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This file contains highlights from the 2008 report of UNSCEAR to the General Assembly (A/63/46) related to the Chernobyl accident. The report and its detailed scientific annexes are envisaged to be published in the first quarter of 2010.

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Contents

I. Introduction

1. Exposure to radiation has origins such as medical diagnostic and therapeutic procedures; nuclear weapons production and testing; natural background radiation; nuclear electricity generation; accidents such as the one at Chernobyl in 1986; and occupations that entail increased exposure to artificial or naturally occurring sources of radiation.

2. Since the establishment of the United Nations Scientific Committee on the Effects of Atomic Radiation by General Assembly resolution 913 (X) of 3 December 1955, the mandate of the Committee has been to undertake broad reviews of the sources of ionizing radiation and of the effects of that radiation on human health and the environment. In pursuit of its mandate, the Committee thoroughly reviews and evaluates global and regional exposures to radiation; and it evaluates evidence of radiation-induced health effects in exposed groups, including survivors of the atomic bombings in Japan. The Committee also reviews advances in the understanding of the biological mechanisms by which radiation-induced effects on health or on the environment can occur. Those assessments provide the scientific foundation used, inter alia, by the relevant agencies of the United Nations system in formulating international standards for protection of the public and of workers against ionizing radiation;[1] those standards, in turn, are linked to important legal and regulatory instruments.

[1] The international basic safety standards for protection against ionizing radiation and for the safety of radiation sources are currently co-sponsored by the International Labour Organization, the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency of the Organization for Economic Cooperation and Development and the Pan American Health Organization.

effective dose increased because of the increased exposure to natural sources of radiation.

Table 6
Trends in average annual occupational effective doses of ionizing radiation, 1980-1984, 1990-1994 and 2000-2002
(Millisieverts)

Source of exposure	*1980-1984*	*1990-1994*	*2000-2002*
Natural sources	..	1.8	2.9
Military activities	0.7	0.2	0.1
Nuclear fuel cycle	3.7	1.8	1.0
Medical uses	0.6	0.3	0.5
Industrial uses	1.4	0.5	0.3
Miscellaneous	0.3	0.1	0.1
Weighted average	**1.3**	**0.8**	**1.8**

(c) Exposures in accidents

62. Early acute effects of radiation exposure occur only as the result of accidents (or malicious acts). Some serious accidents have led to significant population exposures owing to dispersion of radioactive material in the environment. Radiation exposures from accidents have been discussed in several past reports of the Committee, including specific evaluations of the Chernobyl accident. The Committee has categorized and summarized reported radiation accidents that resulted in early acute health effects, deaths or major environmental contamination over the past 60 years.

63. Accidents associated with the nuclear fuel cycle included a small number of serious accidents that received extensive publicity and whose consequences were reported in detail. Between 1945 and 2007, 38 serious radiation accidents occurred in nuclear facilities, 26 of them in facilities related to nuclear weapons programmes. Of those 38 accidents, 34 resulted in employee deaths or injury and 7 caused off-site releases of radioactive materials and significant population exposures. Excluding the 1986 accident at Chernobyl (which is discussed in section B below), 29 deaths (including 4 deaths caused by trauma) and 68 cases of radiation-related injuries requiring medical care are known to have occurred as a result of accidents associated with the nuclear fuel cycle.

64. Large radiation sources are in widespread use in industry (industrial irradiation facilities or accelerators) and have been involved in a number of accidents, usually attributable to operator error. All of the 85 accidents covered in the present report involved sufficient levels of exposure to cause radiation-related injuries to workers. Twenty-five deaths and 164 worker injuries were reported in connection with those accidents.

65. Orphan sources are radioactive sources that were originally subject to regulatory control but were then abandoned, lost or stolen. The 29 reported serious accidents involving orphan sources caused radiation-related injuries to the public; altogether, 33 people, including a number of children, died in those accidents. In the accident in Goiânia, Brazil, in 1987, several hundred people were contaminated.

66. In radiation medicine, accidents generally involve errors in the delivery of radiotherapy that are often detected only after many patients have been overexposed. The Committee has reviewed only 29 reported accidents – involving 45 deaths and 613 injuries – since 1967. It is likely that some deaths and many injuries in the medical use of radiation have not been reported. Nevertheless, the reported accidents alone appear to have injured more people than accidents in any other category.

67. Of the accidents that caused exposures of ionizing radiation to the general population, the 1986 Chernobyl accident was by far the most serious one. The collective dose from that accident was many times greater than the combined collective dose from all other accidents causing exposures to the general population.

68. The trends in these accidents vary considerably. Criticality accidents were more common during the early periods of nuclear weapons programmes. Operational events related to the nuclear fuel cycle are sporadic. Accidents in industry and in academic or research establishments appear to have peaked in the late 1970s, falling off to only a few isolated occurrences in industry since 2000. The extensive and worldwide transport of radioactive materials for non-military purposes over the past many years has not resulted in any radiation-related injuries at all. Accidents with orphan sources and those related to medical uses of radiation have shown an increase over recent periods but the data may suffer from underreporting.

(d) Comparison of exposures

69. Although it is clear from the data presented that doses vary substantially by location, group, health-care level and so on, it is nonetheless helpful and customary to summarize the findings on a global basis (see table 1 above). Exposure to natural radiation does not change significantly over time, although individual exposures, particularly to radon, can vary significantly. One of the most striking changes over the past decade or so has been the sharp increase in medical exposures, owing for example to the rapid expansion in the use of computed tomography scanning. In several countries, this has meant that medical exposure has displaced exposure due to natural sources of radiation as the largest overall component. The residual doses from atmospheric testing and from the Chernobyl accident continue to decline slowly. Although occupational exposure shows a low value when averaged across the whole population, the estimated level has increased substantially owing to the recognition of exposure to natural radionuclides in mining. Doses from the nuclear fuel cycle continue to be very small despite the gradual expansion of that sector.

B. Chernobyl accident

70. The 1986 accident at the Chernobyl nuclear power plant in the former Soviet Union was the most severe such accident in the history of civilian nuclear power. Two workers died in the immediate aftermath, and 134 plant staff and emergency personnel suffered acute radiation syndrome, which proved fatal for 28 of them. Several hundred thousand workers were subsequently involved in recovery operations.

71. The accident caused the largest uncontrolled radioactive release into the environment ever recorded for any civilian operation; large quantities of radioactive substances were released into the atmosphere for about 10 days. The radioactive cloud created by the accident dispersed over the entire northern hemisphere and deposited substantial amounts of radioactive material over large areas of the former Soviet Union and other parts of Europe, contaminating land, water and biota and causing particularly serious social and economic disruption to large segments of the population in the countries known today as Belarus, the Russian Federation and Ukraine. Two radionuclides, the short-lived iodine-131 (with a half-life of 8 days) and the long-lived caesium-137 (with a half-life of 30 years), were particularly significant because of the radiation dose they delivered to the public. However, the doses delivered were quite different for the two radionuclides: the thyroid doses from iodine-131 ranged up to several grays within a few weeks after the accident, while the whole-body doses from caesium-137 ranged up to a few hundred millisieverts over the following few years.

72. The contamination of fresh milk with iodine-131 and the lack of prompt countermeasures led to high thyroid doses, particularly among children, in the former Soviet Union. In the longer term, mainly due to radiocaesium, the general population was also exposed to radiation, both externally from radioactive deposits and internally from consuming contaminated foodstuffs. However, the resulting long-term radiation doses were relatively low (the average additional dose over the period 1986-2005 in "contaminated areas"[12] of Belarus, the Russian Federation and Ukraine was 9 mSv, approximately equivalent to that from a medical computed tomography scan), and should not lead to substantial health effects in the general population that could be attributed to radiation. The foregoing notwithstanding, the severe disruption caused by the accident resulted in a major social and economic impact and great distress for the affected populations.

73. Since the accident, the international community has made unprecedented efforts to assess the magnitude and characteristics of its radiation-related health effects. Many initiatives, including those by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Health Organization (WHO), the International Atomic Energy Agency (IAEA) and the European Commission, were launched to better understand the consequences of the accident and assist in their mitigation. The results of those initiatives were synthesized at an international conference on the theme "One decade after Chernobyl: summing up the consequences of the accident", which was held in Vienna from 8 to 12 April 1996. The conference was co-sponsored by WHO, IAEA and the European Commission in cooperation with the United Nations, the United Nations Scientific Committee on the Effects of Atomic Radiation, the Food and Agriculture Organization of the United Nations, UNESCO and the Nuclear Energy Agency of the Organization for Economic Cooperation and Development. In the international scientific assessments, broadly similar conclusions were reached on the extent and character of the consequences of the accident.

[12] The "contaminated areas" were defined arbitrarily by the former Soviet Union as areas where the soil levels of caesium-137 were greater than 37 kilobecquerels per square metre.

74. The Committee first considered the initial radiological consequences of the accident in its 1988 report.[13] In its 2000 report, the Committee provided a detailed account of the situation as it was known at that time. Subsequent to the publication of that report, eight organizations and bodies of the United Nations system[14] (including the Committee) and the three affected States launched the Chernobyl Forum, which was to generate authoritative consensual statements on the environmental and health consequences attributable to radiation exposure and to provide advice on issues such as environmental remediation, special health-care programmes and research activities. The work of the Chernobyl Forum was appraised at an international conference on the theme "Chernobyl: looking back to go forwards; towards a United Nations consensus on the effects of the accident and the future", which was held in Vienna on 6 and 7 September 2005. At that conference, all the previous assessments of the scale and character of the radiation-related health consequences of the accident were essentially reconfirmed.

75. The objective of the Committee in the present evaluation is to provide an authoritative and definitive review of the health effects observed to date that are attributable to radiation exposure due to the accident and a clarification of the projection of potential effects, taking into account the levels, trends and patterns of radiation dose to the exposed populations. To that end the Committee evaluated relevant information that became available since its 2000 report and ascertained that observations were not inconsistent with assumptions used previously to assess radiological consequences. It also recognized that some outstanding details merited further scrutiny and that its work to provide the scientific basis for a better understanding of the radiation-related health and environmental effects of the accident needed to continue.

76. Although a considerable volume of new research data has become available, the major conclusions regarding the scale and nature of the health consequences of the Chernobyl accident are essentially consistent with the Committee's 1988 and 2000 reports. Those conclusions are as follows:

(a) A total of 134 plant staff and emergency workers received high doses of radiation that resulted in acute radiation syndrome (ARS), many of them also incurring skin injuries due to beta irradiation;

(b) The high radiation doses proved fatal for 28 of those people in the first few months following the accident;

(c) Although 19 ARS survivors had died by 2006, those deaths had different causes that usually were not associated with radiation exposure;

(d) Skin injuries and radiation-related cataracts were among the main sequelae of ARS survivors;

(e) Aside from the emergency workers, several hundred thousand people were involved in recovery operations but, apart from indications of an increase in incidence of leukaemia and of cataracts among those who received higher doses,

[13] *Official Records of the General Assembly, Forty-third Session, Supplement No. 45* (A/43/45).

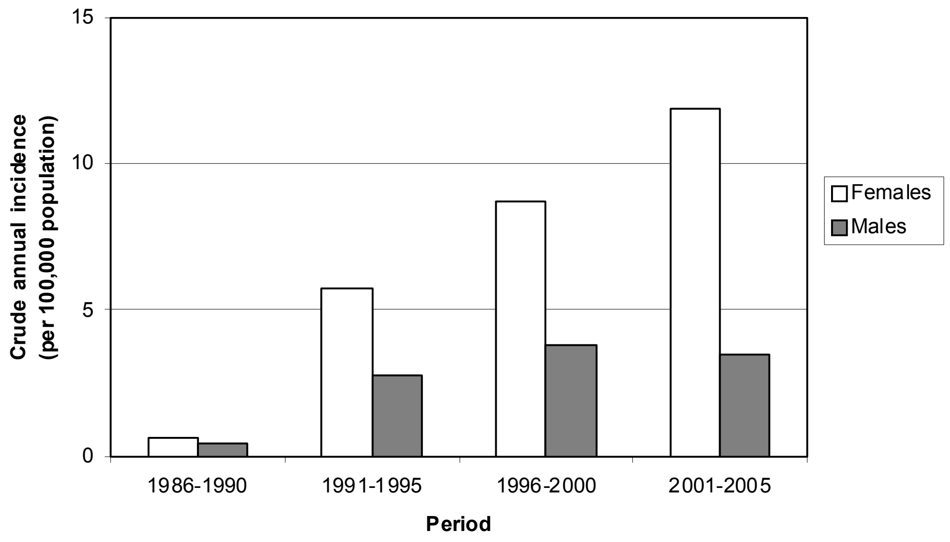
[14] UNEP, Office for the Coordination of Humanitarian Affairs of the Secretariat, the United Nations Development Programme, the United Nations Scientific Committee on the Effects of Atomic Radiation, FAO, WHO, the World Bank and IAEA.

there is to date no consistent evidence of health effects that can be attributed to radiation exposure;

(f) A substantial increase in thyroid cancer incidence among persons exposed to the accident-related radiation as children or adolescents in 1986 has been observed in Belarus, Ukraine and four of the more affected regions of the Russian Federation. For the period 1991-2005, more than 6,000 cases were reported, of which a substantial portion could be attributed to drinking milk in 1986 contaminated with iodine-131. Although thyroid cancer incidence continues to increase for this group (see figure X for the trend in Belarus), up to 2005 only 15 cases had proved fatal;

(g) Among the general public, to date there has been no consistent evidence of any other health effect that can be attributed to radiation exposure.

Figure X
Thyroid cancer incidence among people in Belarus who were children or adolescents at the time of the Chernobyl accident, 1986-1990, 1991-1995, 1996-2000 and 2001-2005



77. Although model-based predictions have been published about possible increases in solid cancer incidence among the general population, for all the population groups considered the doses are relatively small and are comparable to doses resulting from exposure to natural background radiation. The Committee has decided not to use models to project absolute numbers of effects in populations exposed to low doses because of unacceptable uncertainties in the predictions. However, the Committee considers that it is appropriate to continue surveillance.

78. Based on 20 years of studies, it is possible to reconfirm the conclusions of the Committee's 2000 report. Essentially, persons who were exposed as children to radioiodine from the Chernobyl accident and the emergency and recovery operation workers who received high doses of radiation are at increased risk of

radiation-induced effects. Most area residents were exposed to low-level radiation comparable to or a few times higher than the annual natural background radiation levels and need not live in fear of serious health consequences.

79. The Committee considers its most recent evaluation an important point of reference for the United Nations Coordinator of International Cooperation on Chernobyl in responding to the request by the General Assembly pursuant to paragraph 16 of its resolution 62/9 of 20 November 2007, that the Coordinator continue his work in organizing, in collaboration with the Governments of Belarus, the Russian Federation and Ukraine, a further study of the health, environmental and socio-economic consequences of the Chernobyl disaster, consistent with the recommendations of the Chernobyl Forum, and to improve the provision of information to local populations.

C. Effects on non-human biota

80. All species present on the Earth have existed and evolved in environments where they have been exposed to ionizing radiation from the natural background. More recently, however, organisms are also being exposed to artificial sources of radiation, such as global fallout from atmospheric nuclear weapons tests and, in certain locations, controlled discharges of radionuclides or accidental releases of radioactive material.

81. In its 1996 report,[15] the Committee evaluated those doses and dose rates of ionizing radiation below which effects on populations of non-human biota were unlikely. It considered that the individual responses to radiation exposure that were likely to be significant at the population level were in the areas of mortality, fertility, fecundity and the induction of mutations. The Committee also considered that reproductive changes were a more sensitive indicator of radiation effects than mortality, and that mammals were the most sensitive of all animal organisms. On that basis, the Committee derived the dose rates to the most highly exposed individuals that would be unlikely to have significant effects on most populations.

82. Since then, new data on the effects of ionizing radiation have been obtained from follow-up observations of non-human biota in the area around the Chernobyl site. Various organizations have carried out comprehensive reviews of the scientific literature and, in some cases, have developed new approaches for assessing the potential effects on non-human biota. There is a considerable range of end points and corresponding effect levels presented in the literature and also considerable variation in how different researchers evaluate those data. Table 7 provides a brief summary of the relevant data for aggregated categories of organisms.

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[15] *Official Records of the General Assembly, Fifty-first Session, Supplement No. 46* (A/51/46).

Table 7
Some effects of ionizing radiation on selected categories of non-human biota

Chronic dose rate (milligrays per hour)	*Category*	*Effect*	*End point*
0.1-1	Plants	Death of pine needles: reduced numbers of herbaceous plants	Mortality, morbidity
	Fish	Reduction in sperm production, delayed spawning	Reproductive damage
About 0.1	Mammals	No detrimental end points described	Morbidity, mortality, reproductive damage

83. The Committee concluded that, overall, there was no evidence to support changing the conclusions of its 1996 report according to which chronic dose rates of less than 0.1 milligrays per hour to the most highly exposed individuals would be unlikely to have significant effects on most terrestrial communities and chronic dose rates of less than 0.4 milligrays per hour to any individual in aquatic populations of organisms would be unlikely to have any detrimental effect at the population level. For acute exposures, studies of the Chernobyl accident experience had confirmed that significant effects on populations of non-human biota were unlikely at doses below about 1 gray.

84. Since the time of the Committee's 1996 report, a great deal of work has been done to investigate and improve data and methods for evaluating pathways through which biota are exposed to radiation in their environment; there have also been many improvements in assessing doses to biota. It is important to note that many opportunities remain for improving current understanding and methods in those areas. An improved understanding of such aspects will improve the overall understanding of the relationship between levels of radiation and radioactivity in the environment and the potential effects on biota.