Fact Sheet on Codex Guideline Levels for Radionuclides in Foods Contaminated Following a Nuclear or Radiological Emergency– prepared by Codex Secretariat (2 May 2011)

***Fact Sheet***

# ***Codex Guideline Levels for Radionuclides in Foods Contaminated Following a Nuclear or Radiological Emergency***

The Codex Alimentarius reference for food contaminated following a nuclear accident are the *Guideline Levels for Radionuclides in Foods Contaminated Following a Nuclear or Radiological Emergency* (in the following referred to as "Codex Guideline Levels"). They are included in the *General Standard for Contaminants and Toxins in Food and Feeds* – GSCTFF[1].

## History

At the time of the 1986 Chernobyl accident there was no comprehensive international guidance on how to deal with food contaminated as a result of nuclear accidents. Codex discussed radionuclides in food because the accident showed that there was a need to promote harmonization of measures and emergency plans among countries.

The first version of the Codex Guideline Levels was adopted by the Codex Alimentarius Commission (CAC) in 1989 (18th CAC) [2].

The Codex Guideline Levels were elaborated by the Codex Committee on Food Additives and Contaminants (CCFAC)[3] on the basis of a text prepared jointly by the Food and Agriculture Organisation (FAO), the World Health Organisation (WHO) and the International Atomic Energy Agency (IAEA).[4]

The Guideline Levels for six radionuclides[5], applicable for one year following a nuclear accident, were based on very conservative assumptions and intended to be used in international trade as values below which no food control restriction needed to be applied. Following discussion in CCFAC and other Codex committees, the 19th CAC agreed to extend the Codex Guideline Levels on a permanent basis (i.e. subsequent to the accident year); the Commission also clarified that the Codex Guideline Levels applied to ready-for-eat products and emphasized that special consideration be given to foods consumed in small quantities, such as spices. The 19th CAC further agreed to keep the Codex Guideline Levels under review to revise them when necessary.

In 2006, the 29th CAC adopted the revised (and currently valid) Codex Guideline Levels (*see* Appendix 1), which were included in the GSCTFF and superseded the ones adopted in 1989.

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[1] CODEX STAN 193-1995, (pages 33-37 of the English version). The GSCTFF contains the main principles which are recommended by the Codex Alimentarius in dealing with contaminants and toxins in food and feed, and lists the maximum levels and associated sampling plans of contaminants and natural toxicants in food and feed which are recommended by the CAC to be applied to commodities moving in international trade.

[2] The Guideline Levels were originally published as CAC/GL 5-1989 in Supplement 1 of Codex Alimentarius Volume XVII "Contaminants". In 1999, CAC/GL 5-1989 was reproduced in Codex Alimentarius Volume 1A "General Requirements". Publication of Codex texts in Volumes has been discontinued since 2002. Codex texts are now available on the Codex Alimentarius website: www.codexalimentarius.net or published in special publications.

[3] After its 19th session (1987) the terms of reference and name of the Committee on Food Additives (CCFA) were broadened and the name changed to reflect the broadened mandate. In 2006, the CCFAC was split into two committees: on food additives (CCFA) and on contaminants in foods (CCCF)

[4] Following the Chernobyl accident in 1986, FAO, WHO and IAEA, in association with other organizations, held several meetings and expert consultations to develop limits for radionuclides that could be used by countries. The text, jointly prepared by FAO and WHO, takes account of the discussion and recommendation of these previous meetings

[5] Strontium-90 (Sr-90), iodine-131 (I-131), caesium-137 and 134 (Cs-137 and Cs-134), plutonium-239 (Pu-239) and americium-241 (Am-241).

**Information on the revised Guideline Levels**

The Codex Guideline Levels were revised by the CCFAC following a request of the IAEA[6]: to consider levels that could be applied to long-term situations, to broaden the list of radionuclides to include most of those that are listed in Schedule I of the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* and to consider the most recent recommendations of the International Commission on Radiological Protection (ICRP) and significant improvements in the assessment of radiation doses resulting from the human intake of radioactive substances that had become available since 1989. The main changes as result of the revision were:

- Extension of the list to 20 radionuclides[7], divided in four groups according to their Dose per Unit Intake (DPUI) values; the 20 radionuclides were selected because of their importance in relation to uptake into the food chain or because large quantities of these were contained in nuclear facilities or industrial radiation sources, which could potentially contaminate foods because of an accident or malevolent act; naturally-occurring radionuclides were excluded because the resources required calculating exposure would have been out of proportion to the health benefit achieved;
- A revised intervention exemption level of 1 mSv per year[8], in accordance with the most recent recommendations of the ICRP;
- The assumption that 10% of the diet is of imported food[9] all of which is contaminated, giving an import to production factor (IPF)[10] of 0.1[11]; this was based on a more realistic assessment of statistical data of FAO on production and import of all countries worldwide; and
- Guideline Levels may be increased by a factor of 10 for food consumed in small quantity (e.g. spices) and that represent only a small percentage of total diet.

The Guideline Levels are based on 1996 IAEA most conservative values of the radionuclide-specific and age-specific ingestion dose coefficients, i.e. relevant to the chemical forms of radionuclides which are most absorbed from the gastro-intestinal tract and retained in body tissues.

Similar to the previous version of the Guideline Levels are the assumptions for calculating the levels, such as quantity of food consumed per year by an adult (550 kg) and by an infant (200 kg) and the approach to use the most conservative values of the radionuclide-specific and age-specific ingestion dose coefficients[12]. The revised Codex Guideline Levels also address two separate categories of foods (i.e. for infants and for adults) and were drafted with the intention to be easy to apply to facilitate the control of food moving in

[6] IAEA formulated this request following the resolution (GC(44)/RES/15) of the 44th General Conference of the International Atomic Energy Agency (2000) to request the IAEA Secretariat *"to develop, using the Agency's radiation protection advisory mechanisms and in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, during the next two years and within available resources, radiological criteria for long-lived radionuclides in commodities, particularly foodstuffs and wood, and to submit them to the Board of Governors for its approval".*

[7] hydrogen-3 (H-3); carbon-14 (C-14); technetium-99 (Tc-99); sulphur-35 (S-35); cobalt-60 (Co-60); strontium-89 and 90 (Sr-89 and Sr 90); ruthenium-103 and 106 (Ru- 103 and Ru-106); iodine-129 and 131 (I- 129 and I-131); uranium-235 (U-235); caesium-134 and 137 (Cs-134 and Cs-137); plutonium 238, 239 and 240 (Pu-238, Pu-239 and Pu-240); cerium–144 (Ce-144); iridium-192 (Ir-192); and americium-241 (Am-241).

[8] CAC/GL 05-1989 assumed an intervention exemption level of 5 mSv.

[9] In 1999, just over 13% of the per-caput-supply of food was traded internationally on a global basis (FAO Food Balance Sheet).

[10] IPF is defined as the ratio of the amount of foodstuffs imported per year from areas contaminated with radionuclides to the total amount produced and imported annually in the region or country under consideration.

[11] CAC/GL 05-1989 allocated the total amount of radioactivity from a dose of 5 mSv over 100% of food.

[12] These dose coefficients are relevant to the chemical forms of radionuclides, which are most absorbed from the gastro-intestinal tract and retained in body tissues (IAEA, 1996).

international trade and the uniform application by government authorities while ensuring the protection of consumers.

Similar to the previous version, the revised Guideline Levels continue to be based on extremely conservative assumptions and intended to be used in international trade as values below which no food control restriction need to be applied.

**Guideline Levels vs. Maximum Levels**

Codex has established guideline levels[13] for a number of contaminants, namely methylmercury, acrylonitrile, vinylchloride and radionuclides, which are listed in the Codex *General Standard for Contaminants and Toxins in Food and Feeds*.

The GSCTFF defines guideline level (GL) as "*The maximum level of a substance in a food or feed commodity which is recommended by the CAC to be acceptable for commodities moving in international trade. When the GL is exceeded, governments should decide whether and under what circumstances the food should be distributed within their territory or jurisdiction*."

The Codex Alimentarius Commission has decided that the preferred format of a Codex standard in food or feed is a maximum level[14] and that the existing guideline levels shall be reviewed for their possible conversion to a maximum level after a risk assessment performed by JECFA, if appropriate[15]. There has been no request up until now for the conduct of a risk assessment and the conversion of the Guideline Levels for radionuclides into maximum levels.[16]

**Calculation/ formula**

Codex Guideline Levels (GL) in Bq/kg were derived using the following formula:

$$GL = IED/(M \times ipf \times e_{ing}) \qquad \text{Eq. 1}$$

Where:

IED = Intervention Exemption Level of Dose (mSv/year)
M = mass of food consumed (kg/year)
IPF = import to production factor
$e_{ing}$ = ingestion dose coefficient (dose per unit intake, mSv/Bq)[17]

The following assumptions were made in calculating the levels:

i. The intervention exemption level of dose adopted was 1 mSv per year[18];

ii. 550 kg of food is consumed per year by an adult;

[13] Codex texts include standards, codes of practice, guidelines, maximum levels, maximum residue levels, guideline levels, etc. All Codex texts are based on sound science. In the framework of WTO, once food safety standards and related texts have been adopted by the Codex Alimentarius Commission, they are recognized as a reference under the SPS Agreement in matters of food safety. Other Codex texts are recognized as international standards under the TBT Agreement for other technical matters relevant to food regulation.

[14] Codex defines Maximum Level for a Contaminant in a Food or Feed Commodity as "the maximum concentration of that substance recommended by the Codex Alimentarius Commission to be legally permitted in that commodity".

[15] The 50th Executive Committee noted that scientific advice might be required from other bodies than JECFA, especially concerning radionuclides.

[16] The application of higher levels as intervention levels for cesium-137 in reindeer meat of 1500 and 3000 Bq/kg in Sweden and Norway respectively is an example of local conditions requiring levels above the GL.

[17] The list of ingestion dose coefficients is provided in Appendix 2.

[18] In accordance with the most recent recommendations of the International Commission on Radiological Protection (ICRP).

iii. 200 kg of food and milk is consumed per year, by an infant[19];

iv. 10% of the diet is of imported food, all of which is contaminated giving an import to production factor of 0.1;

v. For convenience the GL values were rounded off, and radionuclides with ingestion dose coefficients of similar magnitudes grouped and given similar GL values. However, separate GLs were derived for infants and adults due to differences in radionuclide absorption, metabolism and sensitivity to radiation.

The following examples illustrate how the GLs for I-131 and Cs-137 were derived:

GL for I-131 in infant foods:

Eq. 1 above give: GL = 1 mSv /(200 kg x 0.1 x 0.00018 mSv/Bq) = 278 Bq/kg, which were rounded down to 100 Bq/kg.

GL for Cs-137 in other foods for adults:

Eq. 1 above give: GL = 1 mSv /(550 kg x 0.1 x 0.000013 mSv/Bq) = 1400 Bq/kg, which were rounded down to 1000 Bq/kg.

Rounding the GL values downwards adds additional precaution to the public.

Annex 2 of the Codex GLs gives examples on how to assess doses to the public when applying the GLs. It also summarises the doses that would be received from the different nuclides if food contains activity concentrations equal to the GLs. Furthermore, the annex demonstrates that none will receive doses exceeding the intervention exemption level of 1 mSv per year given that the assumptions on consumption and import fraction are applicable (e.g., maximum 200 and 550 kg of imported contaminated food is consumed per year by infants and adults, respectively).

**Multiple radionuclides in foods**

The Guideline Levels have been developed with the understanding that there is no need to add contributions from radionuclides in different groups. The Guideline Levels apply to each of the four groups of radionuclides (for the two categories of foods) independently. Within each of the four groups, the Guideline Level applies singly or in combination to the radionuclides of the group and the activity concentrations of each radionuclide within the same group should be added together.

Theory and practice of mitigation of nuclear accident consequences prove that the application of the Guideline Levels ensures that the ingestion dose in the first year does not exceed the level of 1 mSv due to the combined effects of the individual levels for the four separate radionuclide groupings. This is because of the different time of appearance and concentration of radionuclides after a nuclear accident, i.e. first month dominated by short-lived radioiodines (e.g., I-131) with insignificant contributions of other radionuclides and the subsequent period (11 months), when longer lived radionuclides dominate (e.g., Cs-134 and Cs-137).

[19] Infant foods are those prepared specifically for consumption by infants less than one year old. Such foods are packaged and identified as being for this purpose.

**The scientific basis of the Codex Guideline Levels**

The Codex Guideline Levels are based on scientific work including expert meetings and consultations held by FAO, WHO and IAEA, in collaboration with other relevant organizations. A first series of meetings and consultations held following the 1986 Chernobyl accident, were the scientific basis of the first version of the Codex Guideline Levels adopted in 1989.

For the revised Codex Guideline Levels adopted in 2006, IAEA, in collaboration with relevant agencies[20], organized a number of consultant meetings to discuss the revised guideline levels and prepare recommendations for consideration of the responsible Codex committee - CCFAC. The revised Guideline Levels take into account the International Commission on Radiological Protection (ICRP) recommendation to revise the generic intervention exemption level of around 1mSv for the individual annual dose from radionuclides in major commodities[21] and relevant radionuclides, listed in Schedule I of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (IAEA, 1996)[22].

**Use of the Codex Guidelines Levels by countries**

The Codex Guideline Levels can be used by countries to control imported foods (when radionuclide levels in food do not exceed the corresponding Guideline Levels, the food should be considered as safe for human consumption) and only apply in situations related to nuclear accidents or radiological events (including both accidents and malevolent actions) and do not apply to routine monitoring purposes.

The Codex Guideline Levels apply to food after reconstitution or as prepared for consumption.

The Codex Guideline Levels allow the adoption of different national values for internal use[23]. For example, where the assumptions concerning food distribution (import to production factor) might not apply, e.g., in the case of widespread radioactive contamination; to take into account of particular age or "critical population" groups, or the particular situation as a result of a nuclear accident such as the proximity to the accident site; or when contamination levels in certain foods persist at higher levels than those based on the 1mSv limiting dose.

**Methods of Analysis and Sampling**

Currently in Codex there is no specific guidance on methods of analysis[24] and sampling for food contaminated following a nuclear accidents. The Codex *General Guidelines for Sampling* (CAC/GL 50-2004) provide general guidance on selection of sampling plans.

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[20] Including the WHO Department of Protection of the Human Environment, the IAEA Division of Radiation and Waste Safety, the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and other national/ regional agencies.

[21] International Commission on Radiological Protection. Principles for the Protection of the Public in Situations of Prolonged Exposure. Annals of the ICRP, V. 29, No 1-2 (1999).

[22] Jointly sponsored by FAO, IAEA, ILO, OECD/NEA, PAHO, WHO

[23] For example: The Council of the European Communities' regulations specifying maximum permitted activity concentrations in marketed foods (Council Food Intervention Levels; CFILs) give a CFIL of 12,500 Bq/kg for minor foods.

[24] For more info on methods of analysis and sampling see the ALMERA Network: http://www-naweb.iaea.org/naml/page.php?page=2 .

**References of Codex work**

Codex *General Standard for Contaminants and Toxins in Foods and Feeds* – GSCTFF (CODEX STAN 193-1995)

http://www.codexalimentarius.net/download/standards/17/CXS_193e.pdf

Codex *General Guidelines for Sampling* (CAC/GL 50-2004)

http://www.codexalimentarius.net/download/standards/10141/CXG_050e.pdf

ALINORM 87/12A (1987): Report of the 19th Session of Codex Committee on Food Additives

ALINORM 87/39 (1987) Report of the 17th Session of the Codex Alimentarius Commission

ALINORM 89/12 (1988): Report of the 20th Session of Codex Committee on Food Additives and Contaminants

ALINORM 89/3 (1988): Report of the 35th Session of the Executive Committee of the Codex Alimentarius Commission

ALINORM 89/12A (1989): Report of the 21st Session of Codex Committee on Food Additives and Contaminants

ALINORM 89/4 (1989): Report of the 36th Session of the Executive Committee of the Codex Alimentarius Commission

ALINORM 89/40 (1989) Report of the 18th Session of the Codex Alimentarius Commission

ALINORM 91/12 (1990): Report of the 22nd Session of Codex Committee on Food Additives and Contaminants

ALINORM 91/12A (1991): Report of the 23rd Session of Codex Committee on Food Additives and Contaminants

ALINORM 91/40 (1991) Report of the 19th Session of the Codex Alimentarius Commission

ALINORM 03/33A (2002): Report of the 50th Session of the Executive Committee of the Codex Alimentarius Commission

ALINORM 03/12A (2003): Report of the 35th Session of Codex Committee on Food Additives and Contaminants

ALINORM 04/27/12 (2004): Report of the 36th Session of Codex Committee on Food Additives and Contaminants

ALINORM 04/27/41 (2004) Report of the 27th Session of the Codex Alimentarius Commission

ALINORM 05/28/12 (2005): Report of the 37th Session of Codex Committee on Food Additives and Contaminants

ALINORM 06/29/12 (2006): Report of the 38th Session of Codex Committee on Food Additives and Contaminants

ALINORM 06/29/41 (2004) Report of the 29th Session of the Codex Alimentarius Commission

**The reports[25] of the above sessions are http://www.codexalimentarius.net/web/archives.jsp?lang=en**

**<u>Others</u>**

International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (IAEA, 1996)

*www-pub.iaea.org/mtcd/publications/pdf/ss.../pub996_web-1a.pdf*

[25] The working documents of the Codex sessions held from 2000 are also available on Codex website on the report page by clicking in the link to the agenda of the relevant session. The other working documents are only available in hard copies and can be requested at the Codex secretariat (email: codex@fao.org).

Appendix 1

**Guideline Levels for Radionuclides in Foods Contaminated Following a Nuclear or Radiological Emergency for Use in International Trade**

**Extract (page 33-37) from the Codex *General Standards for Contaminants and Toxins in Food and Feed* – GSCTFF (CODEX STAN 193-1995)**

**RADIONUCLIDES**

| **Commodity Code** | **Product Name** | **Representative radionuclides** | **Dose per unit intake factor in Sv/Bq** | **Level in Bq/kg** | **Type** | **Reference** | **Notes/Remarks** |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | Infant foods* | $^{238}Pu$, $^{239}Pu$, $^{240}Pu$, $^{241}Am$ | | **1** | **GL** | | |
| | Infant foods * | $^{90}Sr$, $^{106}Ru$, $^{129}I$, $^{131}I$, $^{235}U$ | | **100** | **GL** | | |
| | Infant foods * | $^{35}S$**, $^{60}Co$, $^{89}Sr$, $^{103}Ru$, $^{134}Cs$, $^{137}Cs$, $^{144}Ce$, $^{192}Ir$ | | **1000** | **GL** | | |
| | Infant foods * | $^{3}H$***, $^{14}C$, $^{99}Tc$ | | **1000** | **GL** | | |
| | Foods other than infant foods | $^{238}Pu$, $^{239}Pu$, $^{240}Pu$, $^{241}Am$ | | **10** | **GL** | | |
| | Foods other than infant foods | $^{90}Sr$, $^{106}Ru$, $^{129}I$, $^{131}I$, $^{235}U$ | | **100** | **GL** | | |
| | Foods other than infant foods | $^{35}S$**, $^{60}Co$, $^{89}Sr$, $^{103}Ru$, $^{134}Cs$, $^{137}Cs$, $^{144}Ce$, $^{192}Ir$ | | **1000** | **GL** | | |
| | Foods other than infant foods | $^{3}H$***, $^{14}C$, $^{99}Tc$ | | **10000** | **GL** | | |

* When intended for use as such.

** This represents the value for organically bound sulphur.

**Scope**: The Guideline Levels apply to radionuclides contained in foods destined for human consumption and traded internationally, which have been contaminated following a nuclear or radiological emergency[1]. These guideline levels apply to food after reconstitution or as prepared for consumption, i.e., not to dried or concentrated foods, and are based on an intervention exemption level of 1 mSv in a year.

**Application:** As far as generic radiological protection of food consumers is concerned, when radionuclide levels in food do not exceed the corresponding Guideline Levels, the food should be considered as safe for human consumption. When the Guideline Levels are exceeded, national governments shall decide whether and under what circumstances the food should be distributed within their territory or jurisdiction. National governments may wish to adopt different values for internal use within their own territories where the assumptions concerning food distribution that have been made to derive the Guideline Levels may not apply, e.g., in the case of wide-spread radioactive contamination. For foods that are consumed in small quantities, such as spices, that represent a small percentage of total diet and hence a small addition to the total dose, the Guideline Levels may be increased by a factor of 10.

**Radionuclides:** The Guideline Levels do not include all radionuclides. Radionuclides included are those important for uptake into the food chain; are usually contained in nuclear installations or used as a radiation source in large enough quantities to be significant potential contributors to levels in foods, and; could be accidentally released into the environment from typical installations or might be employed in malevolent actions. Radionuclides of natural origin are generally excluded from consideration in this document.

In the Table, the radionuclides are grouped according to the guideline levels rounded logarithmically by orders of magnitude. Guideline levels are defined for two separate categories “infant foods” and “other foods”. This is because, for a number of radionuclides, the sensitivity of infants could pose a problem. The guideline levels have been checked against age-dependent ingestion dose coefficients defined as committed effective doses per unit intake for each radionuclide, which are taken from the "International Basic Safety Standards" (IAEA, 1996)[2].

**Multiple radionuclides in foods**: The guideline levels have been developed with the understanding that there is no need to add contributions from radionuclides in different groups. Each group should be treated independently. However, the activity concentrations of each radionuclide within the same group should be added together[3].

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1 For the purposes of this document, the term “emergency” includes both accidents and malevolent actions.

2 Food and Agriculture Organization of the United Nations, International Atomic Energy Agency, International Labour Office, OECD Nuclear Energy Agency, Pan American Health Organization, World Health Organization (1996) International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, IAEA, Vienna.

3 For example, if $^{134}Cs$ and $^{137}Cs$ are contaminants in food, the guideline level of 1000 Bq/kg refers to the summed activity of both these radionuclides.

## SCIENTIFIC JUSTIFICATION FOR THE GUIDELINE LEVELS FOR RADIONUCLIDES IN FOODS CONTAMINATED FOLLOWING A NUCLEAR OR RADIOLOGICAL EMERGENCY

The Guideline Levels for Radionuclides in Foods and specifically the values presented in Table 1 above are based on the following general radiological considerations and experience of application of the existing international and national standards for control of radionuclides in food.

Significant improvements in the assessment of radiation doses resulting from the human intake of radioactive substances have become available since the Guideline Levels were issued by the Codex Alimentarius Commission in 1989[4] (CAC/GL 5-1989).

**Infants and adults:** The levels of human exposure resulting from consumption of foods containing radionuclides listed in Table 1 at the suggested guideline levels have been assessed both for infants and adults and checked for compliance with the appropriate dose criterion.

In order to assess public exposure and the associated health risks from intake of radionuclides in food, estimates of food consumption rates and ingestion dose coefficients are needed. According to Ref. (WHO, 1988) it is assumed that 550 kg of food is consumed by an adult in a year. The value of infant food and milk consumption during first year of life used for infant dose calculation equal to 200 kg is based on contemporary human habit assessments (F. Luykx, 1990[5]; US DoH, 1998[6]; NRPB, 2003[7]). The most conservative values of the radionuclide-specific and age-specific ingestion dose coefficients, i.e. relevant to the chemical forms of radionuclides which are most absorbed from the gastro-intestinal tract and retained in body tissues, are taken from the (IAEA, 1996).

**Radiological criterion**: The appropriate radiological criterion, which has been used for comparison with the dose assessment data below, is a generic intervention exemption level of around 1 mSv for individual annual dose from radionuclides in major commodities, e.g. food, recommended by the International Commission on Radiological Protection as safe for members of the public (ICRP, 1999)[8].

**Naturally occurring radionuclides:** Radionuclides of natural origin are ubiquitous and as a consequence are present in all foodstuffs to varying degrees. Radiation doses from the consumption of foodstuffs typically range from a few tens to a few hundreds of microsieverts in a year. In essence, the doses from these radionuclides when naturally present in the diet are unamenable to control; the resources that would be required to affect exposures would be out of proportion to the benefits achieved for health. These radionuclides are excluded from consideration in this document as they are not associated with emergencies.

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4 The Codex Alimentarius Commission at its 18th Session (Geneva 1989) adopted Guideline Levels for Radionuclides in Foods Following Accidental Nuclear Contamination for Use in International Trade (CAC/GL 5-1989) applicable for six radionuclides ($^{90}$Sr, $^{131}$I, $^{137}$Cs, $^{134}$Cs, $^{239}$Pu and $^{241}$Am) during one year after the nuclear accident.

5 F. Luykx (1990) Response of the European Communities to environmental contamination following the Chernobyl accident. In: Environmental Contamination Following a Major Nuclear Accident, IAEA, Vienna, v.2, 269-287.

6 US DoHHS (1998) Accidental Radioactive Contamination of Human Food and Animal Feeds: Recommendations for State and Local Agencies. Food and Drug Administration, Rockville.

7 K. Smith and A. Jones (2003) Generalised Habit Data for Radiological Assessments. NRPB Report W41.

8 International Commission on Radiological Protection (1999). Principles for the Protection of the Public in Situations of Prolonged Exposure. ICRP Publication 82, Annals of the ICRP.

**One-year exposure assessment:** It is conservatively assumed that during the first year after major environmental radioactive contamination caused by a nuclear or radiological emergency it might be difficult to readily replace foods imported from contaminated regions with foods imported from unaffected areas. According to FAO statistical data the mean fraction of major foodstuff quantities imported by all the countries worldwide is 0.1. The values in Table 1 as regards foods consumed by infants and the general population have been derived to ensure that if a country continues to import major foods from areas contaminated with radionuclides, the mean annual internal dose of its inhabitants will not exceed around 1 mSv (see Annex 2). This conclusion might not apply for some radionuclides if the fraction of contaminated food is found to be higher than 0.1, as might be the case for infants who have a diet essentially based on milk with little variety.

**Long-term exposure assessment:** Beyond one year after the emergency the fraction of contaminated food placed on the market will generally decrease as a result of national restrictions (withdrawal from the market), changes to other produce, agricultural countermeasures and decay.

Experience has shown that in the long term the fraction of imported contaminated food will decrease by a factor of a hundred or more. Specific food categories, e.g. wild forest products, may show persistent or even increasing levels of contamination. Other categories of food may gradually be exempted from controls. Nevertheless, it must be anticipated that it may take many years before levels of individual exposure as a result of contaminated food could be qualified as negligible.

**Annex 2**

## ASSESSMENT OF HUMAN INTERNAL EXPOSURE WHEN THE GUIDELINE LEVELS ARE APPLIED

For the purpose of assessment of the mean public exposure level in a country caused by the import of food products from foreign areas with residual radioactivity, in implementing the present guideline levels the following data should be used: annual food consumption rates for infants and adults, radionuclide- and age-dependent ingestion dose coefficients and the import/production factors. When assessing the mean internal dose in infants and adults it is suggested that due to monitoring and inspection the radionuclide concentration in imported foods does not exceed the present guideline levels. Using cautious assessment approach it is considered that all the foodstuffs imported from foreign areas with residual radioactivity are contaminated with radionuclides at the present guideline levels.

Then, the mean internal dose of the public, E (mSv), due to annual consumption of imported foods containing radionuclides can be estimated using the following formula:

$$E = GL(A) \cdot M(A) \cdot e_{ing}(A) \cdot IPF$$

where:

- ***GL(A)*** is the Guideline Level (Bq/kg)
- ***M(A)*** is the age-dependent mass of food consumed per year (kg)
- $e_{ing}(A)$ is the age-dependent ingestion dose coefficient (mSv/Bq)
- ***IPF*** is the import/production factor[9] (dimensionless).

Assessment results presented in Table 2 both for infants and adults demonstrate that for all the twenty radionuclides doses from consumption of imported foods during the 1st year after major radioactive contamination do not exceed 1 mSv. It should be noted that the doses were calculated on the basis of a value for the IPF equal to 0.1 and that this assumption may not always apply, in particular to infants who have a diet essentially based on milk with little variety.

It should be noted that for $^{239}Pu$ as well as for a number of other radionuclides the dose estimate is conservative. This is because elevated gastro-intestinal tract absorption factors and associated ingestion dose coefficients are applied for the whole first year of life whereas this is valid mainly during suckling period recently estimated by ICRP to be as average first six months of life (ICRP, 2005[10]). For the subsequent six months of the first year of life the gut absorption factors are much lower. This is not the case for $^{3}H$, $^{14}C$, $^{35}S$, iodine and caesium isotopes.

As an example, dose assessment for $^{137}Cs$ in foods is presented below for the first year after the area contamination with this nuclide.

For adults: $E = 1000\ \text{Bq/kg} \cdot 550\ \text{kg} \cdot 1.3 \cdot 10^{-5}\ \text{mSv/Bq} \cdot 0.1 = 0.7\ \text{mSv}$;

For infants: $E = 1000\ \text{Bq/kg} \cdot 200\ \text{kg} \cdot 2.1 \cdot 10^{-5}\ \text{mSv/Bq} \cdot 0.1 = 0.4\ \text{mSv}$

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9 The import/production factor (***IPF***) is defined as the ratio of the amount of foodstuffs imported per year from areas contaminated with radionuclides to the total amount produced and imported annually in the region or country under consideration.

10 International Commission on Radiological Protection (2005) Doses to Infants from Radionuclides Ingested in Mothers Milk. To be published.

**TABLE 2**

## ASSESSMENT OF EFFECTIVE DOSE FOR INFANTS AND ADULTS FROM INGESTION OF IMPORTED FOODS IN A YEAR

<table>
<tr><th rowspan="3">Radionuclide</th><th colspan="2">Guideline Level (Bq/kg)</th><th colspan="2">Effective dose (mSv)</th></tr>
<tr><th rowspan="2">Infant foods</th><th rowspan="2">Other foods</th><th colspan="2">1st year after major contamination</th></tr>
<tr><th>Infants</th><th>Adults</th></tr>
<tr><td>$^{238}Pu$</td><td rowspan="4">1</td><td rowspan="4">10</td><td>0.08</td><td>0.1</td></tr>
<tr><td>$^{239}Pu$</td><td>0.08</td><td>0.1</td></tr>
<tr><td>$^{240}Pu$</td><td>0.08</td><td>0.1</td></tr>
<tr><td>$^{241}Am$</td><td>0.07</td><td>0.1</td></tr>
<tr><td>$^{90}Sr$</td><td rowspan="5">100</td><td rowspan="5">100</td><td>0.5</td><td>0.2</td></tr>
<tr><td>$^{106}Ru$</td><td>0.2</td><td>0.04</td></tr>
<tr><td>$^{129}I$</td><td>0.4</td><td>0.6</td></tr>
<tr><td>$^{131}I$</td><td>0.4</td><td>0.1</td></tr>
<tr><td>$^{235}U$</td><td>0.7</td><td>0.3</td></tr>
<tr><td>$^{35}S$*</td><td rowspan="8">1000</td><td rowspan="8">1000</td><td>0.2</td><td>0.04</td></tr>
<tr><td>$^{60}Co$</td><td>1</td><td>0.2</td></tr>
<tr><td>$^{89}Sr$</td><td>0.7</td><td>0.1</td></tr>
<tr><td>$^{103}Ru$</td><td>0.1</td><td>0.04</td></tr>
<tr><td>$^{134}Cs$</td><td>0.5</td><td>1</td></tr>
<tr><td>$^{137}Cs$</td><td>0.4</td><td>0.7</td></tr>
<tr><td>$^{144}Ce$</td><td>1</td><td>0.3</td></tr>
<tr><td>$^{192}Ir$</td><td>0.3</td><td>0.08</td></tr>
<tr><td>$^{3}H$**</td><td rowspan="3">1000</td><td rowspan="3">10000</td><td>0.002</td><td>0.02</td></tr>
<tr><td>$^{14}C$</td><td>0.03</td><td>0.3</td></tr>
<tr><td>$^{99}Tc$</td><td>0.2</td><td>0.4</td></tr>
</table>

* This represents the value for organically bound sulphur.

** This represents the value for organically bound tritium.

See for "Scientific justification for the Guideline Levels" (Annex 1) and the "Assessment of human internal exposure when the Guideline Levels are applied" (Annex 2)

Appendix 2

Ingestion dose coefficients used to derive Codex GLs for radionuclides in foods

| Radionuclide | Ingestion dose coefficient (mSv/Bq) | |
|---|---|---|
| | Infant | Adult |
| **$^{238}$Pu** | **$4.0x10^{-3}$** | **$2.3x10^{-4}$** |
| **$^{239}$Pu** | **$4.2x10^{-3}$** | **$2.5x10^{-4}$** |
| **$^{240}$Pu** | **$4.2x10^{-3}$** | **$2.5x10^{-4}$** |
| **$^{241}$Am** | **$3.7x10^{-3}$** | **$2.0x10^{-4}$** |
| **$^{90}$Sr** | **$2.3x10^{-4}$** | **$2.8x10^{-5}$** |
| **$^{106}$Ru** | **$8.4x10^{-5}$** | **$7.0x10^{-6}$** |
| **$^{129}$I** | **$1.8x10^{-4}$** | **$1.1x10^{-4}$** |
| **$^{131}$I** | **$1.8x10^{-4}$** | **$2.2x10^{-5}$** |
| **$^{235}$U** | **$3.5x10^{-4}$** | **$4.7x10^{-5}$** |
| **$^{35}$S*** | **$7.7x10^{-6}$** | **$7.7x10^{-7}$** |
| **$^{60}$Co** | **$5.4x10^{-5}$** | **$3.4x10^{-6}$** |
| **$^{89}$Sr** | **$3.6x10^{-5}$** | **$2.6x10^{-6}$** |
| **$^{103}$Ru** | **$7.1x10^{-6}$** | **$7.3x10^{-7}$** |
| **$^{134}$Cs** | **$2.6x10^{-5}$** | **$2.0x10^{-11}$** |
| **$^{137}$Cs** | **$2.1x10^{-5}$** | **$1.3x10^{-5}$** |
| **$^{144}$Ce** | **$6.6x10^{-5}$** | **$5.2x10^{-6}$** |
| **$^{192}$Ir** | **$1.3x10^{-5}$** | **$1.4x10^{-6}$** |
| **$^{3}$H**** | **$1.2x10^{-7}$** | **$4.2x10^{--11}$** |
| **$^{14}$C** | **$1.4x10^{-6}$** | **$5.8x10^{-7}$** |
| **$^{99}$Tc** | **$1.0x10^{-5}$** | **$6.4x10^{-7}$** |

Source: International Commission on Radiological Protection Publication 72: Age-dependent doses to members of the public from intake of radionuclides inhalation dose coefficients. 1996.