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The Chernobyl Forum: major findings and recommendations

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Abstract

The accident at the Chernobyl NPP in 1986 was the most severe in the history of the nuclear industry, causing a huge release of radionuclides over large areas of Europe. The recently completed Chernobyl Forum concluded that after a number of years, along with reduction of radiation levels and accumulation of humanitarian consequences, severe social and economic depression of the affected regions and associated psychological problems of the general public and the workers had become the most significant problem to be addressed by the authorities. The majority of the affected land is now safe for life and economic activities. However, in the Chernobyl Exclusion Zone and in some limited areas of Belarus, Russia and Ukraine some restrictions on land-use should be retained for decades to come. Most of the 600,000 emergency and recovery operation workers and five million residents of the contaminated areas in Belarus, Russia and Ukraine received relatively minor radiation doses which are comparable with the natural background levels. Apart from the dramatic increase in thyroid cancer incidence among those exposed at a young age and some increase of leukaemia and solid cancer in most exposed workers, there is no clearly demonstrated increase in the somatic diseases due to radiation.
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1. Introduction

The most severe accident in the history of the world nuclear industry occurred 26 April 1986 at Unit 4 of the Chernobyl nuclear power plant located 130 km to the north–east of Kiev, the

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capital of Ukraine. One of four RBMK type reactors with a graphite moderator, a thermal power of 3200 MW and an electrical power of 1000 MW each, was destroyed by two powerful explosions in the reactor core. The explosions were caused by gross breaches of the operating procedures by staff and technical inadequacies in the safety systems (INSAG, 1986, 1993).

Due to the explosions, the reactor closure head was lifted and the core exposed to air. The reactor caught fire and burned for 10 days. During that time, radioactive substances in the form of gases, vapours, aerosols and 'hot particles' were ejected from the burning reactor and dispersed over Europe, principally Belarus, Ukraine and Russia. The total release of radioactive substances was about 14 EBq, including 1.8 EBq of ^{131}I, 0.085 EBq of ^{137}Cs, 0.01 EBq of ^{90}Sr and 0.003 EBq of plutonium radioisotopes. The noble gases contributed about 50% of the total release (IAEA, 2006).

More than 200,000 km^2 of European territory received levels of ^{137}Cs[1] above 37 kBq m^{-2} (1 Ci km^{-2}). Over 70% of this area was in the three most affected countries, Belarus, Russia and Ukraine. No more than 20% of the radioactive release spread beyond Europe (De Cort et al., 1998). Most of the strontium and plutonium radioisotopes were deposited within 100 km of the destroyed reactor due to larger particle sizes.

About 350,000 emergency and recovery operation workers were initially involved in mitigation of the accident and cleaning up the affected areas in 1986–1987. Later, the number of registered 'liquidators' rose to about 600,000.

About five million people live in areas of Belarus, Russia and Ukraine that are contaminated with radionuclides due to the Chernobyl accident (above 37 kBq m^{-2} of ^{137}Cs). Amongst them, about 400,000 people lived in more contaminated areas – classified at the time by Soviet authorities as zones of 'strict radiation control' (above 555 kBq m^{-2} or 15 Ci km^{-2} of ^{137}Cs). Of this population, 116,000 people were evacuated in April–July 1986 from the vicinity of the Chernobyl NPP (s.c. Chernobyl Exclusion Zone) and some other highly affected areas to non-contaminated areas. Another 220,000 people were relocated in subsequent years (UNSCEAR, 2000).

The environmental and health consequences of the Chernobyl accident were assessed by some relevant national and international bodies and discussed at numerous professional meetings. The medical consequences of the Chernobyl accident were widely discussed at the Kiev conference in 1988 (IAEA, 1989), pursuant to the results of the IAEA Chernobyl project (IAC, 1991), and at the many conferences marking its 10th (Karaoglou et al., 1996; IAEA, 1996) and 15th anniversaries (International Conference, 2001). The health consequences were analysed comprehensively and in depth by UNSCEAR in its reports (UNSCEAR, 1988, 2000).

2. The Chernobyl Forum and its operation

Due to the unprecedented scale of the accident and the radioactive discharges it caused, and in spite of past comprehensive studies, this socially important issue continues to attract the attention of the public and the press. Because substantial contradictions in the interpretation of the consequences of the Chernobyl accident existed between the scientific community and the general public, and also amongst United Nations organisations involved, the IAEA initiated in early 2003 the establishment of the Chernobyl Forum aiming to retrospectively assess the environmental and health consequences of the accident and to advise Governments on future actions, such as environmental remediation and special health care as well as research activities

[1] In the mapping of the deposition, ^{137}Cs was chosen because it is easy to measure long-lived radionuclide, and it is of radiological significance.

(Chernobyl Forum, 2003). It was felt that almost 20 years is long enough time period to study carefully long-term effects both in the environment and in human health.

The Forum participants were eight United Nations organisations (IAEA, WHO, UNDP, FAO, UN-OCHA, UNEP, UNSCEAR[2] and The World Bank) as well as the competent authorities of the three most affected countries, i.e., Belarus, Russia and Ukraine. The Forum was created as a contribution to the United Nations' 10-year strategy for Chernobyl, launched in 2002 with the publication of *Human Consequences of the Chernobyl Nuclear Accident – A Strategy for Recovery* (UNDP and UNICEF, 2002). The Chernobyl Forum and subsequent conference were chaired by Dr Burton Bennett, Radiation Effects Research Foundation, Japan.

The environmental effects have been summarized by an expert working group convened by the IAEA and chaired by Dr Lynn Anspaugh, USA. At the same time, the WHO convened an expert group to summarize the health effects of the accident. The working group on health was co-chaired by Dr Geoff Howe, USA (Thyroid studies), Dr Elisabeth Cardis, France (Solid cancers/leukaemia studies) and Dr Fred Mettler, USA (Non-cancer outcomes and health care programmes). In total, more than 80 recognized experts from 12 countries, including Belarus, Russia and Ukraine, and six relevant international organisations participated in the 11 expert meetings that produced two technical reports on environmental (IAEA, 2006) and health issues (WHO, 2006).

Both two technical reports and the summary report "Chernobyl's Legacy: Health, Environmental and Socio-economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine" were considered in detail and approved by consensus at the last Forum meeting in April 2005 (Chernobyl Forum, 2003). In addition, UNDP contributed to the summary report with the assessment of the socio-economic impact of the Chernobyl accident, based largely on the 2002 UNDP/UNICEF study (UNDP and UNICEF, 2002).

The reports were presented and discussed during the International Conference "Chernobyl: Looking Back to Go Forwards" organised by the IAEA on behalf of the Chernobyl Forum in Vienna in September 2005. In his concluding statement, the Forum and Conference Chairman Dr B. Bennett, inter alia, 'stress(ed) that our conclusions are more than just valid, objective, scientific statements. They are a consensus of all of the scientists, international organization staff and representative of governments who participated in the Chernobyl Forum and this conference. All of us agree … with the evaluations of the health and environmental effects'.

This paper presents a brief summary of the findings and recommendations of the Chernobyl Forum for which the author served as scientific secretary since its inception. More detailed information on environmental consequences of the Chernobyl accident and, more specifically, on radiation effects in plants and animals, environmental aspects of the object 'Shelter' decommissioning and radioactive waste management as well as of its health consequences are presented in the subsequent papers, respectively, of Drs L. Anspaugh, T. Hinton, O. Voitsekhovich and E. Cardis in this issue and in the Forum reports (IAEA, 2006; WHO, 2006; Chernobyl Forum, 2006).

3. Summary of the Chernobyl Forum's findings and recommendations

The accident at the Chernobyl nuclear power plant in 1986 was the most severe in the history of the world nuclear industry. Due to the vast release of radionuclides it also became the first

[2] International Atomic Energy Agency (IAEA), World Health Organisation (WHO), United Nations Development Programme (UNDP), Food and Agriculture Organization (FAO), United Nations Environment Programme (UNEP), United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

magnitude radiological incident. However, in the course of years, along with reductions in radiation levels, the most significant problems have become the severe social and economic depression of the affected Belarusian, Russian and Ukrainian regions and the associated serious psychological problems of the general public and emergency workers.

European-wide radionuclide fallout resulted in contamination of urban, agricultural, forest and aquatic ecosystems that required large scale environmental monitoring and intervention in countries with high radiation levels or high radiological sensitivity. During first weeks after the accident, elevated ^{131}I concentration in milk from grazing cattle led to substantial ^{131}I intake in human body and high thyroid doses of children. Later on, high levels of cesium radionuclides in milk and meat as well as in 'wild foods' caused major radiological problems.

Since 1986, radiation levels in the affected environments have declined several hundred fold because of natural processes and countermeasures. Therefore, the majority of the 'contaminated' territories are now safe for settlement and economic activity. However, in the Chernobyl Exclusion Zone and in certain limited areas some restrictions on land-use will need to be retained for decades to come.

The highest radiation doses were received by emergency workers and on-site personnel, in total about 1000 people, during the first days of the accident, and doses were fatal for 28 workers. Although some of 600,000 'liquidators' received high doses of radiation during their work, many of them and the majority of over five million residents of areas designated as 'contaminated' in Belarus, Russia and Ukraine received relatively low whole-body doses of radiation, not much higher than doses due to natural background radiation. The mitigation measures taken by the authorities, including evacuation of people from the most contaminated areas, substantially reduced radiation exposures and the radiation-related health impacts of the accident. Nevertheless, the accident was a human tragedy and had significant environmental, public health and socio-economic impacts.

Childhood thyroid cancer caused by radioactive iodine fallout is one of the main health impacts of the accident. Doses to the thyroid received in the first few months after the accident were particularly high in those who were children at the time and drank milk with high levels of radioactive iodine. By 2002, more than 4000 thyroid cancer cases had been diagnosed in this group, and it is most likely that a large fraction of these thyroid cancers is attributable to radioiodine intake.

Apart from the dramatic increase in thyroid cancer incidence among those exposed at a young age, there is no clearly demonstrated increase in the incidence of solid cancers or leukaemia due to radiation in the general public. There was, however, an increase in psychological problems among the affected population, compounded by insufficient communication about radiation effects and by the social disruption and economic depression that followed the break-up of the Soviet Union.

Some radiation-induced increases in fatal leukaemia, solid cancers and circulatory system diseases have been reported in Russian 'liquidators' (Ivanov et al., 2004). According to data from the Russian Registry, in 1991–1998, in the cohort of 61,000 Russian workers exposed to an average dose of 107 mSv about 5% of all fatalities that occurred may have been due to radiation exposure. These findings, however, should be considered as preliminary and need confirmation in better-designed studies with careful individual dose reconstruction.

It is impossible to assess reliably, with any precision, numbers of fatal cancers caused by radiation exposure due to the Chernobyl accident — or indeed the impact of the stress and anxiety induced by the accident and the response to it. An international expert group has made projections to provide a rough estimate of the possible health impacts of the accident

and to help plan the future allocation of public health resources. The projections indicate that, among the most exposed populations ('liquidators', evacuees and residents of the 'strict radiation control zones'), total cancer mortality might increase by up to a few per cent owing to Chernobyl related radiation exposure. An increase of this magnitude would be very difficult to detect, even with very careful long-term epidemiological studies.

Irradiation from radionuclides released from the Chernobyl accident caused numerous acute adverse individual and population effects in plants and animals located in areas of highest exposure, i.e., up to a distance of a few tens of kilometres from the release point. Beyond the exclusion zone, no acute radiation-induced effects on biota have been reported. No adverse radiation-induced effects have been reported in plants and animals exposed to a cumulative dose of less than 0.3 Gy during the first month after the radionuclide fallout.

Following the natural reduction of exposure levels due to radionuclide decay and migration, populations have been recovering from acute radiation effects. A few years were needed for recovery from major radiation-induced adverse effects in plants and animals.

The recovery of affected biota in the exclusion zone has been confounded by the overriding response to the removal of human activities in the most affected area. As a result, populations of many plants and animals have eventually expanded, and the present environmental conditions have had a positive impact on the biota in the exclusion zone.

The Governments took many successful countermeasures to address the accident's consequences. However, recent research shows that the direction of current efforts should be changed. Social and economic restoration of the affected Belarusian, Russian and Ukrainian regions, as well as the elimination of the psychological burden on the general public and emergency workers, must be a priority. Additional priorities for Ukraine are to decommission the destroyed Chernobyl Unit 4 and gradually remediate the Chernobyl Exclusion Zone, including safely managing radioactive waste.

Preservation of the tacit knowledge developed in the mitigation of the consequences is essential, and targeted research on some aspects of the environmental, health and social consequences of the accident should be continued in the longer term.

The reports of the Chernobyl Forum, covering environmental radiation, human health and socio-economic aspects, are the most comprehensive evaluations of the accident's consequences to date. About 100 recognized experts from many countries, including Belarus, Russia and Ukraine, have contributed. The reports represent a consensus view of the eight organisations of the UN family according to their competences and of the three affected countries.

4. Dissemination of the Chernobyl Forum's findings and recommendations

In 2005–2006, in connection with the 20th anniversary of the Chernobyl accident, the Chernobyl Forum's findings and recommendations have been reported at 25 scientific and other commemorative meetings. The Vienna conference held in September 2005 (referred to above) was accompanied by an intensive press campaign in the mass media, the Forum major findings were reflected in hundreds of papers in mass media worldwide. Currently, the Forum members are working on the issue of further information dissemination.

In November 2005, the United Nations General Assembly considered a report A/60/443 of the Secretary-General (UN, 2005a) on efforts to promote recovery in areas affected by the Chernobyl legacy that included findings of Chernobyl Forum. The General Assembly also adopted a resolution A/60/L.19 (UN, 2005b) encouraging the international community to redouble its efforts to mitigate the consequences of the accident in which, inter alia,

- noted consensus reached among members of the Chernobyl Forum regarding assessment of the accident consequences and future actions;
- noted the necessity to widely disseminate Forum's findings and recommendations;
- requested to organise further studies consistent with the recommendations of the Chernobyl Forum.

In that way, the organisers and participants of the Chernobyl Forum contribute to clarification of the environmental, health, social and economic consequences of that severe accident based on sound science.

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