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INTERNALLY DEPOSITED FALLOUT FROM THE CHERNOBYL REACTOR ACCIDENT*

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Shortly after the announcement of the Chernobyl reactor accident, health protection scientists in several countries began monitoring the fallout radioactivity in the local citizenry and in people arriving from abroad. Whole-body counting measurements are known to have been made in England, France, Germany, Hungary, Italy, Japan, the Netherlands, Poland, the USA and the USSR. Gamma emitters detected by these methods reported from laboratories in several countries are listed in Table 1. Confirmation of the observation of a nuclide, by more than one laboratory, is indicated by a "Y" in the rightmost column; "N" indicates detection by only one laboratory.

Of these radionuclides ^{131}I and $^{134,137}Cs$ are the radioisotopes of greatest concern to radiological health. In our work with about 100 subjects resident in eastern Europe (mostly Poland) at the time of the accident or traveling as tourists, ^{131}I was readily detectable in the thyroid through mid-June, 1986, and was detectable in some subjects as late as early July, 9 to 10 weeks after the start of the accident. Among 42 subjects who were in eastern Europe on April 26, 1986, and in whom ^{131}I was detectable, the median activity in the thyroid was 1.4 nCi at the time of measurement. When extrapolated back to April 26 using a single exponential retention function for the thyroid and an 8-day effective half-life, the median activity was 42 nCi. The frequency distribution resembled a lognormal distribution. The extrapolated activities lay between approximately 2 and 1200 nCi. (Activities extrapolated to

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April 26, are maximum possible integrated exposure values. Actual integrated exposures were less than this because exposure was prolonged and initial exposures for many subjects began after April 26 due to delayed transport of radioactivity to the subjects' locales.)

The total thyroid dose commitment for most subjects was 1 rad or less. Because of the short environmental residence time of ^{131}I, the dose commitments to the subjects were probably not much less than the dose commitments to persons who remained abroad in the same locales.

The risk coefficient for fatal thyroid cancer implied by current recommendations of the International Commission on Radiological Protection (ICRP) is 3×10^{-6} per rad,[1] implying a very low cancer risk for the observed contamination levels.

The median activities of ^{134}Cs (40 subjects) and ^{137}Cs (51 subjects) on the day of arrival in the United States were 1.7 and 4.6 nCi, respectively. The activity ratio, 0.37, of ^{134}Cs to ^{137}Cs median activities, compares with a ratio of 0.5 reported by Soviet authorities to have been released.[2] The frequency distributions of the cesium isotope activities had a lognormal appearance. Body content on the day of arrival was estimated by extrapolating body content on the day of measurement backward in time, assuming a 100-day half-life for cesium retention and a single exponential retention function.

When plotted against date of arrival, ^{137}Cs body content increased at the rate of 1.3%/day over the approximately 100-day span of arrival dates represented by our subjects. An increase in ^{137}Cs level is to be expected due to intake from foodstuffs following the disappearance of airborne cesium. Among 19 subjects who arrived in eastern Europe after April 26, the average rate of accumulation of ^{137}Cs lay in the range 0.01 to 0.37 nCi per day. Projection of the equilibrium body activities that would result from accumulation at these rates, and of the 50-year dose commitments implied by these equilibrium levels, leads to the conclusion that the lifetime risks of fatal cancer for these people lay between 1.4×10^{-6} and 4.2×10^{-5} per person. These results include the risk contribution from ^{134}Cs; this amounts to only 5% of the total.

The risk levels derived from these observations of internal radioactivity and my conservative dose projection assumptions are as much as 10 times less than the risk levels published in the lay press during the months following the accident. This underscores the importance of basing risk estimation for internal radioactivity on direct observations.

REFERENCES

1. ICRP Publication 26. 1977. Recommendations of the International Commission on Radiological Protection. *Ann. ICRP 1(3)*.

2. State Committee for Using the Atomic Energy of the USSR. 1986. The Accident at Chernobyl AES and Its Consequences. Working Document for the Chernobyl Post Accident Review Meeting. Unpublished.

Table 1. Gamma emitters detected by whole-body or thyroid counting.

Nuclide	$T_{1/2}$	Confirmed
$^{95}Zr/^{95}Nb$	65 d/35 d	Y
$^{103}Ru/^{103}Rh$	39.5 d/stable	Y
$^{106}Ru/^{106}Rh$	1 y/30 s	Y
^{131}I	8.0 d	Y
$^{132}Te/^{132}I$	78 h/2.3 h	Y
^{134}Cs	2.05 y	Y
^{137}Cs	30.0 y	Y
$^{140}Ba/^{140}La$	12.8 c/40.2 h	Y
^{144}Ce	284 d	N