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COMMENTS ON ICRP-60 RATIONALE FOR DOSE LIMITS FOR THE PREGNANT WORKER

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by

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Research report

COMMENTS ON ICRP-60 RATIONALE FOR DOSE LIMITS FOR THE PREGNANT WORKER

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ABSTRACT

ICRP Publication 60 has recently recommended new dose limits for the radiation exposure of pregnant workers. These new dose limits for pregnant workers are more restrictive than the current limits in force in Canada. Recent presentations by Dr. R.H. Mole have faulted the arguments provided by ICRP as justification for reducing the previously recommended limits for pregnant radiation workers. The present paper provides a brief review of the development of the human conceptus, of the biological effects of low doses of radiation on the fœtus, and discusses R.H. Mole's comments on ICRP-60. On the critical issues concerning the presence or absence of threshold doses for induction of specific biological endpoints, Dr. Mole and ICRP-60 appear to be in agreement.

The basic disagreement between Dr. Mole and ICRP-60 seems to revolve around the philosophical question of whether dose limits should be based on quantitative risks to the fœtus or whether dose limits to the pregnant worker should provide a standard of protection to the fœtus which is broadly comparable with that provided for members of the general public. Further research is recommended on one of the topics raised by Dr. Mole, namely, fœtal doses from radionuclides inhaled or ingested by the mother.

RÉSUMÉ

Dans sa publication 60, la Commission internationale de protection radiologique (CIPR) recommandait de nouvelles limites de doses plus rigoureuses pour les travailleuses enceintes que les limites réglementaires actuelles au Canada. De récentes présentations du Dr R.H. Mole ont attaqué les arguments de la CIPR en vue de réduire les limites de doses recommandées antérieurement pour les travailleuses enceintes. Le présent rapport résume brièvement le développement du produit de conception humain et les effets biologiques des faibles doses de rayonnement sur le fœtus, puis abrode les remarques du Dr Mole sur la publication 60 de la CIPR. Le Dr Mole et la CIPR semblent d'accord sur les questions cruciales concernant la présence ou l'absence de seuils de doses pour causer des conséquences biologiques particulières.

Le Dr Mole et la CIPR diffèrent de vue sur la question de principe à savoir si les limites de doses doivent se baser sur les risques quantitatifs du fœtus ou si les limites de doses des travailleuses enceintes doivent assurer un niveau de protection suffisant au fœtus qui soit généralement comparable à la protection dont jouit le public. L'auteur du présent rapport recommande de poursuivre la recherche sur l'un des aspects soulevés par le Dr Mole, soit les doses au fœtus attribuables aux radionucéides que la mère respire ou avale.

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COMMENTS ON ICRP-60 RATIONALE FOR

DOSE LIMITS FOR THE PREGNANT WORKER

A. INTRODUCTION AND HISTORICAL BACKGROUND

Protection of the unborn child against the possible harmful effects of radiation exposure has a long history in the Canadian nuclear industry dating back to 1945 [1]. There was a legal discrimination between male and female atomic radiation workers (ARWs) of reproductive capacity with respect to working conditions up until 1984. This discrimination was supported by the recommendations of the International Commission on Radiological Protection (ICRP), during this time.

Following queries from the Canadian Human Rights Commission, the Atomic Energy Control Board (AECB) of Canada in turn consulted its medical and scientific advisory panels. After consideration of the risk of harm to the offspring of women of childbearing age [2,3], the advisors indicated that the regulation governing radiation exposure of non-pregnant female ARWs was unduly restrictive. The Canadian regulations were modified in 1985 to eliminate discrimination between male and female ARWs until such time as the woman advised her employer of pregnancy. This notification of pregnancy was mandatory. At that time, the employer is then required to ensure that the pregnant worker is assigned to a job where the total occupational dose to the abdomen during the remainder of pregnancy cannot exceed 10 mSv, accumulated at a rate of not more than 0.6 mSv per 2 weeks [4]. The radiation exposure limits after declaration of pregnancy were compatible with those recommended by the ICRP [5,6]. A dose of 0.6 mSv is 3 times the lower limit of detection in the current federal dosimetry service operated by Health and Welfare Canada. These 1985 regulations seem to be working smoothly and have not interfered with employment of women as ARWs in major nuclear facilities. The 1985 regulations governing exposure limits for pregnant women have remained essentially unchanged in the 1991 Proposed General Amendments to the Atomic Energy Control Regulations [7] in Canada, except that the limits on dose are now to the foetus, not the mother's abdomen.

The new 1991 recommendations of the ICRP[8] have introduced a number of changes in recommended dose limits for all radiation workers. Most important is the recommendation to reduce occupational dose limits from 50 mSv to 20 mSv per year, the latter limit being averaged over 5 year periods. In as far as female ARWs are concerned, the ICRP now recommends that "the basis for the control of the occupational exposure of women who are not pregnant

is the same as that for men" [para. 176 in 8]. This has brought the ICRP recommendations on non-pregnant women into line with the 1985 Canadian recommendations. However, the ICRP further recommends that "once pregnancy has been declared the conceptus should be protected by applying a supplementary equivalent-dose limit to the surface of the woman's abdomen (lower trunk) of 2 mSv for the remainder of pregnancy and by limiting intakes of radionuclides to about 1/20 of the ALI" [para. 178 in 8]. This latter recommendation is the topic of considerable discussion. These new ICRP dose limits for pregnant workers are of course more restrictive than the current limits in force in Canada.

It is the new ICRP policy that "the methods of protection at work for women who may be pregnant should provide a standard of protection for any conceptus broadly comparable with that provided for members of the general public" [para. 177 in 8]. The recommended standards of protection for the conceptus and for members of the general public are indeed broadly comparable but not necessarily identical. The recommended exposure limit for members of the public is 1 mSv per year for the sum of the relevant doses from external sources and the committed dose from intakes of radionuclides [Table 6, para. 194 in 8]; averaging of total effective doses over a 5 year period is permissible under special circumstances. Maximum doses to the foetus, after pregnancy is declared, under the recommended limits for exposure of the pregnant mother are expected to be in the region of 1 mSv from external sources plus a maximum of about 1 mSv for committed dose from radionuclides that are inhaled or ingested by the mother [9,10]. A more detailed discussion of foetal doses from internal radionuclides will be included in a subsequent portion of the present review.

At the June 1991 Annual Meeting of the Canadian Radiation Protection Association (CRPA) in Winnipeg [11] as well as in other recent presentations, Dr. R.H. Mole (an internationally recognized expert in the field with a long and distinguished career in radiation protection) faulted the arguments provided by ICRP [8] as justification for reducing the previously recommended dose limits for the pregnant radiation worker. If the new ICRP recommendations on exposure limits for pregnant workers [8] were implemented in Canada, as is proposed [9], these recommendations may have a secondary effect of providing fewer employment opportunities for female workers of reproductive age. Thus, the decision [9] to adopt the new ICRP recommended dose limits for pregnant workers may not be justified if Dr. Mole is correct, and may well impose a greater hardship on women searching for employment, or on those who are currently employed, in the nuclear field.

The objective of the present paper is to review critically the analysis of Dr. R.H. Mole on the rationale used by the ICRP to arrive at its new recommendations [8] for limiting the dose from ionizing radiation to pregnant workers.

B. DEVELOPMENT OF THE HUMAN CONCEPTUS

A brief summary of the stages in development of the human conceptus may be useful at this point. Further details of these stages can be found in many other sources [see, for example, 12-17].

Fertilization of the human egg cell by the sperm, i.e. conception, usually occurs 2 weeks after the last maternal menses. The large fertilized egg cell undergoes several cell divisions with no increase in total mass as it passes along the fallopian tube to the uterus of the mother. Up until the stages at which 8 to 32 cells are present, each separate cell has the potential (in studies on livestock) to produce a complete and normal offspring. At this point, usually about 1 week after conception, the developing embryo attaches itself to the lining of the uterus, reorganization of the structure of the uterine lining and of the developing embryo occurs, and a placenta is formed by means of which oxygen and nutrients are supplied from the maternal circulatory system to the embryo. The whole process from fertilization to complete implantation in the uterus takes about 2 weeks.

An exponential growth in the mass of the embryo commences about 3 weeks after conception. All the major external and internal structures begin to appear (organogenesis) during the fourth to eighth week after conception. The transition from "embryo" to "foetus" at the beginning of the ninth week is not abrupt but the name change is made to indicate that the embryo has developed distinct human characteristics by the end of the eighth week. Growth, development and maturation of body organs and systems proceed during the foetal period from the ninth week through to birth at about 38 weeks after conception.

Specific radiobiological interest is attached to the development of the brain and central nervous system. Although a primitive central nervous system is recognizable 4-7 weeks after conception, a rapid increase in the number of neurons (the nerve cells which carry messages throughout the brain and the remainder of the nervous system) occurs at 8 to 15 weeks. During this time, the neurons also migrate to their ultimate development site and lose their capacity to divide, though further growth in size of the neurons without increase in number continues to occur for months and even years. The basic structures of the cerebral cortex are developed during this time 8-15 weeks after conception. During the time from 16 to 25 weeks after conception, differentiation in situ continues,

synapses (specialized junctions between neuronal cells) are formed and the cytoarchitecture of the brain unfolds.

At birth, all of the organs typical of the human adult are formed and functional. Further growth of these organs continues at differing rates up to about age 18. All of the oocytes in the female ovary and all of the neurons (though not of the supporting glial or "insulating" cells) in the central nervous system are formed before birth; cell division in most other tissues continues for some years after birth and in certain tissues, notably the bone marrow, intestinal lining and skin, cell division continues throughout adult life. High doses of radiation at high dose rate consistently result in the death of dividing cells and can also interfere with normal development in other ways. The stage at which the organs formed in the embryo become functional during foetal development varies considerably. For example, there is little uptake of iodide by the developing thyroid gland during the first third of pregnancy, while calcification of the foetal bones does not occur until shortly before birth.

Development of the human conceptus from a single cell to a live-born child is a highly complex process which is still imperfectly understood. Many things can go wrong in this process; it is currently estimated that some 30-50 percent of the developing concepti undergo spontaneous abortion by which errors in the development process are spontaneously eliminated. Roughly 6 percent of the remaining live-born children are estimated to suffer from some congenital abnormality which can be detected at, or shortly after, birth [13]. Of these congenital anomalies found in live-births, roughly 11% are thought to be due to genetic factors, 56% to environmental factors either on their own or in combination with polygenic disposition, while the remaining third have unknown causes [13].

C. BIOLOGICAL EFFECTS OF LOW DOSES OF RADIATION ON THE FOETUS

Current estimates of the effects of low doses of radiation on the developing conceptus are given in Table 1. The data in this table are similar to those given in a previous paper [10] and are based on the values given in ICRP Publication 60 [8] with additional information from other scientific reviews [13,17,18]. Further comments [cf. 10] on individual items listed in Table 1 follow.

Estimation of lethal effects depends entirely on extrapolation from the results of studies on experimental animals, primarily mice. The most sensitive period in humans is assumed to be the first few days after fertilization, when the fertilized egg cell is preparing

for implantation in the uterus. The 50% lethal dose is probably close to 1 Sv but effects have been observed in animals with doses as low as 0.1 Sv at high dose rate. Irradiation with doses up to 10 mSv during this brief stage might result in a very small, non-detectable risk of failure to implant, but surviving embryos develop normally when implantation does occur [8,17]. As the embryo and foetus develop, the lethal dose of radiation at high dose rate increases to approach that for adults; foetal deaths at low doses of radiation at low dose rate should be zero, as they are for adults.

Irradiation of pregnant mice at high dose rate during the time of major organogenesis, corresponding to about 3 or 4 to 8 weeks after conception in humans, can produce a variety of congenital malformations in the offspring. The dose response curves are usually curvilinear and dose thresholds probably apply [8,13,17].

Severe mental retardation, mostly combined with small head size, has been observed in 21 out of 514 children who were exposed at high dose rate in utero at Hiroshima and Nagasaki in 1945 [13]. No excess cases were observed in children who were 0-7 weeks or later than 25 weeks post-conception at the time of irradiation. The most vulnerable period was 8-15 weeks after conception, where the incidence of mental retardation was about 40% after exposure to 1 Sv at high dose rate; this is a risk 50 times greater than that in the unexposed comparison group [8,13,17]. Analysis of the dose response curve using the new DS86 dosimetry suggested that a threshold or quasi-threshold was likely [8,19]. The normal incidence of mental retardation in the general population has been found by various investigators to vary from about 0.2% to 8% depending on the methods and criteria used to define mental retardation [20]. The value of 0.8% given in Table 1 is that recorded for the control population at Hiroshima and Nagasaki [13].

The increased incidence of mental retardation in these children has been linked with a general decrease in IQ for all children exposed in utero to high doses of radiation at high dose rate at Hiroshima and Nagasaki [8,17]. Schull and co-workers discovered that the average IQ of the children exposed to 1 Sv at high dose rate at 8-15 weeks after conception was reduced by about 30 IQ points [18,19]. The spectrum of intelligence levels in any population is known to be very broad and to follow approximately a normal distribution. A general decrease of 30 IQ points on average would increase the fraction of mentally retarded children with an IQ of less than 67 from about 1% to 40%. It has been concluded that the observed shift of 30 IQ points at 1 Sv is best suited to describe the risk of mental retardation [8]. As noted in ICRP-60 [para.93 in 87], "all the observations on IQ and severe mental retardation relate to high dose and high dose rate, and their direct use probably over-estimates the risks of exposure to low doses at low dose rate.

ICRP-60 [8] is rather ambiguous about the classification of the shift in IQ caused by irradiation of the foetus during the period 8-15 weeks after conception. On the one hand, it assumes that "the shift is proportional to dose" [para.92]; on the other hand, "the effect is presumed to be deterministic with a threshold related to the minimum shift in IQ that can be recognized" [para.S-7].

It is known that IQ is not a fixed clinical value but is dependent on the environment and age of a given individual. The best that can be done with any standardized test is to fit the observed values on a given group of persons at any given time to a mean value of 100; the standard deviation in the normal distribution of the individual data is usually about 14-16 points. We do not know if the average innate intelligence of humans is changing appreciably over long periods of time. In Table 1, it was arbitrarily assumed that there was no change which could not be ascribed to differences in age and in environment.

The stochastic effects of radiation on the foetus are assumed to include cancer induction. However, estimates of the probability of cancer induction after irradiation of the foetus are again highly uncertain [8]. Studies of large numbers of children in the U.S. and the U.K. who were exposed to low doses of medical diagnostic x-rays in utero suggest a significant excess of childhood cancers before age 15. The risk estimates derived from these studies have been interpreted as being in the region of 2 fatal cancers [18] or 4-6 total cancers [21,22] per 100 person-Sv to the foetus [17]. No increase in fatal childhood cancers was observed in the much smaller number of children exposed to high radiation doses at Hiroshima and Nagasaki. However, it is considered prudent to assume that irradiation of the foetus will increase the risk of childhood cancer [13,23]. Constancy of risk during most of pregnancy may be assumed in the absence of convincing evidence to the contrary [13,23]. Data on the normal incidence of childhood cancers in Canada can be derived (Table 1) from the National Cancer Institute of Canada [24]. In Table 1, we have assumed that the risk of induction of childhood cancers before age 15 following foetal irradiation is 5 per 100 person-Sv. This would mean that about 2% of all childhood cancers might be attributed to exposure of the foetus to natural background radiation at a rate of 1 mSv per year.

A 40 year followup of 1630 Japanese bomb survivors irradiated in utero shows some indications that excess fatal cancers may appear after age 15, although the followup is far from complete and the magnitude of the risk is uncertain. ICRP-60 "assumes that the nominal fatality probability coefficient is, at most, a few times that for the population as a whole" [para.91 at 8]. The results of calculations given in BEIR [18] and ICRP-60 [8] agree that the predicted lifetime risk of fatal cancers after irradiation of

children is about 2 times greater than after irradiation of the whole population. For simplicity, we have assumed in Table 1 that the lifetime risk of fatal cancers after irradiation of the foetus is at most 3 times the ICRP estimate for the general population, i.e. is about 15 per 100 person-Sv. Animal studies have failed to demonstrate unusual sensitivity of the foetus to induction of cancer by radiation [13]. The ICRP [para.91 in 8] has assumed that cancers can be induced in humans by exposure to radiation throughout the period from 3 weeks after conception until the end of pregnancy.

The stochastic risk of induced heritable changes in the germ cells after irradiation of the foetus was not specifically considered in ICRP-60 [8] although this possibility was noted in ACRP-6 [3]. Induced frequencies of specific-locus mutations in mice are slightly lower after irradiation of foetal or of newborn males than of adult males [25]. A conservative approach would be to assume the same genetic risk coefficient for human adults and for the human foetus in the later stages of development after the gonadal tissues have been formed. Assuming then a conservative total approaching 2.5 per 100 children per person-Sv of parental radiation for serious heritable changes summed over all subsequent generations [8], a small risk of heritable changes could exist following exposure of the foetus to low doses of radiation (Table 1). This radiation risk is particularly small when compared to the normal incidence of serious genetic diseases; following the lead of ICRP-60, we have taken this normal incidence (Table 1) to be 20-30%, i.e., one third of the total incidence of 60-100% for all diseases with a genetic or partially genetic component [13,18].

An important conclusion can be drawn from recent scientific reviews of the relevant scientific literature: The biological effects of low doses of radiation to the foetus are close to zero when radiation exposures occur during the first four weeks after conception, i.e., during the first six weeks after onset of the last maternal menses. The critical issue for protection of the foetus is thus the radiation doses received after the first 6 weeks following onset of the last menses of the mother. It might be assumed that female ARWs will currently have been able to ascertain the probability of pregnancy within six weeks after their last menses, whether or not they choose to do so.

D. COMMENTS BY R.H. MOLE ON ICRP-60 DOSE LIMITS FOR EXPOSURE OF PREGNANT RADIATION WORKERS

The first part of this discussion of Mole's comments [11,26] on ICRP-60 dose limits [8] for exposure of pregnant ARWs will be organized into the same categories of biological effects that are listed in Table 1, with two additional topics at the end of this section. Further background information relevant to Mole's comments [11,26] on ICRP-60 is given in other papers [15,16].

1. Lethal effects.

Both R.H. Mole and ICRP-60 appear to agree that this is a non-issue. There are no detectable lethal effects of radiation exposure of the human conceptus at low doses of radiation. (Low doses are interpreted here to mean any dose up to the current legal limits of 50 mSv per year or 30 mSv per quarter year to the adult worker, or up to 10 mSv to the conceptus after pregnancy is declared. Other definitions are provided in ICRP-60 [8]).

2. Congenital anomalies.

Mole has criticized [11,26] earlier ICRP publications from 1959 to 1977 on radiation protection of the conceptus for two mistaken beliefs: (a) that "the earliest stage of development in utero is very sensitive to induction of malformations by ionizing radiation", and (b) that "during a later stage there are brief periods of high radiosensitivity". These beliefs resulted in at least two important consequences: former discrimination between male and non-pregnant female ARWs with respect to maximum permissible rates of radiation exposure, as noted in the Introduction, and secondly, the so-called 10 day rule for radiological examination of women. This latter rule suggests that any radiological examination of the female abdomen should be carried out during the 10 day interval following the onset of menstruation in order to avoid radiological hazards to the developing embryo (and is a rule which is apparently still considered by some medical practitioners in Canada).

In retrospect and in the light of current knowledge, Mole's criticism of earlier ICRP recommendations on radiation exposure of women of reproductive capacity is perfectly valid. The early ICRP recommendations on this issue are now known to be overly conservative. However, this does not appear to have anything much to do with the recommendations in ICRP-60 [8]. The 10 day rule was dropped by the ICRP in 1984 [6], while the former discrimination between male and non-pregnant female ARWs was dropped by the AECB in 1985 [4] and by the ICRP in 1991 [8].

Both Mole and ICRP-60 appear to agree now that the induction of congenital anomalies by radiation is a deterministic effect which is characterized by a threshold dose below which no effects are observed. That is to say, the probability of inducing congenital malformations by exposure of the conceptus to low doses of radiation is zero. In this respect, Mole's criticism [11,26] of ICRP-60 [8] for their citation of Table 15 from Annex C of the 1986 UNSCEAR report [13] does not appear to be highly relevant. The table in question is reproduced from publications by R.L. Brent, an internationally recognized scientific expert from the U.S.A. who

has conducted many studies on the teratogenic effects of radiation in animals. Mole's criticism is not directly to the point since he agrees with the ICRP [8] that induction of congenital anomalies by irradiation of pregnant animals exhibits a threshold dose; the only disagreement might be on the magnitude of the proposed threshold dose, which is in both cases well above 50 mSv even at high dose rate.

3. Severe mental retardation.

Induction of an excess of cases of severe mental retardation in Japanese children exposed in utero to high doses of radiation at high dose rate at Hiroshima and Nagasaki was reviewed in the 1977 UNSCEAR report and has been the topic of considerable further analyses and research since that time. The diagnosis of severe mental retardation in these Japanese children was made on the basis of clinical standards by medical examiners in Japan. The basic definition was a child who was "unable to perform simple calculations, to make simple conversation, to care for himself or herself, or if he or she was completely unmanageable or had been institutionalised". Since that time, the diagnosis has been further defined to mean an IQ of below 67-70 [8]. The number of cases is relatively small; and hence the statistics are not very reliable. However, the data provide the only source of quantitative data on the probability of induction of severe mental retardation in humans by exposure in utero to high radiation doses at high dose rate, or indeed at any dose rate.

As noted in section C, the ICRP [8] has linked the induction of severe mental retardation to a general downward shift in IQ following exposure to radiation at high dose rate, where it is assumed that the IQ values observed in individual humans follow a normal Gaussian distribution pattern. Mole [26] has criticised this linkage on the basis that "IQ distribution in the unirradiated diverges increasingly from the Gaussian as severity of mental retardation increases". There may well be an apparent small excess of cases of severe mental retardation in the general population due to developmental diseases such as Down syndrome (trisomy 21). However, the Hiroshima-Nagasaki data have been corrected by exclusion of 4 cases of mental retardation (3 with Down syndrome and 1 with infantile encephalitis) for which the causal disease was known; this correction did not alter the data appreciably [13].

Mole [27,28] has also published two detailed papers concerned with the mechanisms by which high radiation doses at high dose rate could produce a decrease in IQ and cases of severe mental retardation. The maternal kerma for 10 of the 13 cases of severe mental retardation exposed at 8-15 weeks after conception was from

1.8 to 5.5 Gy, which is close to the lethal dose for the mother. The foetal haematopoietic tissue probably received 0.9-2.2 Gy using the revised DS 86 dosimetry system. After such large exposures, the foetal haematopoietic tissues cannot escape severe damage and a consequent reduction in the formation of red blood cells [28]. This in turn will diminish oxygen transport from placenta to foetus. "Impaired oxygen transport to the developing forebrain will augment the localized forebrain damage caused directly by large radiation doses" [28]. This possibility had been rejected earlier by an ICRP committee [29], probably on the basis of insufficient evidence. Mole's papers [27,28] certainly deserve further critical study by persons involved in the support of research on the mechanisms responsible for the induction of severe mental retardation in Japanese bomb survivors exposed in utero.

However, the implications for ICRP-60 [8] are not critical. Mole has indicated that linear extrapolation of observations on severe mental retardation at foetal doses exceeding 1 Gy to much smaller doses would be invalid, that a threshold dose would be expected, and that the risk estimates derived from bomb survivor experience should be reduced for all practical applications involving exposure at low dose rate [27,28]. ICRP-60 [8] is in basic agreement with these conclusions, although not necessarily for the same reasons. "The linear, non-threshold responses appeared, a priori, unlikely...", the dose-response relationship probably included a threshold with a lower bound (lower confidence limit) of 0.12-0.2 Gy [para. B165 in 8], and the direct use of risk coefficients derived from the Japanese experience probably over-estimates the risks of foetal exposure to low doses at low dose rate [para. 93 in 8]. There is thus no conflict between the conclusions of R.H. Mole and ICRP-60 as to the practical implications of these data (as distinguished from the mechanisms involved).

4. Decrease in IQ.

Mole [27] has commented extensively and clearly on the problems involved in measuring IQ; these difficulties have been known for years [cf. 20] and are a topic of continuing scientific discussion. It is certainly useful to be aware of these difficulties. However, this comment does not appear to invalidate any of the conclusions in ICRP-60 [8] on the topic. Mole's major criticism [11,27] of ICRP-60 seems to be that the postulated general shift downwards of IQ with increasing dose must imply additional detriment due to a decrease in numbers of persons with the highest IQ values, and that ICRP-60 [8] does not give any consideration to this fact. Although this criticism can be kept in mind, it is, as noted by Mole,

implicit in the general downward shift in IQ postulated by the ICRP [see Fig. B-7 in 8]. It is not clear to the present author whether the loss of a few persons with high IQ is necessarily more important to the society than is a general decrease in IQ of the majority of the population.

The critical item would appear to be rather the magnitude of this downward IQ shift. This has been estimated to be about 30 IQ points per Sv received by the foetus at high dose and high dose rate during the period 8-15 weeks after conception [Table B.11 in 8]. If the dose - response relationship were truly linear and non-threshold, the average decrease in IQ would then be about 0.3 IQ points for 10 mSv received by the foetus at high dose rate during the critical 8-15 weeks of development. This effect is so small that it could not be recognized; Mole does not comment on this fact. As noted in ICRP-60 [8], the postulated effects are likely to be even smaller for radiation received at low dose rate.

5. Induction of childhood cancers appearing before age 15.

Mole has recently published the best quantitative analyses of the increase in risk of childhood cancer after exposure to low doses of radiation in utero that is available to date [22,30]. The risk coefficient is given as 4-5 X 10^{-2} per Gy, with 95% confidence limits of 0.8 - 9.5 X 10^{-2} per Gy [16,22,30]. Unfortunately these papers were not reviewed in ICRP-60 [8], perhaps because they appeared too recently for inclusion. ICRP-60 cites risk estimates from other publications ranging from 2.8 to 13 X 10^{-2} per Gy [para. B172 in 8]; no confidence limits are given. For the compilation in Table 1, we have used an average value of 5 X 10^{-2} per Sv. As noted by Mole, this is essentially identical to the estimated probability of induction of fatal cancer after exposure of the whole population to low doses of radiation at low dose rate [Tables 3 and B-11 in 8].

Other important points are noted by Mole [22,30]. The 95% confidence limits on the two childhood cancers observed in the Japanese bomb survivors exposed to radiation in utero do not exclude compatibility with the more extensive data on childhood cancers in British children exposed to diagnostic radiation in utero. There is no dependable evidence in the British data for differences in susceptibility to radiation-induced cancer at different stages in development in utero. And finally, the derived risk coefficient applies almost equally to childhood cancer incidence and mortality because in 1958-61 the effect of therapy on survival of children was small. Thus the risk coefficient used in Table 1 applies to nearly all childhood cancers; fortunately an appreciable portion of all childhood cancers are currently curable by therapy [17].

Mole's criticisms [11,26] of ICRP-60 [8] statements on induction of childhood cancer, apart from the regrettable omission of reference to Mole's recent 1990 papers [22,30], is that the ICRP seems to doubt that cancer is caused by very low doses in utero. The cited paragraph [para. B172 in 8] states that "irradiated fetuses seem to be susceptible to childhood leukemias and other childhood cancers which are expressed during approximately the first decade in life. The evidence for this, which comes mainly from the exposure of the mothers to diagnostic x-radiation, is only marginally at variance with direct observations on the Japanese survivors. Thus at the present time it is considered wise to regard the special susceptibility as real even at very low doses". The main text of ICRP-60 states that "throughout the period from 3 weeks after conception until the end of pregnancy, it is likely that radiation exposure can cause stochastic effects resulting in an increased probability of cancer in the live born" [para. 91 in 8]. Allowing for differences in the type of phraseology used by the ICRP and by Mole, it is difficult for the present author to ascribe any importance to the cited criticism by Mole [11,26].

6. Risk of induced fatal cancers in later life.

The ICRP has taken a cautious approach to this topic. It notes that the studies are incomplete but that there currently appears to be an increased incidence of cancers in later life in those irradiated in utero; this increase is comparable with the values for those irradiated postnatally [para. B173 in 8]. The Commission assumed that "the nominal fatality probability coefficient is, at most, a few times that for the population as a whole" [para. 91 in 8].

The risk of radiation-induced cancers in later life after exposure in utero might thus become the largest component of the total stochastic risks after irradiation in utero (Table 1). Unfortunately Mole does not seem to have paid much quantitative attention to this factor as yet. However, he has stated that "it is clearly of first importance that the follow-up of the UK childhood cohorts should be extended beyond the current 15 year cut-off in order to learn whether induced cancers will continue to appear at later times after x-ray... or whether induced cancers will decrease with the passage of time" [11]. The present author would agree with Mole's suggestion; this would provide an additional source of invaluable information for future refinements in current risk estimates, but does not impact upon ICRP-60 which is necessarily based on current data.

7. Induced genetic changes.

Neither Mole nor ICRP-60 has listed genetic risks after irradiation in utero. Conservative estimates were included in Table 1 for

completeness. However, it is evident that the stochastic risks of induction of genetic changes after irradiation in utero are appreciably smaller than the risks of induction of cancer (Table 1).

8. High accidental exposures.

Mole [11] has queried what ICRP-60 [paras. 176 and 178 in 8] means exactly in its recommendation that pregnant workers should not be employed in situations where there is a significant probability of high accidental doses. No definition of the terms high or accidental is given by the ICRP in this context. Deterministic effects such as induction of congenital abnormalities [para. 90 in 8] and severe mental retardation [para. B165 in 8] resulting from exposure in utero are stated to have a threshold of 100 mSv or higher. Stochastic risks from in utero exposure (Table 1) would presumably increase in direct proportion to total dose. The identification of situations where high accidental doses might be received by pregnant workers is left to regulatory agencies to determine [para. 178 in 8].

9. Effective foetal doses from internal radionuclides.

Mole [11] has criticised ICRP-60 for failing to recognize that reduction of the annual limit on intake (ALI) of radionuclides for a mother, after she declares her pregnancy, to 1/20 of the occupational limit [para. 178 in 8] makes protection of her child against risk much more stringent than for any other member of the public. The basic reason for this conclusion [11] is the absence of risk to the respiratory or gastrointestinal tracts of the foetus from inhalation or ingestion of radionuclides, in contrast to the situation for the mother. "No radionuclides can reach the individual in utero except via the maternal blood. In terms of the compartmentalized models of the body used for dosimetry of radionuclides, the individual in utero is merely another compartment in the mother's body to and from which there is transport of radionuclides circulating in the maternal blood. If radionuclides are taken up and concentrated in other compartments, so reducing the concentration in maternal blood, transport to embryo or fetus will be proportionately smaller" [11].

Mole's description is undoubtedly correct but his criticism does not necessarily apply to all radionuclides. Effective doses from certain radionuclides such as inhaled or ingested uranium dust are expected to be appreciably smaller for the foetus than for the mother [10]. However, this is not necessarily true for other radionuclides such as tritium (in the form of tritiated water) or soluble caesium-137 which are rapidly and completely absorbed from the respiratory or gastrointestinal tract to the body and uniformly

distributed to all soft tissues. In order to obtain further quantitative information on this topic, data for a few radionuclides in both categories have been assembled in Table 2. The sources of information used for this table were ICRP Publication 30 [31], printouts from GENMOD [32] which is based on the dosimetric models used in ICRP-30 and which were provided by S. Linauskas of the Chalk River Laboratories, and ICRP Publication 61 [33] which is again based on the dosimetric models used in ICRP-30 but modified in accordance with the new tissue weighting factors and occupational dose limits recommended in ICRP-60 [8]. Radiation weighting factors used in ICRP-30 [31] for alpha particles, beta and gamma rays have not been changed in ICRP-61 [33]. Other data from GENMOD, including retention in different tissues at various times after a single exposure, are given in Appendix B. The type of data shown in Table 2 are of further interest due to the fact that the 1991 Proposed General Amendments to the Canadian regulations [7] base the limits to pregnant ARWs on dose to the embryo or foetus, not on dose to the mother as in ICRP-60 [8] and in C-122 [9].

None of the references used for Table 2 give doses to the embryo or foetus. However, ICRP-30 [31] and GENMOD [32] do provide doses to other soft tissues in the adult person. These values should be the same as doses to the embryo and foetus in the case of tritiated water and caesium-137, for which there is normally no hindrance to absorption in the respiratory and gastrointestinal tracts ($f1 = 1$) and no hindrance in the placenta between the maternal blood stream and the foetus [cf. 34]. This is not necessarily true for other radionuclides. Table 3 summarises a few of the absorption coefficients suggested in a recent review [34]. Doses to other soft tissues as given in Table 2 should be multiplied by some factor similar to that given in the last column of Table 3 in order to obtain the average dose to the embryo and foetus (Table 2).

The results (Table 2) should be taken as rough approximations only. There is still considerable uncertainty concerning absorption coefficients through the placenta [34], distributions of certain radionuclides in different tissues of the foetus are not necessarily uniform [13, 34-37], and research in this area is progressing rapidly [35-37]. Radionuclides such as plutonium which have a long residence time in the mother's body may also be transferred in the mother's milk to the young child [35], thus increasing the committed dose to the developing child beyond that due to radionuclides which reach the foetus in utero. We have used the 50 year committed dose to other soft tissues for the approximate calculations in Table 2. Accumulated doses at less than 50 years can be derived from the GENMOD printouts in Appendix B if desired. Some increase in the approximate foetal doses suggested in Table 2 might also be necessary if the mother had been

exposed to radionuclides with long retention times prior to pregnancy (J.W. Stather, personal communication, 1992).

The approximate estimates of foetal doses given in Table 2 confirm the general postulates given earlier. Foetal doses from maternal intakes of tritiated water and caesium-137 are very similar to the effective doses to the adult worker, while foetal doses from maternal intakes of polonium, uranium, thorium and plutonium are likely to be much lower than the effective doses to the adult. Mole's criticism [11] of ICRP-60 [8] in this respect is thus likely to be correct for some but not for all radionuclides. However, it would be difficult for the ICRP to adopt a different approach at this time in the absence of reliable estimates of doses to the foetus and to the developing child from maternal intakes of radionuclides. These problems are currently being considered by NRPB and Committee 2 of the ICRP (J.W. Stather, personal communication, 1992).

It should of course be noted that the above discussion relates only to maternal intake of radionuclides and not to the additional restriction on exposure to radiation from external sources.

E. DISCUSSION AND CONCLUSIONS.

It is regrettable that ICRP-60 [8] did not have an opportunity to review 4 major papers by R.H. Mole [22,27,28,30], all of which were published in 1990. These should have had some influence on the wording in section B.9 of ICRP-60 [paras. B160 to B173 in 8]. However, after review of these papers, it seems unlikely to this author that the ICRP would have changed its major recommendations on dose limits to the pregnant mother in any way. On the critical issues concerning the presence or absence of threshold doses for induction of specific biological endpoints, Mole and ICRP-60 appear to be in agreement. Mole's weakness has been his failure to consider quantitatively stochastic endpoints other than induction of childhood cancer.

Four unpublished manuscripts forwarded to the author by Dr. R.H. Mole [38-41] have also been examined. All four manuscripts are of high quality and do much to elucidate the background to earlier abstracts [11, 26] of talks given recently by Dr. Mole. The last concluding comment by Mole in one of these papers [39] might be cited in full as an expression of his recent views: "This paper is confined to scientific considerations and does not trespass on ICRP's duty and prerogative to modify scientific considerations by prudence when setting protection standards." It is to be hoped that these manuscripts will be published and will be seriously considered in future scientific reviews of the biological effects of radiation on the foetus. However, it still seems unlikely to

the author that the ICRP would have changed its major recommendations on dose limits to the pregnant mother even if these publications had been available to it prior to the preparation of its recommendations [8].

The major disagreement between Mole's earlier abstracts [11,26] and ICRP-60 [8] does not seem to be directly related to any of the specific topics discussed in section D above, but to be related rather to the basic philosophy of radiation protection of the conceptus. The new ICRP policy is that methods of protection "should provide a standard of protection for any conceptus broadly comparable with that provided for members of the general public" [para. 177 in 8]. Mole on the other hand suggests that "the standard for the embryo and fetus ought to be stated in terms of risk, not dose" [11]. This of course raises the question as to the degree of risk to the foetus which could be considered acceptable.

The sum of the stochastic risks to the foetus may well be similar to that for children exposed shortly after birth. The sum of the stochastic risks as calculated in Table 1, using the assumptions given (which are compatible with ICRP-60) but omitting any small additional detriment due to radiation-induced curable cancers in later life, is in the region of 20×10^{-2} SV^{-1}. This can be compared with the aggregated detriment coefficient of about 7×10^{-2} SV^{-1} for members of the general population [8]. The value in Table 1 may be too high, since it depends largely on an unknown probability of induction of fatal cancers in later life after radiation exposure in utero. However, after allowing for the fact that about half the childhood cancers induced by foetal irradiation are now curable and for the fact that loss of life expectancy due to fatal cancers in children is much greater than for fatal cancers in adults, it seems likely that the aggregate detriment coefficient (calculated in the same manner as in ICRP-60) would be appreciably higher for the foetus than for a member of the general public after radiation exposure, even if most of the postulated cancers later in life failed to develop. Preliminary calculations suggest that the aggregated detriment for the foetus would be about 3-5 times that for the general population after exposure to low doses of radiation. These preliminary calculations are quite uncertain, since they depend on a number of assumptions as discussed in section C. However, even the best ICRP estimate of excess fatal cancers in the general population depends on a number of assumptions [8], which have a major impact on the estimates of lifetime risks for all persons exposed before age 30 [42]. ICRP-60 does not provide best quantitative estimates of stochastic risks or aggregated detriment coefficients for the foetus.

The philosophical question as to acceptable risk of exposure of the foetus depends on social judgements. The Advisory Committee on Radiological Protection (ACRP) [43] and the U.K. National Radiological Protection Board (NRPB) [44] have recommended alternative but widely different approaches to the question of dose limits for the pregnant radiation worker. The original documents cited should be examined for details.

The reasoning given in C-122 [9] for adopting the ICRP-60 recommendations on dose limits to pregnant workers [8] happened to be incorrect, but this does not mean that the ICRP philosophy of protecting the foetus to about the same degree as a member of the general public is wrong. The reasons cited by the ACRP for not adopting ICRP protection standards in this particular case include human rights issues and practical difficulties in the measurement of the low doses required by the ICRP-60 recommendations [43].

The removal of women from radiation work during pregnancy does not involve discrimination and human rights if the employer provides alternate work at equal pay. The problem arises with those employers (e.g. in nuclear medicine) who employ only a few specialized workers, and who may not have the resources to provide alternate work and simultaneously hire a qualified temporary replacement [43]. One of the basic difficulties arises from the fact that AECB determines the legal limits for radiation exposure of pregnant workers, while other government agencies determine the amount of financial compensation provided by taxpayers to those pregnant workers who must be laid off work in order to comply with proposed new AECB regulations [9]; this financial compensation is limited and considerably smaller than the normal wage in most Canadian provinces. If the ICRP recommendations on pregnant workers were implemented in Canada, the decision could impose appreciable hardship on many young women searching for employment, or on those who are currently employed, in the nuclear field. Solutions to this problem need to be considered before the ICRP-60 recommendations on dose limits for pregnant radiation workers are adopted.

Another problem which was raised specifically by R.H. Mole [11] concerns foetal doses from radionuclides which are inhaled or ingested by the mother. This topic was discussed in detail in section D.9 above and, in the author's opinion, should be the topic of considerable further research. The ICRP recommendation that intakes of radionuclides by the mother should be restricted to one-twentieth of the ALI after declaration of pregnancy [8] is likely to be unnecessarily restrictive in the case of inhalation of short-lived radon progeny [cf. 45] and uranium ore dust (Table 2) for example. Foetal doses from the radionuclides used in nuclear medicine may also require further examination. This topic requires a great deal of expensive research. One of the ways in which to

use limited research funds most efficiently would be to make arrangements for AECB staff to keep in close contact with relevant developments at the U.K. NRPB, as well as with the work of the Task Group (Chairman: Prof. Kaul) of Committee 2 of the ICRP which is concerned with age-dependent dosimetry. These contacts might suggest additional research projects which would be useful in the solution of particular problems relevant to this topic.

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We were dismayed to hear of the death of Robin H. Mole in March 1992. However, we were greatly indebted to the late Dr. R.H. Mole for two letters and copies of four additional unpublished manuscripts which Dr. Mole forwarded to the author in February 1992, in response to the first draft of the present report. The author is also indebted to J.W. Stather, Assistant Director, NRPB, for a long and thoughtful response to the first draft of the present report. Invaluable comments were also received from W.J. Schull (University of Texas, Houston), W.K. Sinclair (NCRP, Bethesda), S.J. Linauskas (Chalk River Laboratories), A.M. Marko (Deep River), K.L. Gordon (Winnipeg), and members of AECB staff who discussed this report with the author. Any errors or misinterpretations in the present report are of course the fault of the author and not of these reviewers.

Table 1. Approximate estimates of the effects of low doses of radiation on the human embryo and foetus.

Effect	Most radiosensitive stage of gestation after conception	Potential risk X 100 for foetal exposure to 10 mSv over the 8 months of pregnancy	Spontaneous incidence per 100 children born
DETERMINISTIC			
Death and spontaneous abortion	Very early	Zero (a)	30-50 (per 100 conceptions)
Viable congenital anomaly	4-8 weeks	Zero (a)	6-8
Mental retardation	8-15 weeks	Close to zero (b)	0.8
Decrease in IQ	8-15 weeks	Not detectable (b)	0.(?)
STOCHASTIC			
Childhood cancers	Unknown	0.05	0.2
Lifetime fatal cancers	3 weeks to birth	0.15	25.
Serious genetic changes in all subsequent generations	Last 6-7 months	0.02	20-30

Footnotes: (a) The threshold dose for induction of these effects by radiation is well above 10 mSv. (b) As discussed in the text, a quasi-threshold or a real threshold dose which is well above 10 mSv is likely.

Table 2. Committed dose (a) to the embryo-foetus following acute intake of certain radionuclides by the mother.

Radio-nuclide	Class	Fractional absorption coefficient F1 for workers	Route of maternal intake	Committed dose in Sv/Bq intake to other soft tissues in the worker		Rough estimate of committed dose in Sv to the foetus per Bq maternal intake (b)	Effective dose in Sv/Bq to the worker [33] (c)
				[31]	Appendix B		
H-3 (HTO)		1.0	Ingestion or inhalation	2E-11	2E-11	2E-11	2E-11
Cs-137	D	1.0	Ingestion	1.5E-8	1.3E-8	1.4E-8	2E-8
	D	1.0	Inhalation	9E-9	8E-9	1E-8	1E-8
Po-210	D	0.1	Ingestion	---	1E-7	1E-9	2E-7
	D	0.1	Inhalation	---	5E-7	5E-9	1E-6
Th-232	W	0.0002	Ingestion	---	1.3E-9	$\leq$1.3E-12	4E-7
	W	0.0002	Inhalation	---	8E-7	$\leq$8E-10	2E-4
U-238	D (d)	0.05	Ingestion	---	2E-9	7E-11	2E-8
	Y	0.002	Inhalation	---	2E-9	7E-11	3E-5
	D	0.05	Inhalation	---	2E-8	7E-10	2E-7
Pu-239	W (e)	0.001	Ingestion	2.6E-7	2.2E-7	1.4E-8	5E-7
	W (e)	0.001	Inhalation	3.2E-5	2.7E-5	1.8E-6	7E-5

Footnotes:

(a) Doses are expressed as an exponential. Thus 2E-11, for example, designates a dose of 2 X 10^{-11} Sv per Bq intake by the worker. Minor differences between values from ICRP-30 and GENMOD are not important.

(b) Data on committed dose in Sv/Bq to other soft tissues in the worker were multiplied by the fractional absorption coefficients for the placenta as given in Table 3 [34] to obtain rough estimates of dose to the foetus.

(c) Effective dose is 20 mSv divided by the ALI given in ICRP-61 [33].

(d) The absorption coefficient (F1) for U-238 in the gastro-intestinal tract was assumed to be 0.05 for class D material, as specified in ICRP-61 [33]. Note that committed doses for natural uranium should be very close to those for U-238 (Appendix B).

(e) Doses to other soft tissues are not given in ICRP-30 metabolic models. Dose to gonads was used as a surrogate for dose to other soft tissues in the case of Pu-239.

Table 3. Examples of some values for fractional absorption of radionuclides in the gastrointestinal (GI) tract, lung and placenta [34]

Material	Fractional absorption		
	GI tract (a)	Lung (a)	Placenta
Caesium	1.0	1.0	1.0
Plutonium	0.001	0.0001	0.06
Polonium	0.3	0.1	0.01
Thorium	0.001	0.0004	$\leq$0.001
Uranium	0.05	0.05	0.03

Footnote: (a) These values were not used for the calculations in Table 2, but can be compared with the ICRP F1 values listed in the third column of Table 2.

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APPENDIX A

Further comments on risk estimates for the foetus.

During the review of the first draft of this manuscript, several questions were raised by reviewers that appeared to deserve some additional comment. Reference was made in the tenth paragraph of section C above to the lower value for induced frequencies of specific-locus mutations in mice after irradiation of foetal or of newborn males than of adult males. These data are reviewed in paragraphs 261-263 of reference [25]. The reported mutation rates were 1.8 and 1.4 x 10^{-5} Sv^{-1} per locus for foetal and newborn males respectively; these values do not differ significantly from each other but are significantly lower than the rate of 2.9 x 10^{-5} Sv^{-1} per locus observed after irradiation of adult males.

A question was also raised concerning the sensitive period for induction of cancer after irradiation of the foetus, as discussed in paragraphs eight and nine of section C. ICRP-60 [8] is only slightly ambiguous on this issue. Paragraph 90 of ICRP-60 notes "When the number of cells in the conceptus is small and their nature is not yet specialised, the effect of damage to these cells is most likely to take the form of a failure to implant or of an undetectable death of the conceptus. It is thought that any cellular damage at this stage is much more likely to cause the death of the conceptus than to result in stochastic effects expressed in the live-born. Exposure of the embryo in the first three weeks following conception is not likely to result in deterministic or stochastic effects in the live-born child...." On the other hand, paragraph B172 of ICRP-60, referring to a previous review on induction of childhood cancer, states that "constancy of risk throughout pregnancy was assumed". There does not appear to the author to be any major discrepancy between these two statements. The reasoning used in paragraph 90 of ICRP-60, and the conclusion repeated in paragraph 91, could apply equally well to the induction of childhood cancer; it seems probable that irradiation during the first 2 or 3 weeks after conception is not likely to lead either to childhood leukemia, other childhood cancers or to cancers appearing later in adult life. The major target organs are not formed at 3 weeks after conception; moreover, the mass of the target increases at an exponential rate at later stages of foetal development.

Questions were also raised as to whether or not radiation of the foetus increased the risk of childhood leukemia only or of all childhood cancers, and as to the reliability of the dosimetry used by Mole in his quantitative analysis of the risk of childhood

cancer following medical X-rays to the foetus [22,30]. Childhood leukemia accounts for about half of all childhood cancers. Irradiation of the foetus increased the incidence of both childhood leukemia and solid tumors in the British and U.S. studies on the effects of exposure of pregnant women to medical diagnostic X-rays. Further information on this topic can be found in paragraphs 303-308 in Annex G of the 1977 UNSCEAR report, in paragraphs 343-376 of reference [13] and in paragraphs 154-170 of reference [23].

Previous assessments of quantitative risk of childhood cancer following medical X-rays of pregnant mothers in the U.K. were based on estimates of the number of X-ray films taken and estimates of average foetal dose per film in six metropolitan teaching hospitals, primarily in London, England, for which scattered reports were available during the period 1946 to 1957. Mole [22,30] noted that these earlier assessments appeared to ignore one of the best sources of available information, namely, the report of the Adrian Committee set up in 1957 to review practice in diagnostic radiology in the U.K. This report was concerned with recorded dose measurements made in 1958 during routine radiological examinations in a large number of representative hospital X-ray departments all over Britain. Mole combined the 1958 dose data from the Adrian Committee report, together with data from the Oxford survey of childhood cancer for births in 1958-1961, to produce a more reliable estimate of the risk of childhood cancer per Sv of foetal exposure [22,30]. This value was two times higher than that previously suggested in the UNSCEAR reports. This topic is currently under further consideration by the NRPB in the U.K. [J.W. Stather, personal communication, 1992].

One substantive issue was raised by W.J. Schull [personal communication, 1992]. The doses used in the analysis of the Japanese data on severe mental retardation in children exposed *in utero* to high doses of radiation at Hiroshima and Nagasaki are actually doses to the uterus of a non-pregnant woman. The foetal doses would be somewhat smaller. If actual foetal doses could be estimated, the risk of induction of severe mental retardation would be somewhat higher than that given in ICRP-60 [8] and in paragraph 4 of section C above.

APPENDIX B

Retention of radionuclides and committed doses to various tissues after single acute exposures of adult workers to selected radionuclides.

Note: All data are taken from GENMOD [32] using ICRP-30 [31] metabolic models. The given H(t) values, derived from ICRP-30 models, are not valid for the new ALI values derived from ICRP-60 [8] and ICRP-61 [33], but the committed doses in Sv per Bq intake should be identical for both sets of publications. Abbreviations used for various target organs and tissues of the body are as follows: LUNG = lung, LYMPH = lymph nodes, SI = small intestine, ULI = upper large intestine, LLI = lower large intestine, GUT = remainder of intestinal tract (primarily the stomach), BONE SUR = bone surfaces, R MARROW = red bone marrow, LIVER = liver, KIDNEYS = kidneys, OTHER = other soft tissues.

Retention Table. Results (Bq) are per Bq intake.

DAVE MYERS CASE RUN

H 3 (T¨=4.50e+03 d) (HTO model)

Acute Inhalation
Adult subject.
ALI: 2.5e+09 Bq
DAC: 1.1e+06 Bq/m3

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	OTHER
0.00	1.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	8.25e-03	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.81e-01
0.50	7.28e-06	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.69e-01
1.00	6.29e-07	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.36e-01
2.00	2.11e-07	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.73e-01
5.00	3.48e-09	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.10e-01
7.00	7.01e-10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.19e-01
14.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.84e-01
30.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.34e-01
60.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.45e-02
90.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.16e-03
180.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.06e-03
182.50	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.01e-03
365.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.37e-04
730.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.92e-04
1825.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.39e-05
3650.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.11e-06
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

DAVE MYERS CASE RUN

H 3 (T =4.50e+03 d) (HTO model)

Acute Inhalation
Adult subject.
ALI: 2.5e+09 Bq
DAC: 1.1e+06 Bq/m3

Time (d)	LUNG	GUT	SI	ULI	LLI	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	3.25e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.96e-13	5.84e-13
0.50	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.59e-13	9.40e-13
1.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.15e-12	1.51e-12
2.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.27e-12	2.60e-12
5.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.21e-12	5.45e-12
7.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.84e-12	7.04e-12
14.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.11e-11	1.12e-11
30.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.57e-11	1.57e-11
60.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.81e-11	1.80e-11
90.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.86e-11	1.84e-11
180.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.91e-11	1.89e-11
182.50	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.91e-11	1.89e-11
365.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.93e-11	1.92e-11
730.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.96e-11	1.94e-11
1825.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.98e-11	1.96e-11
3650.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.98e-11	1.96e-11
7300.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.98e-11	1.96e-11
18250.00	3.29e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.98e-11	1.96e-11

Retention Table. Results (Bq) are per Bq intake.

DAVE MYERS CASE RUN

CS 137 P (T¨=1.10e+04 d) (General model)

Acute Ingestion
f1: 1.000e+00
Adult subject.
ALI: 3.6e+06 Bq

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	OTHER
0.00	0.00e+00	0.00e+00	1.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	0.00e+00	0.00e+00	8.25e-03	0.00e+00	0.00e+00	0.00e+00	3.50e-01
0.50	0.00e+00	0.00e+00	6.71e-06	0.00e+00	0.00e+00	0.00e+00	7.09e-01
1.00	0.00e+00	0.00e+00	3.52e-08	0.00e+00	0.00e+00	0.00e+00	9.07e-01
2.00	0.00e+00	0.00e+00	2.14e-08	0.00e+00	0.00e+00	0.00e+00	9.44e-01
5.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.95e-01
7.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.73e-01
14.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.26e-01
30.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.45e-01
60.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.16e-01
90.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.09e-01
180.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.87e-01
182.50	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.82e-01
365.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.84e-02
730.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.66e-03
1825.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.47e-06
3650.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.56e-07
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.55e-07
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

)(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

DAVE MYERS CASE RUN

CS 137 P (T¨=1.10e+04 d) (General model)

Acute Ingestion
F1: 1.000e+00
Adult subject.
ALI: 3.6e+06 Bq

Time (d)	LUNG	GUT	SI	ULI	LLI	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	2.11e-12	3.49e-10	2.99e-12	3.68e-12	1.50e-12	2.87e-12	2.70e-11
0.50	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	1.79e-11	4.37e-11
1.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	5.56e-11	8.48e-11
2.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	1.40e-10	1.77e-10
5.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	3.90e-10	4.50e-10
7.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	5.49e-10	6.24e-10
14.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	1.09e-09	1.21e-09
30.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	2.23e-09	2.45e-09
60.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	4.06e-09	4.46e-09
90.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	5.58e-09	6.12e-09
180.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	8.74e-09	9.56e-09
182.50	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	8.81e-09	9.63e-09
365.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	1.16e-08	1.27e-08
730.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	1.27e-08	1.39e-08
1825.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	1.29e-08	1.40e-08
3650.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	1.29e-08	1.40e-08
7300.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	1.29e-08	1.40e-08
18250.00	2.13e-12	3.52e-10	3.02e-12	3.72e-12	1.52e-12	1.29e-08	1.40e-08

Retention Table. Results (Bq) are per Bq intake.

DAVE MYERS CASE RUN

CS 137 P (T 1.10e+04 d) (General model)

Acute Inhalation to class D material.
AMAD: 1.00 im (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 1.000e+00
Adult subject.
ALI: 5.6e+06 Bq
DAC: 2.3e+03 Bq/m3

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	OTHER
0.00	3.30e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	1.91e-01	1.05e-02	8.49e-03	0.00e+00	0.00e+00	0.00e+00	1.10e-01
0.50	1.26e-01	1.73e-02	5.03e-03	0.00e+00	0.00e+00	0.00e+00	2.58e-01
1.00	6.26e-02	1.73e-02	2.09e-03	0.00e+00	0.00e+00	0.00e+00	4.22e-01
2.00	1.56e-02	8.66e-03	3.66e-04	0.00e+00	0.00e+00	0.00e+00	5.50e-01
5.00	2.45e-04	3.38e-04	2.07e-06	0.00e+00	0.00e+00	0.00e+00	5.67e-01
7.00	1.57e-05	2.99e-05	6.71e-08	0.00e+00	0.00e+00	0.00e+00	5.53e-01
14.00	0.00e+00	9.70e-09	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.22e-01
30.00	0.00e+00	2.76e-08	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.71e-01
60.00	0.00e+00	5.52e-10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.89e-01
90.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.21e-01
180.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.81e-01
182.50	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.78e-01
365.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.59e-02
730.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.48e-03
1825.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.68e-06
3650.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

DAVE MYERS CASE RUN

CS 137 P (T=1.10e+04 d) (General model)

Acute Inhalation to class D material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 1.000e+00
Adult subject.
ALI: 5.6e+06 Bq
DAC: 2.3e+03 Bq/m3

Time (d)	LUNG	GUT	SI	ULI	LLI	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	1.81e-10	1.56e-11	4.94e-13	6.50e-13	1.66e-13	9.50e-13	2.54e-11
0.50	3.81e-10	3.51e-11	1.06e-12	1.39e-12	3.59e-13	6.04e-12	5.79e-11
1.00	5.91e-10	5.20e-11	1.62e-12	2.13e-12	5.46e-13	2.18e-11	1.03e-10
2.00	7.75e-10	6.28e-11	2.08e-12	2.74e-12	6.93e-13	6.71e-11	1.77e-10
5.00	8.50e-10	6.56e-11	2.25e-12	2.97e-12	7.46e-13	2.22e-10	3.55e-10
7.00	8.54e-10	6.56e-11	2.26e-12	2.98e-12	7.48e-13	3.23e-10	4.67e-10
14.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	6.63e-10	8.38e-10
30.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	1.38e-09	1.63e-09
60.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	2.54e-09	2.89e-09
90.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	3.51e-09	3.95e-09
180.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	5.50e-09	6.12e-09
182.50	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	5.54e-09	6.16e-09
365.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	7.29e-09	8.06e-09
730.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	8.00e-09	8.84e-09
1825.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	8.08e-09	8.93e-09
3650.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	8.08e-09	8.93e-09
7300.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	8.08e-09	8.93e-09
18250.00	8.55e-10	6.56e-11	2.26e-12	2.98e-12	7.49e-13	8.08e-09	8.93e-09

Retention Table. Results (Bq) are per Bq intake.

PO 210 (T¨=1.38e+02 d) (General model)

Acute Ingestion
F1: 1.000e-01
Adult subject.
ALI: 9.5e+04 Bq

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	LIVER	KIDNEYS	SPLEEN	OTHER
0.00	0.00e+00	0.00e+00	1.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	0.00e+00	0.00e+00	8.23e-03	3.53e-01	4.83e-01	8.57e-02	1.47e-03	1.47e-03	1.47e-03	1.03e-02
0.50	0.00e+00	0.00e+00	6.78e-06	4.92e-02	4.80e-01	3.07e-01	5.48e-03	5.48e-03	5.48e-03	3.84e-02
1.00	0.00e+00	0.00e+00	1.05e-07	1.75e-03	2.17e-01	4.17e-01	8.69e-03	8.69e-03	8.69e-03	6.08e-02
2.00	0.00e+00	0.00e+00	2.96e-08	3.19e-06	3.61e-02	2.52e-01	9.63e-03	9.63e-03	9.63e-03	6.74e-02
5.00	0.00e+00	0.00e+00	0.00e+00	3.44e-08	1.62e-04	1.60e-02	9.17e-03	9.17e-03	9.17e-03	6.42e-02
7.00	0.00e+00	0.00e+00	0.00e+00	1.29e-09	5.04e-06	2.18e-03	8.83e-03	8.83e-03	8.83e-03	6.18e-02
14.00	0.00e+00	0.00e+00	0.00e+00	1.34e-06	0.00e+00	2.13e-06	7.74e-03	7.74e-03	7.74e-03	5.42e-02
30.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.32e-11	5.72e-03	5.72e-03	5.72e-03	4.00e-02
60.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.24e-03	3.24e-03	3.24e-03	2.27e-02
90.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.84e-03	1.84e-03	1.84e-03	1.29e-02
180.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.37e-04	3.37e-04	3.37e-04	2.36e-03
182.50	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.21e-04	3.21e-04	3.21e-04	2.25e-03
365.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.03e-05	1.03e-05	1.03e-05	7.19e-05
730.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.09e-08	2.09e-08	2.09e-08	1.47e-07
1825.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
3650.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

PO 210 (T =1.38e+02 d) (General model)

Acute Ingestion
F1: 1.000e-01
Adult subject.
ALI: 9.5e+04 Bq

Time (d)	LUNG	GUT	SI	ULI	LLI	LIVER	KIDNEYS	SPLEEN	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	5.05e-17	1.21e-09	1.75e-09	1.66e-09	3.05e-10	8.00e-11	4.65e-10	8.00e-10	1.85e-11	3.92e-10
0.50	8.69e-17	1.22e-09	2.60e-09	6.80e-09	3.61e-09	9.63e-10	5.59e-09	9.63e-09	2.23e-10	2.01e-09
1.00	1.33e-16	1.22e-09	2.75e-09	1.23e-08	1.41e-08	4.04e-09	2.35e-08	4.04e-08	9.34e-10	6.66e-09
2.00	1.88e-16	1.22e-09	2.75e-09	1.56e-08	3.29e-08	1.19e-08	6.89e-08	1.19e-07	2.73e-09	1.73e-08
5.00	2.67e-16	1.22e-09	2.75e-09	1.63e-08	4.76e-08	3.53e-08	2.05e-07	3.53e-07	8.17e-09	4.63e-08
7.00	3.07e-16	1.22e-09	2.75e-09	1.63e-08	4.83e-08	5.02e-08	2.92e-07	5.02e-07	1.16e-08	6.42e-08
14.00	4.32e-16	1.22e-09	2.75e-09	1.63e-08	4.84e-08	9.79e-08	5.69e-07	9.79e-07	2.27e-08	1.21e-07
30.00	6.65e-16	1.22e-09	2.75e-09	1.63e-08	4.84e-08	1.87e-07	1.08e-06	1.87e-06	4.33e-08	2.28e-07
60.00	9.50e-16	1.22e-09	2.75e-09	1.63e-08	4.84e-08	2.95e-07	1.72e-06	2.95e-06	6.82e-08	3.57e-07
90.00	1.11e-15	1.22e-09	2.75e-09	1.63e-08	4.84e-08	3.58e-07	2.08e-06	3.58e-06	8.25e-08	4.32e-07
180.00	1.28e-15	1.22e-09	2.75e-09	1.63e-08	4.84e-08	4.23e-07	2.46e-06	4.23e-06	9.78e-08	5.10e-07
182.50	1.29e-15	1.22e-09	2.75e-09	1.63e-08	4.84e-08	4.24e-07	2.46e-06	4.24e-06	9.81e-08	5.11e-07
365.00	1.32e-15	1.22e-09	2.75e-09	1.63e-08	4.84e-08	4.37e-07	2.54e-06	4.37e-06	1.01e-07	5.27e-07
730.00	1.32e-15	1.22e-09	2.75e-09	1.63e-08	4.84e-08	4.38e-07	2.54e-06	4.38e-06	1.01e-07	5.28e-07
1825.00	1.32e-15	1.22e-09	2.75e-09	1.63e-08	4.84e-08	4.38e-07	2.54e-06	4.38e-06	1.01e-07	5.28e-07
3650.00	1.32e-15	1.22e-09	2.75e-09	1.63e-08	4.84e-08	4.38e-07	2.54e-06	4.38e-06	1.01e-07	5.28e-07
7300.00	1.32e-15	1.22e-09	2.75e-09	1.63e-08	4.84e-08	4.38e-07	2.54e-06	4.38e-06	1.01e-07	5.28e-07
18250.00	1.32e-15	1.22e-09	2.75e-09	1.63e-08	4.84e-08	4.38e-07	2.54e-06	4.38e-06	1.01e-07	5.28e-07

Retention Table. Results (Bq) are per Bq intake.

PO 210 (T=1.38e+02 d) (General model)

Acute Inhalation to class D material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 1.000e-01
Adult subject.
ALI: 1.9e+04 Bq
DAC: 8.0e+00 Bq/m3

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	LIVER	KIDNEYS	SPLEEN	OTHER
0.00	3.30e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	1.91e-01	1.05e-02	8.48e-03	2.20e-02	1.24e-02	1.41e-03	1.03e-02	1.03e-02	1.03e-02	7.19e-02
0.50	1.25e-01	1.73e-02	5.02e-03	2.19e-02	4.03e-02	1.43e-02	2.21e-02	2.21e-02	2.21e-02	1.55e-01
1.00	6.23e-02	1.72e-02	2.07e-03	1.00e-02	4.53e-02	4.14e-02	3.39e-02	3.39e-02	3.39e-02	2.38e-01
2.00	1.55e-02	8.58e-03	3.62e-04	1.76e-03	1.77e-02	4.78e-02	4.34e-02	4.34e-02	4.34e-02	3.04e-01
5.00	2.39e-04	3.30e-04	2.01e-06	9.71e-06	2.35e-04	5.18e-03	4.51e-02	4.51e-02	4.51e-02	3.16e-01
7.00	1.53e-05	2.88e-05	7.02e-08	3.36e-07	1.04e-05	7.61e-04	4.35e-02	4.35e-02	4.35e-02	3.05e-01
14.00	7.49e-08	1.07e-07	0.00e+00	0.00e+00	1.68e-07	1.45e-06	3.82e-02	3.82e-02	3.82e-02	2.67e-01
30.00	4.70e-09	0.00e+00	0.00e+00	0.00e+00	7.07e-08	0.00e+00	2.82e-02	2.82e-02	2.82e-02	1.97e-01
60.00	3.54e-10	0.00e+00	0.00e+00	0.00e+00	3.04e-09	0.00e+00	1.60e-02	1.60e-02	1.60e-02	1.12e-01
90.00	1.04e-10	0.00e+00	0.00e+00	0.00e+00	3.02e-10	0.00e+00	9.08e-03	9.08e-03	9.08e-03	6.36e-02
180.00	5.27e-12	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.66e-03	1.66e-03	1.66e-03	1.16e-02
182.50	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.58e-03	1.58e-03	1.58e-03	1.11e-02
365.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.06e-05	5.06e-05	5.06e-05	3.54e-04
730.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.91e-08	9.91e-08	9.91e-08	6.93e-07
1825.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
3650.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

PO 210 (T=1.38e+02 d) (General model)

Acute Inhalation to class D material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 1.000e-01
Adult subject.
ALI: 1.9e+04 Bq
DAC: 8.0e+00 Bq/m3

Time (d)	LUNG	GUT	SI	ULI	LLI	LIVER	KIDNEYS	SPLEEN	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	6.92e-08	4.57e-11	4.23e-11	2.69e-11	3.72e-12	8.30e-10	4.82e-09	8.30e-09	1.92e-10	9.37e-09
0.50	1.45e-07	1.04e-10	1.73e-10	3.00e-10	1.17e-10	4.96e-09	2.88e-08	4.96e-08	1.15e-09	2.36e-08
1.00	2.26e-07	1.53e-10	3.15e-10	1.05e-09	8.96e-10	1.68e-08	9.78e-08	1.68e-07	3.89e-09	4.76e-08
2.00	2.96e-07	1.81e-10	4.03e-10	2.07e-09	3.57e-09	4.98e-08	2.89e-07	4.98e-07	1.15e-08	9.57e-08
5.00	3.24e-07	1.88e-10	4.21e-10	2.50e-09	7.17e-09	1.63e-07	9.45e-07	1.63e-06	3.75e-08	2.34e-07
7.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.38e-09	2.37e-07	1.37e-06	2.37e-06	5.45e-08	3.23e-07
14.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	4.73e-07	2.75e-06	4.73e-06	1.09e-07	6.06e-07
30.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	9.13e-07	5.30e-06	9.13e-06	2.10e-07	1.13e-06
60.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	1.44e-06	8.39e-06	1.44e-05	3.34e-07	1.77e-06
90.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	1.75e-06	1.02e-05	1.75e-05	4.06e-07	2.13e-06
180.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	2.07e-06	1.20e-05	2.08e-05	4.79e-07	2.52e-06
182.50	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	2.08e-06	1.21e-05	2.08e-05	4.82e-07	2.53e-06
365.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	2.15e-06	1.25e-05	2.15e-05	4.96e-07	2.61e-06
730.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	2.15e-06	1.25e-05	2.15e-05	4.96e-07	2.61e-06
1825.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	2.15e-06	1.25e-05	2.15e-05	4.96e-07	2.61e-06
3650.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	2.15e-06	1.25e-05	2.15e-05	4.96e-07	2.61e-06
7300.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	2.15e-06	1.25e-05	2.15e-05	4.96e-07	2.61e-06
18250.00	3.25e-07	1.88e-10	4.21e-10	2.50e-09	7.44e-09	2.15e-06	1.25e-05	2.15e-05	4.96e-07	2.61e-06

Retention Table. Results (Bq) are per Bq intake.

#1

TH 232 (T+=5.13e+12 d) -> RA 228 (T+=2.10e+03 d) -> TH 228 P (T+=6.99e+02 d) (General model)

Acute Ingestion
F1: 2.000e-04
Adult subject.
ALI: 2.7e+04 Bq

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	BONE SUR	LIVER	OTHER
0.00	0.00e+00	0.00e+00	1.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.10	0.00e+00	0.00e+00	9.08e-02	6.11e-01	2.77e-01	2.06e-02	2.31e-06	1.32e-07	5.29e-07
-1-	0.00e+00	0.00e+00	3.00e-06	2.02e-05	9.15e-06	6.79e-07	7.64e-11	4.36e-12	1.75e-11
-2-	0.00e+00	0.00e+00	1.49e-10	1.00e-09	4.54e-10	3.37e-11	3.79e-15	2.17e-16	8.66e-16
0.20	0.00e+00	0.00e+00	8.24e-03	3.91e-01	5.07e-01	8.86e-02	1.05e-05	5.98e-07	2.39e-06
-1-	0.00e+00	0.00e+00	5.44e-07	2.58e-05	3.35e-05	5.85e-06	6.90e-10	3.94e-11	1.58e-10
-2-	0.00e+00	0.00e+00	5.40e-11	2.56e-09	3.32e-09	5.80e-10	6.85e-14	3.91e-15	1.57e-14
0.50	0.00e+00	0.00e+00	6.17e-06	6.63e-02	5.33e-01	3.30e-01	4.63e-05	2.64e-06	1.06e-05
-1-	0.00e+00	0.00e+00	1.02e-09	1.09e-05	8.80e-05	5.45e-05	7.64e-09	4.36e-10	1.75e-09
-2-	0.00e+00	0.00e+00	2.52e-13	2.71e-09	2.18e-08	1.35e-08	1.89e-12	1.08e-13	4.33e-13
1.00	0.00e+00	0.00e+00	3.80e-11	3.30e-03	2.51e-01	4.64e-01	9.20e-05	5.25e-06	2.10e-05
-1-	0.00e+00	0.00e+00	1.26e-14	1.09e-06	8.27e-05	1.53e-04	3.03e-08	1.73e-09	6.93e-09
-2-	0.00e+00	0.00e+00	6.23e-18	5.40e-10	4.10e-08	7.59e-08	1.51e-11	8.60e-13	3.44e-12
2.00	0.00e+00	0.00e+00	2.57e-21	8.15e-06	4.22e-02	2.86e-01	1.28e-04	7.31e-06	2.92e-05
-1-	0.00e+00	0.00e+00	1.55e-24	5.38e-09	2.78e-05	1.89e-04	8.45e-08	4.82e-09	1.93e-08
-2-	0.00e+00	0.00e+00	1.46e-27	5.34e-12	2.76e-08	1.87e-07	8.37e-11	4.78e-12	1.91e-11
5.00	0.00e+00	0.00e+00	0.00e+00	1.23e-13	1.91e-04	1.85e-02	1.40e-04	7.96e-06	3.18e-05
-1-	0.00e+00	0.00e+00	0.00e+00	2.03e-16	3.14e-07	3.06e-05	2.30e-07	1.31e-08	5.25e-08
-2-	0.00e+00	0.00e+00	3.24e-41	5.04e-19	7.78e-10	7.57e-08	5.71e-10	3.25e-11	1.30e-10
7.00	0.00e+00	0.00e+00	0.00e+00	8.38e-19	5.21e-06	2.56e-03	1.40e-04	7.95e-06	3.18e-05
-1-	0.00e+00	0.00e+00	0.00e+00	1.90e-21	1.20e-08	5.90e-06	3.23e-07	1.84e-08	7.34e-08
-2-	0.00e+00	0.00e+00	0.00e+00	6.47e-24	4.17e-11	2.04e-08	1.12e-09	6.36e-11	2.54e-10
14.00	0.00e+00	0.00e+00	0.00e+00	4.95e-31	1.76e-11	2.34e-06	1.40e-04	7.90e-06	3.16e-05
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.10e-14	1.08e-08	6.45e-07	3.64e-08	1.46e-07
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.61e-16	7.46e-11	4.46e-09	2.52e-10	1.01e-09
30.00	0.00e+00	0.00e+00	0.00e+00	1.23e-43	5.52e-24	2.63e-13	1.40e-04	7.77e-06	3.11e-05
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.43e-26	2.59e-15	1.38e-06	7.66e-08	3.06e-07
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.01e-28	3.83e-17	2.03e-08	1.13e-09	4.52e-09
60.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.39e-04	7.55e-06	3.02e-05
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.73e-06	1.48e-07	5.92e-07

-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.00e-08	4.33e-09	1.73e-08
90.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.39e-04	7.32e-06	2.93e-05
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.07e-06	2.14e-07	8.58e-07
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.77e-07	9.34e-09	3.74e-08
180.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.38e-04	6.70e-06	2.68e-05
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.95e-06	3.86e-07	1.55e-06
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.76e-07	3.29e-08	1.31e-07
365.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.36e-04	5.58e-06	2.23e-05
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.54e-05	6.33e-07	2.53e-06
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.53e-06	1.04e-07	4.16e-07
730.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.31e-04	3.89e-06	1.55e-05
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.81e-05	8.32e-07	3.33e-06
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.41e-06	2.49e-07	9.94e-07
1825.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.20e-04	1.31e-06	5.26e-06
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.41e-05	5.95e-07	2.38e-06
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.12e-05	3.43e-07	1.37e-06
3650.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.02e-04	2.16e-07	8.63e-07
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.15e-05	1.51e-07	6.04e-07
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.76e-05	1.22e-07	4.87e-07
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.44e-05	5.81e-09	2.32e-08
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.77e-05	5.29e-09	2.12e-08
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.44e-05	5.03e-09	2.01e-08
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.88e-05	1.14e-13	4.54e-13
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.87e-05	1.13e-13	4.53e-13
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.87e-05	1.13e-13	4.53e-13

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

#1

TH 232 (T+=5.13e+12 d) -> RA 228 (T+=2.10e+03 d) -> TH 228 P (T+=6.99e+02 d) (General model)

Acute Ingestion
F1: 2.000e-04
Adult subject.
ALI: 2.7e+04 Bq

Time (d)	LUNG	GUT	SI	ULI	LLI	BONE SUR	R MARROW	LIVER	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.10	9.91e-16	8.49e-10	6.96e-10	2.95e-10	2.47e-11	1.54e-13	1.83e-14	4.55e-15	3.15e-16	1.12e-10
0.20	1.21e-15	9.25e-10	1.40e-09	1.31e-09	2.40e-10	1.53e-12	1.37e-13	2.82e-14	3.15e-15	2.34e-10
0.50	1.62e-15	9.34e-10	2.18e-09	5.58e-09	2.92e-09	2.09e-11	1.72e-12	3.36e-13	4.31e-14	7.00e-10
1.00	2.06e-15	9.34e-10	2.32e-09	1.04e-08	1.17e-08	1.03e-10	8.35e-12	1.62e-12	2.11e-13	1.53e-09
2.00	2.44e-15	9.34e-10	2.34e-09	1.33e-08	2.78e-08	3.66e-10	2.95e-11	5.69e-12	7.51e-13	2.69e-09
5.00	2.63e-15	9.34e-10	2.34e-09	1.39e-08	4.07e-08	1.31e-09	1.05e-10	2.03e-11	2.69e-12	3.54e-09
7.00	2.65e-15	9.34e-10	2.34e-09	1.39e-08	4.14e-08	1.96e-09	1.57e-10	3.03e-11	4.02e-12	3.60e-09
14.00	2.67e-15	9.34e-10	2.34e-09	1.39e-08	4.15e-08	4.21e-09	3.38e-10	6.50e-11	8.61e-12	3.71e-09
30.00	2.72e-15	9.34e-10	2.34e-09	1.39e-08	4.15e-08	9.36e-09	7.51e-10	1.43e-10	1.90e-11	3.93e-09
60.00	2.89e-15	9.34e-10	2.34e-09	1.39e-08	4.15e-08	1.90e-08	1.52e-09	2.87e-10	3.81e-11	4.34e-09
90.00	3.24e-15	9.34e-10	2.34e-09	1.39e-08	4.15e-08	2.86e-08	2.30e-09	4.28e-10	5.67e-11	4.74e-09
180.00	6.10e-15	9.34e-10	2.34e-09	1.39e-08	4.15e-08	5.80e-08	4.66e-09	8.29e-10	1.10e-10	5.99e-09
365.00	2.69e-14	9.34e-10	2.34e-09	1.39e-08	4.15e-08	1.21e-07	9.74e-09	1.60e-09	2.12e-10	8.65e-09
730.00	1.65e-13	9.34e-10	2.34e-09	1.39e-08	4.15e-08	2.69e-07	2.16e-08	2.99e-09	3.96e-10	1.48e-08
1825.00	1.65e-12	9.35e-10	2.34e-09	1.39e-08	4.15e-08	9.83e-07	7.88e-08	6.46e-09	8.56e-10	4.40e-08
3650.00	7.25e-12	9.38e-10	2.34e-09	1.39e-08	4.15e-08	3.00e-06	2.40e-07	9.26e-09	1.22e-09	1.25e-07
7300.00	2.27e-11	9.47e-10	2.36e-09	1.39e-08	4.15e-08	8.06e-06	6.45e-07	1.01e-08	1.34e-09	3.28e-07
18250.00	5.58e-11	9.67e-10	2.38e-09	1.39e-08	4.16e-08	1.85e-05	1.48e-06	1.02e-08	1.34e-09	7.46e-07

Retention Table. Results (Bq) are per Bq intake.

#2

TH 232 (T+=5.13e+12 d) -> RA 228 (T+=2.10e+03 d) -> TH 228 P (T+=6.99e+02 d) (General model)

Acute Inhalation to class W material.
AMAD: 1.00 fm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 2.000e-04
Adult subject.
ALI: 4.5e+01 Bq
DAC: 1.9e-02 Bq/m3

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	BONE SUR	LIVER	OTHER
0.00	3.30e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.10	2.77e-01	1.73e-05	2.05e-02	2.81e-02	6.79e-03	3.48e-04	5.49e-03	3.14e-04	1.25e-03
-1-	9.15e-06	5.71e-10	6.76e-07	9.28e-07	2.24e-07	1.15e-08	1.81e-07	1.04e-08	4.14e-08
-2-	4.54e-10	2.83e-14	3.35e-11	4.60e-11	1.11e-11	5.69e-13	8.99e-12	5.14e-13	2.05e-12
0.20	2.66e-01	3.46e-05	1.92e-02	5.17e-02	2.86e-02	3.23e-03	1.11e-02	6.37e-04	2.55e-03
-1-	1.76e-05	2.28e-09	1.27e-06	3.41e-06	1.89e-06	2.13e-07	7.36e-07	4.20e-08	1.68e-07
-2-	1.74e-09	2.26e-13	1.26e-10	3.38e-10	1.87e-10	2.12e-11	7.30e-11	4.17e-12	1.67e-11
0.50	2.40e-01	8.60e-05	1.20e-02	5.62e-02	9.84e-02	3.42e-02	2.41e-02	1.38e-03	5.51e-03
-1-	3.97e-05	1.42e-08	1.97e-06	9.28e-06	1.62e-05	5.64e-06	3.98e-06	2.27e-07	9.09e-07
-2-	9.83e-09	3.52e-12	4.89e-10	2.30e-09	4.03e-09	1.40e-09	9.86e-10	5.63e-11	2.25e-10
1.00	2.11e-01	1.71e-04	5.71e-03	2.98e-02	1.20e-01	1.04e-01	3.67e-02	2.10e-03	8.39e-03
-1-	6.97e-05	5.64e-08	1.88e-06	9.82e-06	3.96e-05	3.45e-05	1.21e-05	6.92e-07	2.77e-06
-2-	3.46e-08	2.80e-11	9.34e-10	4.87e-09	1.96e-08	1.71e-08	6.01e-09	3.43e-10	1.37e-09
2.00	1.78e-01	3.37e-04	1.65e-03	8.14e-03	5.74e-02	1.34e-01	4.64e-02	2.65e-03	1.06e-02
-1-	1.17e-04	2.22e-07	1.09e-06	5.37e-06	3.79e-05	8.83e-05	3.06e-05	1.75e-06	6.99e-06
-2-	1.16e-07	2.21e-10	1.08e-09	5.33e-09	3.75e-08	8.75e-08	3.04e-08	1.73e-09	6.93e-09
5.00	1.44e-01	8.08e-04	1.74e-04	7.63e-04	4.06e-03	2.37e-02	5.05e-02	2.88e-03	1.15e-02
-1-	2.38e-04	1.33e-06	2.87e-07	1.26e-06	6.70e-06	3.91e-05	8.33e-05	4.74e-06	1.90e-05
-2-	5.89e-07	3.30e-09	7.11e-10	3.11e-09	1.66e-08	9.67e-08	2.06e-07	1.17e-08	4.70e-08
7.00	1.37e-01	1.10e-03	8.18e-05	3.43e-04	1.44e-03	6.37e-03	5.12e-02	2.91e-03	1.16e-02
-1-	3.17e-04	2.54e-06	1.89e-07	7.92e-07	3.33e-06	1.47e-05	1.18e-04	6.72e-06	2.69e-05
-2-	1.10e-06	8.80e-09	6.55e-10	2.74e-09	1.15e-08	5.10e-08	4.10e-07	2.33e-08	9.32e-08
14.00	1.24e-01	2.00e-03	4.80e-05	1.93e-04	6.49e-04	1.21e-03	5.35e-02	3.02e-03	1.21e-02
-1-	5.71e-04	9.21e-06	2.21e-07	8.88e-07	2.99e-06	5.57e-06	2.47e-04	1.39e-05	5.58e-05
-2-	3.95e-06	6.37e-08	1.53e-09	6.14e-09	2.07e-08	3.85e-08	1.71e-06	9.65e-08	3.86e-07
30.00	9.92e-02	3.43e-03	3.83e-05	1.53e-04	5.16e-04	9.41e-04	5.82e-02	3.25e-03	1.30e-02
-1-	9.78e-04	3.38e-05	3.77e-07	1.51e-06	5.08e-06	9.27e-06	5.74e-04	3.20e-05	1.28e-04
-2-	1.44e-05	4.99e-07	5.57e-09	2.23e-08	7.50e-08	1.37e-07	8.47e-06	4.72e-07	1.89e-06

	60.00	6.55e-02	4.53e-03	2.53e-05	1.01e-04	3.40e-04	6.21e-04	6.52e-02	3.55e-03	1.42e-02
	-1-	1.28e-03	8.87e-05	4.95e-07	1.98e-06	6.67e-06	1.22e-05	1.28e-03	6.97e-05	2.79e-04
	-2-	3.76e-05	2.60e-06	1.45e-08	5.81e-08	1.95e-07	3.56e-07	3.74e-05	2.04e-06	8.16e-06
	90.00	4.32e-02	4.48e-03	1.67e-05	6.68e-05	2.24e-04	4.10e-04	7.03e-02	3.75e-03	1.50e-02
	-1-	1.26e-03	1.31e-04	4.88e-07	1.95e-06	6.57e-06	1.20e-05	2.06e-03	1.10e-04	4.39e-04
	-2-	5.51e-05	5.71e-06	2.13e-08	8.51e-08	2.86e-07	5.22e-07	8.96e-05	4.78e-06	1.91e-05
	180.00	1.24e-02	2.57e-03	4.79e-06	1.92e-05	6.44e-05	1.18e-04	7.83e-02	3.89e-03	1.56e-02
	-1-	7.15e-04	1.48e-04	2.76e-07	1.11e-06	3.72e-06	6.78e-06	4.52e-03	2.24e-04	8.98e-04
q	-2-	6.08e-05	1.26e-05	2.35e-08	9.40e-08	3.16e-07	5.77e-07	3.84e-04	1.91e-05	7.63e-05
	365.00	9.54e-04	4.01e-04	3.68e-07	1.48e-06	4.96e-06	9.05e-06	8.12e-02	3.45e-03	1.38e-02
	-1-	1.08e-04	4.56e-05	4.18e-08	1.67e-07	5.63e-07	1.03e-06	9.22e-03	3.92e-04	1.57e-03
	-2-	1.78e-05	7.47e-06	6.86e-09	2.75e-08	9.23e-08	1.69e-07	1.51e-03	6.43e-05	2.57e-04
	730.00	6.06e-06	5.09e-06	2.34e-09	9.37e-09	3.15e-08	5.74e-08	7.92e-02	2.43e-03	9.71e-03
	-1-	1.30e-06	1.09e-06	5.00e-10	2.01e-09	6.74e-09	1.23e-08	1.70e-02	5.20e-04	2.08e-03
	-2-	3.87e-07	3.26e-07	1.49e-10	5.99e-10	2.01e-09	3.67e-09	5.06e-03	1.55e-04	6.21e-04
	1825.00	1.55e-12	3.25e-12	5.97e-16	2.39e-15	8.04e-15	1.47e-14	7.20e-02	8.21e-04	3.28e-03
	-1-	7.00e-13	1.47e-12	2.70e-16	1.08e-15	3.64e-15	6.64e-15	3.26e-02	3.72e-04	1.49e-03
	-2-	4.04e-13	8.50e-13	1.56e-16	6.25e-16	2.10e-15	3.83e-15	1.88e-02	2.14e-04	8.57e-04
p	3650.00	3.90e-21	5.15e-21	1.50e-24	6.03e-24	2.02e-23	3.70e-23	6.15e-02	1.35e-04	5.39e-04
	-1-	1.34e-21	9.19e-22	5.29e-25	2.12e-24	7.12e-24	1.30e-23	4.31e-02	9.44e-05	3.77e-04
	-2-	4.97e-22	0.00e+00	2.08e-25	8.33e-25	2.80e-24	5.11e-24	3.47e-02	7.60e-05	3.04e-04
	7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.48e-02	3.63e-06	1.45e-05
	-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.08e-02	3.30e-06	1.32e-05
	-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.88e-02	3.14e-06	1.26e-05
	18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.74e-02	7.10e-11	2.84e-10
	-1-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.73e-02	7.08e-11	2.83e-10
	-2-	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.73e-02	7.07e-11	2.83e-10

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

DAVE MYERS CASE RUN

TH 232 (T=5.11e+12 d) -> RA 228 (T=2.08e+03 d) -> TH 228 P (T=6.97e+02 d) (General model)

Acute Inhalation to class W material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 2.000e-04
Adult subject.
ALI: 4.5e+01 Bq
DAC: 1.9e-02 Bq/m3

Time (d)	LUNG	GUT	SI	ULI	LLI	BONE SUR	R MARROW	LIVER	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	6.34e-08	7.82e-11	7.46e-11	4.70e-11	6.48e-12	2.48e-09	1.99e-10	3.88e-11	5.13e-12	7.78e-09
0.50	1.49e-07	1.81e-10	3.21e-10	5.45e-10	2.09e-10	1.50e-08	1.20e-09	2.33e-10	3.08e-11	1.87e-08
1.00	2.76e-07	2.76e-10	6.17e-10	2.01e-09	1.68e-09	5.08e-08	4.08e-09	7.88e-10	1.04e-10	3.58e-08
2.00	4.94e-07	3.47e-10	8.46e-10	4.25e-09	7.14e-09	1.49e-07	1.19e-08	2.31e-09	3.06e-10	6.68e-08
5.00	1.03e-06	3.85e-10	9.59e-10	5.65e-09	1.59e-08	4.90e-07	3.93e-08	7.56e-09	1.00e-09	1.46e-07
7.00	1.35e-06	3.90e-10	9.73e-10	5.78e-09	1.70e-08	7.22e-07	5.79e-08	1.12e-08	1.48e-09	1.95e-07
14.00	2.39e-06	3.99e-10	9.96e-10	5.93e-09	1.76e-08	1.57e-06	1.26e-07	2.42e-08	3.21e-09	3.57e-07
30.00	4.45e-06	4.15e-10	1.04e-09	6.15e-09	1.83e-08	3.64e-06	2.92e-07	5.56e-08	7.37e-09	6.95e-07
60.00	7.35e-06	4.35e-10	1.09e-09	6.48e-09	1.93e-08	7.90e-06	6.34e-07	1.20e-07	1.59e-08	1.23e-06
90.00	9.33e-06	4.51e-10	1.12e-09	6.68e-09	1.99e-08	1.26e-05	1.01e-06	1.89e-07	2.49e-08	1.67e-06
180.00	1.22e-05	4.71e-10	1.17e-09	6.99e-09	2.08e-08	2.85e-05	2.28e-06	4.11e-07	5.44e-08	2.69e-06
182.50	1.23e-05	4.72e-10	1.17e-09	6.99e-09	2.09e-08	2.90e-05	2.32e-06	4.17e-07	5.52e-08	2.72e-06
365.00	1.36e-05	4.88e-10	1.20e-09	7.11e-09	2.12e-08	6.58e-05	5.28e-06	8.75e-07	1.16e-07	4.43e-06
730.00	1.36e-05	5.41e-10	1.27e-09	7.17e-09	2.13e-08	1.55e-04	1.24e-05	1.75e-06	2.32e-07	8.14e-06
1825.00	1.36e-05	1.07e-09	1.99e-09	7.86e-09	2.22e-08	5.87e-04	4.70e-05	3.93e-06	5.21e-07	2.58e-05
3650.00	1.36e-05	3.06e-09	4.70e-09	1.04e-08	2.55e-08	1.81e-03	1.45e-04	5.68e-06	7.52e-07	7.50e-05
7300.00	1.37e-05	8.52e-09	1.22e-08	1.75e-08	3.46e-08	4.87e-03	3.90e-04	6.22e-06	8.22e-07	1.98e-04
18250.00	1.37e-05	2.01e-08	2.81e-08	3.25e-08	5.41e-08	1.12e-02	8.96e-04	6.25e-06	8.24e-07	4.50e-04

Retention Table. Results (Bq) are per Bq intake.

DAVE MYERS CASE RUN

U 238 (T=1.63e+12 d) (General model)

Acute Ingestion
F1: 5.000e-02
Adult subject.
ALI: 5.0e+05 Bq

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	BONE VOL	KIDNEYS	OTHER
0.00	0.00e+00	0.00e+00	1.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	0.00e+00	0.00e+00	8.24e-03	3.73e-01	4.95e-01	8.72e-02	1.58e-03	8.51e-04	8.51e-04
0.50	0.00e+00	0.00e+00	6.39e-06	5.77e-02	5.07e-01	3.19e-01	5.99e-03	3.18e-03	3.18e-03
1.00	0.00e+00	0.00e+00	0.00e+00	2.45e-03	2.34e-01	4.42e-01	9.60e-03	4.95e-03	4.95e-03
2.00	0.00e+00	0.00e+00	0.00e+00	4.97e-06	3.92e-02	2.70e-01	1.06e-02	5.06e-03	5.06e-03
5.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.79e-04	1.75e-02	9.72e-03	3.62e-03	3.62e-03
7.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.62e-06	2.41e-03	9.15e-03	2.88e-03	2.88e-03
14.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.56e-06	7.43e-03	1.30e-03	1.30e-03
30.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.75e-03	2.26e-04	2.26e-04
60.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.42e-03	3.17e-05	3.17e-05
90.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.59e-03	2.53e-05	2.53e-05
180.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.14e-03	2.39e-05	2.39e-05
182.50	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.14e-03	2.39e-05	2.39e-05
365.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.09e-03	2.20e-05	2.20e-05
730.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.04e-03	1.85e-05	1.85e-05
1825.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.93e-04	1.12e-05	1.12e-05
3650.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.93e-04	4.81e-06	4.81e-06
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.18e-04	8.90e-07	8.90e-07
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.16e-05	5.17e-09	5.17e-09

class D
ICRP 61

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

DAVE MYERS CASE RUN

U 238 (T½=1.63e+12 d) (General model)

Acute Ingestion
F1: 5.000e-02
Adult subject.
ALI: 5.0e+05 Bq

Time (d)	LUNG	GUT	SI	ULI	LLI	BONE SUR	R MARROW	KIDNEYS	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	3.80e-14	9.71e-10	1.44e-09	1.35e-09	2.49e-10	1.30e-11	9.25e-13	2.12e-10	1.21e-12	2.56e-10
0.50	5.55e-14	9.80e-10	2.19e-09	5.64e-09	2.99e-09	1.59e-10	1.01e-11	2.57e-09	1.46e-11	8.84e-10
1.00	7.69e-14	9.81e-10	2.33e-09	1.04e-08	1.19e-08	6.73e-10	4.21e-11	1.07e-08	6.10e-11	2.26e-09
2.00	1.01e-13	9.81e-10	2.33e-09	1.33e-08	2.79e-08	1.98e-09	1.23e-10	3.03e-08	1.73e-10	4.73e-09
5.00	1.25e-13	9.81e-10	2.33e-09	1.38e-08	4.06e-08	5.81e-09	3.59e-10	7.96e-08	4.54e-10	8.90e-09
7.00	1.32e-13	9.81e-10	2.33e-09	1.38e-08	4.13e-08	8.19e-09	5.06e-10	1.04e-07	5.95e-10	1.07e-08
14.00	1.52e-13	9.81e-10	2.33e-09	1.38e-08	4.14e-08	1.55e-08	9.54e-10	1.57e-07	8.96e-10	1.44e-08
30.00	1.81e-13	9.81e-10	2.33e-09	1.38e-08	4.14e-08	2.74e-08	1.69e-09	1.94e-07	1.11e-09	1.74e-08
60.00	2.10e-13	9.81e-10	2.33e-09	1.38e-08	4.14e-08	4.03e-08	2.48e-09	2.03e-07	1.16e-09	1.85e-08
90.00	2.27e-13	9.81e-10	2.33e-09	1.38e-08	4.14e-08	4.76e-08	2.93e-09	2.07e-07	1.18e-09	1.91e-08
180.00	2.59e-13	9.81e-10	2.33e-09	1.38e-08	4.14e-08	6.19e-08	3.81e-09	2.15e-07	1.22e-09	2.03e-08
182.50	2.60e-13	9.81e-10	2.33e-09	1.38e-08	4.14e-08	6.23e-08	3.83e-09	2.15e-07	1.23e-09	2.03e-08
365.00	3.18e-13	9.81e-10	2.33e-09	1.38e-08	4.14e-08	8.77e-08	5.40e-09	2.31e-07	1.32e-09	2.25e-08
730.00	4.30e-13	9.81e-10	2.33e-09	1.38e-08	4.14e-08	1.37e-07	8.44e-09	2.59e-07	1.48e-09	2.65e-08
1825.00	7.28e-13	9.82e-10	2.33e-09	1.38e-08	4.14e-08	2.69e-07	1.66e-08	3.20e-07	1.82e-09	3.65e-08
3650.00	1.13e-12	9.82e-10	2.33e-09	1.38e-08	4.14e-08	4.51e-07	2.77e-08	3.73e-07	2.12e-09	4.81e-08
7300.00	1.69e-12	9.82e-10	2.33e-09	1.38e-08	4.14e-08	7.01e-07	4.31e-08	4.04e-07	2.30e-09	6.15e-08
18250.00	2.35e-12	9.82e-10	2.33e-09	1.38e-08	4.14e-08	9.97e-07	6.13e-08	4.11e-07	2.34e-09	7.55e-08

Genmod-PC v3.0

Thu Jan 16 16:32:35 1992

Retention Table. Results (Bq) are per Bq intake.

DAVE MYERS CASE RUN

U 238 (T½=1.63e+12 d) (General model)

Acute Inhalation to class Y material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 2.000e-03
Adult subject.
ALI: 1.6e+03 Bq
DAC: 6.6e-01 Bq/m3

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	BONE VOL	KIDNEYS	OTHER
0.00	3.30e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	2.86e-01	1.04e-05	2.39e-02	6.54e-02	3.65e-02	4.15e-03	3.42e-04	1.83e-04	1.83e-04
0.50	2.48e-01	2.60e-05	1.40e-02	6.77e-02	1.22e-01	4.29e-02	6.52e-04	3.44e-04	3.44e-04
1.00	2.14e-01	5.19e-05	6.24e-03	3.33e-02	1.42e-01	1.27e-01	8.75e-04	4.48e-04	4.48e-04
2.00	1.81e-01	1.04e-04	1.67e-03	8.35e-03	6.34e-02	1.56e-01	9.78e-04	4.66e-04	4.66e-04
5.00	1.53e-01	2.59e-04	1.26e-04	5.70e-04	3.47e-03	2.45e-02	9.39e-04	3.51e-04	3.51e-04
7.00	1.50e-01	3.61e-04	3.49e-05	1.55e-04	8.11e-04	5.51e-03	8.93e-04	2.84e-04	2.84e-04
14.00	1.47e-01	7.18e-04	5.90e-06	2.37e-05	8.11e-05	1.71e-04	7.50e-04	1.38e-04	1.38e-04
30.00	1.44e-01	1.51e-03	5.55e-06	2.21e-05	7.38e-05	1.33e-04	5.29e-04	3.97e-05	3.97e-05
60.00	1.38e-01	2.94e-03	5.32e-06	2.12e-05	7.08e-05	1.28e-04	3.44e-04	2.22e-05	2.22e-05
90.00	1.32e-01	4.28e-03	5.10e-06	2.04e-05	6.79e-05	1.22e-04	2.87e-04	2.20e-05	2.20e-05
180.00	1.17e-01	7.82e-03	4.50e-06	1.80e-05	6.00e-05	1.08e-04	2.89e-04	2.32e-05	2.32e-05
182.50	1.17e-01	7.91e-03	4.49e-06	1.79e-05	5.98e-05	1.08e-04	2.90e-04	2.32e-05	2.32e-05
365.00	9.05e-02	1.32e-02	3.49e-06	1.39e-05	4.64e-05	8.36e-05	3.63e-04	2.48e-05	2.48e-05
730.00	5.45e-02	1.85e-02	2.10e-06	8.39e-06	2.80e-05	5.04e-05	4.94e-04	2.60e-05	2.60e-05
1825.00	1.20e-02	1.71e-02	4.60e-07	1.84e-06	6.13e-06	1.11e-05	7.33e-04	2.23e-05	2.23e-05
3650.00	9.53e-04	8.67e-03	3.67e-08	1.46e-07	4.89e-07	8.81e-07	7.81e-04	1.24e-05	1.24e-05
7300.00	6.33e-06	4.18e-03	2.44e-10	9.73e-10	3.25e-09	5.85e-09	5.39e-04	2.77e-06	2.77e-06
18250.00	0.00e+00	3.75e-03	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.20e-04	2.00e-08	2.00e-08

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

DAVE MYERS CASE RUN

U 238 (T=1.63e+12 d) (General model)

Acute Inhalation to class Y material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 2.000e-03
Adult subject.
ALI: 1.6e+03 Bq
DAC: 6.6e-01 Bq/m3

Time (d)	LUNG	GUT	SI	ULI	LLI	BONE SUR	R MARROW	KIDNEYS	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	7.22e-08	1.04e-10	1.00e-10	6.35e-11	8.79e-12	4.36e-12	2.99e-13	7.09e-11	4.04e-13	8.75e-09
0.50	1.66e-07	2.35e-10	4.21e-10	7.18e-10	2.78e-10	2.38e-11	1.57e-12	3.85e-10	2.19e-12	2.02e-08
1.00	3.01e-07	3.46e-10	7.83e-10	2.58e-09	2.18e-09	7.31e-11	4.76e-12	1.16e-09	6.60e-12	3.68e-08
2.00	5.32e-07	4.26e-10	1.04e-09	5.27e-09	8.98e-09	1.92e-10	1.24e-11	2.93e-09	1.67e-11	6.55e-08
5.00	1.11e-06	4.64e-10	1.16e-09	6.81e-09	1.93e-08	5.58e-10	3.54e-11	7.62e-09	4.34e-11	1.36e-07
7.00	1.46e-06	4.67e-10	1.17e-09	6.89e-09	2.04e-08	7.88e-10	4.97e-11	1.00e-08	5.71e-11	1.79e-07
14.00	2.70e-06	4.70e-10	1.17e-09	6.95e-09	2.08e-08	1.51e-09	9.46e-11	1.54e-08	8.77e-11	3.29e-07
30.00	5.46e-06	4.74e-10	1.18e-09	6.97e-09	2.09e-08	2.78e-09	1.74e-10	2.00e-08	1.14e-10	6.62e-07
60.00	1.05e-05	4.82e-10	1.19e-09	7.02e-09	2.11e-08	4.37e-09	2.73e-10	2.30e-08	1.31e-10	1.28e-06
90.00	1.55e-05	4.87e-10	1.20e-09	7.08e-09	2.12e-08	5.53e-09	3.46e-10	2.55e-08	1.45e-10	1.87e-06
180.00	2.93e-05	5.08e-10	1.22e-09	7.24e-09	2.17e-08	8.70e-09	5.45e-10	3.33e-08	1.89e-10	3.55e-06
182.50	2.97e-05	5.08e-10	1.22e-09	7.24e-09	2.17e-08	8.79e-09	5.51e-10	3.35e-08	1.91e-10	3.59e-06
365.00	5.42e-05	5.40e-10	1.27e-09	7.50e-09	2.25e-08	1.62e-08	1.02e-09	5.03e-08	2.86e-10	6.56e-06
730.00	9.18e-05	5.88e-10	1.33e-09	7.84e-09	2.35e-08	3.61e-08	2.25e-09	8.57e-08	4.88e-10	1.11e-05
1825.00	1.52e-04	6.54e-10	1.40e-09	8.27e-09	2.47e-08	1.23e-07	7.63e-09	1.89e-07	1.07e-09	1.84e-05
3650.00	1.89e-04	6.85e-10	1.42e-09	8.37e-09	2.50e-08	3.02e-07	1.86e-08	3.08e-07	1.75e-09	2.29e-05
7300.00	2.13e-04	7.01e-10	1.43e-09	8.37e-09	2.51e-08	6.09e-07	3.75e-08	4.00e-07	2.28e-09	2.58e-05
18250.00	2.62e-04	7.32e-10	1.43e-09	8.38e-09	2.51e-08	9.97e-07	6.14e-08	4.23e-07	2.41e-09	3.17e-05

Retention Table. Results (Bq) are per Bq intake.

DAVE MYERS CASE RUN

U 238 (T½=1.63e+12 d) (General model)

Acute Inhalation to class D material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 5.000e-02
Adult subject.
ALI: 5.2e+04 Bq
DAC: 2.2e+01 Bq/m3

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	BONE VOL	KIDNEYS	OTHER
0.00	3.30e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	1.91e-01	1.05e-02	8.49e-03	2.26e-02	1.26e-02	1.43e-03	2.29e-02	1.23e-02	1.23e-02
0.50	1.26e-01	1.73e-02	5.03e-03	2.32e-02	4.19e-02	1.48e-02	4.89e-02	2.58e-02	2.58e-02
1.00	6.26e-02	1.73e-02	2.09e-03	1.08e-02	4.81e-02	4.35e-02	7.44e-02	3.83e-02	3.83e-02
2.00	1.56e-02	8.66e-03	3.66e-04	1.91e-03	1.91e-02	5.11e-02	9.41e-02	4.54e-02	4.54e-02
5.00	2.45e-04	3.38e-04	2.04e-06	1.07e-05	2.59e-04	5.65e-03	9.46e-02	3.61e-02	3.61e-02
7.00	1.57e-05	2.98e-05	7.26e-08	3.71e-07	1.13e-05	8.40e-04	8.92e-02	2.88e-02	2.88e-02
14.00	5.79e-08	5.64e-08	3.10e-10	0.00e+00	1.40e-07	1.17e-06	7.24e-02	1.30e-02	1.30e-02
30.00	1.49e-08	0.00e+00	2.66e-10	0.00e+00	6.52e-08	0.00e+00	4.63e-02	2.25e-03	2.25e-03
60.00	3.61e-10	0.00e+00	2.75e-11	0.00e+00	6.29e-09	0.00e+00	2.35e-02	3.08e-04	3.08e-04
90.00	0.00e+00	0.00e+00	1.50e-11	0.00e+00	1.95e-09	0.00e+00	1.54e-02	2.44e-04	2.44e-04
180.00	0.00e+00	0.00e+00	9.84e-14	0.00e+00	2.42e-11	0.00e+00	1.10e-02	2.32e-04	2.32e-04
182.50	0.00e+00	0.00e+00	2.47e-14	0.00e+00	1.54e-11	0.00e+00	1.10e-02	2.31e-04	2.31e-04
365.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.06e-02	2.13e-04	2.13e-04
730.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.01e-02	1.80e-04	1.80e-04
1825.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.64e-03	1.08e-04	1.08e-04
3650.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.71e-03	4.66e-05	4.66e-05
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.04e-03	8.63e-06	8.63e-06
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.86e-04	5.63e-08	5.63e-08

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

DAVE MYERS CASE RUN

U 238 (T=1.63e+12 d) (General model)

Acute Inhalation to class D material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 5.000e-02
Adult subject.
ALI: 5.2e+04 Bq
DAC: 2.2e+01 Bq/m3

Time (d)	LUNG	GUT	SI	ULI	LLI	BONE SUR	R MARROW	KIDNEYS	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	5.48e-08	3.67e-11	3.46e-11	2.19e-11	3.04e-12	2.82e-10	1.74e-11	4.57e-09	2.60e-11	6.94e-09
0.50	1.15e-07	8.35e-11	1.44e-10	2.47e-10	9.60e-11	1.67e-09	1.03e-10	2.69e-08	1.53e-10	1.58e-08
1.00	1.79e-07	1.23e-10	2.66e-10	8.83e-10	7.50e-10	5.64e-09	3.47e-10	8.95e-08	5.10e-10	2.78e-08
2.00	2.34e-07	1.46e-10	3.43e-10	1.76e-09	3.03e-09	1.65e-08	1.01e-09	2.54e-07	1.45e-09	4.58e-08
5.00	2.57e-07	1.51e-10	3.60e-10	2.13e-09	6.10e-09	5.30e-08	3.26e-09	7.32e-07	4.17e-09	8.14e-08
7.00	2.58e-07	1.52e-10	3.60e-10	2.13e-09	6.32e-09	7.61e-08	4.68e-09	9.79e-07	5.58e-09	9.87e-08
14.00	2.59e-07	1.52e-10	3.60e-10	2.13e-09	6.37e-09	1.47e-07	9.06e-09	1.51e-06	8.59e-09	1.36e-07
30.00	2.59e-07	1.52e-10	3.61e-10	2.13e-09	6.37e-09	2.64e-07	1.63e-08	1.87e-06	1.07e-08	1.65e-07
60.00	2.59e-07	1.52e-10	3.61e-10	2.13e-09	6.37e-09	3.89e-07	2.39e-08	1.97e-06	1.12e-08	1.77e-07
90.00	2.59e-07	1.52e-10	3.61e-10	2.13e-09	6.37e-09	4.59e-07	2.83e-08	2.00e-06	1.14e-08	1.82e-07
180.00	2.59e-07	1.52e-10	3.61e-10	2.13e-09	6.37e-09	5.98e-07	3.68e-08	2.08e-06	1.18e-08	1.94e-07
182.50	2.59e-07	1.52e-10	3.61e-10	2.13e-09	6.37e-09	6.02e-07	3.70e-08	2.08e-06	1.18e-08	1.94e-07
365.00	2.59e-07	1.53e-10	3.61e-10	2.13e-09	6.37e-09	8.48e-07	5.22e-08	2.24e-06	1.27e-08	2.15e-07
730.00	2.59e-07	1.53e-10	3.62e-10	2.13e-09	6.37e-09	1.32e-06	8.13e-08	2.51e-06	1.43e-08	2.54e-07
1825.00	2.59e-07	1.55e-10	3.63e-10	2.13e-09	6.37e-09	2.60e-06	1.60e-07	3.09e-06	1.76e-08	3.51e-07
3650.00	2.59e-07	1.57e-10	3.66e-10	2.14e-09	6.37e-09	4.37e-06	2.69e-07	3.60e-06	2.05e-08	4.64e-07
7300.00	2.59e-07	1.60e-10	3.68e-10	2.14e-09	6.38e-09	6.78e-06	4.17e-07	3.92e-06	2.24e-08	5.94e-07
18250.00	2.59e-07	1.63e-10	3.72e-10	2.14e-09	6.39e-09	9.64e-06	5.93e-07	4.00e-06	2.28e-08	7.29e-07

Retention Table. Results (Bq) are per Bq intake.

U NAT (T¨=1.00e+10 d) (General model)

Acute Inhalation to class D material.
AMAD: 1.00 ìm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 5.000e-02
Adult subject.
ALI: 5.0e+04 Bq
DAC: 2.1e+01 Bq/m3

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	BONE VOL	KIDNEYS	OTHER
0.00	3.30e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	1.91e-01	1.05e-02	8.49e-03	2.26e-02	1.26e-02	1.43e-03	2.29e-02	1.23e-02	1.23e-02
0.50	1.26e-01	1.73e-02	5.03e-03	2.32e-02	4.19e-02	1.48e-02	4.89e-02	2.58e-02	2.58e-02
1.00	6.26e-02	1.73e-02	2.09e-03	1.08e-02	4.81e-02	4.35e-02	7.44e-02	3.83e-02	3.83e-02
2.00	1.56e-02	8.66e-03	3.66e-04	1.91e-03	1.91e-02	5.11e-02	9.41e-02	4.54e-02	4.54e-02
5.00	2.45e-04	3.38e-04	2.04e-06	1.07e-05	2.59e-04	5.65e-03	9.46e-02	3.61e-02	3.61e-02
7.00	1.57e-05	2.98e-05	7.26e-08	3.71e-07	1.13e-05	8.40e-04	8.92e-02	2.88e-02	2.88e-02
14.00	5.88e-08	5.87e-08	2.75e-10	0.00e+00	1.43e-07	1.19e-06	7.24e-02	1.30e-02	1.30e-02
30.00	1.50e-08	0.00e+00	2.67e-10	0.00e+00	6.50e-08	0.00e+00	4.63e-02	2.25e-03	2.25e-03
60.00	3.52e-10	0.00e+00	2.70e-11	0.00e+00	6.12e-09	0.00e+00	2.35e-02	3.08e-04	3.08e-04
90.00	0.00e+00	0.00e+00	1.49e-11	0.00e+00	1.90e-09	0.00e+00	1.54e-02	2.44e-04	2.44e-04
180.00	0.00e+00	0.00e+00	9.71e-14	0.00e+00	2.42e-11	0.00e+00	1.10e-02	2.32e-04	2.32e-04
182.50	0.00e+00	0.00e+00	2.20e-14	0.00e+00	1.52e-11	0.00e+00	1.10e-02	2.31e-04	2.31e-04
365.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.06e-02	2.13e-04	2.13e-04
730.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.01e-02	1.80e-04	1.80e-04
1825.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.64e-03	1.08e-04	1.08e-04
3650.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.71e-03	4.66e-05	4.66e-05
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.04e-03	8.63e-06	8.63e-06
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.86e-04	5.63e-08	5.63e-08

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

U NAT (T=1.00e+10 d) (General model)

Acute Inhalation to class D material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 5.000e-02
Adult subject.
ALI: 5.0e+04 Bq
DAC: 2.1e+01 Bq/m3

Time (d)	LUNG	GUT	SI	ULI	LLI	BONE SUR	R MARROW	KIDNEYS	OTHER	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	5.69e-08	3.81e-11	3.59e-11	2.28e-11	3.16e-12	2.93e-10	1.80e-11	4.75e-09	2.70e-11	7.21e-09
0.50	1.20e-07	8.68e-11	1.50e-10	2.57e-10	9.97e-11	1.74e-09	1.07e-10	2.80e-08	1.59e-10	1.64e-08
1.00	1.86e-07	1.28e-10	2.77e-10	9.19e-10	7.79e-10	5.85e-09	3.60e-10	9.29e-08	5.29e-10	2.89e-08
2.00	2.43e-07	1.52e-10	3.57e-10	1.83e-09	3.15e-09	1.71e-08	1.05e-09	2.63e-07	1.50e-09	4.76e-08
5.00	2.67e-07	1.57e-10	3.74e-10	2.21e-09	6.34e-09	5.50e-08	3.38e-09	7.59e-07	4.32e-09	8.45e-08
7.00	2.68e-07	1.57e-10	3.74e-10	2.22e-09	6.57e-09	7.91e-08	4.86e-09	1.02e-06	5.79e-09	1.02e-07
14.00	2.69e-07	1.57e-10	3.74e-10	2.22e-09	6.61e-09	1.53e-07	9.40e-09	1.57e-06	8.92e-09	1.41e-07
30.00	2.69e-07	1.57e-10	3.74e-10	2.22e-09	6.61e-09	2.74e-07	1.69e-08	1.95e-06	1.11e-08	1.72e-07
60.00	2.69e-07	1.58e-10	3.74e-10	2.22e-09	6.61e-09	4.04e-07	2.48e-08	2.04e-06	1.16e-08	1.84e-07
90.00	2.69e-07	1.58e-10	3.74e-10	2.22e-09	6.61e-09	4.77e-07	2.93e-08	2.07e-06	1.18e-08	1.89e-07
180.00	2.69e-07	1.58e-10	3.74e-10	2.22e-09	6.61e-09	6.21e-07	3.82e-08	2.16e-06	1.23e-08	2.01e-07
182.50	2.69e-07	1.58e-10	3.74e-10	2.22e-09	6.61e-09	6.25e-07	3.84e-08	2.16e-06	1.23e-08	2.01e-07
365.00	2.69e-07	1.58e-10	3.74e-10	2.22e-09	6.62e-09	8.81e-07	5.42e-08	2.32e-06	1.32e-08	2.23e-07
730.00	2.69e-07	1.58e-10	3.75e-10	2.22e-09	6.62e-09	1.37e-06	8.44e-08	2.60e-06	1.48e-08	2.64e-07
1825.00	2.69e-07	1.59e-10	3.76e-10	2.22e-09	6.62e-09	2.71e-06	1.66e-07	3.21e-06	1.83e-08	3.64e-07
3650.00	2.69e-07	1.61e-10	3.77e-10	2.22e-09	6.62e-09	4.53e-06	2.79e-07	3.74e-06	2.13e-08	4.81e-07
7300.00	2.69e-07	1.62e-10	3.79e-10	2.22e-09	6.62e-09	7.04e-06	4.33e-07	4.07e-06	2.32e-08	6.17e-07
18250.00	2.69e-07	1.64e-10	3.81e-10	2.22e-09	6.63e-09	1.00e-05	6.16e-07	4.15e-06	2.36e-08	7.57e-07

Retention Table. Results (Sq) are per Bq intake.

PU 239 (T½=8.90e+06 d) (General model)

Acute Ingestion
F1: 1.000e-03
Adult subject.
ALI: 2.8e+04 Bq

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	BONE SUR	LIVER	TESTES
0.00	0.00e+00	0.00e+00	1.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	0.00e+00	0.00e+00	8.24e-03	3.90e-01	5.07e-01	8.86e-02	6.18e-05	6.18e-05	4.81e-08
0.50	0.00e+00	0.00e+00	8.33e-06	6.62e-02	5.33e-01	3.30e-01	2.39e-04	2.39e-04	1.86e-07
1.00	0.00e+00	0.00e+00	0.00e+00	3.29e-03	2.50e-01	4.63e-01	3.92e-04	3.92e-04	3.05e-07
2.00	0.00e+00	0.00e+00	0.00e+00	8.57e-06	4.21e-02	2.86e-01	4.46e-04	4.46e-04	3.47e-07
5.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.92e-04	1.85e-02	4.50e-04	4.50e-04	3.50e-07
7.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.14e-06	2.56e-03	4.50e-04	4.50e-04	3.50e-07
14.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.95e-06	4.50e-04	4.49e-04	3.50e-07
30.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.49e-04	4.49e-04	3.50e-07
60.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.49e-04	4.47e-04	3.50e-07
90.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.48e-04	4.46e-04	3.49e-07
180.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.47e-04	4.42e-04	3.49e-07
182.50	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.47e-04	4.42e-04	3.49e-07
365.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.44e-04	4.35e-04	3.48e-07
730.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.38e-04	4.20e-04	3.45e-07
1825.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.20e-04	3.78e-04	3.38e-07
3650.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.92e-04	3.18e-04	3.26e-07
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.41e-04	2.25e-04	3.05e-07
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.25e-04	7.94e-05	2.47e-07

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

PU 239 (T½=8.90e+06 d) (General model)

Acute Ingestion
F1: 1.000e-03
Adult subject.
ALI: 2.8e+04 Bq

Time (d)	LUNG	GUT	SI	ULI	LLI	BONE SUR	R MARROW	LIVER	TESTES	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	8.11e-16	1.19e-09	1.79e-09	1.68e-09	3.06e-10	1.19e-11	9.64e-13	3.24e-12	1.29e-13	2.99e-10
0.50	1.02e-15	1.20e-09	2.77e-09	7.10e-09	3.73e-09	1.49e-10	1.19e-11	4.03e-11	1.61e-12	9.00e-10
1.00	1.24e-15	1.20e-09	2.97e-09	1.32e-08	1.50e-08	6.39e-10	5.11e-11	1.73e-10	6.92e-12	1.99e-09
2.00	1.46e-15	1.20e-09	2.97e-09	1.70e-08	3.56e-08	1.92e-09	1.53e-10	5.19e-10	2.08e-11	3.53e-09
5.00	1.64e-15	1.20e-09	2.97e-09	1.78e-08	5.20e-08	5.91e-09	4.73e-10	1.60e-09	6.42e-11	4.80e-09
7.00	1.70e-15	1.20e-09	2.97e-09	1.78e-08	5.29e-08	8.58e-09	6.87e-10	2.33e-09	9.32e-11	5.01e-09
14.00	1.91e-15	1.20e-09	2.97e-09	1.78e-08	5.30e-08	1.79e-08	1.43e-09	4.86e-09	1.95e-10	5.57e-09
30.00	2.39e-15	1.20e-09	2.97e-09	1.78e-08	5.30e-08	3.92e-08	3.14e-09	1.06e-08	4.26e-10	6.84e-09
60.00	3.28e-15	1.20e-09	2.97e-09	1.78e-08	5.30e-08	7.93e-08	6.34e-09	2.15e-08	8.61e-10	9.22e-09
90.00	4.17e-15	1.20e-09	2.97e-09	1.78e-08	5.30e-08	1.19e-07	9.55e-09	3.23e-08	1.30e-09	1.16e-08
180.00	6.82e-15	1.20e-09	2.97e-09	1.78e-08	5.30e-08	2.39e-07	1.91e-08	6.45e-08	2.60e-09	1.87e-08
182.50	6.89e-15	1.20e-09	2.97e-09	1.78e-08	5.30e-08	2.42e-07	1.94e-08	6.54e-08	2.63e-09	1.89e-08
365.00	1.22e-14	1.20e-09	2.97e-09	1.78e-08	5.30e-08	4.84e-07	3.87e-08	1.30e-07	5.26e-09	3.32e-08
730.00	2.26e-14	1.20e-09	2.97e-09	1.78e-08	5.30e-08	9.62e-07	7.70e-08	2.55e-07	1.05e-08	6.13e-08
1825.00	5.18e-14	1.20e-09	2.97e-09	1.78e-08	5.30e-08	2.36e-06	1.88e-07	6.07e-07	2.60e-08	1.43e-07
3650.00	9.47e-14	1.20e-09	2.97e-09	1.78e-08	5.30e-08	4.54e-06	3.63e-07	1.12e-06	5.09e-08	2.68e-07
7300.00	1.63e-13	1.20e-09	2.97e-09	1.78e-08	5.30e-08	8.52e-06	6.82e-07	1.91e-06	9.85e-08	4.88e-07
18250.00	2.77e-13	1.20e-09	2.97e-09	1.78e-08	5.30e-08	1.76e-05	1.41e-06	3.14e-06	2.23e-07	9.57e-07

Retention Table. Results (Bq) are per Bq intake.

PU 239 (T¨=8.90e+06 d) (General model)

Acute Inhalation to class W material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 1.000e-04
Adult subject.
ALI: 2.4e+02 Bq
DAC: 9.9e-02 Bq/m3

Time (d)	LUNG	LYMPH	GUT	SI	ULI	LLI	BONE SUR	LIVER	TESTES
0.00	3.30e-01	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	2.66e-01	3.46e-05	1.92e-02	5.17e-02	2.86e-02	3.23e-03	1.27e-02	1.27e-02	9.84e-06
0.50	2.40e-01	8.60e-05	1.20e-02	5.62e-02	9.84e-02	3.42e-02	2.33e-02	2.33e-02	1.82e-05
1.00	2.11e-01	1.71e-04	5.71e-03	2.98e-02	1.20e-01	1.04e-01	2.96e-02	2.96e-02	2.30e-05
2.00	1.78e-01	3.37e-04	1.65e-03	8.14e-03	5.74e-02	1.34e-01	3.18e-02	3.18e-02	2.47e-05
5.00	1.44e-01	8.08e-04	1.74e-04	7.63e-04	4.06e-03	2.37e-02	3.26e-02	3.26e-02	2.53e-05
7.00	1.37e-01	1.10e-03	8.19e-05	3.43e-04	1.44e-03	6.37e-03	3.30e-02	3.30e-02	2.57e-05
14.00	1.24e-01	2.00e-03	4.80e-05	1.93e-04	6.49e-04	1.21e-03	3.45e-02	3.45e-02	2.68e-05
30.00	9.92e-02	3.43e-03	3.83e-05	1.53e-04	5.16e-04	9.41e-04	3.75e-02	3.75e-02	2.92e-05
60.00	6.55e-02	4.53e-03	2.53e-05	1.01e-04	3.40e-04	6.21e-04	4.21e-02	4.19e-02	3.27e-05
90.00	4.32e-02	4.48e-03	1.67e-05	6.68e-05	2.24e-04	4.10e-04	4.54e-02	4.52e-02	3.53e-05
180.00	1.24e-02	2.57e-03	4.79e-06	1.92e-05	6.45e-05	1.18e-04	5.07e-02	5.02e-02	3.95e-05
182.50	1.20e-02	2.52e-03	4.62e-06	1.85e-05	6.23e-05	1.14e-04	5.08e-02	5.03e-02	3.96e-05
365.00	9.55e-04	4.01e-04	3.57e-07	1.42e-06	3.44e-06	1.48e-05	5.30e-02	5.20e-02	4.15e-05
730.00	5.89e-06	5.04e-06	2.28e-09	9.15e-09	3.04e-08	5.92e-08	5.26e-02	5.06e-02	4.15e-05
1825.00	0.00e+00	7.12e-10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.05e-02	4.56e-02	4.06e-05
3650.00	0.00e+00	4.50e-10	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.71e-02	3.83e-02	3.92e-05
7300.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.10e-02	2.71e-02	3.66e-05
18250.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.70e-02	9.57e-03	2.97e-05

D(t) and H(t) Dose Table. Results (Sv) are per Bq intake.

PU 239 (T¨=8.90e+06 d) (General model)

Acute Inhalation to class W material.
AMAD: 1.00 lm (%NP: 30.0, %TB: 8.0, %P: 25.0)
F1: 1.000e-04
Adult subject.
ALI: 2.4e+02 Bq
DAC: 9.9e-02 Bq/m3

Time (d)	LUNG	GUT	SI	ULI	LLI	BONE SUR	R MARROW	LIVER	TESTES	H(t)
0.00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
0.20	8.14e-08	1.00e-10	9.54e-11	6.02e-11	8.29e-12	3.80e-09	3.04e-10	1.03e-09	4.13e-11	1.01e-08
0.50	1.91e-07	2.32e-10	4.10e-10	6.98e-10	2.68e-10	2.05e-08	1.64e-09	5.55e-09	2.22e-10	2.44e-08
1.00	3.54e-07	3.53e-10	7.89e-10	2.58e-09	2.15e-09	6.09e-08	4.87e-09	1.65e-08	6.58e-10	4.67e-08
2.00	6.34e-07	4.45e-10	1.08e-09	5.44e-09	9.13e-09	1.53e-07	1.23e-08	4.15e-08	1.66e-09	8.67e-08
5.00	1.32e-06	4.94e-10	1.23e-09	7.23e-09	2.04e-08	4.40e-07	3.52e-08	1.19e-07	4.76e-09	1.87e-07
7.00	1.73e-06	4.99e-10	1.25e-09	7.39e-09	2.18e-08	6.36e-07	5.08e-08	1.72e-07	6.87e-09	2.49e-07
14.00	3.07e-06	5.11e-10	1.27e-09	7.58e-09	2.26e-08	1.34e-06	1.07e-07	3.62e-07	1.45e-08	4.52e-07
30.00	5.71e-06	5.31e-10	1.32e-09	7.87e-09	2.35e-08	3.06e-06	2.45e-07	8.29e-07	3.31e-08	8.74e-07
60.00	9.41e-06	5.57e-10	1.39e-09	8.29e-09	2.47e-08	6.59e-06	5.27e-07	1.79e-06	7.16e-08	1.53e-06
90.00	1.19e-05	5.77e-10	1.44e-09	8.54e-09	2.55e-08	1.05e-05	8.41e-07	2.84e-06	1.14e-07	2.07e-06
180.00	1.56e-05	6.00e-10	1.50e-09	8.93e-09	2.66e-08	2.35e-05	1.88e-06	6.33e-06	2.55e-07	3.28e-06
182.50	1.57e-05	6.00e-10	1.50e-09	8.93e-09	2.67e-08	2.38e-05	1.91e-06	6.43e-06	2.59e-07	3.32e-06
365.00	1.72e-05	6.09e-10	1.52e-09	9.06e-09	2.70e-08	5.23e-05	4.18e-06	1.40e-05	5.67e-07	5.18e-06
730.00	1.73e-05	6.12e-10	1.52e-09	9.06e-09	2.71e-08	1.10e-04	8.76e-06	2.91e-05	1.20e-06	8.56e-06
1825.00	1.73e-05	6.13e-10	1.52e-09	9.06e-09	2.71e-08	2.77e-04	2.22e-05	7.15e-05	3.06e-06	1.83e-05
3650.00	1.73e-05	6.14e-10	1.52e-09	9.06e-09	2.71e-08	5.41e-04	4.32e-05	1.33e-04	6.09e-06	3.34e-05
7300.00	1.73e-05	6.16e-10	1.53e-09	9.06e-09	2.71e-08	1.02e-03	8.15e-05	2.28e-04	1.18e-05	5.98e-05
18250.00	1.73e-05	6.20e-10	1.53e-09	9.07e-09	2.71e-08	2.11e-03	1.69e-04	3.77e-04	2.67e-05	1.16e-04