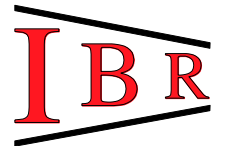


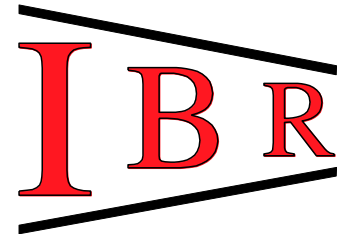
Building materials in the BSS

Rob Wiegers



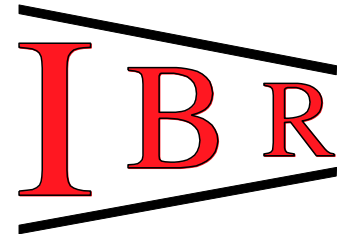
Legislation:

BSS and building materials



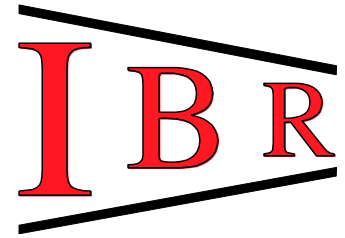
1. The reference level applying to indoor external exposure to gamma radiation emitted by building materials, in addition to outdoor external exposure, shall be 1 mSv per year.
2. For building materials which are identified by the Member State as being of concern from a radiation protection point of view, taking into account the indicative list of materials set out in Annex XIII with regard to their emitted gamma radiation, Member States shall ensure that, before such materials are placed on the market:
 - a) the activity concentrations of the radionuclides specified in Annex VIII are determined, and that,
 - b) information to the competent authority on the results of measurements and the corresponding activity concentration index, as well as other relevant factors, as defined in Annex VIII, are provided if requested.

Topics



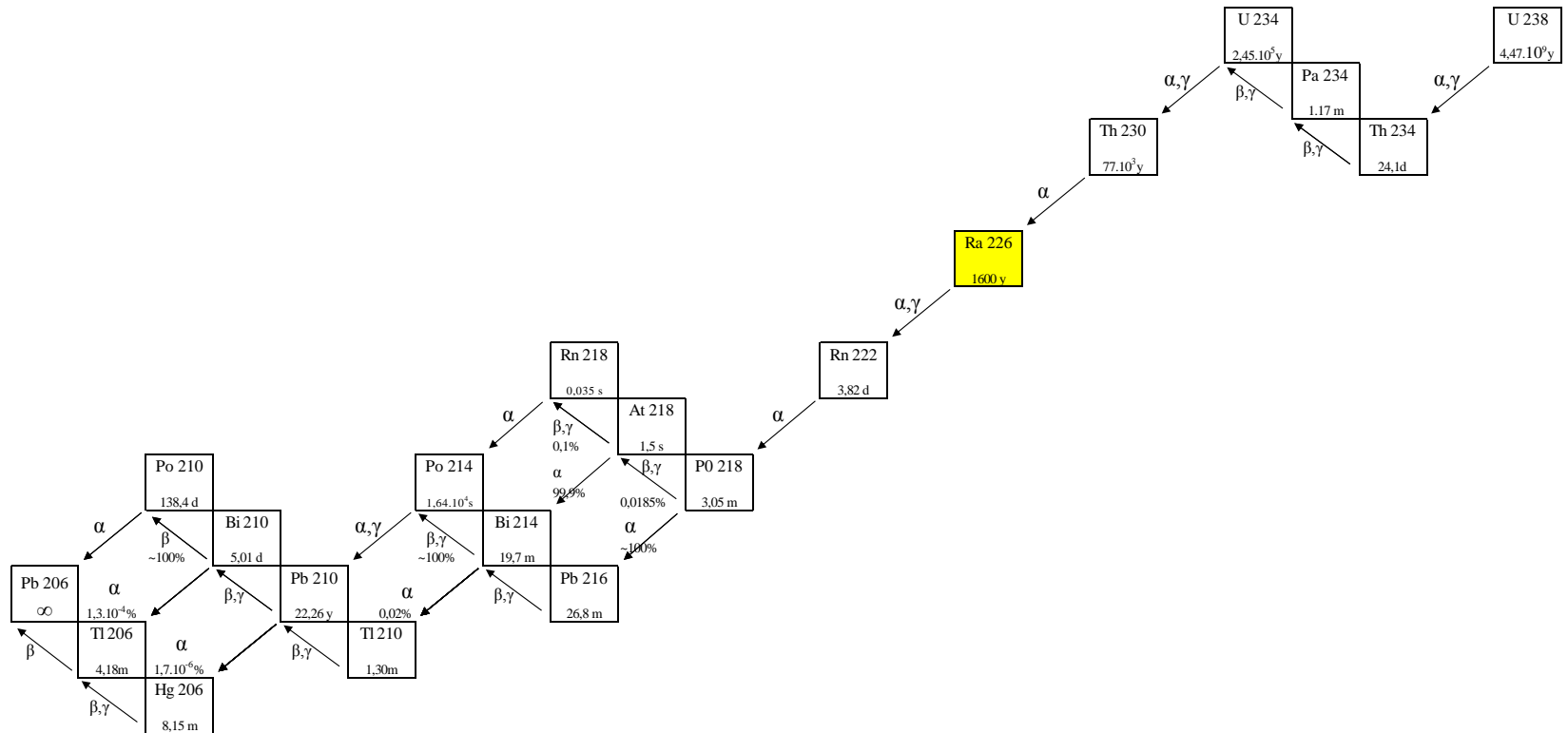
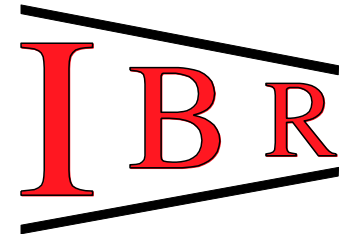
- NORM
- Building industry
- Use of NORM
- Legislation
- Potential impact
- Conclusions

NORM: history (source G. Jonkers)

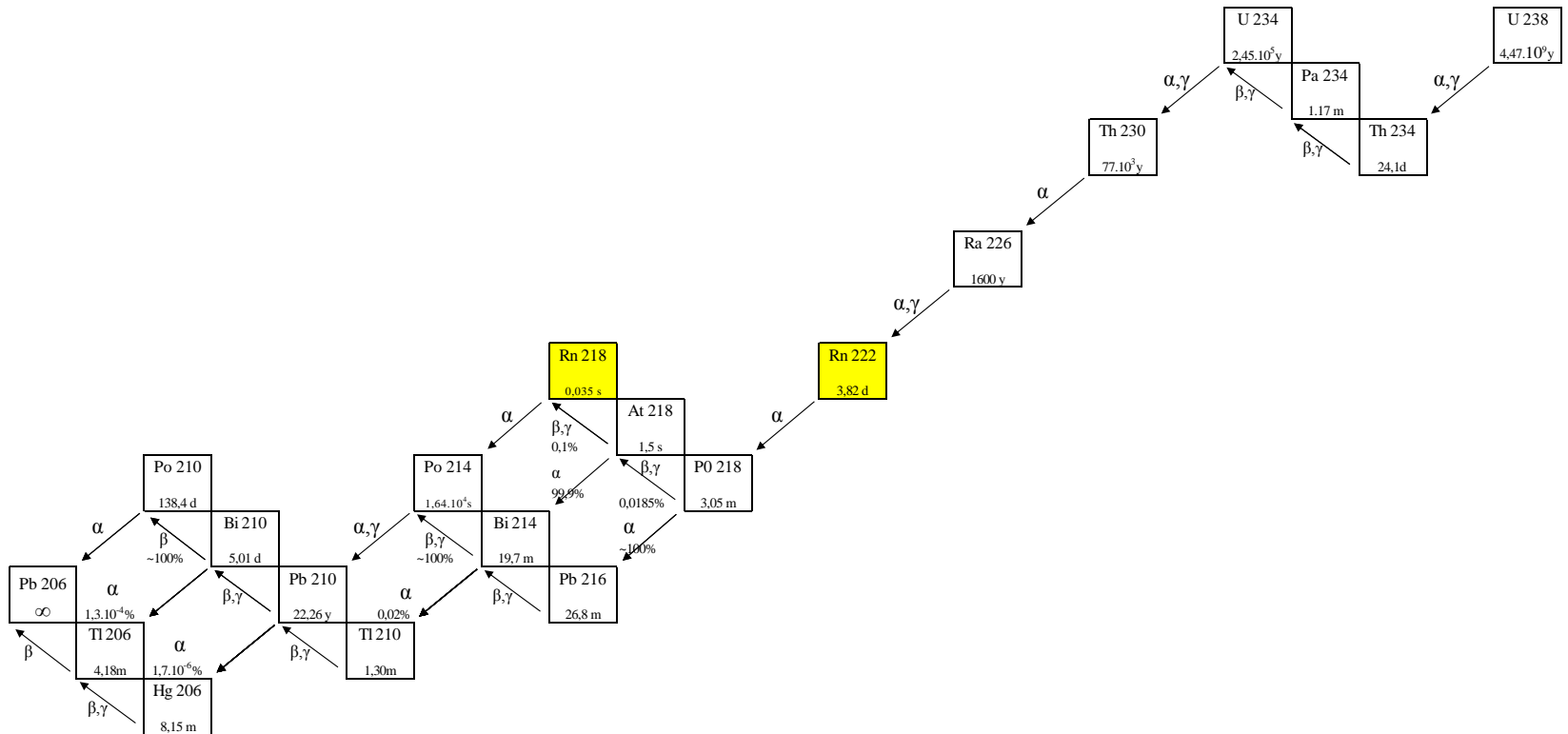
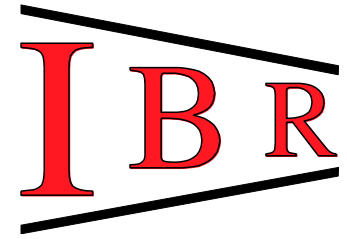


- 1904** *"Radioactivity in Natural Gases"* (Satterly *et al.*) > Radon
- 1928** *"Radioactivity in Oil Fields"* (Tscherepennikov *et al.*) > Radium
- 1951** *"Radioactivity Well Log Anomalies"* (Campbell) – *i.a.* caused US & USSR *"Oil Field Screening"* as a potential resource for Uranium (interest disappeared, when it turned out that the levels of radioactivity were due to enhanced levels of NOR's of Radium).
- 1975** HSE aspects of *"Radon in Natural Gas"* (Gesell) > with reference to *Ploughshare* project)
- 1977** No specific recommendations on Naturally Occurring Radionuclides (NOR's) in **ICRP 26** (basis for National Legislation)
- 1981** *Rediscovery Well Log Anomalies* (Piper α)
- 1983** *Gamma Ray Spectral Logging - A New Evaluation Frontier* (Fertl)
- 1984** Joint Industrial Guidance (E&P Forum > API > ...)
- 1988** National Competent Authority Regulations (US states > AELB > ...)
- 1991** No specific NOR recommendations in **ICRP 60**
- 1996** IAEA Basic Safety Standards (EU Directive) do not address NORM
- ... Turmoil in the Regulatory Scene / IAEA Guidance / Denial NORM issue
- 2005** Specific NOR recommendations in **ICRP 103**

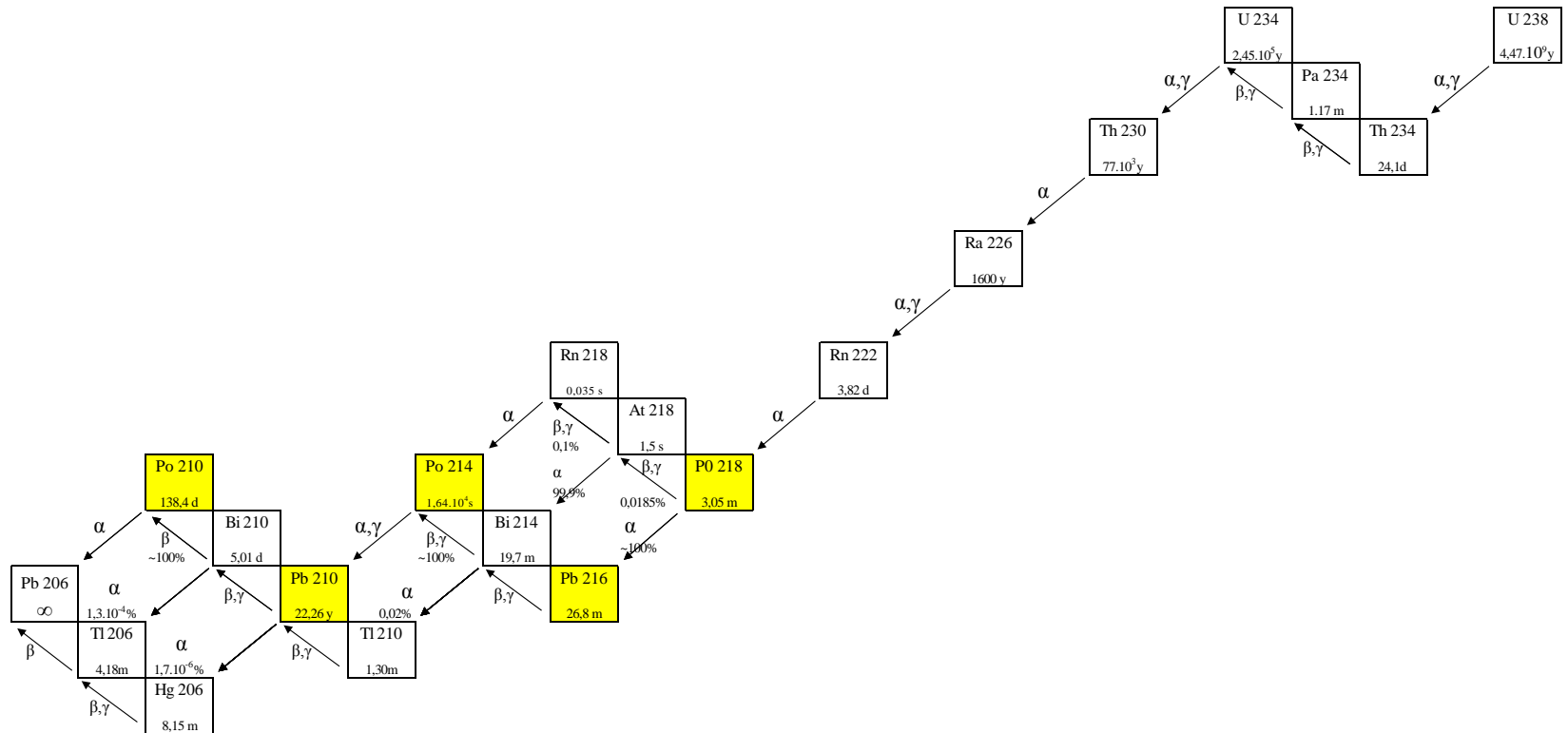
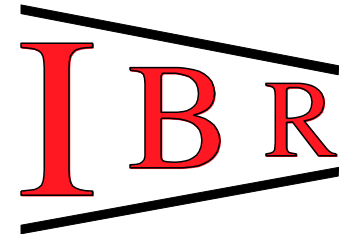
Decay chain U-238



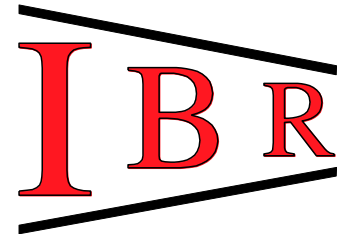
Decay chain U-238



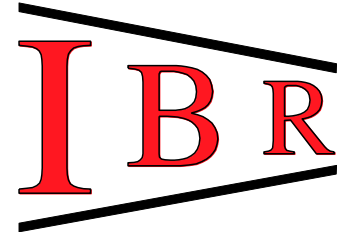
Decay chain U-238



BSS: installations



Use of NORM

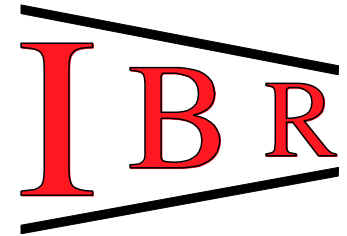


- Fly ash (cement/concrete)
- BF slag (cement/concrete)
- Phosphogypsum (plaster, blocks,...)
- ...

Normal range < 100 – 400 Bq/kg for U-238 and Th-232
and thus exceeding average values of sand, gravel and clay

Overview building materials

Concrete: activity concentration database (source: Risica et al)

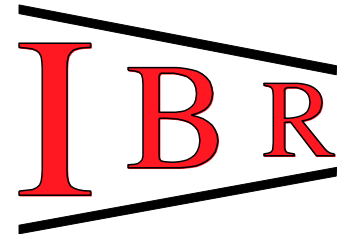


Concrete: ^{226}Ra , ^{232}Th and ^{40}K activity concentration (at least 2727 samples).

Country	N of samples	^{226}Ra (Bq kg $^{-1}$)			^{232}Th (Bq kg $^{-1}$)			^{40}K (Bq kg $^{-1}$)		
		Average	Min	Max	Average	Min	Max	Average	Min	Max
Austria	1	15	7	21	14	3	57	164	16	382
Belgium	37	17	5	42	16	5	42	247	85	490
Bulgaria	2	25	19	30	24	17	30	450	200	700
Czech Republic	491	33			24			495		
Denmark	121	152	15	670	27	10	53	620	280	1190
Finland	294	42	33	53	37	34	39	740	359	964
France	16	44	8	126	40	4	106	88	58	118
Germany	75	54	30	100	57	23	100	629	400	1100
Greece	64	40	22	85	6	3	17	101	7	383
Hungary	97	16	13	18	22	11	33	356	204	437
Ireland	8	29	18	68	12	3	13	217	16	1100
Italy	20	19	13	23	18	12	24	329	230	457
Lithuania	1	32			17			426		
Luxembourg	2	93	88	98	92	90	93	110	73	146
The Netherlands	55	35	10	115	30	6	132	263	140	870
Poland	678	115	65	200	72	36	127	666	492	1005
Portugal	38	61	1	167	50	1	152	747	11	1450
Romania	133	65	17	114	64	16	115	425	163	918
Slovakia	41	34	11	45	27	7	40	402	251	664
Slovenia	3	117	20	309	20	10	40	218	105	406
Spain	24	30			32			204		
Sweden	509	242	42	1300	70	31	100	627	276	819
United Kingdom	17	61	18	89	30	13	42	493	370	650
Overall average		60			35			392		
CV (%)		90			64			53		
Overall range			1	1300		1	152		7	1450

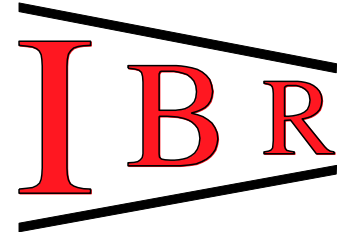
Legislation:

BSS and building materials



1. The reference level applying to indoor external exposure to gamma radiation emitted by building materials, in addition to outdoor external exposure, shall be 1 mSv per year.
2. For building materials which are identified by the Member State as being of concern from a radiation protection point of view, taking into account the indicative list of materials set out in Annex XIII with regard to their emitted gamma radiation, Member States shall ensure that, before such materials are placed on the market:
 - a) the activity concentrations of the radionuclides specified in Annex VIII are determined, and that,
 - b) information to the competent authority on the results of measurements and the corresponding activity concentration index, as well as other relevant factors, as defined in Annex VIII, are provided if requested.

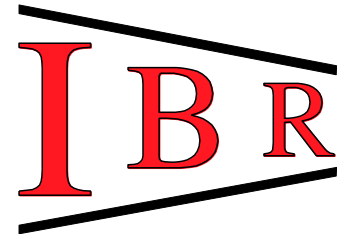
Building industry



- Size
- Structure
- Use of materials
- Environmental impact

Building industry:

Size (source EuroACE)



- 210 million buildings; Area of occupied space equivalent to size of Belgium
- 90% still used in 2050

Structure of the Sector

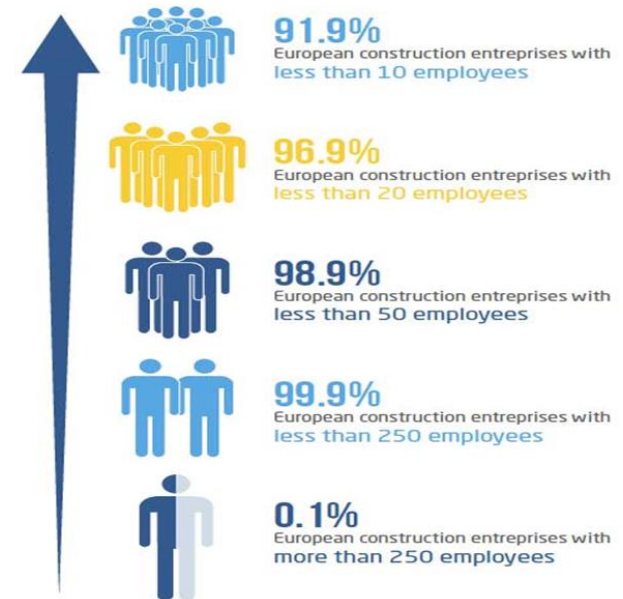
3 million enterprises – mainly micro-enterprises
18 million workers – mainly older, male workers

Impact on EU GDP

Represents about 9% EU GDP
Varies depending on the country

Renovation Market

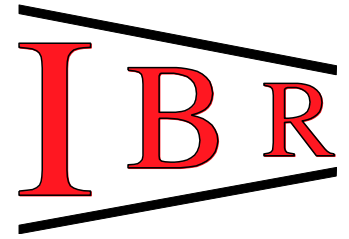
Rate too slow
Ambition too low



Construction Sector = 9% EU GDP

Building industry:

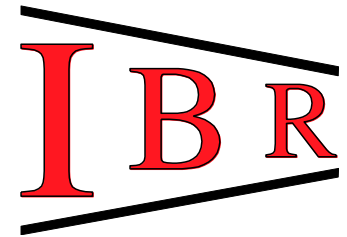
Size (source eurostat)



Use of sand and aggregates (in million Tons/y)

- Austria: 55
- Belgium: 66
- Denmark: 38
- France: 310
- Germany: 450
- Netherlands: 110
- UK: 150

Building industry: Size



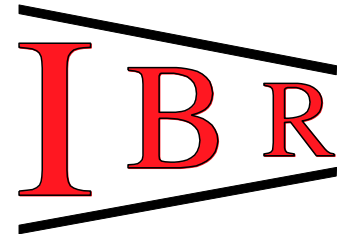
	Enterprises (thousand)	Turnover (EUR million)	Value added (EUR million)	Persons employed (thousand)	Share in total (%)	
					Value added	Persons employed
Ceramic and clay products (2)	21.0	39 074	15 572	368.4	100.0	100.0
Ceramic goods other than for construction purposes	16.2	17 273	6 600	191.9	42.4	52.1
Ceramic tiles and flags (2)	1.8	13 076	4 602	93.5	29.5	25.4
Clay bricks, tiles and construction products	3.0	10 657	4 371	83.0	28.1	22.5

(1) Rounded estimate based on non-confidential data.

(2) Turnover, 2005.

Source: Eurostat (SBS)

Building industry: Simplified structure

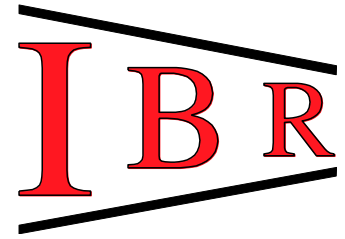


Structure/stakeholders (as far as relevant for this subject):

- Raw material suppliers (e.q. quarries, by-products...) → permits
- Production of building products → permits
- Construction industry → ↓
- Architects → owner
- Users → ↑
- Authorities; legislation/permits

Building industry:

Reducing resource use in buildings

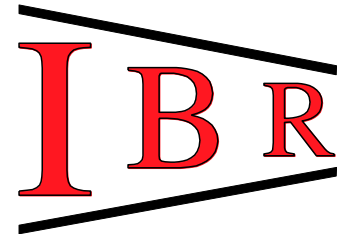


Consumption of resources and related environmental impacts throughout a building's life cycle can be reduced by:

- Promoting better design that weighs resource use against the needs and functionality of the building and considers scenarios for deconstruction;
- Better project planning which ensures a greater use of resource and energy efficient products;
- Promoting more resource efficient manufacturing of construction products by, for example, **using recycled materials, reusing existing materials** and using waste as a fuel;
- Promoting more resource efficient construction and renovation by, for example, **reducing construction waste and recycling/re-using materials** and products so that less is sent to landfill.

Source: COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS ON RESOURCE EFFICIENCY OPPORTUNITIES IN THE BUILDING SECTOR

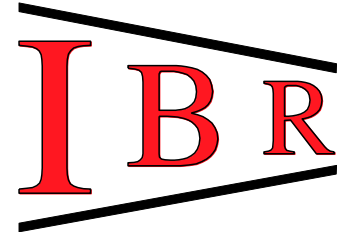
Building industry: Importance of recycling



On 13 September, in his annual [State of the Union address](#), President Jean-Claude Juncker stated: "*I want to make our industry stronger and more competitive. The new Industrial Policy Strategy we are presenting today will help our industries stay or become the world leader in innovation, digitisation and **decarbonisation**.*"

Vice-President for Jobs, Growth, Investment and Competitiveness Jyrki Katainen said: "*By embracing technological change, converting research investments into innovative business ideas, and continuing to pioneer the **low-carbon and circular economy** we will pave the way for a smart, innovative and sustainable industry in Europe.*"

Use of NORM

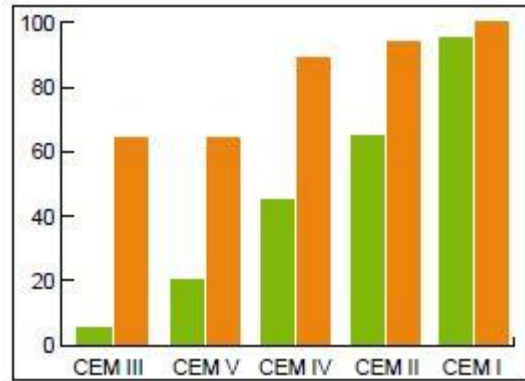
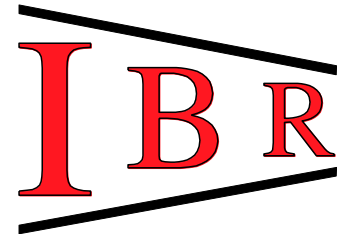


- Fly ash (cement/concrete)
- BF slag (cement/concrete)
- Phosphogypsum (plaster, blocks,...)
- ...

Normal range < 100 – 400 Bq/kg U-238 and Th-232

Impact: reuse, CO₂-emission reduction, specific properties for specific applications

Building industry: Environmental impact



Use of cement clinker for different types of (blended cements).

CEM III: BFC

CEM V: BF + PFA

Typical CO₂ emission per Mg cement: 1,25 Mg

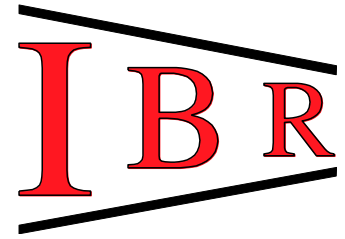
Lowest (NL due to use NORM by-products): 0,75Mg CO₂

EU cement industry: 150.000.000 Mg CO₂/y

Huge potential for further reduction thanks to NORM!

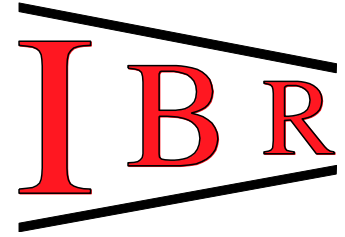
Legislation:

BSS and building materials



1. The reference level applying to indoor external exposure to gamma radiation emitted by building materials, in addition to outdoor external exposure, shall be 1 mSv per year.
2. For building materials which are identified by the Member State as being of concern from a radiation protection point of view, taking into account the indicative list of materials set out in Annex XIII with regard to their emitted gamma radiation, Member States shall ensure that, before such materials are placed on the market:
 - a) the activity concentrations of the radionuclides specified in Annex VIII are determined, and that,
 - b) information to the competent authority on the results of measurements and the corresponding activity concentration index, as well as other relevant factors, as defined in Annex VIII, are provided if requested.

Legislation: BSS building materials



To provide for guidance (1/3)

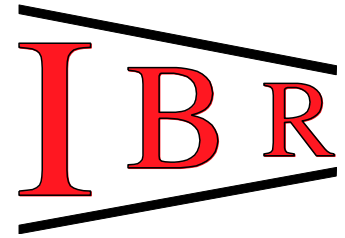
$$I = C_{226\text{Ra}}/300 + C_{232\text{Th}}/200 + C_{40\text{K}}/3000 \quad (C \text{ in Bq/kg})$$

EC mandated CEN under Council dir. 89/106/EEC of Dec. 1988 to help standardize and harmonize activity concentration measurement and test standards.

"TG 31"

Legislation:

BSS index CEN proposal



Proposal

$$D = \left[\begin{array}{l} [281 + 16.3\rho d - 0.0161(\rho d)^2] \cdot C_{Ra} \\ + [319 + 18.5\rho d - 0.0178(\rho d)^2] \cdot C_{Th} \\ + [22.3 + 1.28\rho d - 0.00114(\rho d)^2] \cdot C_K \end{array} \right] \cdot 10^{-6} - 0.29 \text{ mSv}$$

for $\rho d < 500 \text{ kg/m}^2$

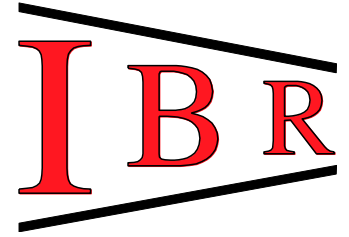
$\cong 60 \text{ nSv/h}$

\approx surface area weighted
average of all 23 countries

(7000 h, 0.7 Sv/Gy)



Demands

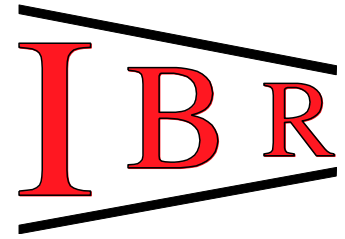


Must serve a purpose

If so, then the implementation should:

- be efficient
- be transparent/enforceable
- social gain must outweigh the (social) costs (ALARA)

Legislation (approaches!)

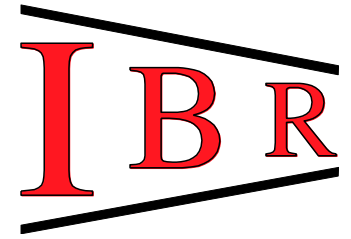


- No problem -> no regulation only monitoring
- No problem -> low implementation level including monitoring
- Full implementation on all levels/involving many stakeholders (and still no problem?)

Aspects to be addressed as well:

- Free movement of products within EU
- Measurement capacity
- (Counter productive) influence on materials use
- Many, many more large and small day by day aspects

Conclusion



- Generally no problem with building materials in EU
- Building industry:
 - Complex
 - Large
 - Collateral damage
 - Cost efficiency

Potentially low gain to cost ratio!!

Thanks for your attention