List of information about the Chernobyl accident and its consequences which can be used during negotiations with foreign specialists

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Secret

List of information about the Chernobyl nuclear power plant accident and its consequences that can be used in negotiations with foreign experts

1. Causes of the accident

The accident at Unit 4 of the Chernobyl Nuclear Power Plant (CNPP) falls under the category of accidents involving the introduction of excess reactivity. The reactor design provided protection against this type of accident, taking into account the reactor's physical characteristics.

The technical protection measures include reactor control and protection systems for overpowering and reducing the runaway period, interlocks and protection systems for faults or switching of equipment and systems within the power unit, and the reactor's emergency cooling system.

In addition to technical protective equipment, strict rules and procedures for conducting the technological process at the nuclear power plant were also stipulated, as defined by the unit's operating regulations. Among the most important rules were requirements prohibiting the reduction of the operating reactivity margin of 30 rods.

During the preparation and testing of the turbogenerator in “coast-down” mode with the unit's auxiliary load, personnel disabled several technical protective equipment and violated key provisions of the operating regulations regarding the safe conduct of the technological process. The primary motive behind the personnel's behaviour was a desire to complete the tests as quickly as possible.

The reactor facility's developers failed to provide for safety systems capable of preventing an accident under the combination of deliberate shutdowns of safety equipment and violations of operating procedures, as they considered such a combination of events impossible.

Thus, the primary cause of the accident was an extremely unlikely combination of violations of operating procedures and procedures committed by the power unit personnel.

2. Priority measures to improve the safety of NPPs with RBMK reactors

At operating NPPs with RBMK reactors, the effectiveness of core protection has been improved (the rate of negative reactivity generation during downward movement of the control rods has been increased).

A number of additional cavitation safety margin alarms have been installed in the main circulation pump (MCP) and an automatic reactivity margin calculation system has been installed, issuing an emergency reactor shutdown signal when the margin falls below a predetermined level.

In addition to technical measures, organizational measures have been implemented to strengthen technological discipline and improve operational quality.

3. Preventing the accident from proliferating and mitigating its consequences

The primary task after the reactor accident was to extinguish the fire that had started.

As a result of explosions in the reactor and the release of highly heated fragments of its core onto the roofs of several service rooms in the reactor compartment, de-aerator stack, and turbine hall, over 30 fires erupted.

At 1:30 a.m., fire departments from the cities of Pripyat and Chernobyl responded to the accident scene. By 2:10 a.m., the main fires on the turbine hall roof and by 2:30 a.m., on the reactor hall roof, were extinguished.

The accident resulted in partial destruction of the reactor core and complete failure of its cooling system.

A team of specialists in military helicopters began dropping boron compounds, dolomite, sand, clay, and lead into the damaged reactor.

From April 27 to May 10, a total of approximately 5,000 tons of materials were dropped.

As a result of these measures, the reactor shaft was covered with a layer of loose material that intensively absorbed aerosol particles. By May 6, radioactivity releases ceased to be a significant factor, declining to several trillions of Becquerels per day, and by the end of the month, to less than a trillion Becquerels.

At the same time, the problem of reducing fuel heating was addressed. To reduce the temperature and oxygen concentration, nitrogen was pumped from the compressor station into the space beneath the reactor shaft.

By May 6, the temperature rise in the reactor shaft had ceased and had begun to decline due to the formation of a stable convective air flow through the core into the open atmosphere. As a precaution against the highly unlikely (but possible in the first days after the accident) destruction of the lower tier of building structures, a decision was made to urgently create an artificial heat-removal layer under the building's foundation in the form of a flat heat exchanger on a concrete slab.
The planned work was completed by the end of June.

Following the accident at Units 4, equipment in Units 1-3 was placed on cold standby.
Radioactive contamination of equipment and premises in Units 1-3 of the nuclear power plant was caused by the entry of radioactive substances through the ventilation system, which continued to operate for some time after the accident.

During the accident, radioactive materials were scattered across the plant grounds, landing on the roof of the turbine hall, the roof of Unit 3, and on the metal supports of the stack.
The plant's grounds, walls, and building roofs were also contaminated by the settling of radioactive aerosols and radioactive dust.

To reduce the spread of radioactive dust, the grounds, the roof of the turbine building, and the roadsides were treated with various polymerizing solutions to stabilize the upper soil layers and prevent dusting.

The mothballing of Unit 4 ensured a normal radiation environment in the surrounding area and airspace, as well as preventing the release of radioactivity into the environment.

The protective shelter for Unit 4 consists of external protective walls around the perimeter, internal concrete dividing walls in the turbine hall between Units 3 and 4, and a protective ceiling beneath the turbine hall. The central hall and other rooms of the reactor have also been sealed.
The thickness of the protective concrete walls is 1 meter or more, depending on the design.

The ventilation system of the mothballed Unit 4 removes heat from the reactor shaft, maintaining a vacuum within the building by extracting air from the upper portion of the structure and discharging it through filters and a stack into the atmosphere.

The NPP's duty personnel continuously monitor the condition of Unit 4, where various instruments (radioactivity, temperature, and air flow) are installed.
The temperature in the sub-reactor rooms has not exceeded 45°C since June 1986, indicating adequate heat removal.
The ventilation stack is ventilated by air with contamination levels well below sanitary standards.

4. Decontamination of the nuclear power plant site, the 30-kilometer zone, and its return to economic activity

To create conditions for comprehensive decontamination work, the nuclear power plant site was divided into separate zones. Decontamination in each zone included removing debris and contaminated equipment, decontaminating roofs and building exteriors, removing 5-10 cm of soil and transporting it in containers to a solid waste storage facility, laying concrete slabs on the ground, if necessary, or adding clean soil, and covering the slabs and unconcreted areas with film-forming compounds.
As a result of the measures taken, the overall gamma background was reduced to levels slightly above normal.

Reactive contamination of the adjacent areas around the nuclear power plant forced a number of emergency decisions regarding the creation of controlled zones, evacuation of the population, prohibition or restriction of economic use of land, etc.

A decision was made to establish three controlled zones: a special zone, a 10-kilometer zone, and a 30-kilometer zone. Strict dosimetric monitoring of transport was established within these zones, and decontamination points were deployed. At the zone boundaries, workers were transferred from one vehicle to another to reduce the transfer of radioactive substances. The radiation situation within the 30-kilometer zone has shown a steady improvement.

To protect groundwater and surface water in the Chernobyl Nuclear Power Plant area from contamination, a special complex of hydraulic structures has been created. This complex consists of a groundwater impermeable wall around the perimeter of the NPP industrial site and dewatering wells, a drainage curtain for the cooling pond, a drainage curtain on the right bank of the Pripyat River, an intercepting drainage curtain in the southwestern sector of the NPP, and drainage water treatment facilities.

Based on completed assessments of the situation regarding soil and vegetation contamination within a 30-kilometer zone, special agrotechnical and decontamination measures have been developed and are being implemented, allowing for the return of contaminated lands to natural use.
These measures include: modifications to traditional soil cultivation systems in the area, the use of special dust suppression compounds, changes in harvesting and processing methods, and more.

5. Monitoring radioactive contamination of the environment and public health

The release of radionuclides beyond the Chernobyl Nuclear Power Plant's damaged unit was a protracted process consisting of several stages: the release of a small amount of fuel in dispersed form, a reduction in the release due to measures taken to stop graphite combustion and filter the release, and the removal of volatile components, particularly iodine.

At the time of the accident, the standard meteorological, radiation, and sanitary-hygienic monitoring system began operating according to the emergency plan.

As soon as the scale of the accident became clear, the monitoring system began to expand, bringing in additional teams of specialists and equipment. Specialized medical institutions in Moscow and Kyiv were brought in to treat those exposed to radiation at the nuclear power plant.

The main contamination zones in the area surrounding the Chernobyl Nuclear Power Plant after the accident formed in the western, north-western, and north-eastern directions from the NPP, and then to a lesser extent to the south.

Radiation levels near the NPP exceeded 1,000 µSv/hr.
In the western area, maximum radiation levels 15 days after the accident were 50 µSv/hr at a distance of 50–60 km from the accident zone, and in the north, at a distance of 35–40 km.

In Kiev, maximum radiation levels in early May reached 5-8 µSv/hr.

Beginning on April 26, 1986, water samples were collected throughout the entire Kiev Reservoir. The highest concentrations of iodine-131 were observed in the Kiev Reservoir on May 3, 1986—1,110 Bq/L.

Irradiation of aquatic organisms in the Kiev Reservoir will not have any significant impact at the population level.

An analysis of radioactive contamination of the environment within a 30-kilometer zone around the Chernobyl Nuclear Power Plant allowed us to estimate the actual predicted radiation doses for the population of cities, towns, villages, and other populated areas.
Based on these estimates, decisions were made to evacuate the population of Pripyat and several other populated areas. A total of 135,000 people were evacuated.

These and other measures prevented the population from being exposed to radiation levels exceeding established limits. The radiological consequences for the population over the next several decades have been assessed. These consequences will be insignificant compared to natural cancers and genetic diseases.

6. Data on the radiation exposure of nuclear power plant personnel and emergency services

As a result of participating in emergency response measures in the first hours after the accident, some of these personnel received high doses (over 1,000 mSv) and also suffered burns while fighting the fire.
All victims received immediate medical attention.

By 6:00 AM on April 26, 1986, 108 people had been hospitalised, and during the day, another 24 people from those examined were hospitalised. One victim died from severe burns at 6:00 AM on April 26, 1986, and one person working at the damaged unit was not found. His workplace was located in a zone of rubble and high activity.

Based on the early diagnosis criteria adopted in the USSR, individuals with the highest probability of developing acute radiation sickness (ARS) were selected for urgent hospitalization within the first 36 hours.
The closest clinical facilities to the accident site in Kiev and a specialized hospital in Moscow were selected for hospitalisation to ensure maximum care and competent analysis of observation results.
In the first two days, 129 patients were sent to Moscow; in Kiev, 17 people were diagnosed with stage II-IV ARS, and 55 with stage I ARS. The total number of deaths from burns and ARS among personnel as of early July 1986 was 31. There are no individuals among the general population who received high doses that would lead to ARS.

Note: This list of information was developed based on information from the State Committee for the Use of Atomic Energy of the USSR, prepared for an IAEA expert meeting, August 1986, Vienna.

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