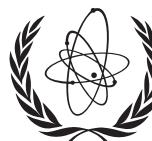


Placing the
Radiological
Health Hazard
in **Perspective**
in an **Emergency**
due to **Severe**
Conditions at a
Light Water Reactor



IAEA

International Atomic Energy Agency

INTRODUCTION

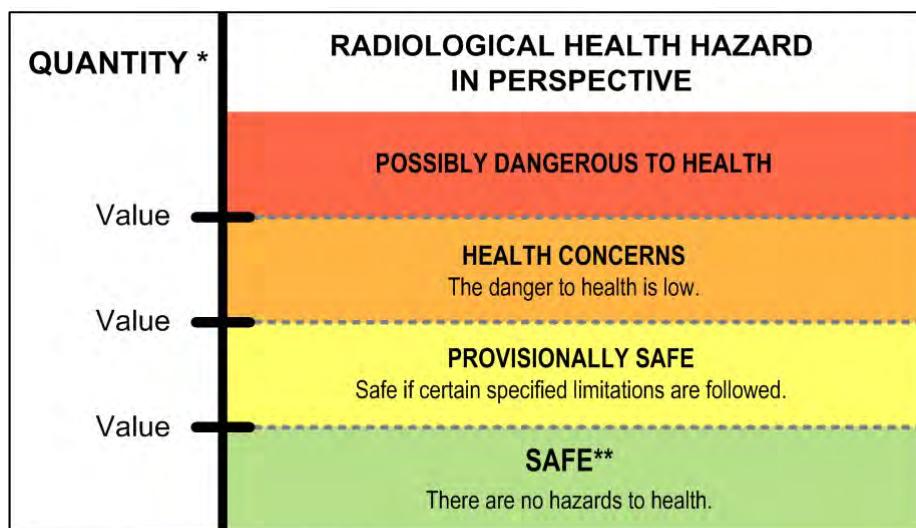
A system has been created in order to place the radiological health hazard in perspective for a measured quantity or calculated dose in a simple and understandable format for use in an emergency due to severe conditions at a light water reactor or its spent fuel pool.

The Charts contained here are from the IAEA publication *Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor*, (EPR-NPP PUBLIC PROTECTIVE ACTIONS, 2013), which provides more information. The intended audience includes emergency planners, decision makers and those involved in communication with the public.

Application of these Charts will facilitate:

- Answering the public's principal concern during an emergency ('Am I safe?'); and
- Preventing inappropriate actions being taken by the public, decision makers and others that are not justified based on the radiation risk.

The definition of safe is understood as meeting international safety standards for which no protective or other response actions need to be taken. *Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency*, IAEA Safety Standards Series No. GSG-2, IAEA, Vienna (2011) provides more information.



* Or another indicator such as the emergency class

** Safe according to international safety standards

MEASURED QUANTITY CHARTS

Charts 1–4 were developed as 'shortcuts' to directly relate various measured quantities to possible radiation induced health effects. The charts were developed taking into consideration all of the radionuclides expected to be present after a release from a reactor core or spent fuel pool, all of the exposure pathways expected to be relevant and all members of the public (including the most sensitive, such as pregnant women and children). The measured quantities are used as key indicators, representative of the exposure scenario and resulting doses.

DOSE CHARTS

Charts 5 and 6 place in perspective the link between the dose that has been calculated and the possible radiation induced health effects.

HOW TO USE THE CHARTS

Step 1 — Select the appropriate chart

Select the chart based on what quantity was measured, which exposure scenario is being considered or which dose was calculated.

Step 2 — Complete the checklist

The back of each chart has a checklist that needs to be completed before using the chart.

Step 3 — Convert the units of the quantity to those in the charts

Ensure that the quantities are in the same units as they appear on the selected chart (e.g. $\mu\text{Sv}/\text{h}$, Bq/kg , mSv , or mGy).

Step 4 — Explaining the charts

When discussing the charts with the public the following points need to be stressed:

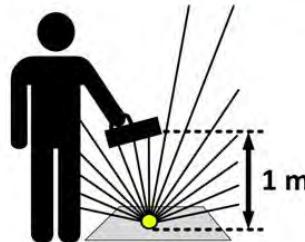
- If a particular radiation induced health effect is indicated on the chart it means that there is only a small chance of someone suffering the effect, it does not mean that it will definitely take place.
- The radiation induced health effects would not be expected to occur for anyone at levels below those indicated in the charts.
- An accurate assessment of the possible radiation induced health effects can only be performed after the individual's exposure is better known and can only be performed by experts in diagnoses and treatment of radiation induced health effects.
- If the situation is possibly dangerous to health or there are health concerns, the appropriate protective actions and other response actions (e.g. medical follow-up) indicated on the charts need to be taken.
- The quality of the data being used and how representative they are needs to be explained. If future refinements of the data are expected, this needs to be stressed.

For more information please see the IAEA publication: *Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor*, (EPR-NPP PUBLIC PROTECTIVE ACTIONS, 2013).





ONLY USE AFTER COMPLETING THE CHECKLIST ON THE BACK.



LIVING IN THE AFFECTED AREA CHART 1

- For a release of radioactive material from a LWR or RBMK
- For all members of the public (including children and pregnant women)
- Based on the dose rate at 1m above ground level.

DOSE RATE

at 1 m above
ground level

HEALTH HAZARD

Living normally in the affected area for:

7 days

1 month

1 year

10 000 $\mu\text{Sv/h}$

POSSIBLY DANGEROUS
TO HEALTH
(check OIL1 and OIL2)

5 000 $\mu\text{Sv/h}$

POSSIBLY DANGEROUS
TO HEALTH
(check OIL1 and OIL2)

2 000 $\mu\text{Sv/h}$

HEALTH CONCERN
(check OIL1 and OIL2)

1 000 $\mu\text{Sv/h}$

PROVISIONALLY SAFE**
FOR 7 DAYS, PROVIDING
ACTIONS ARE TAKEN TO
REDUCE INGESTION OF
RADIOACTIVE MATERIAL

Read footnote * for measurements
between 25 and 100 $\mu\text{Sv/h}$

500 $\mu\text{Sv/h}$

HEALTH CONCERN
(check OIL1 and OIL2)

100 $\mu\text{Sv/h}$

HEALTH CONCERN
(check OIL1 and OIL2)

25 $\mu\text{Sv/h}$

PROVISIONALLY SAFE** FOR
1 MONTH, PROVIDING ACTIONS
ARE TAKEN TO REDUCE INGESTION
OF RADIOACTIVE MATERIAL

10 $\mu\text{Sv/h}$

SAFE** FOR EVERYONE,
PROVIDING FOOD, MILK AND DRINKING WATER ARE SAFE

1 $\mu\text{Sv/h}$

NATURAL
BACKGROUND
DOSE RATE



* Areas showing a dose rate of 25 to 100 $\mu\text{Sv/h}$ during the first 10 days after the release are safe (according to international safety standards), providing food, milk and drinking water are safe.

** Safe according to international safety standards - For further information read the back of this chart



CHART 1 EXPLANATION

'BEFORE USE' CHECKLIST: If the answer to any of the following is 'No', do not use this chart.



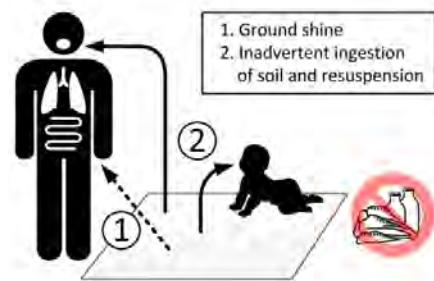
- | | | |
|--|------------------------------|-----------------------------|
| Is the nuclear power plant a LWR or RBMK? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are you assessing the health hazard from living in the affected area? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the dose rate representative of the inhabited area? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the dose rate representative of that from deposition at 1m above ground? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the dose rate value in $\mu\text{Sv}/\text{h}$? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are you outside the area for which evacuation or relocation was recommended? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

PURPOSE: This chart places in perspective the link between the measured dose rate from deposition and the possible health hazard from living normally for the period indicated in the affected area following a release from a reactor or spent fuel pool of a LWR or RBMK.

MEASURED QUANTITY: Dose rate ($\mu\text{Sv}/\text{h}$) from deposition measured at 1m above ground level in the inhabited areas.

EXPOSURE SCENARIO: Members of the public are living normally in an area affected by a release without taking any protective actions, except they do not consume contaminated food, milk or water. All the important ways of being exposed to radioactive material on the ground were taken into account, including: external exposure from deposition (ground shine), inadvertent ingestion (e.g. from eating dirt on hands or from children playing on the ground) and inhalation of resuspension of the deposition (dust).

The chart only considers the health hazard resulting from deposited radioactive material. Therefore, those who were in the area during the plume's passage where the dose rate from deposition is greater than 25 $\mu\text{Sv}/\text{h}$ need to have their dose estimated to determine if a medical examination, counselling or medical follow-up is warranted.



POPULATION CONSIDERED: The possible health hazards shown are for the members of the public most sensitive to radiation (e.g. children and pregnant women (fetus)). For this reason all members of the public have been covered.

HEALTH HAZARD IN PERSPECTIVE:

Possibly dangerous to health (red): There is a possibility of radiation induced health effects that are life threatening or can result in a permanent injury that reduces the quality of life (severe deterministic effects) to include: (a) permanently suppressed ovulation and sperm counts, (b) hypothyroidism (a condition in which the thyroid gland does not produce sufficient thyroid hormones) and (c) severe effects to the fetus. At this level there is also the small possibility of an observable increase in the incidence of cancer due to radiation induced cases, if the number of exposed people is more than a few hundred.

Health concerns (orange): The danger to health is very low. However, there is a possibility of doses exceeding the international criteria that call for taking protective actions and other response actions, to include a medical screening, in order to further assess: (a) the small possible risk to pregnant women (fetus), and (b) the small possible increase in the risk of radiation induced cancers.

Provisionally safe (yellow): It is safe if remaining in the area is limited to the specific time period and the following protective actions are implemented:

- prevent the consumption of food, milk or water with concentrations greater than OIL7, and
- prevent inadvertent ingestion, such as: washing hands before eating and not playing on the ground, or not doing other activities that could result in the creation of dust that could be ingested.

Safe (green): This meets international standards as the doses are less than the generic criteria at which protective actions and other response actions are justified to minimize the health effects from radiation exposure, provided the food, milk or water is safe (i.e. does not have concentrations that exceed OIL7 values). Below this level there will not be any severe deterministic effects or an observable increase in the incidence of cancer, even in a very large exposed group. Furthermore, the risk of cancers and other health effects is too low to justify taking any action, such as a medical screening.

Natural background dose rate: The average annual dose rate from natural sources of radiation exposure is shown for perspective. The worldwide average fluctuates around 0.2 $\mu\text{Sv}/\text{h}$, but in some locations it can be much higher (up to 15 $\mu\text{Sv}/\text{h}$).

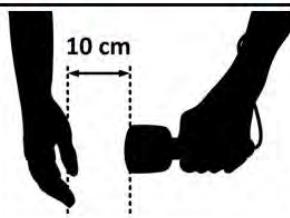
PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS:

If an individual **has been in an area** where conditions indicate the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), the individual needs to be registered and have their doses estimated to determine if a medical examination or counselling and medical follow-up are warranted. Health effects from radiation exposure can only be assessed by experts in diagnosing and treating the health effects of radiation exposure. Others, such as local physicians, probably will not have the expertise needed to make such assessments.

If an individual **is in an area** where conditions indicate the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), take protective actions and other response actions in accordance with OIL1 and OIL2 in Table 7 of the IAEA publication: Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP PUBLIC PROTECTIVE ACTIONS, 2013.



ONLY USE AFTER COMPLETING THE CHECKLIST ON THE BACK.



RADIOACTIVE MATERIAL ON THE SKIN CHART 2

- For a release of radioactive material from a LWR or RBMK
- For all members of the public (including children and pregnant women)
- Based on the dose rate at 10 cm from bare skin (hands or face).

DOSE RATE
above background at
10 cm from bare skin
(hands or face)

HEALTH HAZARD

100 $\mu\text{Sv/h}$

POSSIBLY DANGEROUS TO HEALTH
(check OIL4)

50 $\mu\text{Sv/h}$

10 $\mu\text{Sv/h}$

HEALTH CONCERNS
(check OIL4)

1 $\mu\text{Sv/h}$

SAFE * FOR EVERYONE

0.1 $\mu\text{Sv/h}$



IT IS SAFE TO TREAT THIS PERSON
by taking simple universal precautions



* Safe according to international safety standards - For further information read the back of this chart

SKIN

CHART 2 EXPLANATION

'BEFORE USE' CHECKLIST: If the answer to any of the following is 'No', do not use this chart:



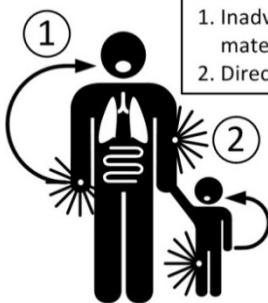
Is the nuclear power plant a LWR or RBMK?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Are you assessing the health hazard from radioactive material on the skin?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the dose rate measurement taken at 10 cm from bare skin?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is the dose rate in $\mu\text{Sv/h}$?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Are you using the above background dose rate?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Are you outside the area for which evacuation or relocation was recommended?	<input type="checkbox"/> Yes <input type="checkbox"/> No

PURPOSE: This chart places in perspective the link between the dose rate of the skin and the possible health hazard from radioactive material on the skin resulting from a reactor or spent fuel pool of a LWR or RBMK.

MEASURED QUANTITY: The dose rate ($\mu\text{Sv/h}$) above background measured by a dose rate instrument at 10 cm from bare skin (hands or face).

EXPOSURE SCENARIO: All the important ways of being exposed to radiation from radioactive material deposited on the skin and from eating contaminated dirt on hands (inadvertent ingestion) were taken into account.

POPULATION CONSIDERED: The possible health hazards shown are for the members of the public most sensitive to radiation (e.g. children and pregnant women (fetus)). For this reason all members of the public have been covered.



- 1. Inadvertent ingestion of radioactive material from the skin
- 2. Direct exposure of skin tissue

HEALTH HAZARD IN PERSPECTIVE:

Always safe to treat a contaminated person: Universal precautions against infection (gloves, mask, etc.) provide sufficient protection for those treating any individual possibly contaminated.

Possibly dangerous to health (red): There is a possibility of radiation induced health effects that are life threatening or can result in a permanent injury that reduces the quality of life (severe deterministic effects) to include hypothyroidism (a condition in which the thyroid gland does not produce sufficient thyroid hormones). At this level there is also the small possibility of an observable increase in the incidence of cancer due to radiation induced cases, if the number of exposed people is more than a few hundred.

Health concerns (orange): The danger to health is very low. However, there is a possibility of doses exceeding the international criteria that call for taking protective actions and other response actions, to include a medical screening, in order to further assess: (a) the small possible risk to pregnant women (fetus) and (b) the small possible increase in the risk of radiation induced cancers. This may also indicate that the person may have inadvertently ingested or inhaled enough contamination to result in doses greater than the generic criteria calling for a medical follow-up.

Safe (green): This meets international standards as the doses are less than the generic criteria at which protective actions and other response actions are justified to minimize the health effects from radiation exposure. Below this level there will not be any severe deterministic effects or an observable increase in the incidence of cancer, even in a very large exposed group. Furthermore, the risk of cancers and other health effects is too low to justify taking any action, such as a medical screening.

PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS:

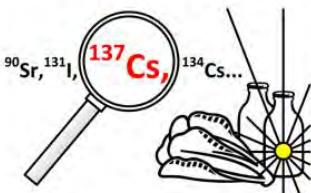
If an individual has levels of radioactive material on the skin that indicates the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), the individual needs to:

- take protective actions and other response actions in accordance with OIL4 of Table 8 of the IAEA publication: Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP PUBLIC PROTECTIVE ACTIONS, 2013; and
- be registered and have their doses estimated to determine if a medical examination or counselling and medical follow-up are warranted. Health effects from radiation exposure can only be assessed by experts in diagnosing and treating the health effects of radiation exposure. Others, such as local physicians, probably will not have the expertise needed to make such assessments.



ONLY USE AFTER COMPLETING THE CHECKLIST ON THE BACK.

1 DAY OF CONSUMPTION OF FOOD, MILK OR WATER CHART 3A



- For a release of radioactive material from a LWR or RBMK
- For all members of the public (including children and pregnant women)
- Based on the marker cesium-137. **The contribution from all other radionuclides (e.g. Ba-140, Sr-90, Cs-134...) has been considered !**
- Use together with Chart 3B

CESIUM-137 CONCENTRATION in food, milk or drinking water

HEALTH HAZARD

Percentage of the diet with this cesium-137 concentration

1 000 000 Bq/kg

10 %

50 %

100 %

POSSIBLY DANGEROUS
TO HEALTH
(check OIL7)

200 000 Bq/kg

POSSIBLY DANGEROUS
TO HEALTH
(check OIL7)

POSSIBLY DANGEROUS
TO HEALTH
(check OIL7)

100 000 Bq/kg

HEALTH CONCERN
(check OIL7)

40 000 Bq/kg

HEALTH CONCERN
(check OIL7)

20 000 Bq/kg

HEALTH CONCERN
(check OIL7)

10 000 Bq/kg

8 000 Bq/kg

4 000 Bq/kg

SAFE * FOR EVERYONE,

ONLY IF CONSUMED FOR 1 DAY OR LESS

AND ONLY IF THE CONCENTRATION OF IODINE-131
IS ALSO SAFE ACCORDING TO CHART 3B

(FOR LONGER PERIODS OF CONSUMPTION USE CHART 4)

1 000 Bq/kg



EXPLANATION

* Safe according to international safety standards. For further information read the back of this chart

FOOD

CHART 3A EXPLANATION

'BEFORE USE' CHECKLIST: If the answer to any of the following is 'No', do not use this chart:

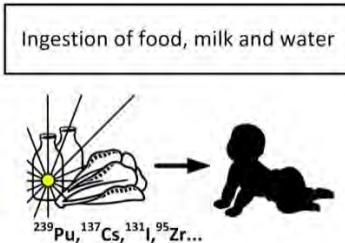


- | | | |
|--|------------------------------|-----------------------------|
| Is the nuclear power plant a LWR or RBMK? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are you assessing the health hazard from consuming food, milk and water for 1 day? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the quantity the concentration of Cs-137 in food, milk or water? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the concentration in Bq/kg? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Was the I-131 concentration in food, milk or water also assessed using Chart 3B? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are you outside the area for which evacuation or relocation was recommended? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

PURPOSE: This chart places in perspective the link between measured Cs-137 concentrations in food, milk and drinking water and the possible health hazard from consumption of food, milk or water affected by a release from a reactor or spent fuel pool of a LWR or RBMK when also used with Chart 3B.

MEASURED QUANTITY: Concentration of I-131 and Cs-137 marker in food, milk or drinking water (Bq/kg) as determined by laboratory analysis. All the other radioactive material from a release that would be present (e.g. Sr-90, Te-132, I-135, Cs-134...) were considered based on their expected amounts relative to the concentrations of Cs-137 (given in this Chart) and I-131 (given in Chart 3B).

EXPOSURE SCENARIO: This is for a single contaminating event. It is assumed that either 10%, 50% or 100% of the diet has the indicated concentration and it was consumed for a period of **1 day or less**.



POPULATION CONSIDERED: The possible health hazards shown are for the members of the public most sensitive to radiation (e.g. children and pregnant women (fetus)). For this reason all members of the public have been covered.

HEALTH HAZARD IN PERSPECTIVE:

Possibly dangerous to health (red): There is a possibility of radiation induced health effects that are life threatening or can result in a permanent injury that reduces the quality of life (severe deterministic effects) to include hypothyroidism (a condition in which the thyroid gland does not produce sufficient thyroid hormones). At this level there is also the small possibility of an observable increase in the incidence of cancer due to radiation induced cases, if the number of exposed people is more than a few hundred.

Health concerns (orange): The danger to health is very low. However, there is a possibility of doses exceeding the international criteria that call for taking protective actions and other response actions, to include a medical screening, in order to further assess: (a) the small possible risk to pregnant women (fetus) and (b) the small possible increase in the risk of radiation induced cancers.

Safe (green): *Is safe only for 1 day of consumption.* This meets international standards as the doses are less than the generic criteria at which protective actions and other response actions are justified to minimize the health effects from radiation exposure, provided that the concentration of I-131 is also safe according to Chart 3B. Below this level there will not be any severe deterministic effects or observable increase in the incidence of cancer, even in a very large exposed group. Furthermore, the risk of cancers and other health effects is too low to justify taking any action, such as a medical screening.

PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS:

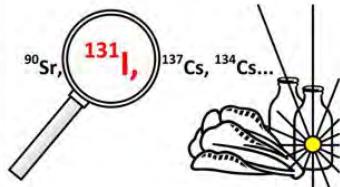
If an individual has consumed food, milk or water with concentrations that indicate the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), the individual needs to be registered and have their doses estimated to determine if a medical examination or counselling and medical follow-up are warranted. Health effects from radiation exposure can only be assessed by experts in diagnosing and treating the health effects of radiation exposure. Others, such as local physicians, probably will not have the expertise needed to make such assessments.

If food, milk or water concentrations indicate that the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), take protective actions and other response actions in accordance with OIL7 of Table 9 of the IAEA publication: Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP PUBLIC PROTECTIVE ACTIONS, 2013.



ONLY USE AFTER COMPLETING THE CHECKLIST ON THE BACK.

1 DAY OF CONSUMPTION OF FOOD, MILK OR WATER CHART 3B

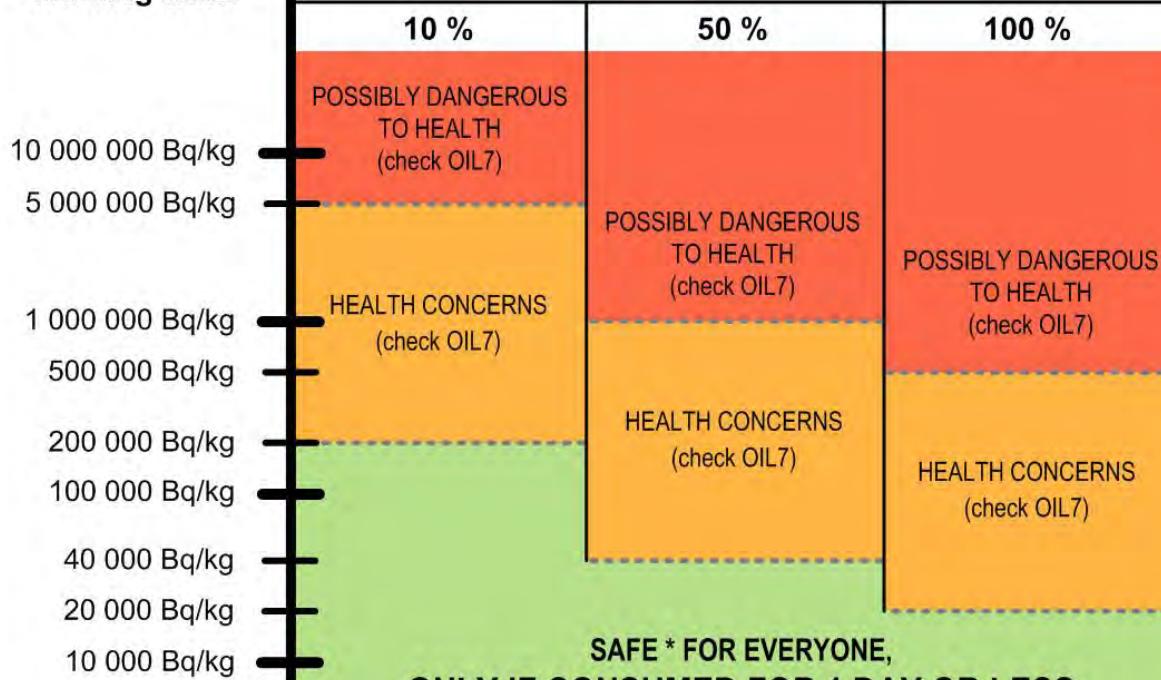


- For a release of radioactive material from a LWR or RBMK
- For all members of the public (including children and pregnant women)
- Based on the marker iodine-131. **The contribution from all other radionuclides (e.g. Ba-140, Sr-90, Cs-134...) has been considered !**
- Use together with Chart 3A

IODINE-131 CONCENTRATION in food, milk or drinking water

HEALTH HAZARD

Percentage of the diet with this iodine-131 concentration



SAFE * FOR EVERYONE,

ONLY IF CONSUMED FOR 1 DAY OR LESS

AND ONLY IF THE CONCENTRATION OF CESIUM-137
IS ALSO SAFE ACCORDING TO CHART 3A

1 000 Bq/kg



(FOR LONGER PERIODS OF CONSUMPTION USE CHART 4)

100 Bq/kg



* Safe according to international safety standards. For further information read the back of this chart

FOOD

CHART 3B EXPLANATION

'BEFORE USE' CHECKLIST: If the answer to any of the following is 'No', do not use this chart:

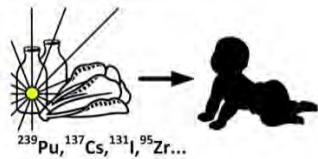


- | | | |
|--|------------------------------|-----------------------------|
| Is the nuclear power plant a LWR or RBMK? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are you assessing the health hazard from consuming food, milk and water for 1 day? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the quantity the concentration of I-131 in food, milk or water? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the concentration in Bq/kg? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Was the Cs-137 concentration in food, milk or water also assessed using Chart 3A? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are you outside the area for which evacuation or relocation was recommended? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

PURPOSE: This chart places in perspective the link between measured I-131 concentrations in food, milk and drinking water and the possible health hazard from consumption of food, milk or water affected by a release from a reactor or spent fuel pool of a LWR or RBMK when also used with Chart 3A.

MEASURED QUANTITY: Concentration of I-131 and Cs-137 marker in food, milk or drinking water (Bq/kg) as determined by laboratory analysis. All the other radioactive material from a release that would be present (e.g. Sr-90, Te-132, I-135, Cs-134...) were considered based on their expected amounts relative to the concentrations of I-131 (given in this Chart) and Cs-137 (given in Chart 3A).

Ingestion of food, milk and water



EXPOSURE SCENARIO: This is for a single contaminating event. It is assumed that either 10%, 50% or 100% of the diet has the indicated concentration and it was consumed for a period of **1 day or less**.

POPULATION CONSIDERED: The possible health hazards shown are for the members of the public most sensitive to radiation (e.g. children and pregnant women (fetus)). For this reason all members of the public have been covered.

HEALTH HAZARD IN PERSPECTIVE:

Possibly dangerous to health (red): There is a possibility of radiation induced health effects that are life threatening or can result in a permanent injury that reduces the quality of life (severe deterministic effects) to include hypothyroidism (a condition in which the thyroid gland does not produce sufficient thyroid hormones). At this level there is also the small possibility of an observable increase in the incidence of cancer due to radiation induced cases, if the number of exposed people is more than a few hundred.

Health concerns (orange): The danger to health is very low. However, there is a possibility of doses exceeding the international criteria that call for taking protective actions and other response actions, to include a medical screening, in order to further assess: (a) the small possible risk to pregnant women (fetus) and (b) the small possible increase in the risk of radiation induced cancers.

Safe (green): *Is safe only for 1 day of consumption.* This meets international standards as the doses are less than the generic criteria at which protective actions and other response actions are justified to minimize the health effects from radiation exposure provided that the concentration of Cs-137 is also safe according to Chart 3A. Below this level there will not be any severe deterministic effects or observable increase in the incidence of cancer, even in a very large exposed group. Furthermore, the risk of cancers and other health effects is too low to justify taking any action, such as a medical screening.

PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS:

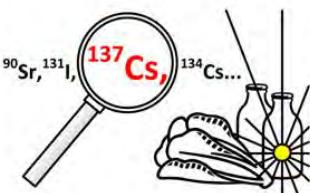
If an individual has consumed food, milk or water with concentrations that indicate the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), the individual needs to be registered and have their doses estimated to determine if a medical examination or counselling and medical follow-up are warranted. Health effects from radiation exposure can only be assessed by experts in diagnosing and treating the health effects of radiation exposure. Others, such as local physicians, probably will not have the expertise needed to make such assessments.

If food, milk or water concentrations indicate that the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), take protective actions and other response actions in accordance with OIL7 of Table 9 of the IAEA publication: Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP PUBLIC PROTECTIVE ACTIONS, 2013.



ONLY USE AFTER COMPLETING THE CHECKLIST ON THE BACK.

1 YEAR OF CONSUMPTION OF FOOD, MILK OR WATER CHART 4A

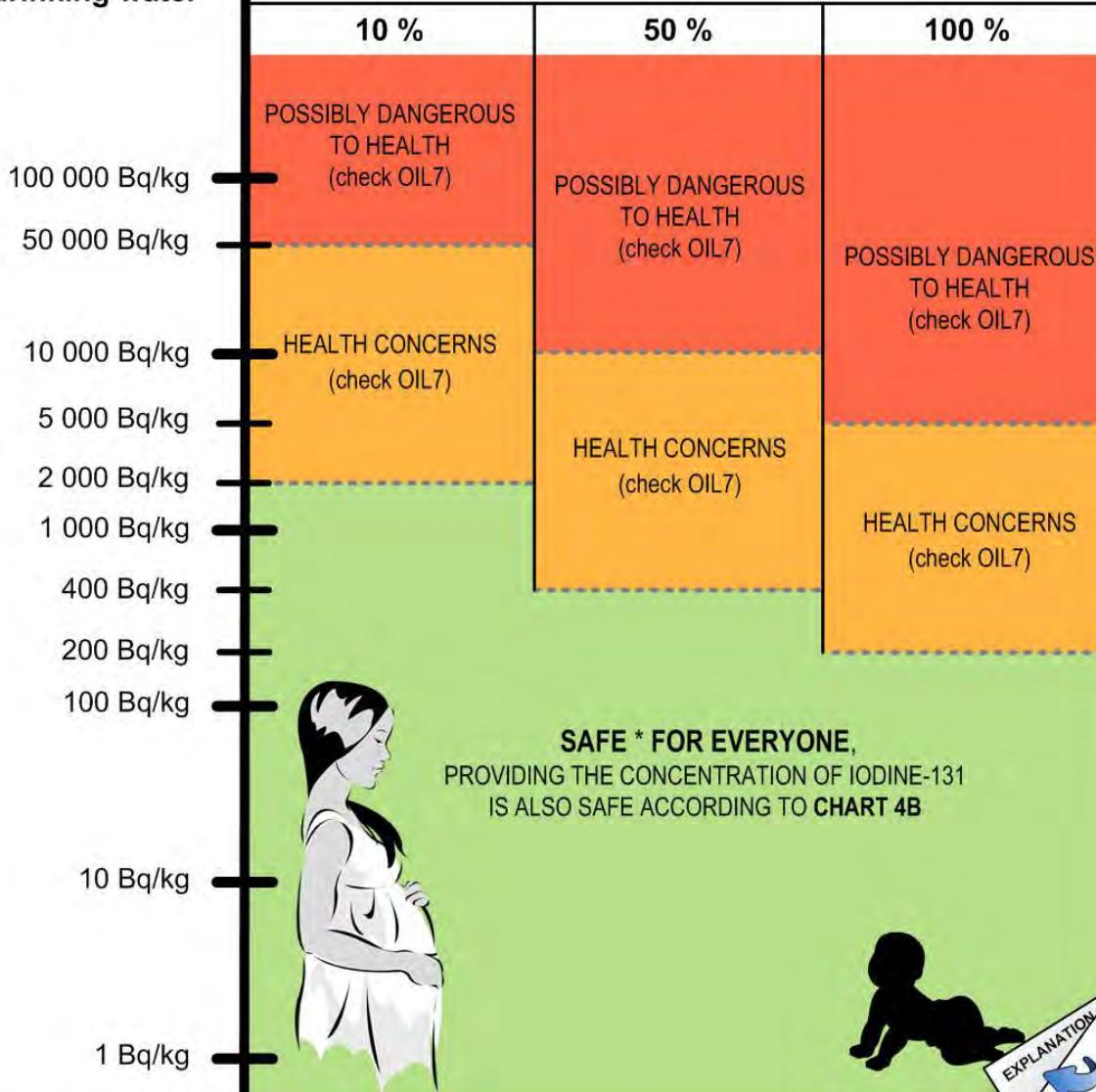


- For a release of radioactive material from a LWR or RBMK
- For all members of the public (including children and pregnant women)
- Based on the marker cesium-137. The contribution from all other radionuclides (e.g. Ba-140, Sr-90, Cs-134...) has been considered !
- Use together with Chart 4B

CESIUM-137 CONCENTRATION in food, milk or drinking water

HEALTH HAZARD

Percentage of the diet with this cesium-137 concentration



* Safe according to international safety standards - For further information read the back of this chart

FOOD

CHART 4A EXPLANATION

'BEFORE USE' CHECKLIST: If the answer to any of the following is 'No', do not use this chart:

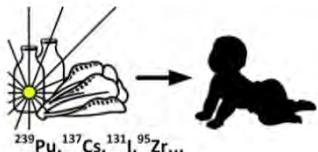


- | | | |
|---|------------------------------|-----------------------------|
| Is the nuclear power plant a LWR or RBMK? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are you assessing the health hazard from consuming food, milk and water for 1 year? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the quantity the concentration of Cs-137 in food, milk or water? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the concentration in Bq/kg? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Was the I-131 concentration in food, milk or water also assessed using Chart 4B? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are you outside the area for which evacuation or relocation was recommended? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

PURPOSE: This chart places in perspective the link between measured Cs-137 concentrations in food, milk and drinking water and the possible health hazard from consumption of food, milk or water affected by a release from a reactor or spent fuel pool of a LWR or RBMK when also used with Chart 4B.

MEASURED QUANTITY: Concentration of I-131 and Cs-137 marker in food, milk or drinking water (Bq/kg) as determined by laboratory analysis. All the other radioactive material from a release that would be present (e.g. Sr-90, Te-132, I-135, Cs-134...) were considered based on their expected amounts relative to the concentrations of Cs-137 (given in this Chart) and I-131 (given in Chart 4B).

Ingestion of food, milk and water



EXPOSURE SCENARIO: This is for a single contaminating event. It is assumed that 10%, 50% or 100% of the diet for **1 year** initially has the indicated concentration.

POPULATION CONSIDERED: The possible health hazards shown are for the members of the public most sensitive to radiation (e.g. children and pregnant women (fetus)). For this reason all members of the public have been covered.

HEALTH HAZARD IN PERSPECTIVE:

Possibly dangerous to health (red): There is a possibility of radiation induced health effects that are life threatening or can result in a permanent injury that reduces the quality of life (severe deterministic effects) to include hypothyroidism (a condition in which the thyroid gland does not produce sufficient thyroid hormones). At this level there is also the small possibility of an observable increase in the incidence of cancer due to radiation induced cases, if the number of exposed people is more than a few hundred.

Health concerns (orange): The danger to health is very low. However, there is a possibility of doses exceeding the international criteria that call for taking protective actions and other response actions, to include a medical screening, in order to further assess: (a) the small possible risk to pregnant women (fetus), and (b) the small possible increase in the risk of radiation induced cancers.

Safe (green): This meets international standards as the doses are less than the generic criteria at which protective actions and other response actions are justified to minimize the health effects from radiation exposure provided the concentration of I-131 is also safe according to Chart 4B. Below this level there will not be any severe deterministic effects or an observable increase in the incidence of cancer, even in a very large exposed group. Furthermore, the risk of cancers and other health effects is too low to justify taking any action, such as a medical screening.

PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS:

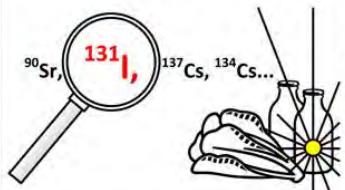
If an individual has consumed food, milk or water with concentrations that indicate the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), the individual needs to be registered and have their doses estimated to determine if a medical examination or counselling and medical follow-up are warranted. Health effects from radiation exposure can only be assessed by experts in diagnosing and treating the health effects of radiation exposure. Others, such as local physicians, probably will not have the expertise needed to make such assessments.

If food, milk or water concentrations indicate the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), take protective actions and other response actions in accordance with OIL7 of Table 9 of the IAEA publication: Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP PUBLIC PROTECTIVE ACTIONS, 2013. The OILs were established at levels well below those at which any radiation induced health effects would be expected; therefore, if restriction of consumption is likely to result in severe malnutrition or dehydration because replacements are not available, food, milk or water with concentration levels above the OIL7 value may be consumed, as directed by local officials, until replacements are available.



ONLY USE AFTER COMPLETING THE CHECKLIST ON THE BACK.

1 YEAR OF CONSUMPTION OF FOOD, MILK OR WATER CHART 4B

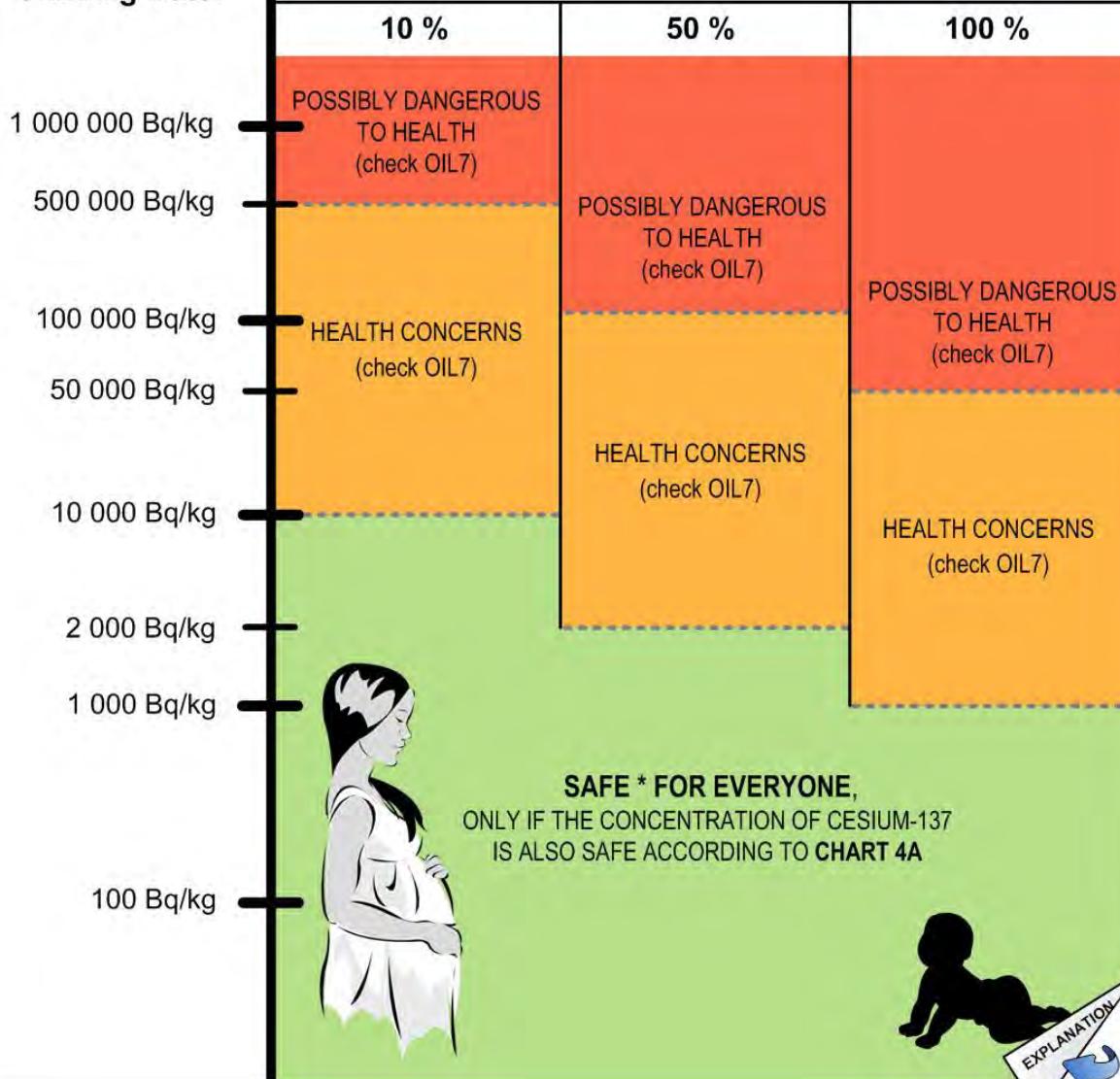


- For a release of radioactive material from a LWR or RBMK
- For all members of the public (including children and pregnant women)
- Based on the marker iodine-131. **The contribution from all other radionuclides (e.g. Ba-140, Sr-90, Cs-134...) has been considered !**
- Use together with Chart 4A

IODINE-131 CONCENTRATION in food, milk or drinking water

HEALTH HAZARD

Percentage of the diet with this iodine-131 concentration



* Safe according to international safety standards. For further information read the back of this chart

FOOD

CHART 4B EXPLANATION

'BEFORE USE' CHECKLIST: If the answer to any of the following is 'No', do not use this chart:

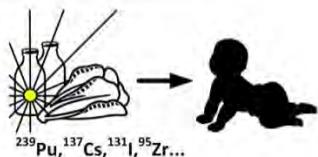


Is the nuclear power plant a LWR or RBMK?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are you assessing the health hazard from consuming food, milk and water for 1 year?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the quantity the concentration of I-131 in food, milk or water?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the concentration in Bq/kg?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Was the Cs-137 concentration in food, milk or water also assessed using Chart 4A?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are you outside the area for which evacuation or relocation was recommended?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

PURPOSE: This chart places in perspective the link between measured I-131 concentrations in food, milk and drinking water and the possible health hazard from consumption of food, milk or water affected by a release from a reactor or spent fuel pool of a LWR or RBMK when also used with Chart 4A.

MEASURED QUANTITY: Concentration of I-131 and Cs-137 marker in food, milk or drinking water (Bq/kg) as determined by laboratory analysis. All the other radioactive material from a release that would be present (e.g. Sr-90, Te-132, I-135, Cs-134...) were considered based on their expected amounts relative to the concentrations of I-131 (given in this Chart) and Cs-137 (given in Chart 4A).

Ingestion of food, milk and water



EXPOSURE SCENARIO: This is for a single contaminating event. It is assumed that 10%, 50% or 100% of the diet for **1 year** initially has the indicated concentration.

POPULATION CONSIDERED: The possible health hazards shown are for the members of the public most sensitive to radiation (e.g. children and pregnant women (fetus)). For this reason all members of the public have been covered

HEALTH HAZARD IN PERSPECTIVE:

Possibly dangerous to health (red): There is a possibility of radiation induced health effects that are life threatening or can result in a permanent injury that reduces the quality of life (severe deterministic effects) to include hypothyroidism (a condition in which the thyroid gland does not produce sufficient thyroid hormones). At this level there is also the small possibility of an observable increase in the incidence of cancer due to radiation induced cases, if the number of exposed people is more than a few hundred.

Health concerns (orange): The danger to health is very low. However, there is a possibility of doses exceeding the international criteria that call for taking protective actions and other response actions, to include a medical screening, in order to further assess: (a) the small possible risk to pregnant women (fetus), and (b) the small possible increase in the risk of radiation induced cancers.

Safe (green): This meets international standards as the doses are less than the generic criteria at which protective actions and other response actions are justified to minimize the health effects from radiation exposure provided the concentration of Cs-137 is also safe according to Chart 4A. Below this level there will not be any severe deterministic effects or an observable increase in the incidence of cancer, even in a very large exposed group. Furthermore, the risk of cancers and other health effects is too low to justify taking any action, such as a medical screening.

PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS:

If an individual has consumed food, milk or water with concentrations that indicate the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), the individual needs to be registered and have their doses estimated to determine if a medical examination or counselling and medical follow-up are warranted. Health effects from radiation exposure can only be assessed by experts in diagnosing and treating the health effects of radiation exposure. Others, such as local physicians, probably will not have the expertise needed to make such assessments.

If food, milk or water concentrations indicate the health hazard level is 'possibly dangerous to health' (red) or 'health concerns' (orange), take protective actions and other response actions in accordance with OIL7 of Table 9 of the IAEA publication: Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP PUBLIC PROTECTIVE ACTIONS, 2013. The OILs were established at levels well below those at which any radiation induced health effects would be expected; therefore, if restriction of consumption is likely to result in severe malnutrition or dehydration because replacements are not available, food, milk or water with concentration levels above the OIL7 value may be consumed, as directed by local officials, until replacements are available.



ONLY USE AFTER COMPLETING THE CHECKLIST ON THE BACK.

ORGAN DOSES CHART 5

- For a release of radioactive material from a LWR or RBMK
- For all members of the public (including children and pregnant women)
- Based on calculated doses to the thyroid fetus and red marrow. All three organ doses have to be assessed !

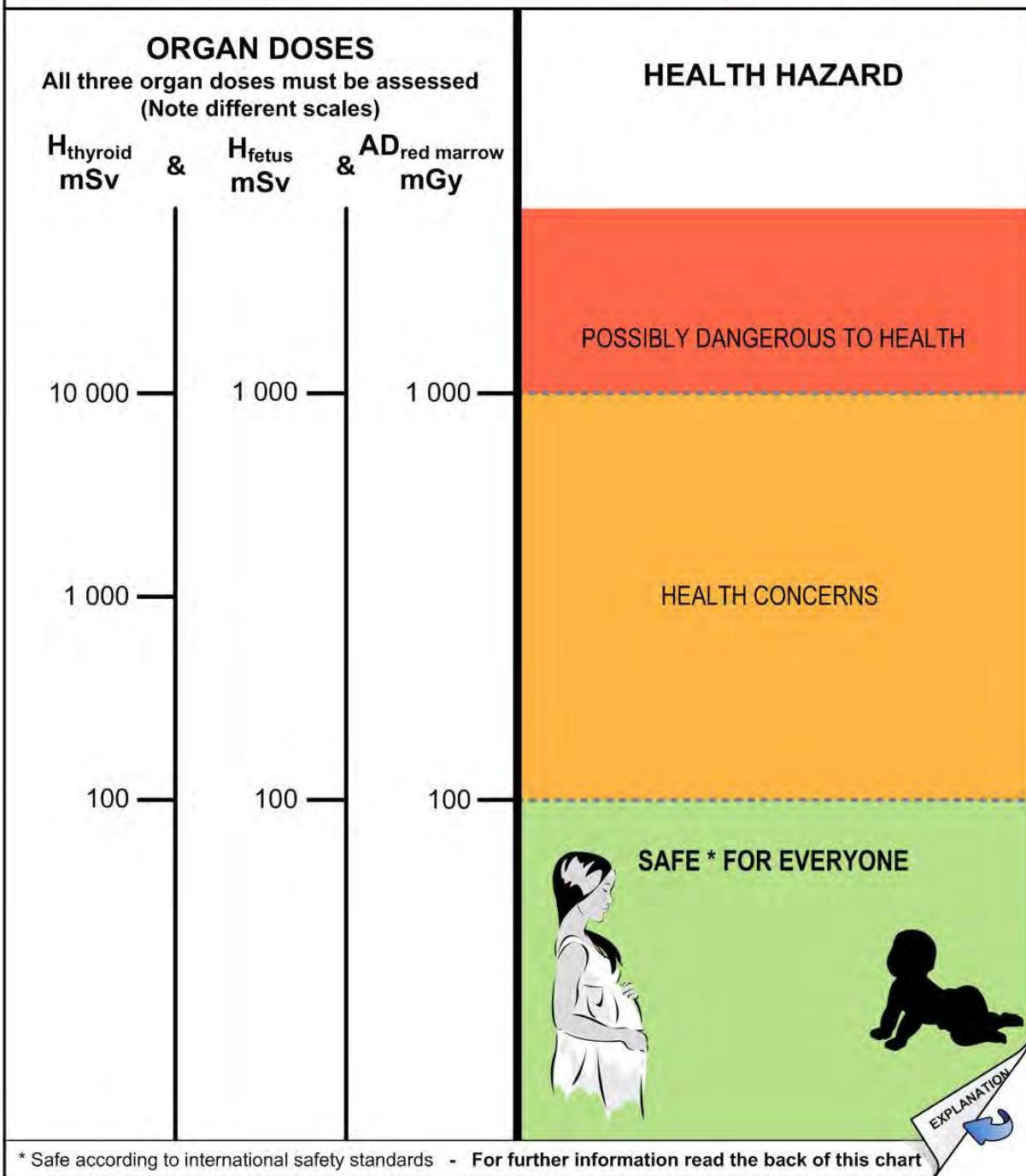


CHART 5 EXPLANATION

PURPOSE: This chart places in perspective the link between the dose that has been calculated following a release from a reactor or spent fuel pool of a LWR or RBMK and the possible health hazard.

CALCULATED DOSE: Organ doses of the thyroid, fetus and red marrow.

CHECKLIST FOR CALCULATION OF THE DOSE:

Do not use incomplete or uncertain data for dose calculations.

Calculation of the dose considers:

- H_{thyroid} , H_{fetus} and $AD_{\text{red marrow}}$;
- The radionuclide mixture released from the reactor core or spent fuel pool;
- The members of the public most sensitive to radiation (e.g. children and pregnant women (fetus)); and
- All exposure pathways, relevant for a release from a LWR or RBMK, to include:

For the equivalent dose to the thyroid (H_{thyroid}):

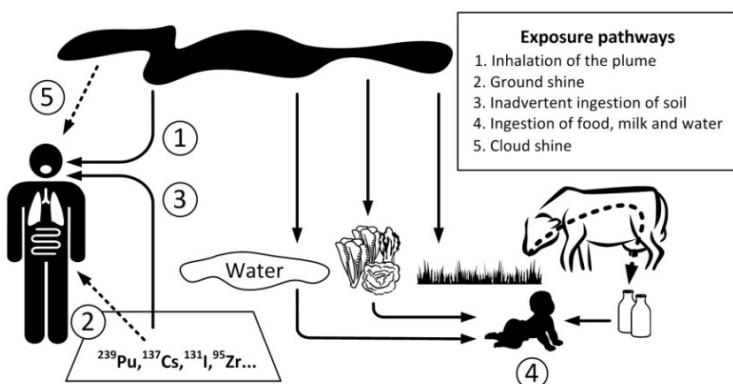
- inhalation of the plume;
- inadvertent ingestion (e.g. from soil on hands); and
- ingestion of food, milk or water.

For the equivalent dose in the fetus (H_{fetus}):

- external exposure from the plume (cloud shine);
- external exposure from ground deposition (ground shine)
- inhalation from the passing plume;
- inadvertent ingestion (e.g. from soil on hands); and
- ingestion of food, milk or water.

For the RBE weighted absorbed dose to the red marrow ($AD_{\text{red marrow}}$):

- external exposure from the plume (cloud shine); and
- external exposure from ground deposition (ground shine).



HEALTH HAZARD IN PERSPECTIVE:

Possibly dangerous to health (red): There is a possibility of radiation induced health effects that are life threatening or can result in a permanent injury that reduces the quality of life (severe deterministic effects) to include: (a) permanently suppressed ovulation and sperm counts, and (b) hypothyroidism (a condition in which the thyroid gland does not produce sufficient thyroid hormones) and (c) severe effects to the fetus. At this level there is also the small possibility of an observable increase in the incidence of cancer due to radiation induced cases, if the number of exposed people is more than a few hundred.

Health concerns (orange): The danger to health is very low. However, there is a possibility of doses exceeding the international criteria that call for taking protective actions and other response actions to include medical screening in order to further assess: (a) the small possible risk to pregnant women (fetus) and (b) the small possible increase in the risk of radiation induced cancers.

Safe (green): This meets international standards as the doses are less than the generic criteria at which protective actions and other response actions are justified. Below these doses there will not be any severe deterministic effects or an observable increase in the incidence of cancer, even in a very large exposed group. Furthermore, the risk of cancers and other health effects is too low to justify taking any action, such as a medical screening.

PROTECTIVE ACTIONS AND OTHER RESPONSE ACTIONS:

If the dose to an individual has been calculated that indicates that the health hazard level is ‘possibly dangerous to health’ (red) or ‘health concerns’ (orange), the individual needs to be registered and have their individual doses estimated to determine if a medical examination or counselling and medical follow-up are warranted. Health effects from radiation exposure can only be assessed by experts in diagnosing and treating the health effects of radiation exposure. Others, such as local physicians, probably will not have the expertise needed to make such assessments.



THIS CHART MUST NOT BE USED AS A BASIS FOR ASSESSING HEALTH HAZARDS (READ THE BACK).

EFFECTIVE DOSE CHART 6

- For a release of radioactive material from a LWR or RBMK
- Based on the calculated effective dose.

EFFECTIVE DOSE

E

HEALTH HAZARD

NOT SAFE

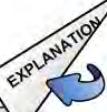
Exceeds international criteria for taking protective actions or other response actions

TAKE PROTECTIVE AND
OTHER RESPONSE ACTIONS
(SEE BACK OF CHART)

100 mSv

MAY NOT BE SAFE

ALWAYS ASSESS DOSE TO
THE THYROID, FETUS AND
RED MARROW, USING CHART 5



For further information read the back of this chart

CHART 6 EXPLANATION

PURPOSE: This chart cannot be used alone to place in perspective the link between the dose that has been calculated following a release from a reactor or spent fuel pool of a LWR or RBMK and the possible health hazard. Chart 5 must also be used to place the calculated dose in perspective.

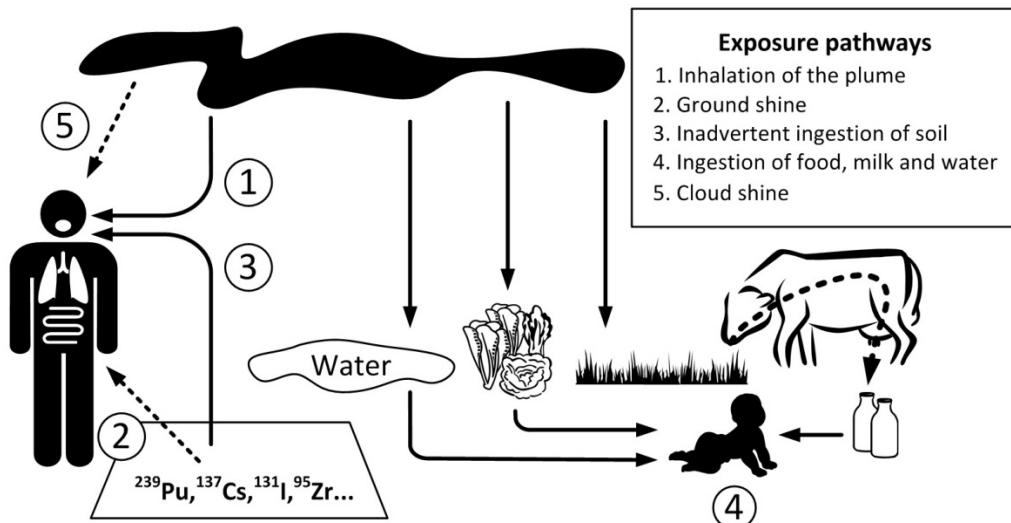
CALCULATED DOSE: Effective dose.

CHECKLIST FOR THE CALCULATION OF THE DOSE:

Do not use incomplete or uncertain data for dose calculations.

Calculation of the effective dose considers:

- The radionuclide mixture released from the reactor core or spent fuel pool;
- The members of the public most sensitive to radiation (e.g. children and pregnant women (fetus));
- All relevant exposure pathways, to include:
 - external exposure from the plume (cloud shine);
 - external exposure from ground deposition (ground shine);
 - inhalation of the plume;
 - inadvertent ingestion (e.g. from soil on hands); and
 - ingestion of food, milk or water.



ASSESSMENT

Not safe: An effective dose above 100 mSv is not safe as it has exceeded the international safety standards that warrant a medical follow-up.

- Take protective actions and other response actions in accordance with the OILs in the IAEA publication: Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, EPR-NPP PUBLIC PROTECTIVE ACTIONS, 2013.

Below 100mSv may not be safe:

- Always assess the dose to the thyroid, fetus and red marrow for a release from a reactor core or spent fuel pool. Chart 5 can be used to place the dose to the thyroid, fetus and red marrow in perspective, provided that the doses have been calculated correctly.



IAEA

Incident and Emergency Centre (IEC)
Department of Nuclear Safety and Security
International Atomic Energy Agency
PO Box 100, Vienna International Centre
1400 Vienna, Austria

Tel: +43 (1) 2600-22028

Fax: +43 (1) 26007-29309

Web: <https://iec.iaea.org>

Email: iec-information@iaea.org

