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Aspects of Assessing Consequences of Nuclear Accidents

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Chernobyl accident: consequences and lessons

In the analysis of the consequences of the Chernobyl accident and their mitigation (ACM) additionally to the scientific and technical aspects the factors of political and socio-economic nature must also be considered.

Begun in the late 80's perestroika and glasnost, political and economic disintegration of the USSR impeded justified decisions.

Chernobyl accident: consequences and lessons (cont.)

Under the influence of all these reasons, in 1991, when adopting the basic regulations for ACM (Chernobyl' Law and the State Long-Term Program of ACM) contrary to the recommendations of competent national and international experts, provisions were introduced that led to strengthening of radiation and social protection policy. As a result, first formally, and then the scale of the accident actually increased by an order of magnitude.

Chernobyl accident: consequences and lessons (cont.)

In 1991, instead of moving to a policy of remediation and rehabilitation, as demanded by the real situation, and recommendations of the specialists, there was increase in the scope of unjustified ACM work, including the additional relocation of population.

The consequences of this approach still persist and hinder the adoption of adequate solutions for the rehabilitation of the affected areas and the restoration of normal life.

The analysis of the Chernobyl accident consequences has been important for learning lessons concerning optimal ACM policy.

Methodology

Regulatory and scientific methodological documents should be available in full on an occasion of ACM after a nuclear accident. That did not happen in 1986.

Over the past 25 years much has been done in this direction in national and international organizations (Rosatom, ICRP, IAEA, etc.).

Methodology (cont.)

This set of documents, together with other decision-support tools (computer codes, databases, etc.) intended for use in regional, branch or facility crisis centers. Appointment of the crisis centers: support emergency in real time (assessment of the emergency situation and its consequences, support decisions on protective and other measures, etc.).

Methodology (cont.)

Other line of developing methodologies: a priori estimate - assessment of the consequences of hypothetical accidents in the frame of PSA. With design and other data scenarios of accidents, should be considered with evaluating their probabilities and consequences.

Methodology (cont.)

The example of methodological development in Russia:

Ivanov E., Bednyakov V., Bulgakov V., Demin V., et. al. Methodology to evaluate the potential economic and environmental consequences from the implementation of internal and external threats to nuclear power plants. Report of VNIIAES, Rosenergoatom, 2004.

One should note that one of the most problematic aspect is a method of damage evaluation concerning population and staff health effects.

Methodology (cont.)

With the use of this technique damage costs of the beyond design basis accident at Balakovo NPP was evaluated.

Ivanov E., Bednyakov V., Bulgakov V., Demin V., et. al. Assessment of potential economic and environmental impact of the implementation of internal and external threats to the Balakovo NPP in the accordance with the methodology above. Report of VNIIAES, Rosenergoatom, 2004.

The following accident was considered (among others): bilateral rupture of the main circulation pipeline (high flow) and the complete failure of the emergency core cooling system (for 24 h).

Aspects of assessing consequences of nuclear accidents

Methodology (cont.)

Types of damage	Cost, mln $
Damage to • population health • property of the population and legal entities • agricultural production • environment	 28 - 3 4
damage to personal health	5
costs of maintenance and repair work	-
cost of post-accident decommissioning	320
damage caused by undersupply of products of NPP	230
costs of decontamination of rooms and plant area	0.2
population relocation costs	-
costs of remediation of contaminated territories	0.6
costs of radioactive waste management outside NPP site	-
Total	≈ 600

Methodology (cont.)

Reasonable consideration of emergencies in the cost of electricity production is only possible in a developed system of insurance of total loss.

Negligible probabilities and small number of insured facilities, create principle difficulty in development of the scientifically justified system of nuclear insurance. the mathematical expectation (ME) of the damage per year that is equal to the product of the full damage resulting from accident Z with the time probability density w ([year^{-1}]) ME = Z×w, cannot be taken as the basis for the insurance premium calculation due to very small statistical power.

Methodology (cont.)

The information on the nuclear accidents that occurred in the past is useful in terms of the safety perfection of the nuclear facilities; however, they are not suitable for statistic data formation:

- **Their number is very small for the low probability accidents' statistics;**
- **After each of such accident (accident at the Three Mile Island NPP, Chernobyl accident, etc.) significant upgrades of the safety systems are implemented, and it results in reduction of severe accidents probability.**

Methodology (cont.)

In such conditions, the insurance system is formed with the view of the legislation requirements, based on the coordination of insurer and insurant interests and expert reports with the use of available data on the facility safety with participation of the control state agencies.

In [1] it is shown that in the current practice of nuclear insurance the system of nuclear insurance for NPP with small capacity can be realized in full.

1. Kuznetsov V.P., Demin V.F., Makarov V.I. et. al. Issues of insurance of civil liability for nuclear damage for low power nuclear power plants. In proceed. of symposium "Atomexpo", 5 June 2012, Moscow, Russia, P. 110 - 119.

Methodology (cont.)

In this case it is possible to take into account the damage from accidents in the cost of electricity production. In the accordance with our study consideration of damage from possible accidents at transportable nuclear power unit with reactor KLT-40C gives the following estimate:

damage Z (third parties) $\leq 2 \cdot 10^{-5}$ \$/kWh

Thank you

for your attantion!