

## 10 UNKNOWN FACTS ABOUT CHERNOBYL

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*В данной статье рассказывается о Чернобыльской трагедии, которую назвали самой большой техногенной катастрофой в истории. В этом году исполнилось 30 лет, как произошла авария на Чернобыльской атомной электростанции и 15 лет как ЧАЭС была полностью остановлена, но интерес к Чернобылю не падает. В статье автор рассматривает не только все подробности этого фатального дня, но и описывает несколько правил поведения в зоне отчуждения, а также цитирует мнения журналистов из других стран об этом печально памятном бедствии. Кажется, мир еще не осознал, что могло бы случиться в тот день, если бы не нашлись мужественные и отважные герои Чернобыля! К 2016 году в окрестностях ЧАЭС установлено много памятников и мемориалов, каждый год 26 апреля люди по всему миру чтут память об этом дне.*

*Ключевые слова: бедствие, радиоактивный, реактор, эвакуация, ядерный.*

*У даній статті розповідається про Чорнобильську трагедію, яку назвали найбільшою техногенною катастрофою в історії. В цьому році виповнилось 30 років, як сталася аварія на Чорнобильській атомній електростанції та 15 років як ЧАЕС була повністю зупинена, але зацікавленість Чорнобилем менше не стає. У статті автор розглядає не тільки усі подробиці цього фатального дня, але також описує декілька правил поведінки у зоні відчуження; крім того, авторка цитує*

думки журналістів з інших країн про це пам'ятне лихо. Здається, світ ще не усвідомив, що могло б статися в той день, якби не знайшлися мужні та відважні герої Чорнобиля! До 2016 року в околицях ЧАЕС було встановлено багато пам'ятників і меморіалів, кожен рік 26 квітня люди по всьому світу шанують пам'ять про цей день.

*Ключові слова: лихо, радіоактивний, реактор, евакуація, ядерний.*

*This article describes Chernobyl disaster which was called the largest man-made disaster in history. This year has been already 30 years from the time the accident occurred at the Chernobyl nuclear power plant, and 15 years since the nuclear plant has been completely stopped; but the interest to Chernobyl hasn't become smaller. The author considers not only the details of that fatal day, but describes a few basic rules of conduct in the alienation zone, as well as cites some journalists from other countries as to this sad memorable disaster. It seems the world doesn't realize what could have happened on that day, if courageous and valiant heroes of Chernobyl hadn't helped! By 2016, many monuments and memorials had been erected near Chernobyl and each year on April 26, people all around the world revere the memory of this day.*

*Key words: disaster, radioactivity, reactor, evacuation, nuclear.*

This year it has been 30 years since Chernobyl disaster but the effects of it will be felt for years to come. Despite all the media coverage, many of us still don't know all the facts about that fatal day. So, here are 10 details you may not have learned about.

**10. Fatal Errors.** Chernobyl disaster is considered to be the worst nuclear accident in the history of human civilization. The estimates of the radioactivity released vary from 50 million Curie to one billion Curie. All four Chernobyl reactors were cooled by water, and in the case of losing this coolant, it overheated instead of shutting itself down. This faulty and unstable design, coupled with a human factor of bad technical judgment, and speedy decisions made by engineers, led to the explosion in the fourth reactor. Prompted by a desire to experiment with a turbine generator's ability to pump water in an inert state, reactor engineers increased the power of the generator while severely decreasing most of the safety measures. A state of no control followed, a reaction was poisoned, water boiled, and the emergency cooling system was purposefully shut down. Finally realizing the critical conditions, operators took measures to reduce the reactivity by using graphite control rods. It was a deadly mistake, as graphite only increased the reaction by displacing water from the rod channels. In the early morning of April 26, 1986, the fourth reactor exploded. The sequence of events which follows has been compiled following a review of a large number of reports and it represents what is considered the most likely sequence of events, but there remain some uncertainties.

**April 25. 01:06** – The scheduled shutdown of the reactor started. Gradual lowering of the power level began.

**03:47** – Lowering of reactor power halted at 1600 MW (thermal).

**14:00** – The emergency core cooling system (ECCS) was isolated (part of the test procedure) to prevent it from interrupting the test later. The fact that the ECCS was isolated did not contribute to the accident; however, had it been available it might have reduced the impact slightly. The power was due to be lowered further; however, the controller of the electricity grid in Kiev requested the reactor operator to keep supplying electricity to enable demand to be met. Consequently, the reactor power level was

maintained at 1600 MWt and the experiment was delayed. Without this delay, the test would have been conducted during the day shift.

**23:10** – Power reduction recommenced.

**24:00** – Shift change. **00:05** – Power level had been decreased to 720 MWt and continued to be reduced. Although *INSAG-1* stated that operation below 700 MWt was forbidden, sustained operation of the reactor below this level was not proscribed.

**00:28** – With the power level at about 500 MWt, control was transferred from the local to the automatic regulating system. The operator might have failed to give the “hold power at required level” signal or the regulating system failed to respond to this signal. This led to an unexpected fall in power, which rapidly dropped to 30 MWt.

**00:43:27** – Turbogenerator trip signal blocked in accordance with operational and test procedures. *INSAG-1* incorrectly reported this event occurring at 01:23:04 and stated: “This trip would have saved the reactor”. However, it is more likely that disabling this trip only delayed the onset of the accident by 39 seconds.

**01:00** – The reactor power had risen to 200 MWt and stabilised. Although the operators may not have known it, the required operating reactivity margin (ORM) of 15 rods had been violated. The decision was made to carry out the turbogenerator rundown tests at a power level of about 200 MWt.

**01:03** – A standby main circulation pump was switched into the left hand cooling circuit in order to increase the water flow to the core (part of the test procedure).

**01:07** – An additional cooling pump was switched into the right hand cooling circuit (part of the test). Operation of additional pumps removed heat from the core more quickly leading to decreased reactivity, necessitating further absorber rod removal to prevent power levels falling. The pumps delivered excessive flow to the point where they exceeded their allowed limits. Increased core flow led to problems with the level in the steam drum.

**01:19 (approx.)** – The steam drum level was still near the emergency level. To compensate, the operator increased feedwater flow. This raised the drum level, but further reduced reactivity to the system. The automatic control rods went up to the upper tie plate to compensate but further withdrawal of manual rods was required to maintain the reactivity balance. System pressure began to fall and, to stabilise pressure, the steam turbine bypass valve was shut off. The operators had trouble with the pressure and level control, they deactivated the automatic trip systems to the steam drum around this time.

**01:22:30** – Calculations performed after the accident found that the ORM at this point proved to be equal to eight control rods. Operating policy required that a minimum ORM of 15 control rods be inserted in the reactor at all times

**April 26, the test. 01:23 approx.** – Reactor parameters stabilised. The unit shift supervisors considered that preparations for the tests had been completed and, having switched on the oscilloscope, gave the order to close the emergency stop valves.

**01:23:04** – Turbine feed valves closed to start turbine coasting. This was the beginning of the actual test. According to Annex I of *INSAG-7*, for the following approximately 30 seconds of rundown of the four coolant pumps, “the parameters of the unit were controlled, remained within the limits expected for the operating conditions concerned, and did not require any intervention on the part of the personnel”.

**01:23:40** – The emergency button (AZ-5) was pressed by the operator. Control rods started to enter the core, increasing the reactivity at the bottom of the core.

**01:23:43** – Power excursion rate emergency protection system signals on; power exceeded 530 MWt.

**01:23:46** – Disconnection of the first pair of main circulating pumps (MCPs) being “run down”, followed immediately by disconnection of the second pair.

**01:23:47** – Sharp reduction in the flow rates of the MCPs not involved in the rundown test and unreliable readings in the MCPs involved in the test; sharp increase of pressure in the steam separator drums; sharp increase in the water level in the steam separator drums.

**01:23:48** – Restoration of flow rates of MCPs not involved in the rundown test to values close to the initial ones; restoration of flow rates to 15% below the initial rate for the MCPs on the left side which were being run down; restoration of flow rates to 10% below the initial rate for one of the other MCPs involved in the test and unreliable readings for the other one; further increase of pressure in the steam separator drums and of water level in the steam separator drums; triggering of systems for dumping of steam to condensers.

**01:23:49** – Emergency protection signal “Pressure increase in reactor space (rupture of a fuel channel)”; No voltage – 48 V’ signal (no power supply to the servodrive mechanisms of the EPS); Failure of the actuators of automatic power controllers №1 and 2’ signals.

**01:24** – From a note in the chief reactor control engineer’s operating log: “01:24: Severe shocks; the RCPS rods stopped moving before they reached the lower limit stop switches; power switch of clutch mechanisms is off”.

**9. First Response.** In the early hours of that spring day, all hell broke loose and hundreds of firefighters were attempting to stop the generator fire. Approximately 300 tonnes of water pumped every hour into the remaining part of the generator, which was damaged beyond repair. According to the World Nuclear Association, they stopped after half a day due to the danger of flooding reactors one and two. In the following days the exploded reactor was still burning, so about 5000 tonnes of boron, clay, sand, dolomite and lead were poured over it by helicopters in an effort to stop the fires and cover the radioactive elements. Chernobyl disaster was a unique event and the only accident in the history of commercial nuclear power where radiation-related fatalities occurred. However, the design of the reactor is unique and in that respect the accident is thus of little relevance to the rest of the nuclear industry outside the then Eastern Bloc. However, it led to major changes in safety culture and in industry cooperation, particularly between East and West before the end of the Soviet Union. Former President Gorbachev said that Chernobyl accident was a more important factor in the fall of the Soviet Union than Perestroika.

**8. While the world was unaware.** At exactly 1:21 am. on April 1986, in Chernobyl the № 4 reactor exploded and released 30-40 times the radiation of the Nagasaki and Hiroshima bombing. But it took the Soviet government a full day to realize the scale of the accident and its consequences. Only after that was the full evacuation of Pripjat and many more villages and small towns in the region ordered. Hundreds of thousands of people were hastily evacuated and later relocated but for many it was too late. The accident destroyed Chernobyl 4 reactor, killing 30 operators and firemen within three months and several further deaths later. One person was killed immediately and a second died in hospital soon after as a result of injuries received. Another person is reported to have died at the time from a coronary thrombosis. Acute radiation syndrome (ARS) was originally diagnosed in 237 people on-site and involved with the clean-up and it was later confirmed in 134 cases. Of these, 28 people died as a result of ARS within a few weeks of the accident. Nineteen more subsequently died between 1987 and 2004 but their deaths cannot necessarily be attributed to radiation exposure. Nobody off-site suffered from acute radiation effects although a large proportion of childhood thyroid cancers diagnosed since the accident is likely to be due to intake of radioactive iodine fallout. Furthermore, large

areas of Belarus, Ukraine, Russia and beyond were contaminated in varying degrees. While the rushed evacuation of the local population was underway, a spike in radiation was noticed in some European countries. The official news went public only two days after the tragedy. As dangerous fumes were leaking into the atmosphere and water for two more weeks, Ukraine, Belarus, and a few parts of Russia were majorly affected. Radiation, however, touched many other countries of Europe. A nuclear cloud was dispersed over Finland, Sweden, and other territories. In fact, it reached as far as the British Islands.

**7. Damage to Human Health.** The health effects of the Chernobyl accident have been the subject of unprecedented study by health professionals and unprecedented speculation and exaggeration by parts of the media. Radiation is a quick menace that embeds itself deep in a victim's body. While initially killing less than a hundred individuals, the radioactive cloud spread across large territories over time. In fact, the amount of radiation was many times higher than the radiation released after the atomic bombing of Hiroshima and Nagasaki, and an echo is still heard in cancer cases in Belarus and Ukraine. Southern Belarus suffered the biggest burden, as many children suffered from thyroid cancer linked to the cesium radiation. According to the United States Nuclear Regulatory Commission, children in 1986 were drinking milk from cows contaminated with a radioactive iodine and were therefore receiving a very high amount of it to their thyroid glands. Approximately 6000 thyroid cancer cases were diagnosed among the youngsters. There is no proof, however, that the Chernobyl explosion is connected to other types of cancers in the region, such as leukemia.

**6. Residents Left Behind.** The most nonsensical action, however, was the evacuation of 336 000 people from the regions of the former Soviet Union, where during the years 1986 – 1995 the Chernobyl fallout increased the average natural radiation dose (about 2.5 mSv per year) by 0.8 to 1.4 mSv per year, i.e. by about 30% to 50%. The evacuation was based on radiation limits recommended by the International Commission for Radiological Protection (ICRP) for “the event of major radiation accidents” and on recommendations for protection of the general population, which were tens to hundreds of times lower than natural doses in many countries. In the asphalt paved streets of the “ghost town” of Pripjat, from which about 50 000 people were relocated, and where nobody can enter without special permission, the total external gamma dose rate measured by a Polish team in May 2001 was 0.9 mSv per year, i.e. the same as in Warsaw, and five times lower than at the Grand Central Station in New York. The evacuation led to development of mass psychosomatic disturbances, great economical losses, and traumatic social consequences.

Over a hundred thousand locals were relocated right after the accident, with thousands more to follow. However, about 1200 people, most of them older women, decided to stay or run back home. What motivated them? During interviews, most spoke about their love of their native land. According to CNN, these women illegally returned to their failing cottages because they received only meager financial support from local authorities and simply needed their land to survive against starvation. Some of them were allowed to stay, half-illegally, because they were past childbearing age. Surprisingly, not only did they survive the long aftermath of the accident, but they're still alive today in their 80s or even 90s. About 3 km away from the reactor, in the new city, Pripjat, there were 49,000 inhabitants. The old town of Chornobyl, which had a population of 12,500, is about 15 km to the southeast of the complex. Within a 30 km radius of the power plant, the total population was between 115,000 and 135,000.

**5. Devastated, but still functional.** Many of us mistakenly think that Chernobyl plant was shut down for good right after the explosion. However, that's not the case. According to the United States Nuclear Regulatory Commission, the other three reactors were soon restarted. They became fully functional again between October 1986 and December 1987. Reactor № 2 suffered a turbine building fire and was closed in 1991. № 1 was shut down in November of 1996 and the last reactor № 3 was finally stopped in December 1999.

**4. A Secret missile radar.** In 1986 the Cold War was still silently raging on the land where Chernobyl stands. It's no surprise that it was carefully guarded. However, it wasn't the only protected facility in the region. There was and still is a secret missile radar built in the 70s about 25 miles from Chernobyl that's now a part of the exclusion zone. According to the newspaper English Russia, it was called both Chernobyl-2 and Duga-1 and wasn't shown on any official map. Its intention was to detect missiles being launched from as far away as the United States. Civilians were prohibited to approach within a few miles, and about 1000 soldiers and officers who worked there lived in a tiny town with a single street called Kurchatov Street. All of them and their families were immediately evacuated after the disaster but the station remained standing tall. The structure was initially ordered demolished but the plans were rescinded under concerns that the tremors would damage Chernobyl sarcophagus.

**3. A place for scientists and tourists.** Secret and mysterious locations always attract people for various reasons. For some, Chernobyl is place of scientific exploration, while for others it's a curiosity to tell others about. It's also a place to make money. There are a few companies that provide tourist services to people wanting to experience the spooky abandoned town of Pripyat or glimpse the city itself. Chernobyl Tour, one of the official companies, reports that one day visits don't cause any harm to your health. You might even be able to visit that radar station. In the 10-kilometer zone, it is allowed to stay for 1 day, in the 30-kilometer zone – no more than 4 days.

*The objects, which are allowed to visit, are:* the observation deck overlooking the Chernobyl «Shelter»; Prometheus monument and memorial plaques to those killed in the accident; Chernobyl cooling pond and feeding the catfish; the central streets of the abandoned city of Pripyat (walking tour); some village areas where people live; cemetery of machines, which participated in the liquidation of the accident; a secret military facility of the Cold War time. In addition, you can check your feelings inside Chernobyl staying at hotel during 2-day Chernobyl tour, and visiting the hats of self-settlers, who usually are happy to meet the guests. Most guides are former residents who witnessed the accident and subsequently studied everything connected to it. They bring tourists to their homeland, and talk about scientific and technological progress and fatal human error, about the memories and dreams, about death in Chernobyl and about the life after that death.

And you may be interested what the rules for visiting Chernobyl are? CEZ territory is fenced with barbed wire, at the entrance there are checkpoints. Lists of tourists are applied in advance to the relevant authorities. At the entrance to the area, it is required to have a passport. *Recommended:* to wear closed-fitting body garment; do not eat, drink or smoke in the open air; do not touch the plants and facilities; do not drink water from land-based sources; do not sit down and put the items on the ground; do not change confirmed route.

Absolutely *forbidden* to take and bring anything from the Zone. All the people, things and vehicles are monitored by radio-control devices. If necessary, the decontamination can be done at the checkpoint.

**2. The Construction of a New Shelter.** When the first sarcophagus was built in 1986, it was constructed hastily and in harsh conditions. Not surprisingly, it's ready to crumble and let out all the contamination again. A New Safe Confinement (NSC) structure is due to be completed in 2017, being built adjacent and then moved into place on rails. It is an arch 110 metres high, 165 metres long and spanning 260 metres, to cover both unit 4 and the hastily-built 1986 structure. The arch frame is a lattice construction of tubular steel members, equipped with internal cranes. The design and construction contract for this was signed in 2007 with Novarka consortium and preparatory work on site was completed in 2010. Construction started in April 2012 and was expected to take four years. The first half, weighing 12,800 tonnes, was moved 112 metres to a holding area in front of unit 4 in April 2014. The second half was completed by the end of 2014 and was joined to the first in July 2015. Cladding, cranes and remote handling equipment were fitted in 2015. The entire 35,000 tonne structure will then be moved 330 metres into position over the reactor building about November 2016, at about 10 metres per hour, and the end walls completed. Final delivery of the project is expected in November 2017.

The hermetically sealed building will allow engineers to remotely dismantle the 1986 structure that has shielded the remains of the reactor from the weather since the weeks after the accident. It will enable the eventual removal of the fuel-containing materials (FCM) in the bottom of the reactor building and accommodate their characterisation, compaction and packing for disposal. This task represents the most important step in eliminating nuclear hazard at the site, and the real start of dismantling. The NSC will facilitate remote handling of these dangerous materials, using as few personnel as possible. During peak construction of the NSC some 1200 workers were on site. The NSC is largest moveable land-based structure ever built.

**1. Radioactive Fauna.** The Chernobyl accident was a radiation event unique in human history, but not in the history of the biosphere. There is evidence of a number of episodes of greater radiation levels during the evolution of life on earth, e.g. due to supernovae. In terms of human losses it was a minor event as compared with many other man-made catastrophes but, in political, economic, social and psychological terms, its impact was enormous. While countless birds and animals were initially killed by the radiation, current living conditions for wild animals in the exclusion zone are not so conclusive. While there are fewer species of birds and some present have been severely physically affected (smaller brains and deformed beaks) some other species are actually thriving. With no humans around, Pripjat became a haven for wolves, beavers, and other animals looking to make a home in the ghost town.

This year the world commemorates the 30<sup>th</sup> anniversary of Chernobyl Nuclear Accident. You have already discovered 10 facts about the biggest nuclear disaster in the history and I hope you've found the answers to your questions. You know, Chernobyl was one of the most memorable disasters of the 20th century. It is fair to say that the dangers presented by former Soviet nuclear power stations in 2003 exceed those of a decade earlier. In the meantime, some 3.5 million people continue to live in contaminated zones. From a necessary panacea, evacuation of those living in zones with high soil contamination today has become an unpopular and slow-moving process. Elderly people in particular have returned to their homes in some areas. Animals continue to live in those "red" forests, acid rains do not stop mercilessly destroy forests. And our government unfortunately continues to hold their own opinion and does more important things. Of

course it is sad. But today we should be proud of that people who gave their life for it and try to change our reality instead of criticizing and crying.

P.S. In 2002, the United Nations confirmed that the most of places in the exclusion zone can be attended without harm to health.

P.P.S. In 2009, Forbes magazine named the Chernobyl nuclear power plant as the most exotic place for tourism on the Earth.

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