STATEMENT FROM THE 1987 WASHINGTON MEETING OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

The Commission wishes to draw attention to the following extracts from *ICRP Publication 48*, "The Metabolism of Plutonium and Related Elements" (ICRP 86).

Absorption from the Gastro-intestinal Tract

The greatly expanded body of data on the absorption of plutonium from the gastrointestinal tract indicates that absorption is influenced by the mass ingested, by fasting, by incorporation into foodstuffs, by complexing anions, such as citrate and DTPA, and by a variety of other factors. The animal data for the absorption of what appears to be the same compound often show wide fluctuations, which suggests that the absorption may be critically dependent on the chemical microenvironment at the site of absorption.

On the basis of the extensive data presented and discussed in Chapter IV of *ICRP Publication 48*, the fractional absorption (f_1) values listed in the table are regarded as best estimates for the purposes of radiation protection. It must be emphasized that the proposed value of $f_1 = 10^{-3}$ for unknown or mixed compounds of plutonium and other actinides is considered to provide an adequate margin of safety for radiation protection purposes. For comparison, the f_1 values used in the assessment of the ALIs for workers given in *ICRP Publication 30* (ICRP 79) are listed in the right hand column of Table 1.

The use of the cautious value of 10^{-3} may not be considered appropriate in all situations where a best estimate of absorption is required, either for a critical group or in estimating population doses. In such cases, if a different value more suitable to the specific situation can be justified, it should be employed.

Table 1. Comparison of proposed values for f_1 and those recommended in *ICRP Publication 30*

Element	Type of exposure compound	$f_1 \times 10^4$	
		This report	*ICRP Publication 30*
Pu	Occupational exposure		
	oxides, excluding "polydisperse" oxides	0.1	0.1
	nitrates	1	1
	other compounds or unknown mixtures	10	1
	Population exposure (via food chains)		
	all compounds	10	
Np	Occupational and population exposure		
	all compounds	10	100
Am Cm Cf	Occupational and population exposure		
	all compounds	10	5

There is strong evidence to suggest that plutonium absorption from the gastro-intestinal tract may be increased by at least an order of magnitude in the human neonate. This increased absorption appears likely to decrease very rapidly during the first days or weeks of life, but the age by which the gastro-intestinal absorption of plutonium will have decreased to adult levels is not known. For the first year of life, a value for f_1 of 10^{-2} is suggested, with the adult value of 10^{-3} being applied to all succeeding years. For the assessment of lifetime risk, and f_1 value of 10^{-3}, if applied to general populations, would seem adequately protective for all ages. Much more information on the absorption of actinides and other heavy metals from the neonatal gastro-intestinal tract of animals and man is needed.

Retention in Liver, Bone and Gonads

The more recent data from analyses of human tissues for plutonium confirm the previous assumptions that liver and bone are the principal deposition sites and account for about 80% of the plutonium which reaches the blood stream. For reasons that are not understood, the partition of plutonium between liver and skeleton varies widely in individual cases, but the most likely average deposition is considered to be 50% in the skeleton and 30% in liver. The available data suggest that this distribution also applies to americium and curium. However, the variability of the deposition of plutonium, americium and curium between individuals is such that, for radiation protection purposes, the *ICRP Publication 30* model of equal distribution between skeleton and liver (45% in each) remains an adequate assumption. Animal data indicate that for the actinides of higher atomic number, i.e. californium, berkelium and einsteinium, an initial distribution of 65% in skeleton and 25% in liver would seem more appropriate; for neptunium the corresponding values would be 75% and 15%.

The partition of actinides between skeleton and liver in children and neonates is likely to be different from that observed in adults because of the differences in metabolism.

For the gonads, the currently assumed values of 0.035% in testes and 0.011% in ovaries give an unjustified impression of precision, but seem otherwise to be appropriate. However, these figures should be kept under review as more sensitive analytical methods become available for the analysis of human autopsy material.

With regard to the retention parameters, there is considerable evidence to suggest that both the 40 year half-time for plutonium in liver and the 100 year half-time for plutonium in the skeleton, recommended in *ICRP Publication 19* (ICRP 72) and employed in *ICRP Publication 30* are too long. Values of 20 and 50 years for retention half-times in liver and skeleton, respectively, now seem more reasonable.

A case can be made for a shorter retention half-time for americium than for plutonium in liver; but human data are limited and a confident basis for extrapolation of animal data is lacking. At present, no compelling argument can be made for assuming retention times for neptunium, americium or the higher actinides which are substantially different from those of plutonium.

The assumption in *ICRP Publication 30* of an infinite retention half-time for all actinides in testes and ovaries is a cautious one, consistent with much of the experimental animal data, although non-human primate studies suggest a relatively short half-time.

Effect of the Proposed Changes in f_1 and Retention Half-life in Liver and Bone on ALIs

The suggested changes in the metabolic parameters have some implications for the values of ALI given in *ICRP Publication 30*. For isotopes of plutonium of long physical half-life, the ALI

for the ingestion of unknown or mixed compounds will need to be decreased by almost a factor of ten. However, the ALIs for ingestion of long-lived isotopes of plutonium as nitrates or oxides, as well as those for the ingestion of isotopes of short physical half-life, where the dose to the intestinal mucosa is of overriding importance, will need little change. Similarly, the effect on ALIs for inhaled isotopes of plutonium will also be small, since, in this situation, transfer from gastro-intestinal tract to blood is very small in comparison with transfer from lung to blood. Values of ALI for ingested americium, curium and californium will be much less affected, since the proposed change in f_1 values is only a factor of two. For ^{237}Np, the ALI by ingestion will need to be increased by about an order of magnitude.

The Commission now recommends the adoption of the values and procedures proposed in *ICRP Publication 48*.

References

ICRP (1972). The Metabolism of Compounds of Plutonium and Other Actinides. A report prepared by a Task Group of Committee 2 of the International Commission on Radiological Protection, ICRP Publication 19. Pergamon Press, Oxford.

ICRP (1979). Limits for Intakes of Radionuclides by Workers, ICRP Publication 30, Part 1. *Annals of the ICRP* **2** (3/4).

ICRP (1986). The Metabolism of Plutonium and Related Elements, ICRP Publication 48. *Annals of the ICRP* **16** (2/3).