Information exchange after Chernobyl

From a radiation protection viewpoint, observations on the information flow

by Anneli Salo

Observations on elevated radiation levels were announced from Sweden and Finland on the day of 28 April 1986. The first "rumours" pointed to a reactor accident in Forsmark, Sweden, but they were soon discounted. Meteorological conditions pointed to a source in the USSR. The composition of radioactive substances in the measured debris suggested a reactor accident rather than a nuclear explosion. In addition, the presence of certain radioactive substances indicated that high temperatures and graphite were probably involved in the release mechanism. On the evening of 28 April, it was confirmed by the USSR that a severe accident had occurred at the Chernobyl nuclear power plant.

Contact with authorities

It was natural that initial questions directed to the IAEA were whether the occurrence of a reactor accident had been reported to it, and if so, where. After the accident had been announced by the USSR, the questions related to the technical details of the accident. Member States in Europe were concerned about the magnitude of the release, its distribution, and the extent of contamination measured.

Informal contacts with radiation protection authorities in most of the European countries were established during the last few days of April to obtain a more complete picture of the extent of the affected areas. This also served to facilitate establishing contacts between the organizations in Member States performing the measurements. No official request was made by the Agency for Member States to report their measurements, as the IAEA had no mandate for requesting such information, nor is it in a position to advise Member States on decisions regarding public health matters. The Agency was also fully aware of the pressure upon national institutions to perform measurements for the immediate decision making by the responsible national authorities. It therefore deferred data collection for the purpose of overall assessment of the health consequences until a later stage.

Nevertheless, countries started voluntarily sending to the Agency information on their radiological measurements regarding dose rates in the environment, radioactive substances in air, water, ground, grass, and foodstuffs. Also iodine measurements in thyroid and results of whole body counting were reported. (See graphs, page 21.)

During the visit of the Director General and his senior staff to the USSR it was agreed that the Soviet authorities would provide daily dose rate readings from seven stations, one close to the accident site (68 kilometres) and six along the western border of the USSR. These readings have been received since 9 May and transmitted to radiation protection authorities in affected Member States, first on a daily basis and then, as the levels stabilized, twice a week.

Observations in Member States

The Agency has received information on radiological measurements and protective measures from 23 Member States. Information received indicates that weather conditions during and after the accident have resulted in a wide distribution of the contamination in Europe and that the ground contamination is extremely uneven. Moreover, the initial height (about 1000 metres) of the release plume contributed to the transport of small amounts of radioactive substances, outside of Europe, including China, Japan, and the USA.

Radioiodine and caesium

Shortly after the accident, concern was concentrated on the avoidance of uptake of radioiodine (mainly iodine-131) by the thyroid gland, where it effectively concentrates, primarily through consumption of milk and leafy vegetables. Because of the short half-life (approximately 8 days) of iodine-131 — and therefore the relatively short period for which relevant protective measures are needed — many authorities introduced measures to avoid radiation doses due to this exposure pathway.

From the radiation protection point of view, radiocaesium (caesium-137 and caesium-134) is the

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Note: The dates of first observations refer to the day of measurement, not necessarily the day when that measurement was reported to or received by IAEA.

most difficult contaminant. Caesium-137 has a relatively long half-life (approximately 30 years). It contributes to the radiation dose received by man in two ways: first, externally from the contamination on the ground and other surfaces; second, internally by consumption of contaminated food. Taken internally it will be distributed throughout the soft tissues of the body. With the exception of affected areas within the USSR, the present levels of contamination are sufficiently low as to require careful consideration whether and under what circumstances protective measures would be justified on radiological grounds.

Lessons learned for the future

Although there appeared to be an adequate level of preparedness in terms of measurement capacity upon which to support decision making in countries affected, decision making itself was complicated by several factors. For example:

- There was a lack of information on the resultant release following the accident.
- The existing guidance on intervention published by the International Commission on Radiological Protection (ICRP), the World Health Organization (WHO), and the IAEA is applicable to the immediate surroundings of the accident site, and its primary purpose is to avoid acute and other effects to individuals. This guidance does not address the type of situation that resulted from Chernobyl, in which the decision-making authorities had to look for a balance between protecting a large population group exposed to moderate radiation levels, and the socio-economic penalties associated with implementing large-scale protective measures.
- The magnitude of the situation required the involvement of several other authorities and organizations in addition to those concerned with radiation protection, not all of which were as familiar with the criteria for radiation protection.

One further major problem was the provision of information to the public and to those exercising political authority. The general fear of radiation at any level of exposure, and the complex units in which measurements of exposure, radioactivity, and dose are expressed do not facilitate the exchange of information.

The questions and requests received by the Agency from Member States relating to the provision of assistance indicate that in some areas having less advanced nuclear programmes, the capacity to deal with this type of transboundary contamination situation may be considerably lower than was generally the situation in Europe.

The lessons learned from Chernobyl for responding to any possible future accident indicate that it is of vital importance to get information on the accident at as early a stage as possible. Early predictions of areas likely to be affected and the potential level of associated contamination, based on expected release and meteorological information, would help authorities to decide the course of actions needed in a timely manner. It is clear from the Chernobyl accident that national authorities will wish to receive radiological measurement data from their neighbouring countries for comparison and information purposes. These data should, however, be comparable in terms of parameters measured and units in which the measurements are expressed, in order to be of real assistance.

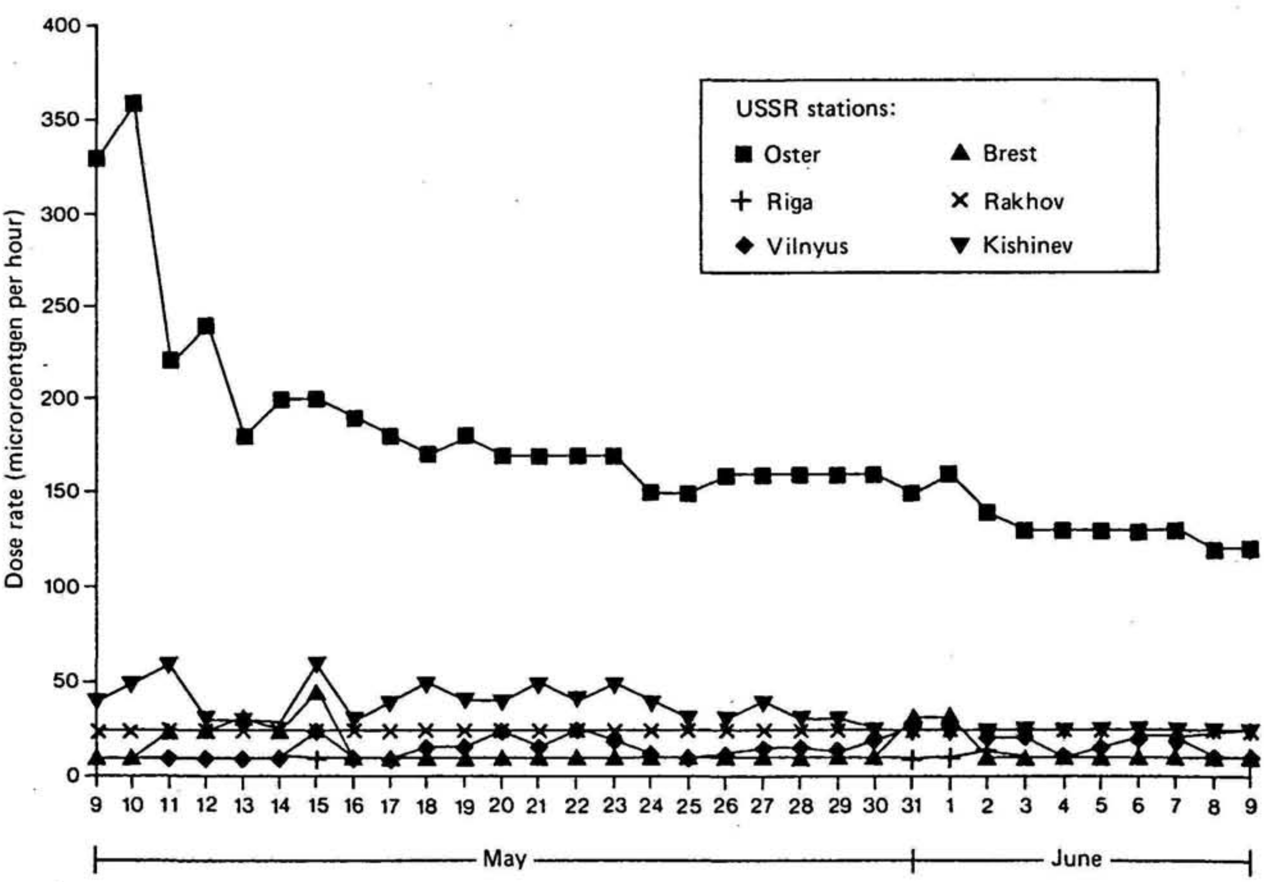
The IAEA presently is assessing how to improve:

- Timely reporting on accidents (the Convention on early notification)
- The capability to predict the transboundary distribution of contamination
- Exchange of radiological data in transboundary contamination situations
- Comparability of data
- Guidance on intervention levels for application by Member States
- Provision of assistance to Member States, on request, during an accident (the Convention on emergency assistance).

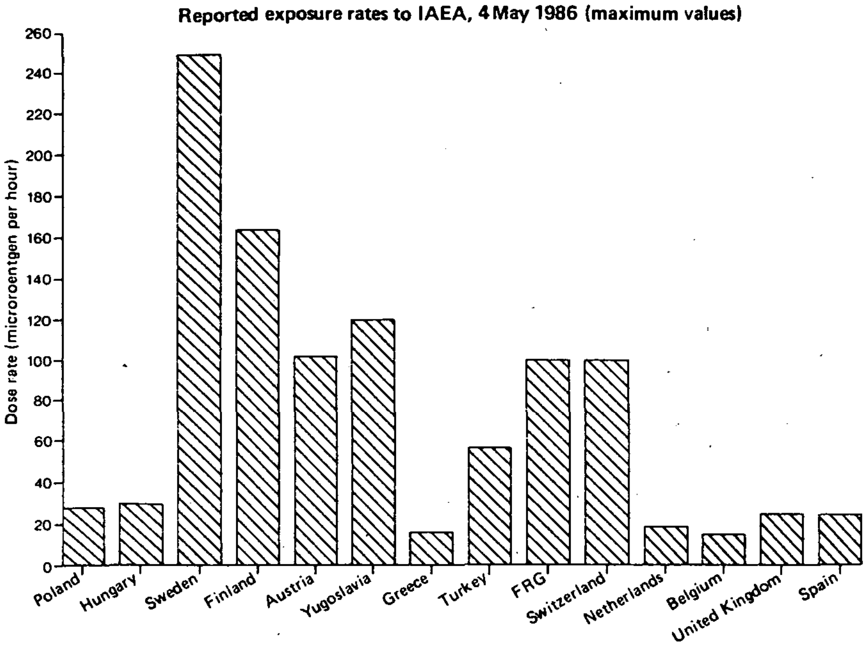
Many agencies involved

Several of these issues will necessitate close co-operation with other relevant international organizations. Involvement of the World Meteorological Organization (WMO) is essential in developing the prediction of contamination distribution. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) is specialized in assessing the overall health consequences. WHO is mainly responsible for the provision of guidance to national health authorities on the protection of health. Guidance on any necessary changes in agricultural practices and in food processing is expected from the Food and Agriculture Organization (FAO). The International Labour Organization (ILO) will be involved in providing guidance on the protection of workers working in contaminated surroundings. Some preliminary discussions already have taken place on these matters. However, a long-term co-operative programme will need to be developed in conjunction with all international organizations mentioned, and with others as appropriate.

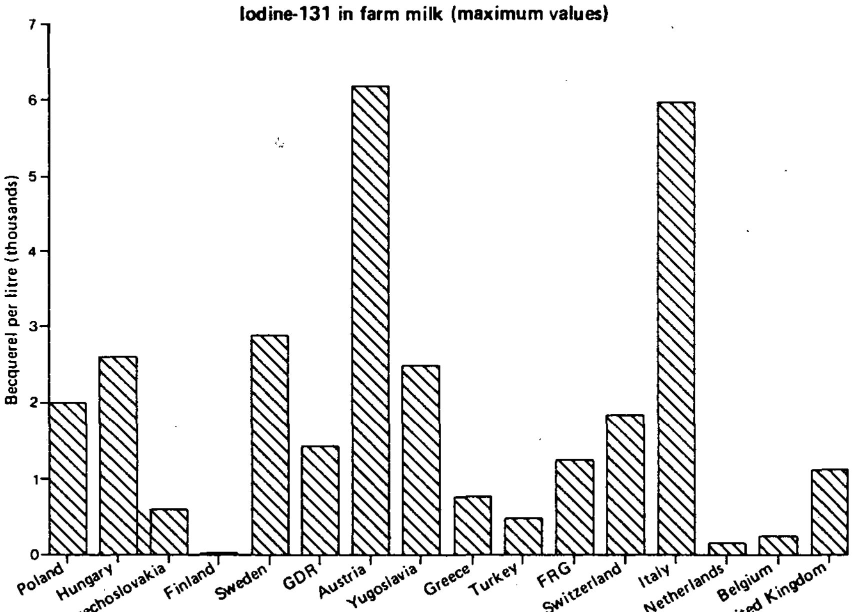
USSR: Reported exposure rates to IAEA, 9 May to 9 June 1986



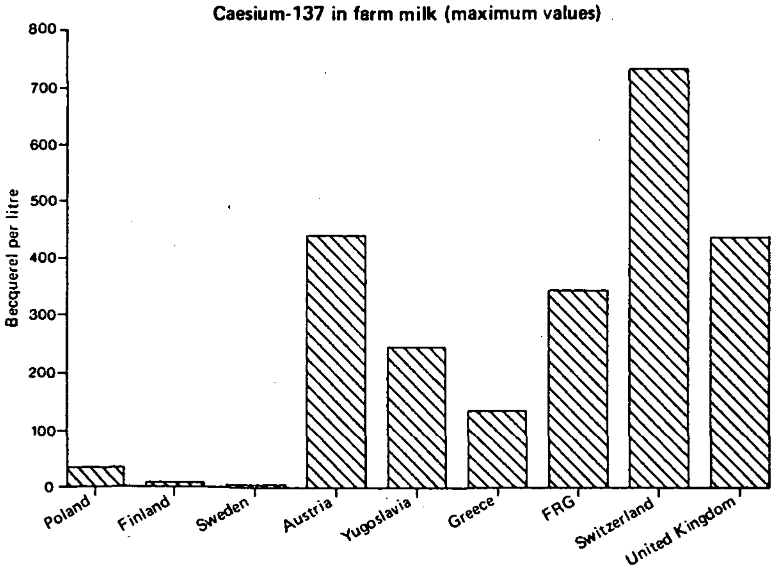
Reported exposure rates to IAEA, 4 May 1986 (maximum values)



Iodine-131 in farm milk (maximum values)



Caesium-137 in farm milk (maximum values)



Radiation units: The old and the new

Most of us do not know what to make of 0.12 $\mu Sv \cdot h^{-1}$ and 2.7 $Bq \cdot m^{-3}$, even though the Chernobyl accident probably increased our desire to learn. What we do know is that radiation measurements, and interpreting them, is not easy without some homework on energy measurements in general and, in many cases, access to a calculator, physics book, and friendly radiation expert. Unfortunately, familiar units of measurement alone — for example, kilowatts and kilograms — cannot be used to measure radiation. Instead, the units go by the names of *rads, rems, curies, becquerels, sieverts, grays,* and *roentgens.*

Complicating the picture is that not everyone uses the same terms because of recent changes to the international system of measurement. There are "old" terms — rems, rads and curies — and "new" ones — *becquerels, sieverts, grays.* Most of the time we see these terms with prefixes attached — usually kilo (one thousand), milli (one-thousandth), micro (one-millionth), or nano (one-billionth) etc. — because even the new terms are too big or small for the radiation doses most likely to be measured. After the Chernobyl accident, for example, reports were made using millirem (mrem) and millisievert (mSv), nanocuries (nCi) and becquerels (Bq), microroentgen (μR) and millirads (mrad).

How do these terms relate to one another and what do they mean?

- *Curies and becquerels.* These units measure how fast a radioactive element spontaneously decays or disintegrates and releases its energy. In pinpointing this rate, they quantify the element and answer the question of how much "activity" or "radioactivity" it gives off. The "new" term *becquerel* (Bq) — one becquerel corresponds to the decay of one atom per second — is much smaller than the "old" term *curie:* one curie equals 37 billion becquerels (3.7 times 10^{10}). And a nanocurie — another term frequently heard — is one billionth of a curie (0.000 000 001, or 10^{-9}), which under the "new" name becomes 37 becquerels.

Important to remember is that becquerels and curies do not measure biological or health effects. During the Chernobyl accident, they were frequently used by health authorities simply to describe how much of a radioactive substance, such as iodine-131 or caesium-137, could be detected in air, the surrounding environment, and in foods. This was then often expressed in terms of nanocuries or becquerels per kilogram, litre, square metre or cubic metre, depending on the medium in which the radioactive substance was being measured, e.g. in vegetables ($Bq \cdot kg^{-1}$), milk ($Bq \cdot L^{-1}$), air (Bq/m^3) and on the ground (Bq/m^2).

- *Rads and grays.* These terms are used to measure the dose of radiation absorbed by a body or substance. This is expressed in terms of energy transfer — joules per kilogram, for example — since radiation basically involves the transfer of energy from one source to another, either electromagnetically (light, heat, X-rays, and gamma rays) or via electrically charged or neutral particles (alpha, beta, neutrons). One gray (Gy) — the "new" term — equals 100 rads, the "old" term.

- *Rems and sieverts.* From the health standpoint, these terms put all types of ionizing radiation on an equal basis with regard to their potential for causing harm, thus allowing biological comparisons, regardless of the source of radiation. Over the same period of time, an exposure of 10 millirem or 100 μSv from cosmic rays or other natural "background" radiation has the same biological effect as an exposure of 10 millirem or 100 μSv from radioactive material released in a nuclear power plant accident (in either case negligible). In short, both the rem and sievert already take into account the characteristics of the particular type of radiation involved and its relevant potential for causing harm in body cells and tissues.

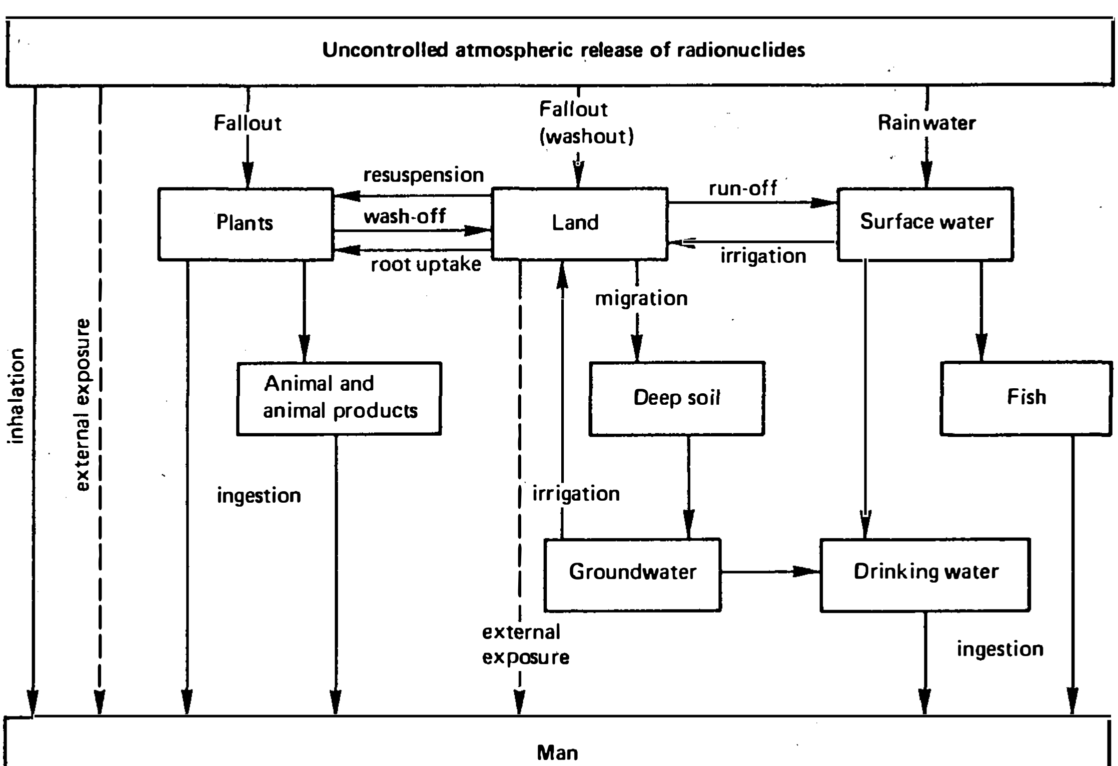
One sievert, the "new" term, is equal to 100 rem, the "old" term. Or, put another way to use the example above, 10 millirem is equal to 100 microsieverts. (By way of perspective, every year people are unavoidably exposed to about 1.5 to 2 millisievert (150 to 200 millirem) of radiation from natural sources in the environment.)

Generally speaking, the concept of radiation doses and effects is not different from that applying in the medical administration of drugs. Just as one aspirin is unlikely to harm the individual patient and 100 may have a serious or even lethal effect, so a small dose of radiation will have no discernible affect on the individual, whereas a large dose may produce serious biological damage. Important to recognize is the rate at which the dose is delivered: Taking 100 aspirins in one day may well kill a patient, but 100 aspirins taken in one year are unlikely to cause any harm. The same rule applies to radiation doses.

— *Editor*

Additional information may be found in references used for this article: *Nuclear Power, the environment and man*, IAEA STI/PUB/635, Vienna (1982); *Facts about low-level radiation*, an IAEA public information brochure (1986); and *What the general practitioner (MD) should know about medical handling of overexposed individuals*, IAEA TECDOC-366, Vienna (1986).

Major pathways of radionuclides to man due to uncontrolled release of radioactivity



Source: *Umweltradioaktivität und Strahlenexposition in Südbayern durch den Tschernobyl-Unfall*; Bericht des Instituts für Strahlenschutz der Gesellschaft für Strahlen- und Umweltforschung, Munich/Neuherberg, FRG, GSF-Bericht 16/86.

Adapted from GSF-Report 16/86 (1986), Ref. [2].