RADIATION PROTECTION

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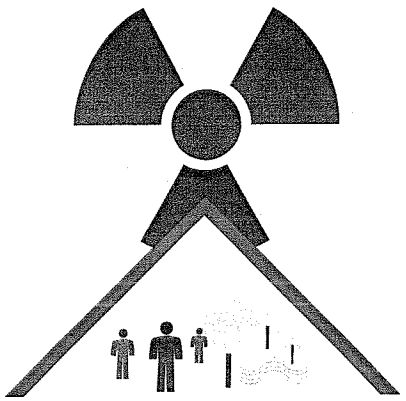

EU Food Restriction Criteria
for Application after an Accident

EUROPEAN
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Directorate-General
Environment, Nuclear Safety
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FOREWORD

Maximum permitted levels of contamination of foodstuffs have been laid down in Council Regulation 87/3954/EURATOM for application in the event of a future accident or radiological emergency. Provision has been made within the Regulation for possible amendment of the levels by the Commission, taking into account the actual circumstances of the accident, within one month of its occurrence.

The Regulation was established following the Chernobyl accident, essentially with a view to responding to accidents of a similar magnitude. It is desirable, however, that guidance is available with application to a wider range of circumstances.

It was therefore appropriate to review the rationale which underlied the Regulation, to examine it in the light of new information and to examine a possible wider application.

The document considers only the radiological protection aspects of setting criteria for the withholding of foodstuffs from the market. Broader areas of agricultural countermeasures and socio-economic factors are allowed for but are not explicitly addressed. Restrictions on feedingstuffs are within the scope of the Regulation but are not addressed in the present guidance in view of the fact that a possible need to revise the maximum permitted levels in feedingstuffs would not be as urgent as for foodstuffs.

The present document contains guidance on which factors need to be considered in the event of a radiological emergency to help the Commission and the Article 31 Group of Experts decide whether the Regulation should be amended in the light of the specific features of the actual emergency. The document was prepared by the Article 31 Group of Experts and adopted at their meeting on 27 November 1998. It is published with a view of the use of this guidance by any similar Group of Experts which may be confronted with such an emergency in the future. The Commission does not propose to revise the Regulation at this stage.

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Summary

This report reviews the food and radionuclide categories specified in Council Regulation 87/3954/EURATOM for application in the event of a future accident or radiological emergency. Guidance is provided by the Article 31 Group of Experts for consideration in the period of one month following the entry into force of the Regulation, in particular with regard to radionuclides in the category half-life greater than 10 days', which is split in two groups as a function of the ingestion dose coefficients.

This guidance is meant for consideration by the Commission and by future Article 31 Experts in the event of a radiological emergency. It is not proposed to revise the Council Regulation at this stage.

EU Food Restriction Criteria for Application after an Accident

1. Introduction

Maximum permitted levels of contamination of foodstuffs have been laid down in Council Regulation 87/3954/EURATOM[1] (as amended by 89/2218/EURATOM[2] and supplemented by Commission Regulation 89/944/EURATOM[3]) for application in the event of a future accident or radiological emergency (hereafter termed 'the Regulation'). Provision has been made within the Regulation for possible amendment of the levels, taking into account the actual circumstances of the accident, within one month of its occurrence. The adoption of such a revision by Council depends upon a qualified majority agreement by Member States.

The Regulation was established following the Chernobyl accident, essentially with a view to responding to accidents of a similar magnitude. It is desirable, however, that guidance is available with application to a wider range of circumstances. Meanwhile, other international bodies have introduced guidance on the control of foodstuffs, in particular the Codex Alimentarius Commission of the WHO, IAEA (endorsing the CAC levels) and ICRP[4]. In addition, updated dose coefficients have been proposed by ICRP[5] and have been included in the latest Basic Safety Standards Directive[6]. It is therefore appropriate to review the Regulation in the light of this new information and proposed wider application. The aim of such a review is to provide better guidance to the Commission and to Member States in the event of any future nuclear accident.

The primary objectives of this paper are to review the food and radionuclide categories specified in the current Regulation and to suggest options for extending their application to a wider range of circumstances. The limiting activity concentrations specified in the Regulation, in terms of four categories of radionuclide and five categories of food, are shown in Table 1.

Table 1: Current Council Regulation

Radionuclide	Maximum permitted levels ($Bq\ kg^{-1}$)				
	Baby foods	Dairy produce	Minor foods	Other foods	Liquid foods
Isotopes of strontium, notably ^{90}Sr	75	125	7,500	750	125
Isotopes of iodine, notably ^{131}I	150	500	20,000	2,000	500
Alpha-emitting isotopes of plutonium and transplutonium elements	1	20	800	80	20
All other radionuclides of half-life greater than 10 days, notably ^{134}Cs and ^{137}Cs*	400	1,000	12,500	1,250	1,000

* ^{14}C and ^{3}H excluded

In particular, the paper will consider the following: options for extending and/or re-defining the radionuclide categories; the continuing appropriateness of the food categories and their consequent dose implications; the latest recommendations of the ICRP and other relevant international guidance. The paper considers only the radiological protection aspects of setting criteria for the withholding of foodstuffs from the market. Broader areas of agricultural countermeasures and socio-economic factors are allowed for but are not explicitly addressed. Restrictions on feedingstuffs are within the scope of the Regulation but are not addressed in the present guidance in view of the fact that a possible need to revise the maximum permitted levels is not as urgent as it would be for foodstuffs. Furthermore, consideration is limited to the protection of individuals after an accident or radiological emergency affecting a significant fraction of the population, i.e. the primary scope of the Regulation is not under review. It does not apply in normal situations and thus the maximum permitted levels should not be applied to foods containing radionuclides released to the environment under authorisation. In line with the scope of the Regulation the present guidance does not address the regulatory control of discharges or of levels of natural radioactivity in the environment.

2. Scope of Application of the Regulation.

The main purpose of the recommendations made in the document is to ensure that in the case of an accident or radiological emergency, the Article 31 Group of Experts can provide appropriate guidance to the Commission at very short notice, with the objective of limiting individual doses. While the experts will take into account the actual characteristics of the emergency situation, it is intended that this document will provide useful general information and indicate possible circumstances where scientific judgement will be required.

A possible forthcoming revision of the Regulation has not been a factor in the preparation of the document. It is noted that such a revision is foreseen under Article 5 of the Regulation, but it is judged that there is at present no immediate need for this. On the same grounds it was judged appropriate to develop the guidance starting from the existing set of maximum permitted levels and using the same rationale as that on which those levels were originally based.

The document also examines in which circumstances it may be appropriate to introduce all or part of the guidance proposed by other international bodies.

3. Radionuclide Categories

Three of the four radionuclide categories specified in the Regulation are clearly defined as isotopes of iodine, isotopes of strontium, and as alpha-emitting isotopes of plutonium and transplutonium elements. The fourth category is more broadly defined as 'all other radionuclides of half-life greater than 10 days'. For ease of reference this category will be called Category 4.

The definition of Category 4 encompasses a large number and wide range of radionuclides. Some of these radionuclides (e.g. sulphur-35 and technetium-99) have much lower dose coefficients than others (e.g. radioisotopes of caesium and ruthenium). The activity concentration limits specified in the Regulation for this category reflect the likely need, following a severe reactor accident, to restrict individual doses arising from contamination of foods with isotopes of caesium and ruthenium. The implied incorporation of radionuclides with much lower radiotoxicity within this category means that, in terms of dose, the limits specified are significantly more restrictive for some radionuclides than for others (e.g. by a factor of 10 or more). This is illustrated in Table 2, where ingestion dose coefficients for some radionuclides that are likely to be of importance in nuclear accidents or emergencies are listed. Ingestion dose coefficients are taken from the latest BSS Directive[5].

Table 2: BSS Ingestion dose coefficients (Sv Bq^{-1})

Nuclide	Physical half-life	≤ 1 y	1-2 y	2-7 y	7-12 y	12-17 y	Adult
HTO*	12.3 y	6.4E-11	4.8E-11	3.1E-11	2.3E-11	1.8E-11	1.8E-11
OBT**	12.3 y	1.2E-10	1.2E-10	7.3E-11	5.7E-11	4.2E-11	4.2E-11
C-14	5.73E+03 y	1.4E-09	1.6E-09	9.9E-10	8.0E-10	5.7E-10	5.8E-10
P-32	14.3 d	3.1E-08	1.9E-08	9.4E-09	5.3E-09	3.1E-09	2.4E-09
S-35 (inorg)	87.4 d	1.3E-09	8.7E-10	4.4E-10	2.7E-10	1.6E-10	1.3E-10
S-35 (organic)	87.4 d	7.7E-09	5.4E-09	2.7E-09	1.6E-09	9.5E-10	7.7E-10
Ca-45	163 d	1.1E-08	4.9E-09	2.6E-09	1.8E-09	1.3E-09	7.1E-10
Fe-55	2.7 y	7.6E-09	2.4E-09	1.7E-09	1.1E-09	7.7E-10	3.3E-10
Co-57	271 d	2.9E-09	1.6E-09	8.9E-10	5.8E-10	3.7E-10	2.9E-10
Co-60	5.27 y	5.4E-08	2.7E-08	1.7E-08	1.1E-08	7.9E-09	3.4E-09
Sr-90	29.1 a	2.3E-07	7.3e-08	4.7E-08	6.0E-08	8.0E-08	2.8E-08
Zr-95	64 d	8.5E-09	5.6E-09	3.0E-09	1.9E-09	1.2E-09	9.5E-10
Nb-95	35.1 d	4.6E-09	3.2E-09	1.8E-09	1.1E-09	7.4E-10	5.8E-10
Tc-99	2.13E+05 y	1.0E-08	4.8E-09	2.3E-09	1.3E-09	8.2E-10	6.4E-10
Ru-103	39.3 d	7.1E-09	4.6E-09	2.4E-09	1.5E-09	9.2E-10	7.3E-10
Ru-106	1.01 y	8.4E-08	4.9E-08	2.5E-08	1.5E-08	8.6E-09	7.0E-09
Ag-110m	250 d	2.4E-08	1.4E-08	7.8E-09	5.2E-09	3.4E-09	2.8E-09
Sb-125	2.77 y	1.1E-08	6.1E-09	3.4E-09	2.1E-09	1.4E-09	1.1E-09
I-131	8.04 d	1.8E-07	1.8E-07	1.0E-07	5.2E-08	3.4E-08	2.2E-08
Cs-134	2.06 y	2.6E-08	1.6E-08	1.3E-08	1.4E-08	1.9E-08	1.9E-08
Cs-137	30 y	2.1E-08	1.2E-08	9.6E-09	1.0E-08	1.3E-08	1.3E-08
Ba-140	12.7 d	3.2E-08	1.8E-08	9.2E-09	5.8E-09	3.7E-09	2.6E-09
Ce-144	284 d	6.6E-08	3.9E-08	1.9E-08	1.1E-06	6.5E-09	5.2E-09
Pu-239	2.41E+04 y	4.2E-07	4.2E-07	3.3E-07	2.7E-07	2.4E-07	2.5E-07

*HTO: tritiated water

**OBT: organically bound tritium

A notable feature of the Regulation is that it specifically excludes tritium and carbon-14. Nevertheless, both radionuclides are potentially available for accidental release from nuclear and radiochemical sites. Therefore, if the scope of the Regulation were to be broadened to take account of radionuclides with relatively low radiotoxicity, it would be reasonable to include tritium and carbon-14. Ingestion dose coefficients for tritium and carbon-14 are also given in Table 2.

It is recognized that some chemical substances containing tritium or carbon-14 are used in scientific research and are capable of incorporation into tissue at the cellular level where more serious damage may be produced. Such substances would not be released in accidents of the type covered by the Regulation and the guidance in this document is not intended to cover such circumstances.

It is clear that the intention of the Regulation was to define a small number of categories that would facilitate specific control of the most important radionuclides likely to be released in an accident, whilst ensuring adequate and broadly similar levels of protection for individuals following a wide range of possible accidental releases. The question therefore arises whether an extension to the existing categories might achieve these goals in a better way .

3.1 Sub-division of Category 4

A possible option for the revision of Category 4 would be to sub-divide the category of radionuclides currently defined according to their dose coefficients. It should be emphasised that the Regulation must be kept as simple and transparent as possible and any sub-division should therefore be minimal. One method may therefore be to sub-divide this category into 3 sub-categories. For example, sub-categories could be defined for: radionuclides with dose coefficients greater than, say 10^{-8} Sv Bq^{-1}; those with dose coefficients in the range 10^{-9}-10^{-8} Sv Bq^{-1}; and, those with dose coefficients less than 10^{-9} Sv Bq^{-1}. Activity concentration limits could be specified as simple factor of ten multiples of the existing levels for Category 4. A variation of this option could be to increase the 'other foods' and 'minor foods' levels in isolation, thus maintaining a strict control of foods likely to be consumed by young children.

Any sub-division by ingestion dose coefficient would naturally need to take account of the variation with age and would ideally be based upon a single age group. If the levels for all food groups were subject to factor of ten increases, then it would be most consistent with the original Article 31 Group methodology to specify the use of dose coefficients appropriate to the 1 year old. It was considered whether, if only the 'other foods' and 'minor foods' groups were relaxed, the choice of either ten year old or young adult dose coefficients would be more appropriate. It was concluded that, even taking into account the lower ingestion rates of the one year old, it was prudent to use this as the reference age group, at least for the relative scaling on the basis of ingestion dose coefficients. The division of the radionuclides in Table 2, into 3 sub-categories in this way, is illustrated in Table 3. Ingestion dose coefficients have been divided based upon values for the 1 year old. It is worth noting that a potential drawback of sub-division solely according to dose coefficient is that slight revisions in the estimation of these quantities could result in movement of radionuclides between categories. This method also means that isotopes of the same radionuclide could be subject to different controls (e.g., from Table 3, ruthenium-103 and ruthenium-106).

An alternative approach would be to specify, directly, the radionuclides included within each sub-division of Category 4 radionuclides. The rationale for this grouping would still, primarily, be based on the magnitude of the dose coefficient for each radionuclide, but would enable the inclusion of other considerations in determining the composition of each sub-category. For example, all isotopes of an element could be kept in the same category if appropriate. Furthermore, this approach would avoid the need for explicit linking to a particular age-group or estimated value of a dose coefficient. A further advantage of this approach is that it would enable Category 4 to be divided into only two sub-categories. The disadvantage of this approach, however, is the possibility of failing to include a radionuclide that is subsequently released accidentally. Clearly, a careful selection of radionuclides for classification would reduce this risk to a minimum. An example of radionuclides classified according to this approach is given in Table 4. Very broadly, radionuclides have been classified according to whether their dose coefficient for one year old children is above or below 10^{-8} Sv Bq^{-1}, but some adjustments have been made to keep all isotopes of each element in the same category.

A small modification to this approach is to specify that the sub-division of Category 4 radionuclides should be made wholly on the basis of dose coefficient. This procedure received considerable though not unanimous support from the Working Group.

Table 3: Division of category 4 into 3 sub-categories

Ingestion Dose Coefficient (Sv Bq^{-1}) for 1-2 year old.		
$< 10^{-9}$	10^{-9}-10^{-8}	$> 10^{-8}$
HTO	C-14	P-32
OBT		Ru-106
S-35 (inorg)	S-35 (org)	Ag-110m
	Ca-45	Cs-134
	Fe-55	Cs-137
	Zr-95	Ba-140
	Nb-95	Ce-144
	Tc-99	
	Ru-103	
	Sb-125	

Table 4: Division of Category 4 "All other radionuclides $t_{1/2} > 10$ days" into 2 Sub-Categories

Dose coefficient for 1-year old less than 10^{-8} Sv Bq^{-1}	**Dose coefficient for 1-year old greater than or equal to 10^{-8} Sv Bq^{-1}**
HTO	P-32
OBT	Co-60
C-14	Ru-103*
S-35 (inorg)	Ru-106
S-35 (org)	Ag-110m
Ca-45	Cs-134
Fe-55	Cs-137
Co-57	Ba-140
Nb-95	Ce-144
Zr-95	
Tc-99	
Sb-125	

* included in this group in view of the fact that its occurrence will always be associated with Ru-106.

4. Food Categories

The current Regulation specifies five categories of food: baby foods, dairy produce, minor foods, other foods and liquid foods. These five categories were chosen to represent the major components of diet and the two major age groups. The differing limits of radionuclide concentrations for each food category reflect the differences in consumption rates between categories. For example, the limits for minor foods are considerably less restrictive than for dairy produce, since individuals consume larger quantities of the latter.

4.1 Indicative Doses

There is no simple relationship, however, between the size and composition of an accidental release of radionuclides and the individual doses that would result from ingestion of contaminated foods. In the first place, there will be a distribution of activity concentrations in foods depending upon, for example, the weather conditions prevailing at the time of the accident and local environmental conditions and agricultural practices. Activity concentrations in foods also vary with time after the accident, in a manner that again depends on local environmental conditions and agricultural practices, as well as on the type of food. In the second place, food processing methods can serve to reduce or, in some cases, concentrate radionuclide contamination, either by introducing a delay before the food is consumed (during which time radioactive decay takes place), or directly, through the action of the process itself. Since a single type of food may be subject to a wide range of different processes (e.g. milk as fresh, pasteurised, long-life, yoghurt, cream, etc.), these activities will add further complexity to the relationship between the characteristics of the accident and individual ingestion doses. In the third place, individuals in the EU have a wide range of dietary habits, and also differ in where they obtain their foods from. Thus, the dose to an individual in the year following an accident will be made up from intakes of radionuclides from foods contaminated at a wide range of different levels. These activity concentration levels will vary from zero up to a maximum determined by the characteristics of the accident, the environmental conditions and the maximum permitted levels. The ingestion dose received by an individual following an accident, therefore, is not simply related to the contamination level of a particular food or the rate at which it is consumed. However, for the purposes of examining the dose implications of adopting a given set of maximum permitted activity concentration levels, it is necessary to assume a simple relationship.

The Article 31 Group convened to advise on the formulation of the Regulation made the assumption that an appropriately conservative indication of maximum permitted concentration could be obtained from the following equation[7]:

$$CFIL = E / (f \times D \times I \times C)$$

where

E is the reference individual effective dose arising from consumption of contaminated foods in a year subsequent to the accident and

CFIL is the activity concentration limit specified in the Regulation for a given radionuclide category and food group,

f is a factor which reflects a judgement that the average annual concentration in food actually consumed by the individual is a fraction of the activity concentration limit. Experience in the EU subsequent to the Chernobyl accident suggests that a value of 0.1 is appropriate for accidents occurring under similar conditions as regards type and distance from an affected area. In special circumstances this may not be the case; such situation are dealt with later.

It is important to recognize that the choice of a value for f will always be to some extent arbitrary and can only be made by Experts who have taken into account the circumstances pertaining to any accident under consideration.

D is the ingestion dose coefficient in Sv Bq^{-1},

I is the annual consumption rate of the relevant food in kg, and

C is a correction factor to allow for the additivity of foods within the category 'other foods', taken as 5 for all radionuclides with a physical half-life greater than a few weeks, and as 1 for radionuclides, e.g. iodine-131, with a half-life of days or shorter.

Correspondingly, individual doses can be calculated using the inverse relationship:

$$E = CFIL \times f \times D \times I \times C$$

It should be noted that the additivity factor C, when assessing actual doses for different groups of the population, should be taken as 1 for each relevant food group and then added up. It is presumed that additivity of radionuclide groups should in general not be considered. The Article 31 Group of Experts would consider the circumstances of any specific accident to confirm or modify this presumption, as appropriate, in their advice to the Commission.

Table 5 presents the annual doses for an adult and for a one year old for some of the key radionuclides specified in the Regulation that result from application of this assumption, using the ingestion dose coefficients given in BSS . Doses are clearly highly dependent on the consumption rates assumed. Since these can vary quite markedly between EU Member States, it is useful to consider the likely range of doses that would result from adopting country-specific consumption rates. Unfortunately, although studies are underway to provide detailed data on consumption rates in different Member States, at present only limited data are available. An EUR report from one of the 'Post-Chernobyl Actions' gives higher and lower consumption rates for various foodstuffs groups in most Member States[7]. These data and estimated consumption rates for the one year old are given in Table 6 and were used to calculate the doses given in Table 5.

It is recommended that each Member State should establish regularly the typical dietary distribution for different regions. In case of an accident giving rise to significant contamination of certain foods, for which the standard assumptions would underestimate the actual consumption rates, Member States should include such data in their urgent exchange of information relating to the emergency with the Commission. It is assumed however that, in general, the uncertainties in the additivity factor C and the factor f, discussed below, are more important than any deviations from the standard diet.

The value of f assumed in the equation, 0.1, essentially includes factors such as variation of activity concentrations within foods as a function of time and variation of the geographical origin of an individual's diet. Consequently, on average within a region, over the first year following a release, an individual's intake of radionuclides from a given food can be equated to consumption of 10% of his diet contaminated at the level specified in the Regulation, and 90% at zero contamination. In countries where most people obtain their food from shops, largely supplied from a wide geographical area, this assumption probably overestimates the average level of contamination. In countries where food is less widely distributed it may be helpful to review the appropriateness of this assumption. In all countries, however, there is the potential for a minority of the population to be largely self-sufficient in a particular food, or largely reliant on only local sources. Where a minority of the population are likely to be at risk in this way, a higher value of f could be specified; however, an alternative approach is discussed in Section 4.2.

What is clear from even this deliberately simplified calculation is that there is likely to be a wide range of possible individual doses received following restrictions placed on foods at the levels specified in the Regulation. It follows from the above that the doses given in Table 5 apply to individuals who are likely to be among those most exposed. Following an accident, the majority of individuals would be

expected to receive lower doses than these, owing to the wide variation in activity concentrations in foods to be expected across the EU.

It is recognised that within the spectrum of consumer habits some individuals may consume extreme amounts of specific foods. It these foods should happen to be more contaminated than others, it is very difficult to anticipate whether such habits would be maintained. It is concluded that such particular situations should be dealt with by the provision of appropriate information at national level and should not affect the setting of maximum permitted levels for placing specific foods on the market.

It is the opinion of the Working Group that the existing levels and food groups clearly achieve the objective of providing appropriate protection to individual consumers. It would be possible to revise the levels specified in the Regulation by a moderate margin without in practice significantly affecting the degree of protection afforded. In addition, there may also be scope for reducing the number of food categories specified, based on information regarding consumption rates, without significantly affecting the degree of protection afforded. On the other hand, the results in no way imply that such revisions are necessary from a scientific point of view.

Table 5. Annual Doses based on dietary data (mSv)

	Carbon 14[a]			Strontium 90		
Foodstuff	1yr old[a]	EU adult lower level	EU adult higher level	1yr old	EU adult lower level	EU adult higher level
Baby food	0.10	-	-	0.30	-	-
Dairy products	0.32	0.03	0.12	0.18	0.02	0.07
Potatoes	0.02	0.03	0.09	0.05	0.07	0.26
Meat	0.02	0.04	0.08	0.05	0.12	0.22
Fruit	0.04[c]	0.04	0.12	0.11[c]	0.11	0.36
Vegetables	-	0.05	0.11	-	0.15	0.33
Cereals	0.04	0.04	0.08	0.11	0.12	0.24
Liquid foodstuffs	0.04	0.03	-	0.02	0.02	-

	Iodine 131[1]			Caesium 137		
Foodstuff	1yr old	EU adult lower level	EU adult higher level	1yr old	EU adult lower level	EU adult higher level
Baby food	0.47	-	-	0.15	-	-
Dairy products	1.80	0.05	0.23	0.24	0.06	0.27
Potatoes	0.36	0.15	0.55	0.02	0.06	0.20
Meat	0.36	0.24	0.47	0.02	0.09	0.17
Fruit	0.72[c]	0.23	0.76	0.03[c]	0.08	0.28
Vegetables	-	0.31	0.69	-	0.12	0.25
Cereals	0.72	0.26	0.51	0.03	0.09	0.19
Liquid foodstuffs	0.23	0.07	-	0.03	0.08	-

[1] The effective doses calculated for I-131 would result from the continuous consumption of contaminated food at the maximum permitted levels for a whole year; given the short half-life of I-131 this is not realistic except in situations such as outlined in chapter 4.3. On the other hand, in case of protracted intake of I-131 it is advisable to check, in addition to effective dose, also the dose to the thyroid, in particular for children.

Table 5. (continued) Annual Dose based on dietary data(mSv)

	Plutonium 239		
Foodstuff	1yr old	EU adult lower level	EU adult higher level
Baby food	0.01	-	-
Dairy products	0.17	0.02	0.1
Potatoes	0.03	0.07	0.25
Meat	0.03	0.11	0.21
Fruit	0.07[c]	0.1	0.34
Vegetables	-	0.14	0.31
Cereals	-	0.14	0.31
Liquid foodstuffs	0.02	0.03	-

Table 6. Dietary data. Proposed intake yr^{-1} for dose calculations.

Foodstuff	1yr old	EU adult lower value	EU adult higher value
Baby food[d]	35 kg in 0.5 yr.	-	-
Dairy products	200 kg	49 kg	206 kg
Potatoes	10 kg	35 kg	126 kg
Meat	10 kg	55 kg	106 kg
Fruit	20 kg (fruit + vegetables)	52 kg	172 kg
Vegetables	-	71 kg	156 kg
Cereals	20 kg	58 kg	115 kg
Liquid foodstuffs including drinking water[e]	250 litres	600 litres	-

[a] for maximum permitted levels 10 times higher than for category 4
[b] calculated with the dose coefficients for 1-2 y old, except for baby food (1 y)
[c] fruit + vegetables
[d] The fraction of food contaminated to the intervention level is assumed to be 0.5 in the case of baby food. Note also intake is for 6 months only from 0.5 - 1 yr.
[e] Drinking water assumed to be 1% contaminated to intervention level.

4.2 Consumers of mainly local foods

In discussing the levels of dose individuals might receive from the consumption of contaminated foods, it is important to bear in mind those individuals for whom the above assumptions are particularly unsuited. These are individuals who habitually consume large amounts of certain foods from a limited geographical area. It would be inappropriate, however, to specify a general Regulation that is focused specifically on such a group. To do this would result in significant quantities of food being unnecessarily withheld from consumption. Protection of such individuals may be effected by ensuring that they are fully informed of the likely levels of contamination in their food, the health risks associated with consuming this food, and the action which they could take to reduce these risks. In some circumstances, it might even be appropriate for assistance to be provided to facilitate the change of food sources and dietary habits required. However, it would be important to recognise that consumption of some local produce contaminated to levels even exceeding those specified in the Regulation would not necessarily be a cause for concern from the health point of view.

4.3 Deliberate mixing of contaminated and uncontaminated foods.

A further situation which deserves attention is when a significant part of a harvest is contaminated at levels much higher than the maximum permitted levels and is liable to be mixed with non-contaminated produce (e.g. milk, cereals). Such mixing may be normal practice for reasons unrelated to radioactive contamination and "placing on the market" would then pertain to the mixed produce. Deliberate mixing should not be encouraged, in order to keep the amount of contaminated food as low as possible. Agricultural intervention measures should ensure that produce from the most contaminated areas is discarded. Within reasonable boundaries, however, mixing should not be prohibited from a radiation protection point of view, as long as it does not invalidate the assumption of the calculations in this document. In extreme situations deliberate mixing down to the maximum permitted levels would cause f to equal unity, thus substantially increasing individual doses.

A similar situation may arise in case there is a broad range of levels of contamination in foodstuffs which can be conserved until the radioactivity decays (e.g. I-131 in milk powder) and then be placed on the market at the maximum permitted levels.

4.4 Drinking water and liquid foodstuffs.

The above presentation does not allow for the ingestion of liquid foodstuffs other than milk. The uncertainty on the annual intake of specific contaminated liquids (the product of consumption rate and factor f) is even higher than for other foodstuffs. In order for the assumption $f = 0.1$ to be valid it would be necessary to assume that general drinking water supplies are contaminated to a large extent. For many Member States, a substantial fraction of drinking water originates as ground water and will not suffer direct contamination from fallout. The grid of interconnection between reservoirs would also provide in most cases for switching to supply uncontaminated water to any region which had been affected by a nuclear accident or emergency. Thus, it is more likely that there would be no general contamination of supplies (very small f)[2]. Alternatively, such widespread contamination of reservoirs or rivers from which drinking water is extracted may have occurred in some regions such that no other supplies are available. Should this situation arise it is a matter for the competent authorities to make an assessment of the radiological consequences and possible remedial action. This would be a an intervention situation with a primary concern for health rather than a matter of placing on the market with economic implications, to which the Council Regulation applies. This is the reason why footnote 6 of the Annex of the Regulation

[2] The doses listed in Table 5 have been calculated with f=0.01 which is a conservative assumption.

states that 'Values are calculated taking into account consumption of tap-water and the same values should be applied to drinking water supplies at the discretion of competent authorities in Member States'. This margin of discretion, which is necessary to allow for unforeseeable situations, may be removed if the features of an accident imply it is not relevant in the particular circumstances.

5. ICRP Advice on Avertable Doses

ICRP recommends that food restrictions should be implemented such that the averted individual dose is optimised[4]. ICRP further advises that averted doses in the range 5-50 mSv in a year are likely to be optimum. It should be noted that the optimisation of levels for the withdrawal of food does not depend on how the food is distributed among the population. Thus the contamination levels proposed by ICRP, which are intervention levels rather than maximum permitted levels for placing on the market, do not depend on assumptions on dietary habits or on the extent of contamination (factor f). The ICRP levels are 10-100 Bq kg^{-1} for alpha-emitting radionuclides and 1000-10,000 Bq kg^{-1} for beta/gamma emitting radionuclides. Comparison of these values with those in Table 1 (bearing in mind that the definition of food categories in the Regulation provides for greater flexibility in the specification of levels) indicates broad consistency between the two sets of advice, with the possible exception of the levels for strontium-90. Since this isotope is a beta-emitter, however, with a dose coefficient approximately midway between those for the principal gamma-emitters and those for the alpha-emitters, it is reasonable to infer from ICRP advice that activity concentrations in the range 100-1000 Bq kg^{-1} would be appropriate for comparison with the Regulation. Such a comparison again shows broad consistency between the two sets of advice.

It is concluded that there is no a priori reason to revise the activity concentration levels specified in the Regulation to provide better consistency with ICRP advice. The agreement with ICRP demonstrates that, notwithstanding the complex relationship between activity concentrations of radionuclides in foods and the range of resulting individual doses from ingestion, the maximum permitted levels are fairly robust.

6. Other International Guidance

Other international organisations, most notably the Codex Alimentarius Commission (CAC)[8] and the International Atomic Energy Agency (IAEA)[9], have published advice on activity levels in foodstuffs. The CAC guidance addresses food moving in international trade. The CAC guidance and the IAEA action levels are the same, although the IAEA advice includes more detailed guidance on the grouping of foods and the specified isotopes. The IAEA intervention levels for foodstuffs and the intervention levels for foodstuffs given by the ICRP[4] are consistent.

Comparison of Table 1 with Table 7 shows that the IAEA/CAC advice is broadly consistent with the Regulation even though the IAEA figures refer to action levels rather than to maximum permitted levels for the placing of food on the market as is the case for the EU Regulation. The main differences are that the Regulation is rather less restrictive for strontium-90 in foods intended for general consumption, for iodine-131 in milk and for alpha-emitting radionuclides in milk and foods intended for general consumption. On the other hand, it is rather more restrictive for caesium and ruthenium radioisotopes in baby foods. The question therefore arises whether the benefits of having a single set of levels agreed world-wide would outweigh the disadvantages of loss of flexibility incurred by having fewer food categories? It would appear that adoption of fewer food categories is unlikely to result in significantly different levels of protection in practice; whether it would produce administrative benefits and how it would affect the quantities of food banned would depend on the particular circumstances of the accident. It seems clear, however, that there is no strong scientific case for preferring one system over the other. Were it decided to revise the Regulation to be numerically consistent with other international advice then the comments regarding the desirability of widening the range of radionuclides covered would still apply

(in spite of some individual differences resulting from the different approaches and the distinction between maximum permitted levels and intervention levels).

The addition of one further category of radionuclides would extend the usefulness of the Regulation. Such addition is also consistent with the approach adopted by the IAEA/CAC.

Table 7: ICRP Intervention Levels and IAEA Action Levels[a] for Foodstuffs

Organisation	Radionuclides	Recommended levels	
ICRP	β/γ emitters α emitters	1,000-10,000 Bq kg^{-1} 10-100 Bq kg^{-1}	
IAEA		Foods for general consumption kBq kg^{-1}	Milk, infant foods and drinking water kBq kg^{-1}
	Cs-134, Cs-137, Ru-103, Ru-106, Sr-89	1	1
	I-131	1	0.1
	Sr-90	0.1	0.1
	Am-241, Pu-238, Pu-239, Pu-240, Pu-242	0.01	0.001

[a]IAEA also recommends intervention levels for withdrawal and substitution of foodstuffs. These intervention levels are consistent with the ICRP intervention levels.

7. Summary

The EU Regulation on maximum permitted levels of radionuclide concentrations in foods was specifically developed to cover the release of radionuclides resulting from a serious nuclear reactor accident. Since accidental releases might occur from other types of plant, or from smaller accidents involving nuclear reactors or their fuel, the Regulation would be of wider practical benefit if its scope were expanded to cover radionuclides that might be released in other accidents. In addition, it is recognised that whilst the Regulation is broadly consistent with advice promulgated by other international organisations (specifically ICRP, IAEA and CAC), there may be presentational and administrative benefits in revising the Regulation so that the levels are numerically consistent. With respect to radiological protection considerations, however, it must be emphasised that the one system cannot be taken to have more scientific justification than the other.

The Working Group considers that the existing maximum permitted levels of radioactive contamination specified in the existing Council Regulation are appropriate for the first three categories of radionuclides specified in the Regulation. The fourth category at present specifically excludes two isotopes (tritium and carbon 14) which could be of importance in a nuclear accident or emergency. The Group is of the opinion that a sub-division of Category 4 into two or three sub-groups of radionuclides with the inclusion of tritium and carbon 14 would lead to a more useful and readily applicable Regulation. The Working Group favours the two sub-group category as a more practical choice, but there is also support for the inclusion of a third sub-group.

Table 8 presents a summary of the maximum permitted levels resulting from the sub-division of category 4 into two sub-groups and includes the existing levels for the first three categories.

Table 8. Proposed maximum permitted levels (Bq/kg) for foodstuffs.

RADIONUCLIDE	Baby foods	Dairy produce	Minor food	Other foods	Liquid foods
Isotopes of strontium, Notably ^{90}Sr	75	125	7 500	750	125
Isotopes of iodine, Notably ^{131}I	150	500	20 000	2 000	500
Alpha emitting isotopes of plutonium and transplutonium elements	1	20	800	80	20
Radionuclides of half-life greater than 10 days and with a dose coefficient greater than or equal to 1.0E -8, notably ^{134}Cs and ^{137}Cs	400	1 000	12 500	1 250	1 000
Other radionuclides of half-life greater than ten days and with a dose coefficient less than 1.0E-8, notably ^{14}C and HTO	4 000	10 000	125 000	12 500	10 000

Values given in the first four rows of the table are existing values.

References

1. CEC Council Regulation 87/3954/EURATOM laying down the maximum permitted levels of radioactive contamination of foodstuffs and feeding stuffs following a nuclear accident or any other case of radiological emergency. Off. J. Eur. Commun., L371/11 (1987).

2. CEC Council Regulation 89/2218/EURATOM Amendment to CEC Council Regulation (Euratom) No. 3954/87 laying down the maximum permitted levels of radioactive contamination of foodstuffs and feeding stuffs following a nuclear accident or any other case of radiological emergency. Off. J. Eur. Commun., L211/1 (1989).

3. CEC Council Regulation 89/944/EURATOM laying down the maximum permitted levels of radioactive contamination in minor foodstuffs following a nuclear accident or any other case of radiological emergency. Off. J. Eur. Commun., L101/17 (1989).

4. ICRP. Principles for intervention for protection of the public in a radiological emergency. ICRP Publication 63. Ann. ICRP, 22, 4 (1993).

5. ICRP. Age-dependent doses to members of the public from intake of radionuclides: Part 5 Compilation of ingestion and inhalation dose coefficients. ICRP Publication 72. Ann. ICRP, 26, 1 (1995).

6. CEC Council Directive 96/29/EURATOM laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. Off. J. Eur. Commun., L159/1 (1996).

7. CEC. Underlying data for derived emergency reference levels, Post-Chernobyl action. EUR 12539 EN (1991).

8. Codex Alimentarius Commission. Contaminants: Guideline levels for radionuclides in food following accidental nuclear contamination for use in international trade. Geneva, WHO, Supplement 1 to Codex Alimentarius, Volume XVII (1989).

9. IAEA. Intervention Criteria in a Nuclear or Radiation Emergency. Safety Series No.109. IAEA, Vienna (1994).