornobyl victims in 2017, when the fifth President of Ukraine, Petro Poroshenko, signed Law No. 2082-VIII, "On Amendments to Article 48 of the Law of Ukraine On the Status and Social Protection of Citizens Affected by the Chornobyl Disaster". This normative legal act amended the right to receive annual rehabilitation assistance for children who lost one of their parents as a result of the Chornobyl disaster and were evacuated from the exclusion zone in 1986.

On 1 July 2021, Law No. 1584-IX, "On Amendments to the Law of Ukraine On the Status and Social Protection of Citizens Affected by the Chornobyl Disaster" was enacted, signed by the sixth President of Ukraine, Volodymyr Zelenskyi. According to this law, the minimum disability pensions and minimum pension payments to persons who became disabled as a result of the accident at the Chornobyl Nuclear Power Plant significantly increased. Despite these positive steps, work aimed at improving the social protection of this category of citizens must continue.

Thus, the echo of the Chornobyl Nuclear Power Plant accident remains noticeable for the population of Ukraine 36 years later. The unresolved tasks of minimising the consequences of the tragedy, set at the beginning of the 21st century, require modern approaches. First, a return to life must be made possible; namely, the safe living and farming of territories that have been exposed to radiation contamination must be realised, and using the latest technologies, we must restore

agricultural soils. Second, the state must stabilise the demographic situation by improving the birth rate and mortality rates, quickly detecting diseases in the population affected by the accident and providing high-quality medical services primarily to those who are classified as high-risk. Third, only by the joint efforts of Ukraine and the international community is it possible to resist the nuclear threat posed by Russia's shelling of the Zaporizhzhia Nuclear Power Plant and prevent another nuclear catastrophe, the devastating consequences of which would be felt not only by Ukraine but by the whole world.

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