IAEA
International Atomic Energy Agency

BUILDING MATERIALS

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Natural Radioactivity of Building Materials

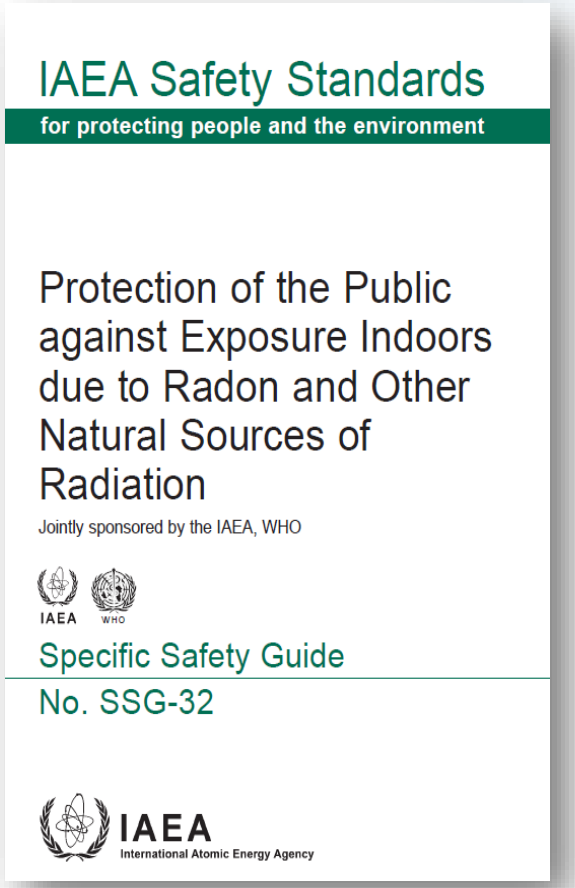
- All building materials contain various amounts of natural radioactive nuclides.
- Materials derived from rock and soil contain mainly natural radionuclides of the U and Th series, and the radioactive isotopes of potassium (K-40)
- In the U series, the decay chain segment starting from radium (Ra-226) is radiologically the most important and therefore reference is often made to radium instead of uranium
- Worldwide average concentrations in the earth's crust
  - radium: 40 Bq/kg, thorium: 40 Bq/kg, potassium: 400 Bq/kg

Activity Concentration in Building Materials

Material	Typical activity concentration (Bq/kg)			Maximum activity concentration (Bq/kg)		
Most common buildings	^{226}Ra	^{232}Th	^{40}K	^{226}Ra	^{232}Th	^{40}K
Concrete	40	30	400	240	190	1600
Aerated and light-weight concrete	60	40	430	2600	190	1600
Clay (red) bricks	50	50	670	200	200	2000
Sand-lime bricks	10	10	330	25	30	700
Natural building stones	60	60	640	500	310	4000
Natural gypsum	10	10	80	70	100	200
Most common industrial by-products used in building materials						
By-product gypsum (phosphogypsum)	390	20	60	1100	160	300
Blast furnace slag	270	70	240	2100	340	1000
Coal fly ash	180	100	650	1100	300	1500

Reference Level for Building Materials

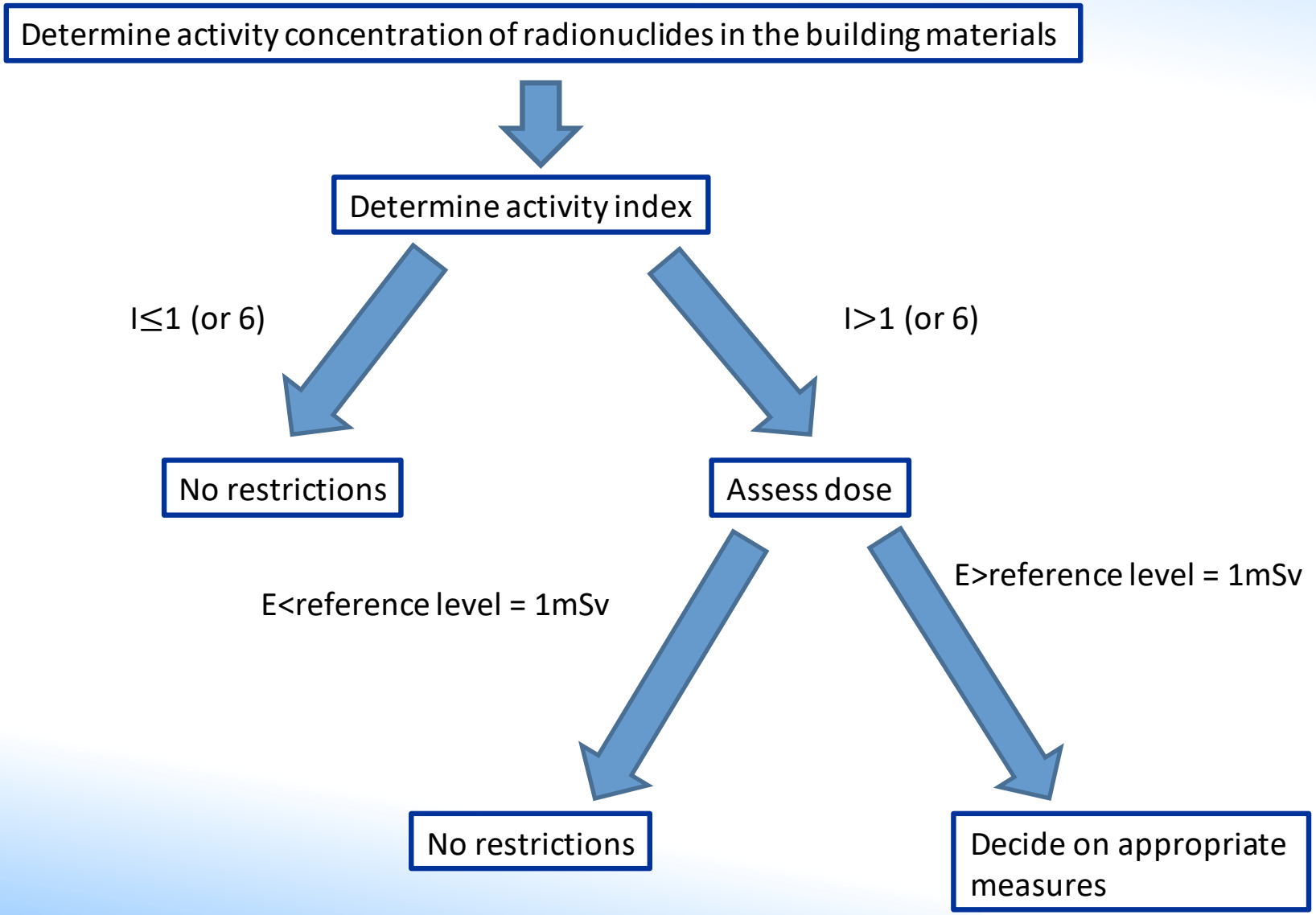
- Reference level of “annual effective dose to the representative person generally that does not to exceed a value of about 1 mSv” (para. 5.22)
- Several countries restrict the amount of radionuclides of natural origin in building materials
- Safety Guide SSG-32 proposes the use of an activity concentration index as a screening tool for identifying building materials that may need to be subject to restrictions



Reference Level for Building Materials

- $I = \frac{C_{Ra}}{300\ Bq/kg} + \frac{C_{Th}}{200\ Bq/kg} + \frac{C_K}{3\,000\ Bq/kg}$
- C_{Ra} is activity concentration of ^{226}Ra, C_{Th}:^{232}Th, C_K :^{40}K
- I < 1 for bulk materials or I < 6 for superficial materials (e.g. tiles), then annual effective dose less than reference level of 1 mSv
- The activity concentration index should be used only as a screening tool for identifying materials which might be of concern.
- Any actual decision on restricting the use of a material should be based on a separate dose assessment.
- Such assessment should be based on scenarios where the material is used in a typical way for the type of material in question.
- Scenarios resulting in theoretical, most unlikely maximum doses, should be avoided.

Flow-chart of the recommended system of control of building materials



Gamma Radiation from building materials in existing building

- Protective actions may be necessary for existing buildings with high annual effective dose levels caused by gamma radiation due to radionuclides in the building materials.
- If considered necessary, the national authority should establish reference levels for exposure to gamma radiation emitted from building materials in existing buildings.
  - Feasible protective measures are not easy to implement.
- Note that the protective measure carries serious economic and penalties and should not be applied without careful consideration.

Key Message

- Some NORM residues are used as building materials
- National responsibility to set a reference level
- Controls may be necessary