The radiological consequences of the Chernobyl accident - the UNSCEAR report

Preamble: *April 26 this year will mark the 15th anniversary of the 1986 accident at the Chernobyl nuclear power plant in the Ukraine. In its report to the General Assembly in late 2000 the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) included a section on the radiological consequences of that accident.*

The UNSCEAR 2000 report, titled Sources and Effects of Ionizing Radiation*, contains some 1220 pages encompassing a 20 page summary and ten technical annexes. It was prepared over several years by 146 committee members of 21 national delegations plus 15 scientific staff and consultants. Two of the topics are of particular interest, those on natural radiation and on The Chernobyl Accident. Following are excerpts from the summary of the annex on Chernobyl.*

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THE CHERNOBYL ACCIDENT

The Committee has given special attention to the accident at the Chernobyl nuclear reactor that occurred on 26 April 1986. It was the most serious accident ever to have occurred in the nuclear power industry. The reactor was destroyed in the accident, considerable amounts of radioactive materials were released to the environment, and many workers were exposed to high doses of radiation that had serious, even fatal, health consequences (see below). Among the residents of the local regions of Belarus, the Russian Federation, and Ukraine, over a thousand cases of thyroid cancer (about 1,800) have been reported in children. Notwithstanding problems associated with screening, these cancers were most likely caused by radiation exposures received at the time of the accident. Many other health problems have been noted in the populations that are less likely to be related to radiation exposures.

Soon after the accident, the deposition of dispersed radionuclides and the exposures that resulted were measured and evaluated throughout the affected region. The Committee made use of these data to evaluate the average individual and population doses for the various regions and countries and for the northern hemisphere as a whole. The results were presented in the UNSCEAR 1988 Report, Annex D, “Exposures from the Chernobyl accident”.

Evaluating the exposures received by the people who were evacuated or who still reside in the areas most affected by the accident has required much time and effort. The initial measurements must be supplemented by information on such things as the location and diet of the people in each settlement. The accumulation of data on late health effects has also required further time. Only now, some 15 years after the accident, can an initial assessment of the local exposures and effects of the accident be made.

RELEASE OF RADIONUCLIDES

The accident at the Chernobyl reactor happened during an experimental test of the electrical control system as the reactor was being shut down for routine maintenance. The operators, in violation of safety regulations, had switched off important control systems and allowed the reactor to reach unstable, low-power conditions. A sudden power surge caused a steam explosion that ruptured the reactor vessel. This allowed further violent fuel-steam interactions that destroyed the reactor core and severely damaged the reactor building.

It is noteworthy that an earlier accident in 1979 at the Three Mile Island reactor in the United States also resulted in serious damage to the reactor core but without a steam explosion. In that case, however, the containment building surrounding the reactor prevented the release of all but trace amounts of radioactive gases. The Chernobyl reactor lacked the containment feature. Following the explosions, an intense graphite fire burned for 10 days. Under these conditions, large releases of radioactive materials took place.

The radioactive gases and particles released in the accident were carried by the wind initially in the westerly and northerly directions. On subsequent days, the winds came from all directions. The deposition of radionuclides was governed primarily by precipitation occurring during the passage of the radioactive cloud. This led to a complex and variable exposure pattern throughout the affected region.

EXPOSURE OF INDIVIDUALS

The radionuclides released from the reactor that caused exposure of individuals were mainly iodine-131, caesium-134, and caesium-137. Iodine-131 has a short radioactive half-life (eight days), but it can be transferred to humans relatively rapidly from the air and through milk and leafy vegetables. Iodine becomes localized in the thyroid gland. For reasons related to the intake of these foods by infants and children, as well as the size of their thyroid glands and their metabolism, the radiation doses are usually higher for this age group than for adults..

The isotopes of caesium have relatively longer half-lives (caesium-134 has a half-life of 2 years while the half-life of caesium-137 is 30 years). These radionuclides cause longer-term exposures through the ingestion pathway and through external exposure from their deposition on the ground. Many other radionuclides were associated with the accident, and these have been considered as well in the exposure assessments.

Average doses to those persons most affected by the accident were about 100 mSv for 240,000 recovery operation workers, 30 mSv for 116,000 evacuated persons and 10 mSv during the first decade after the accident to those who continued to reside in contaminated areas. Maximum values of the dose may be an order of magnitude higher. Outside Belarus, the Russian Federation, and Ukraine, other parts of European countries were affected by the accident. Doses there were at most 1 mSv in the first year after the accident with progressively decreasing doses in subsequent years. The dose over a lifetime was estimated to be 2-5 times the first-year dose. **These doses are comparable to an annual dose from natural background radiation and are, therefore, of little radiological significance.** *(Our emphasis.)*

The exposures were much higher for those involved in mitigating the accident and those who resided nearby. These exposures are reviewed in great detail in this assessment of the Committee.

HEALTH EFFECTS

The Chernobyl accident caused many severe radiation effects almost immediately. Of 600 workers present on the site during the early morning of 26 April 1986, 134 received high doses (0.7 to 13.4 Gy) and suffered from radiation sickness. Of these, 28 died in the first three months and another two soon afterwards. In addition, during 1986 and 1987, about 200,000 recovery operation workers received doses between 0.01 and 0.5 Gy. This cohort is at potential risk of late consequences such as cancer and other diseases and their health will be followed closely.

The Chernobyl accident also resulted in widespread radioactive contamination in areas of Belarus, the Russian Federation, and Ukraine inhabited by several million people. In addition to causing radiation exposure, the accident caused long-term changes in the lives of the people living in the contaminated districts, since the measures intended to limit radiation doses included resettlement, changes in food supplies, and restrictions on the activities of individuals and families. Later on, these changes were accompanied by the major economic, social, and political changes that took place when the former Soviet Union was dismantled.

For the last 14 years, attention has been focused on investigating the association between exposure caused by radionuclides released in the Chernobyl accident and late effects, particularly thyroid cancer in children. A majority of the studies completed to date are of the descriptive type, in which average population exposures are correlated with the average rates of cancer incidence in specific time periods. As long as individual dosimetry is not available, it is difficult to determine whether the effects are radiation-related, and it is also impossible to make reliable quantitative estimates of risk. The reconstruction of individual doses is a key element for future research on radiation-associated cancers related to the Chernobyl accident.

The number of thyroid cancers (about 1,800) in individuals exposed in childhood, particularly in the severely contaminated areas of the three affected countries, is considerably greater than expected based on previous knowledge. The high incidence and the short induction period are unusual. Other factors may be influencing the risk. If the current trend continues, additional thyroid cancers can be expected to occur, especially in those who were exposed at young ages.

Apart from the increase in thyroid cancer after childhood exposure, **no increases in overall cancer incidence or mortality have been observed that could be attributed to ionizing radiation**. *(Our emphasis.)* The risk of leukaemia, one of the main concerns (leukaemia is the first cancer to appear after radiation exposure owing to its short latency time of 2-10 years), does not appear to be elevated, even among the recovery operation workers. Neither is there any proof of other non-malignant disorders that are related to ionizing radiation. However, there were widespread psychological reactions to the accident. These are due to fear of the radiation, not due to the radiation doses.

There is a tendency to attribute increases in the rates of all cancers over time to the Chernobyl accident, but it should be noted that increases were also observed before the accident in the affected areas. Moreover, a general increase in mortality has been reported in recent years in most areas of the former USSR, and this must be taken into account when interpreting the results of the Chernobyl-related studies.

The present understanding of the late effects of protracted exposure to ionizing radiation is limited, since the dose-response assessments rely heavily on studies of exposure to high doses and animal experiments; extrapolations are needed, which always involves uncertainty. The Chernobyl accident might shed light on the late effects of protracted exposure, but given the low doses received by the majority of exposed individuals, any increase in cancer incidence or mortality will be difficult to detect in epidemiological studies. One future challenge will be to develop individual dose estimates including estimates of uncertainty and determine the effects of doses accumulated over a long period of time.

Previous articles on Chernobyl in the *CNS Bulletin:*

Vol. 12, No. 2,	Summer 1991	“Chernobyl revisited”
Vol. 17, No. 2	Spring 1996	“More on Chernobyl”
Vol. 20, No. 4	January 2000	“Chernobyl-4 - Post accident radiation monitoring in the exclusion zone”