DERIVED REFERENCE LEVELS FOR PRENATAL EXPOSURE IN A RADIOLOGICAL EMERGENCY

C. Nuccetelli, S. Risica, A. Rogani,

Istituto Superiore di Sanità (National Institute of Health),
Physics Laboratory, Viale Regina Elena 299, Rome, Italy

INTRODUCTION

After the Chernobyl accident many countries renewed their radiological emergency plans, also considering the possibility of overboundary accidents. This has been set out by the 96/29/Euratom Directive (Council Directive, 1996), which states that "Each Member State shall ensure that account is taken of the fact that radiological emergencies may occur in connection with practices on or outside its territory and affect it". Moreover, after September 11, 2001, the need to prepare emergency plans for possible terroristic attacks became evident and these plans are now being worked out in many countries for intervention in case of biological, chemical and/or radiological risk. In the event of radiological emergency, all decisions to be taken are based on possible doses to *critical groups* (European Commission, 1997), which are the population groups most at risk. These critical groups are, in most cases, infants or children, given that dose coefficients for these age groups are generally higher than for adults. However, a new ICRP Recommendation (ICRP, 2001) has recently been published that gives dose coefficients for embryo/foetus due to intake by the mother, by inhalation or ingestion, of 31 radionuclides. Also as a result of the revaluation in the last years of the possible health effects of prenatal exposure to ionising radiation (see e.g. the review in P. Fattibene et al., 1999), the consequences for the embryo/foetus of a possible radiological emergency connected to a nuclear plant and to possible dispersion of Depleted Uranium (DU) in the environment are analysed and discussed in this paper. For the former type of accident, Derived Intervention Levels (DILs) are calculated for prenatal exposure due to acute inhalation by the mother (female member of the public) and an assessment is performed of ingestion doses for the offspring resulting from consumption of foodstuffs by the mother of which 10% of the annual consumption is contaminated at the maximum levels permitted by the Council Regulation (Council Regulation, 1987). For Depleted Uranium, DILs are calculated for acute inhalation and chronic ingestion by the mother of contaminated drinking water.

DOSES TO THE EMBRYO/FOETUS

Up to the end of 2001, ICRP assessments of prenatal dose coefficients as a consequence of radionuclide intake by the mother were not available. However, the US Nuclear Regulatory Commission had already published a report (M.R. Sikov and T. H. Hui 1996) assessing equivalent dose coefficients to the embryo/foetus due to inhalation and ingestion by the mother of 30 radioisotopes of occupational, medical and environmental significance in the nineties. The dose coefficients refer to different pregnancy stages, due both to internal chronic intake at different pregnancy stages and pre-existing body burden (M.R. Sikov and T. H. Hui 1996). Using this report, the intake of radionuclides by pregnant women as a consequence of both environmental contamination and diagnostic administration of radiopharmaceuticals was analysed in a previous paper (S.Risica et al., 2002). In particular, the activities of main radionuclides typical of nuclear fallout and depleted uranium giving a 1-mSv equivalent dose to the embryo/foetus were calculated.

The recent ICRP Recommendation 88 (ICRP, 2001) gives dose coefficients for the offspring following intake by the mother (members of the public as well as workers) of 31 elements for which age-dependent biokinetic models had been provided in previous ICRP reports. Dose coefficients are given for acute and chronic intake, either by inhalation or ingestion. A range of acute intake times by the mother - or possible mother - was adopted both before and during pregnancy, whereas for continuous exposure a constant intake was assumed for three different periods during pregnancy or before conception.

For each radionuclide, dose coefficients are given for the effective dose to the offspring up to birth ($e_{\text{in utero}}$), the committed effective dose from birth to age 70 ($e_{\text{postnatal}}$) resulting from activity present at birth, and the total committed effective dose to age 70 ($e_{\text{offspring}}$), the last being the sum of the other two ($e_{\text{offspring}} = e_{\text{in utero}} + e_{\text{postnatal}}$).

Since organ weighting factors are not available for the embryo/foetus, the ICRP used factors for adults in its calculations (ICRP, 1991).

PRENATAL EXPOSURE IN CASE OF A RADIOLOGICAL EMERGENCY CONNECTED TO A NUCLEAR PLANT

In the early phase of an accident, the exposure of a member of the public may be external (from the plume and ground deposition of radioactive material) or internal, through inhalation of contaminated air.

In the following, for the early phase, only the inhalation of radioactive material is considered because prenatal dose coefficients are available only for this type of exposure.

Inhalation in the early phase

In table 1, the total committed effective dose coefficients for offspring up to age 70 ($e_{\text{offspring}}$) due to acute inhalation by the mother at conception and at different stages of pregnancy are shown for the most significant artificial radionuclides in case of a radioactive release. Prenatal exposure due to inhalation before conception was not considered due to the lower dose coefficients. Type F (fast) lung absorption was chosen because it corresponds to the most conservative value of effective dose for the offspring. The same table also shows dose coefficients for adults (ICRP, 1996). It can be noted that at some pregnancy stages dose coefficients for offspring are higher than those for adults for Sr-90, Te-131 and I-131.

In case of radiological emergency, Italian legislation (Decreto, 2000) sets the dose intervention levels to be used for adoption of protective measures. These dose intervention levels recommended by a European technical guide (European Commission, 1997), are reported in table 2.

The DILs for different exposure pathways and different age groups have been assessed and are now under revision, on the basis of the new stated intervention levels, within the CEVaD

(Centre for Elaboration and Evaluation of Data), a technical structure working as a support for the Department for Civil Protection in case of radiological emergency.

Table 1. Effective dose coefficients (Sv/Bq) for offspring due to acute inhalation by the mother at different stages of pregnancy and, for comparison, for adults

Radio-nuclide	lung abs type	effective dose coefficient (Sv/Bq)						
	.	at conception	week 5	week 10	week 15	week 25	week 35	adults
Sr-90	F	$2.3\cdot10^{-9}$	$3.5\cdot10^{-9}$	$1.6\cdot10^{-8}$	$2.5\cdot10^{-8}$	$3.1\cdot10^{-8}$	$3.5\cdot10^{-8}$	$2.4\cdot10^{-8}$
Ru-103	F	$4.3\cdot10^{-10}$	$3.7\cdot10^{-10}$	$2.7\cdot10^{-10}$	$2.6\cdot10^{-10}$	$2.2\cdot10^{-10}$	$1.5\cdot10^{-10}$	$4.8\cdot10^{-10}$
Ru-106	F	$3.1\cdot10^{-9}$	$2.2\cdot10^{-9}$	$1.2\cdot10^{-9}$	$1.2\cdot10^{-8}$	$1.1\cdot10^{-9}$	$1.3\cdot10^{-9}$	$7.9\cdot10^{-9}$
Te-132	F	$3.6\cdot10^{-10}$	$3.4\cdot10^{-10}$	$3.7\cdot10^{-10}$	$1.5\cdot10^{-9}$	$3.6\cdot10^{-9}$	$5.9\cdot10^{-9}$	$1.8\cdot10^{-9}$
I-131	F	$2.6\cdot10^{-11}$	$2.7\cdot10^{-11}$	$7.1\cdot10^{-11}$	$4.2\cdot10^{-9}$	$1.2\cdot10^{-8}$	$2.1\cdot10^{-8}$	$7.4\cdot10^{-9}$
Cs-134	F	$3.9\cdot10^{-9}$	$3.7\cdot10^{-9}$	$3.5\cdot10^{-9}$	$3.5\cdot10^{-9}$	$3.0\cdot10^{-9}$	$1.6\cdot10^{-9}$	$6.6\cdot10^{-9}$
Cs-137	F	$2.5\cdot10^{-9}$	$2.4\cdot10^{-9}$	$2.3\cdot10^{-9}$	$2.3\cdot10^{-9}$	$1.9\cdot10^{-9}$	$1.1\cdot10^{-9}$	$4.6\cdot10^{-9}$
Pu-239	F	$1.7\cdot10^{-6}$	$1.7\cdot10^{-6}$	$1.6\cdot10^{-6}$	$2.0\cdot10^{-6}$	$4.3\cdot10^{-6}$	$1.2\cdot10^{-5}$	$1.2\cdot10^{-4}$
Am-241	F	$1.4\cdot10^{-6}$	$1.3\cdot10^{-6}$	$1.3\cdot10^{-6}$	$1.4\cdot10^{-6}$	$1.3\cdot10^{-6}$	$1.2\cdot10^{-6}$	$9.6\cdot10^{-5}$

Table 2. Recommended European intervention levels, in terms of avertable dose, implemented in the Italian legislation

Protective measure	range of optimised intervention levels (mSv)
sheltering	a few to a few tens (effective dose)
evacuation	a few tens to a few hundreds (effective dose)
iodine prophylaxis	some tens to a few hundreds (equivalent dose)

It should be mentioned that DILs are relevant to only one radionuclide and one exposure pathway, whereas dose intervention levels are defined for each protective action, and should take into account not only all exposure pathways relevant to that protective action but also all radionuclides released. Therefore, particular care should be taken in applying DILs to situations in which exposure could originate from different pathways and from more than one radionuclide. For this reason, and also considering the higher radiosensitivity of the embryo/foetus with respect to the adult (ICRP, 1991), DILs for the offspring were calculated for an intervention level of effective dose for sheltering equal to 1 mSv, due to acute inhalation by the mother at some pregnancy stages. The DILs are expressed as time integrals of radionuclide concentration in air (see table 3) and the calculations were carried out using the dose coefficients for radionuclides considered in table 1.

Table 4 reports the most restrictive value of DILs for each radionuclide, together with the corresponding stages of pregnancy. It also reports the DILs for pregnant women and for 10-year old children. The comparison is made with children in this age group because they receive a higher inhalation dose than infants, due to the combination of their dose coefficients

Table 3. Derived intervention levels (Bq s m^{-3}) corresponding to a 1-mSv effective dose for the offspring due to acute inhalation by the mother at some stages of pregnancy

Radionuclide	lung abs. type	derived intervention level (Bq s m^{-3})			
		at conception	week 10	week 25	week 35
Sr-90	F	$2.1 \cdot 10^{9}$	$3.1 \cdot 10^{8}$	$1.6 \cdot 10^{8}$	$1.4 \cdot 10^{8}$
Ru-103	F	$1.1 \cdot 10^{10}$	$1.8 \cdot 10^{10}$	$2.2 \cdot 10^{10}$	$3.3 \cdot 10^{10}$
Ru-106	F	$1.6 \cdot 10^{9}$	$4.1 \cdot 10^{9}$	$4.4 \cdot 10^{9}$	$3.8 \cdot 10^{9}$
Te-132	F	$1.4 \cdot 10^{10}$	$1.3 \cdot 10^{10}$	$1.4 \cdot 10^{9}$	$8.3 \cdot 10^{8}$
I-131	F	$1.9 \cdot 10^{11}$	$6.9 \cdot 10^{10}$	$4.1 \cdot 10^{8}$	$2.3 \cdot 10^{8}$
Cs-134	F	$1.3 \cdot 10^{9}$	$1.4 \cdot 10^{9}$	$1.6 \cdot 10^{9}$	$3.1 \cdot 10^{9}$
Cs-137	F	$2.0 \cdot 10^{9}$	$2.1 \cdot 10^{9}$	$2.6 \cdot 10^{9}$	$4.4 \cdot 10^{9}$
Pu-239	F	$2.9 \cdot 10^{6}$	$3.1 \cdot 10^{6}$	$1.1 \cdot 10^{6}$	$4.1 \cdot 10^{5}$
Am-241	F	$3.5 \cdot 10^{6}$	$3.8 \cdot 10^{6}$	$3.8 \cdot 10^{6}$	$4.1 \cdot 10^{6}$

(higher than those for adults, but lower than those for infants) and their pulmonary ventilation rate which is higher than that of infants. For pregnant women and prenatal exposure, calculations were made using the mean ventilation rate for pregnant women members of the public (ICRP, 2001).

Looking at the table, the lower critical values for prenatal exposure to radionuclides with higher dose coefficients (Sr-90, Te-132 and I-131) can be noted.

Table 4. Most restrictive value of DILs (Bq s m^{-3}) corresponding to a 1-mSv effective dose from acute inhalation for the offspring, pregnant women and children.

Radionuclides	lung abs. type	DIL for offspring (Bq s m^{-3})	critical stage of pregnancy	DIL for pregnant women (Bq s m^{-3})	DIL for 10-y old children (Bq s m^{-3})
Sr-90	F	$1.4{\cdot}10^{8}$	week 35	$2.0{\cdot}10^{8}$	$1.4{\cdot}10^{8}$
Ru-103	F	$1.1{\cdot}10^{10}$	at conception	$1.0{\cdot}10^{10}$	$6.1{\cdot}10^{9}$
Ru-106	F	$1.6{\cdot}10^{9}$	at conception	$6.2{\cdot}10^{8}$	$3.5{\cdot}10^{8}$
Te-132	F	$8.3{\cdot}10^{8}$	week 35	$2.8{\cdot}10^{9}$	$1.3{\cdot}10^{9}$
I-131	F	$2.3{\cdot}10^{8}$	week 35	$6.6{\cdot}10^{8}$	$3.0{\cdot}10^{8}$
Cs-134	F	$1.3{\cdot}10^{9}$	at conception	$7.4{\cdot}10^{8}$	$1.1{\cdot}10^{9}$
Cs-137	F	$2.0{\cdot}10^{9}$	at conception	$1.1{\cdot}10^{9}$	$1.5{\cdot}10^{9}$
Pu-239	F	$4.1{\cdot}10^{5}$	week 35	$3.9{\cdot}10^{4}$	$4.7{\cdot}10^{4}$
Am-241	F	$3.5{\cdot}10^{6}$	at conception	$1.4{\cdot}10^{5}$	$5.6{\cdot}10^{4}$

Chronic ingestion

The European Commission has not stated dose intervention levels in case of ingestion of contaminated food, but in 1987 it promulgated a Council Regulation (Euratom) 3954/87 which states "... maximum permitted levels of radioactive contamination of foodstuffs … following a nuclear accident or any other case of radiological emergency" (Council Regulation, 1987). These levels are shown in table 5.

Table 5. Maximum permitted levels of radionuclide concentration in foodstuffs stated in the Council Regulation N. 3954/87 (Council Regulation, 1987)

Radionuclide group	activity concentration (Bq/kg)			
	baby food	dairy products	other foodstuffs	liquid food
Isotopes of Sr, notably Sr-90	75	125	750	125
Isotopes of I, notably I-131	150	500	2000	500
Alpha emitting isotopes of Pu and trans-plut. elements, notably Pu-239 and Am-241	1	20	80	20
All other nuclides with half-life greater than 10 days, notably Cs-134 and Cs-137	400	1000	1250	1000

Using these levels, the EU Commission assessed ingestion doses for a full year for infants and adults due to consumption of foodstuffs of which 10% of the annual consumption was contaminated at the maximum levels permitted by the Council Regulation (Council Regulation, 1987), taking as representative for each group the radionuclide with the highest dose coefficient. Annual doses turned out to be about 2 mSv and 5 mSv, respectively.

Using the same hypotheses, the effective doses to the offspring due to chronic ingestion by the mother of contaminated foodstuffs during pregnancy (38 weeks) were calculated. The calculations were carried out with the effective dose coefficients for offspring due to chronic intake (see table 6).

For the dose calculation, the mean Italian diet for adults, based on national statistical surveys, was assumed, and a two-thirds reduction in cereal consumption applied, as it has been referred in a previous paper (S. Risica et al., 1992). Results of the calculation are given in table 6.

It can be noted that the total effective dose to offspring is up to 3.5 mSv, notwithstanding the fact that the contribution of only four radionuclides is considered. Therefore, the possibility of introducing limitations on the consumption of some foods in the diet of pregnant women, if contaminated at the maximum levels permitted by the Council Regulation, should be considered in emergency planning. This decision should obviously take the actual emergency situation into account.

Table 6. Effective dose coefficients (Sv/Bq) for offspring due to chronic ingestion by the mother of radionuclides during pregnancy, and effective dose due to chronic ingestion by the mother

Radionuclide	dose coefficients for offspring (Sv/Bq)	effective dose to offspring (mSv) from		
		dairy products	foodstuffs	liquid food
Sr-90	$4.3\ 10^{-8}$	0.04	0.8	0.2
I-131	$2.3\ 10^{-8}$	0.08	1.2	0.5
Cs-134	$8.7\ 10^{-9}$	0.06	0.3	0.3
Cs-137	$5.7\ 10^{-9}$	--	--	--
Pu-239	$9.5\ 10^{-9}$	0.001	0.02	0.01
Am-241	$2.7\ 10^{-9}$	--	--	--
	total	≈ 0.2	≈ 2.3	≈ 1.0

PRENATAL EXPOSURE IN CASE OF A RADIOLOGICAL EMERGENCY DUE TO DISPERSION OF DEPLETED URANIUM

Acute inhalation

The same calculations carried out for inhalation of radionuclides released in case of a radiological emergency connected to a nuclear plant were performed for depleted uranium (DU) (see table 7). Dose coefficients obtained by means of the total committed effective dose coefficients for the offspring for different uranium isotopes (ICRP, 2001) and their well known activity fraction in DU (UNEP, 2000, S.Risica et al., 2002) are reported in the same table. For comparison, the corresponding values for adults are reported. As in the previous calculations, the mean ventilation rate of pregnant women (ICRP, 2001) was used. Possible traces of Pu and other artificial nuclides were not taken into account.

It can be noted that offspring are not exposed to a higher dose than pregnant women, but it must be remembered that equality of dose does not mean equality of risk (ICRP, 1991).

Table 7. Effective dose coefficients (Sv/Bq) for the offspring at different stages of pregnancy and for pregnant women, due to acute inhalation (lung absorption type F) and DILs for DU (Bq s m^{-3} and mg s m^{-3}) corresponding to 1-mSv effective dose.

	Depleted uranium		
Period of intake	dose coefficient (Sv/Bq)	DIL	
		Bq s m^{-3}	mg s m^{-3}
at conception	$1.5\ 10^{-7}$	$3.2\ 10^{7}$	$2.1\ 10^{6}$
week 5	$1.7\ 10^{-7}$	$2.8\ 10^{7}$	$1.9\ 10^{6}$
week 10	$1.9\ 10^{-7}$	$2.5\ 10^{7}$	$1.7\ 10^{6}$
week 15	$1.8\ 10^{-7}$	$2.7\ 10^{7}$	$1.8\ 10^{6}$
week 25	$1.5\ 10^{-7}$	$3.2\ 10^{7}$	$2.1\ 10^{6}$
week 35	$1.4\ 10^{-7}$	$3.4\ 10^{7}$	$2.3\ 10^{6}$
adults	$5.1\ 10^{-7}$		
pregnant women	$5.1\ 10^{-7}$	$9.6\ 10^{6}$	$6.4\ 10^{5}$

Chronic ingestion

As regards possible ingestion of DU with the diet, it seemed interesting to consider possible chronic ingestion from contaminated drinking water, which could be a source of exposure for the offspring. DILs for drinking water consumption (corresponding to a 1-mSv effective dose) were calculated with offspring dose coefficients for DU – obtained as explained previously - for the different time periods of chronic exposure considered in ICRP Recommendation 88 (see table 8). A drinking water consumption of 2 l d^{-1} was considered as it is the hypothesis used by the WHO (WHO, 1998) in its calculation and by the EU for its assessments (see Council Directive 1998, S. Risica and S. Grande, 2000). Results are given in table 8.

Table 8. Effective dose coefficients (Sv/Bq) for offspring due to chronic ingestion by the mother and DILs for DU, corresponding to a 1-mSv effective dose.

Period of intake	Depleted uranium		
	dose coefficient (Sv/Bq)	DIL for drinking water	
		Bq/l	mg/l
5 y before conception	$8.6\ 10^{-10}$	$3.2\ 10^{2}$	21
1 y before conception	$1.1\ 10^{-9}$	$1.2\ 10^{3}$	82
during pregnancy	$1.3\ 10^{-8}$	$1.4\ 10^{2}$	9.5

These DILs in terms of Bq seem to be quite low and, then again, no certain information is currently available on possible contamination of drinking water in, for example, the territories of the countries bombed with DU. However, some preliminary findings seem to indicate that the metal may now be present in drinking water and/or the food chain (N.D. Priest and M.Thirwall, 2001). In any case, it should be remembered that uranium's chemical toxicity is higher than its radioactive toxicity. Therefore, if this type of contamination were present in drinking water, the chemical toxicity for the mother, and probably for the embryo/foetus, should be considered first (see appendix 1).

CONCLUSION

As regards possible prenatal exposure in the event of release of radionuclides as a result of a radiological emergency in a nuclear plant, no particular attention seems to be necessary in stating Derived Intervention Levels specific for the offspring in the early phase. Indeed, even if the DILs for Sr-90, I-131 and Te-132 are critical for offspring, dose intervention level being equal, differences with respect to 10-year old children are not so significant as to justify particular choices.

A different approach seems to be required for chronic ingestion of radionuclides due to the same type of accident. Indeed, it has been shown that the effective doses to offspring due to chronic ingestion by pregnant women of foodstuffs of which 10% of the annual consumption are contaminated at the maximum levels permitted by the Council Regulation N.3954/87 (Council Regulation, 1987) can be significantly higher than 1 mSv. Therefore, in emergency planning, the introduction of specific limitations in consumption of some foodstuffs – if contaminated at the maximum permitted levels - in the diet of pregnant women should be considered.

As regards possible dispersion of DU in the environment, DU inhalation seems to expose mothers to higher doses than their offspring, whereas possible chronic ingestion of DU with drinking water seems to be worthy of attention. For this reason, long-term monitoring should be carried out in contaminated territories and possible health consequences for local populations investigated.

APPENDIX 1

THE WHO APPROACH TO CHEMICAL TOXICITY OF URANIUM

A few years ago, WHO set a provisional guideline value for uranium in drinking water of 2 μg/l (WHO, 1998), obtained by means of the Tolerable Daily Intake (TDI) of 0.6 μg/kg of body weight, assuming a 60-kg adult consuming 2 litres of drinking water per day and a 10% allocation of the TDI to drinking water. The 10% allocation is justified by the fact that the greatest part of the daily intake of uranium was shown to come from food. The TDI was derived using the LOAEL (lowest-observed-adverse-effect level) of 60 μg/kg of body weight per day and an uncertainty factor of 100 (for intra-and interspecies variation).

It is worth noting that TDI "…is an estimate of the amount of a substance in food or drinking water, expressed on a body weight basis (mg/kg or μg/kg of body weight) that can be ingested daily over a lifetime without appreciable health risk […]. TDIs […] are not so precise that they cannot be exceeded for short periods of time. Short-term exposure to levels exceeding the TDI is not a cause for concern, provided the individual's intake averaged over longer periods of time does not appreciably exceed the level set […]. However, consideration should be given to any potential acute toxic effects that may occur if the TDI is substantially exceeded for short periods of time" (WHO, 1998).

ACKNOWLEDGEMENTS

The authors are very grateful to Mr. M. Sabatini for his skilful technical support.

REFERENCES

Council Directive 96/29/Euratom of 13 May 1996, laying down basic safety standards for the protection of health of workers and the general public against the danger arising from ionizing radiation, Official Journal of the European Communities L 159, 29.6.1996.

Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption. Official Journal of the European Communities L 330/32, 5.12.98.

Council Regulation (Euratom) No 3954/87 of 22/12/1987 laying down maximum permitted levels of radioactive contamination of foodstuffs and feedingstuffs following a nuclear accident or any other case of radiological emergency. Official Journal of the European Communities, L. 146, 30.12.1987.

Decreto legislativo 26 maggio 2000 n°241. Attuazione della direttiva 96/29/EURATOM in materia di protezione sanitaria della popolazione e dei lavoratori contro i rischi derivanti delle radiazioni ionizzanti. Supplemento ordinario alla Gazzetta Ufficiale della Repubblica Italiana N° 203 (31/08/00) Roma: Istituto Poligrafico e Zecca dello Stato, 2000.

European Commission. Radiation Protection 87. Radiation protection principles for urgent countermeasures to protect the public in the event of accidental releases of radioactive material. Luxembourg, 1997.

Fattibene P., F. Mazzei, C. Nuccetelli and S. Risica. Prenatal exposure to ionising radiation: sources, effects and regulatory aspects. Acta Paediatr. 88: 693-702, 1999.

ICRP Publication 60. 1990 Recommendations of the International Commission on Radiological Protection. Ann. ICRP 21 (1-3), 1991.

ICRP Publication 72. Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 5 Compilation of Ingestion and Inhalation Dose Coefficients. Ann. ICRP 26 (1), 1996.

ICRP Publication 88. Doses to Embryo and Fetus from Intakes of Radionuclides by the Mother. Ann. ICRP 31 (1-3), 2001.

Priest N.D. and M. Thirwall. Early results of studies on the levels of depleted uranium excreted by Balkan residents. Archive of Oncology 9 (4): 237 - 240, 2001.

Risica S. and S. Grande. Council Directive 98/83/EC on the quality of water intended for human consumption: calculation of derived activity concentrations. Rapporto ISTISAN 00/16 (2000), p.47, also available on the website http://www.iss.it, in PDF format.

Risica S. and C. Nuccetelli. Prenatal exposure due to ingestion of natural radionuclides, in press in: Proceedings of the Seventh International Symposium Natural Radiation Environment (NRE VII), 20-24 May 2002, Rhodes, Greece.

Risica S., G. Campos Venuti, A. Rogani, D. Baronciani, M. Petrone (1992). Caesium Contamination in Human Milk and Transfer Factor from Diet. Analyst, 117: 511-514, 1992.

Risica S., P. Fattibene, F. Mazzei, C. Nuccetelli, A. Rogani. Radionuclides in pregnancy and breast-feeding, presented at the X Hungarian-Italian Symposium on Spectrochemistry: Trace Substances in the Biosphere, in press on Microchemical Journal, 2002.

Sikov M. R. and T. H. Hui. Contribution of Maternal Radionuclide Burdens to Prenatal Radiation Doses. NUREG/CR-5631 PNL-7445 Rev. 2 Washington 1996.

UNEP. Depleted Uranium in Kosovo. Post-conflict Environmental Assessment. UNEP Scientific Mission to Kosovo, 5-19 November 2000.

WHO. Guidelines for drinking-water quality, second edition, World Health Organisation Geneva, 1998. Volume 2 and Addendum to volume 2.