Naturally Occurring Radioactive Materials (NORM) used in French industrial facilities:

Uranium and thorium series activities concentrations and associated occupational exposures

6th International Symposium on Naturally Occuring Radioactive Material (NORM VI)

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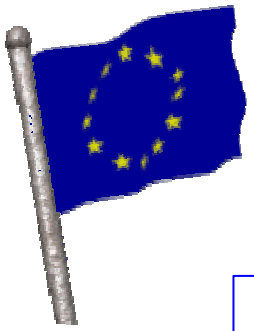
Contents

- Regulations
- Synthesis of data
  - Uranium and thorium series activities
  - Occupational exposures
- Conclusions

Regulations

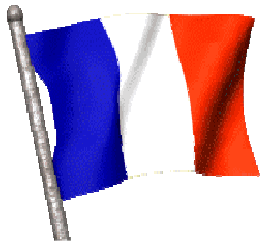
A potential radiation risk can result from the presence of natural radionuclides in materials usually considered as not radioactive and used in non nuclear manufacturing.



96/29 EURATOM Directive
Title VII - Significant increase in exposure due to natural radiation sources

Art. 40: Which industries are concerned ?
Art. 41: Are radiation protection actions required ?

French Public health code | **French Labour code**



French Ministerial Order of May 25, 2005

* Defines a list of ten industries concerned

The list of relevant industrial activities

- Coal combustion in thermal power plants
- Treatment of tin, aluminium, copper, titanium, niobium, bismuth and thorium ores
- Production of refractory ceramics and smelting, metallurgy and glass industry using them
- Production or use of compounds with thorium
- Production of zircon and baddeleyite, and smelting or metallurgy plants using them
- Production of phosphated fertilizers and phosphoric acid
- Treatment of titanium dioxide
- Treatment of rare earths and production of pigments containing them
- Underground water treatment by filtration
- Spas

A significant number of industrial facilities potentially concerned

Regulations

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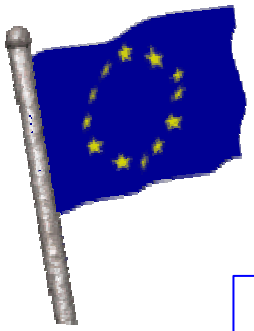

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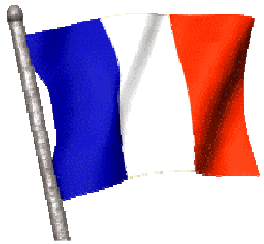


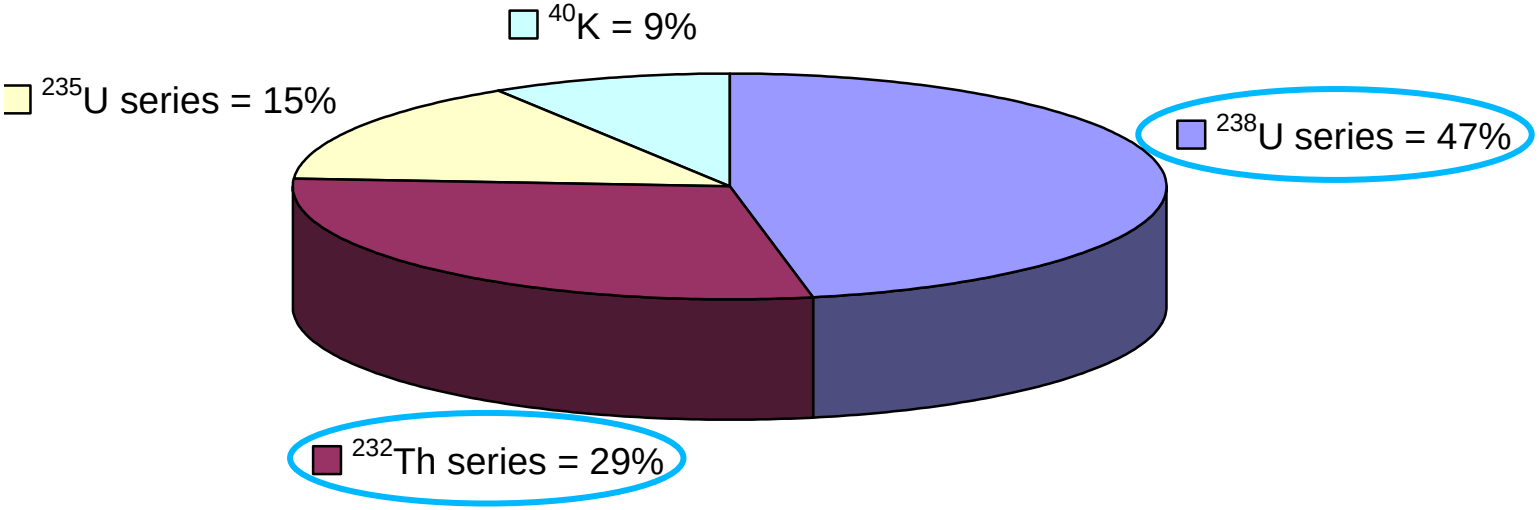
French Ministerial Order of May 25, 2005

* Defines a list of ten industries concerned
* Imposes on the operator to carry out dose assessments for workers and population
* Characterization of raw materials, products and waste

Doses assessments are conducted under the responsibility of the industrial operator and conclusions are addressed to the French Nuclear Safety Authority (ASN) and to the IRSN

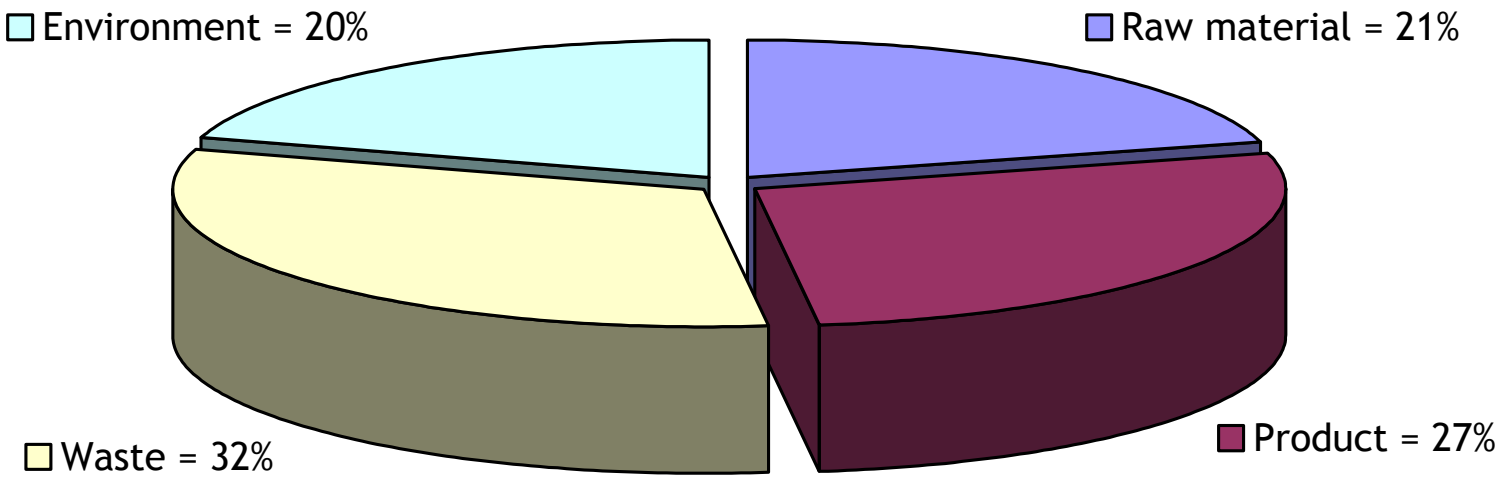
The studies received

- 90 studies received at the end of 2009
- 43 studies present activity concentration measurements
  - mainly carried out by gamma spectrometry
- 4200 results of measurements for 500 samples

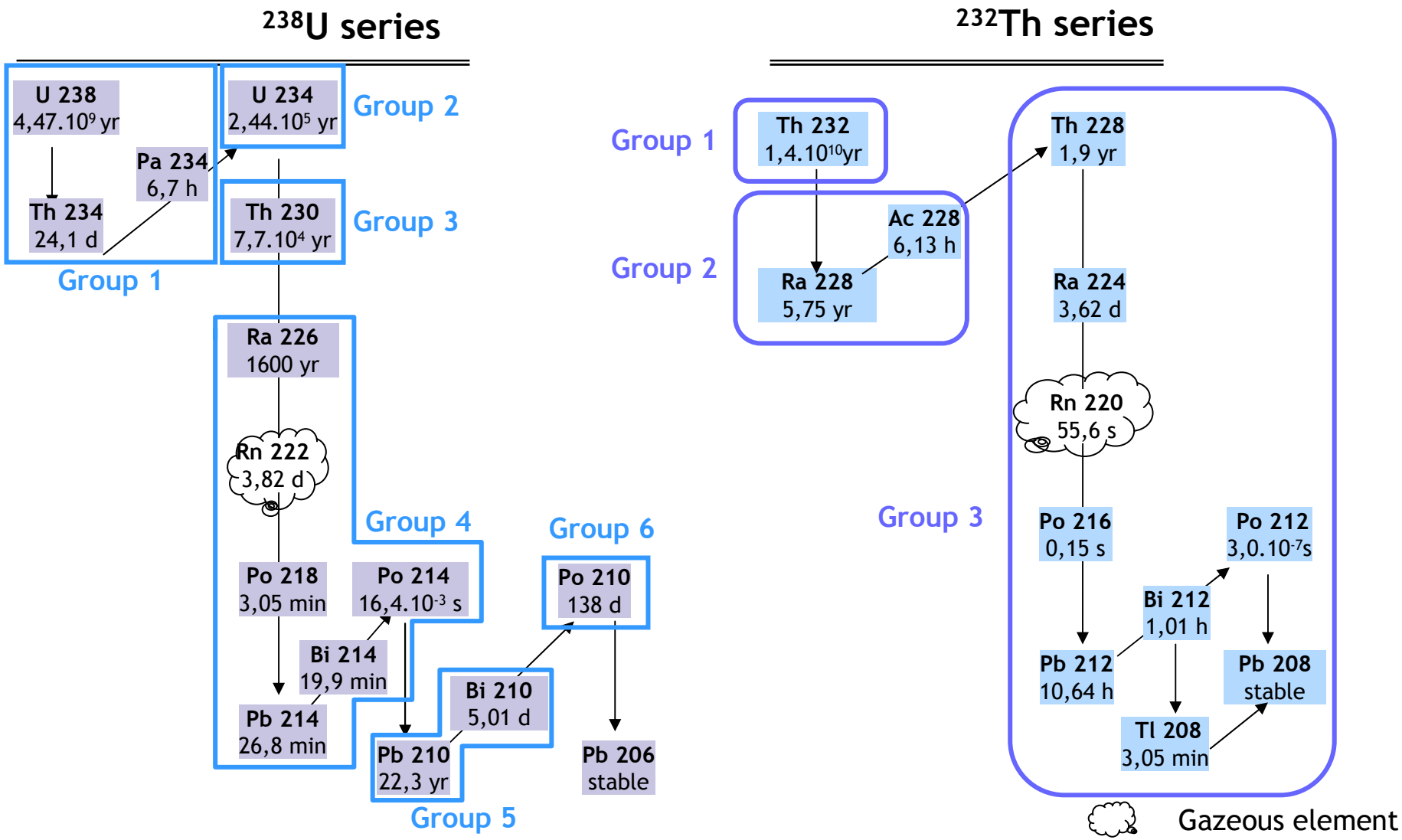


Sorting of samples

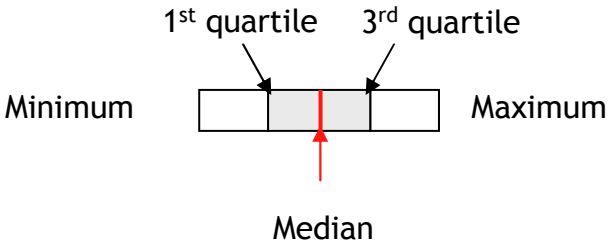
- Type of industrial activity
- Nature of the sample
  - Raw material
  - Product and by-product
  - Waste, effluent, sludge and dust
  - Environment (excluded from our work)



Chain segments of ^{238}U and ^{232}Th series



$^{226}Ra^{+}$ activities



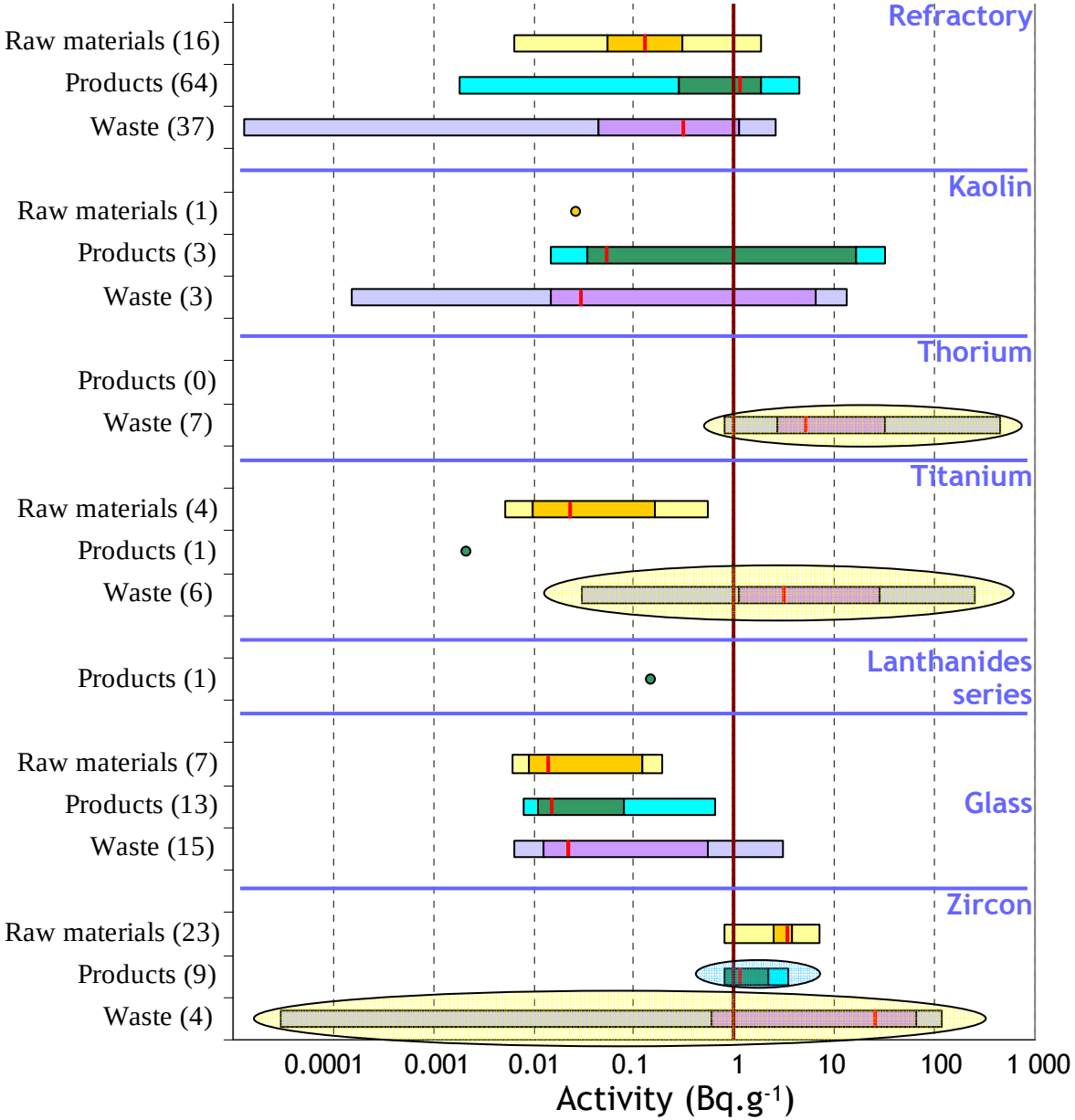
Raw material

Product

Waste

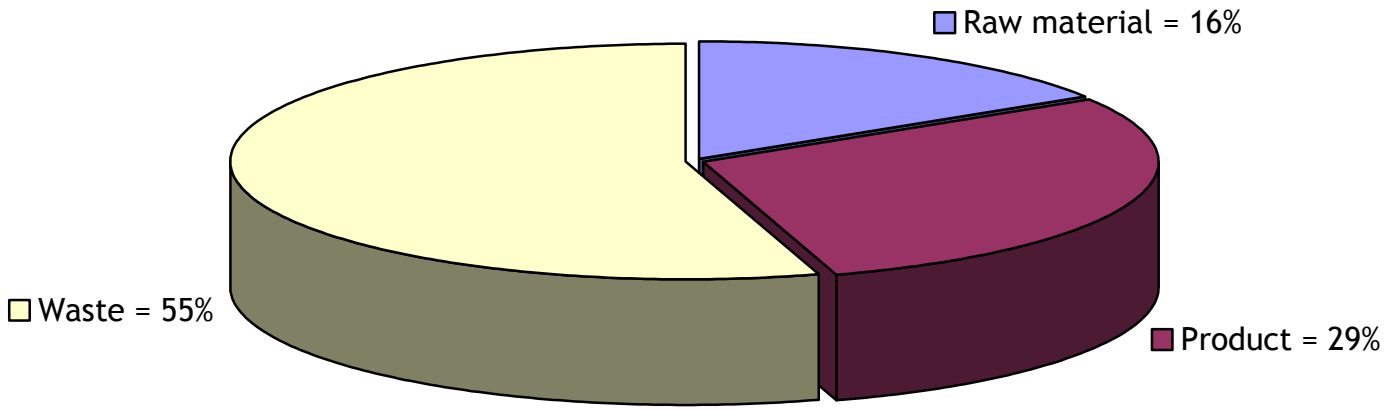
(X) Number of samples with an activity > LD

IAEA's exemption level recommended for NORM



Conclusions on U and Th series activities (1/2)

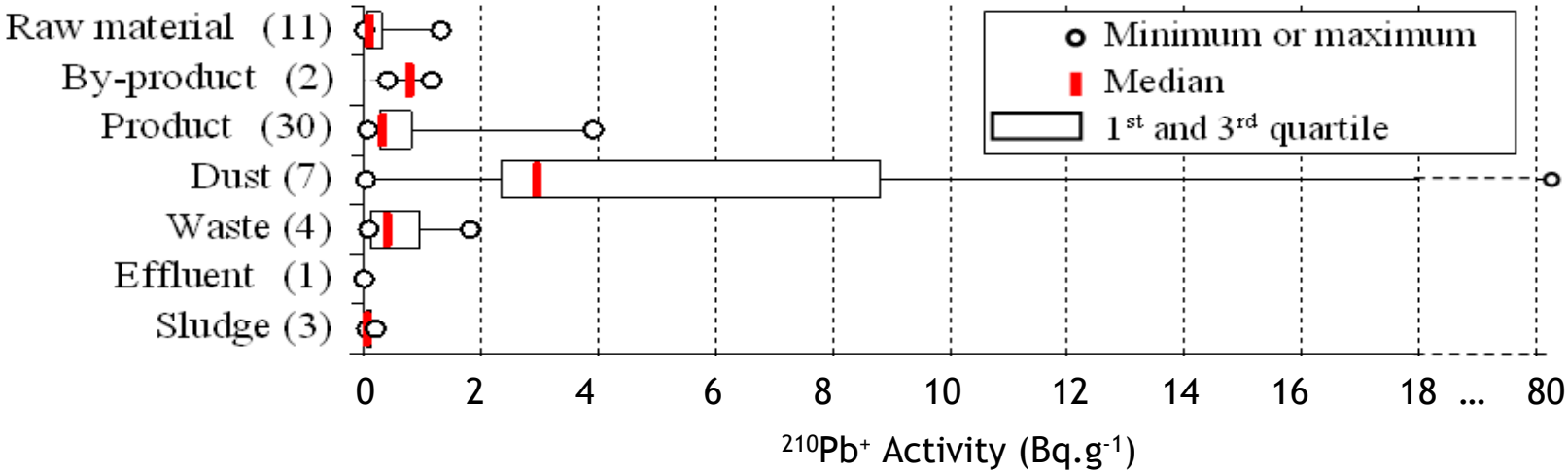
- **Wide variability according to:**
  - Type of industrial activity
  - Nature of the sample
- **The highest activities in general correspond to waste**
- **Activities greater than 1 Bq.g^{-1} (IAEA's exemption level recommended for NORM):**

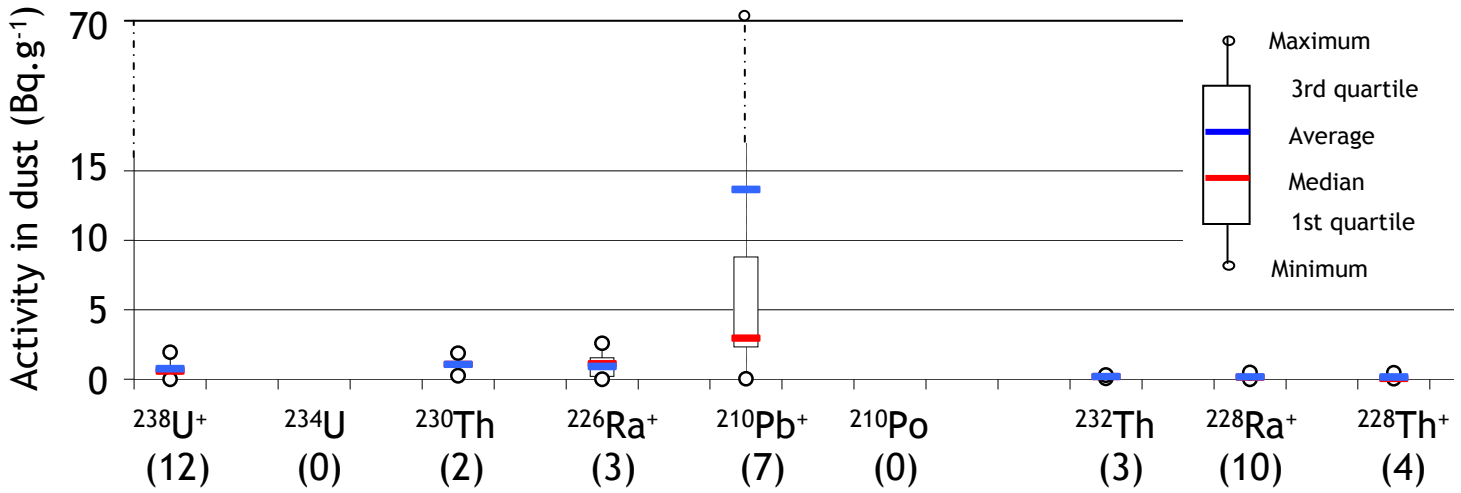


- **Some imbalances have been identified :**
  - ^{226}Ra in excess in waste from filtration of underground water
  - ^{210}Pb in excess in ashes or dust produced by heating processes

Conclusions on U and Th series activities (2/2)

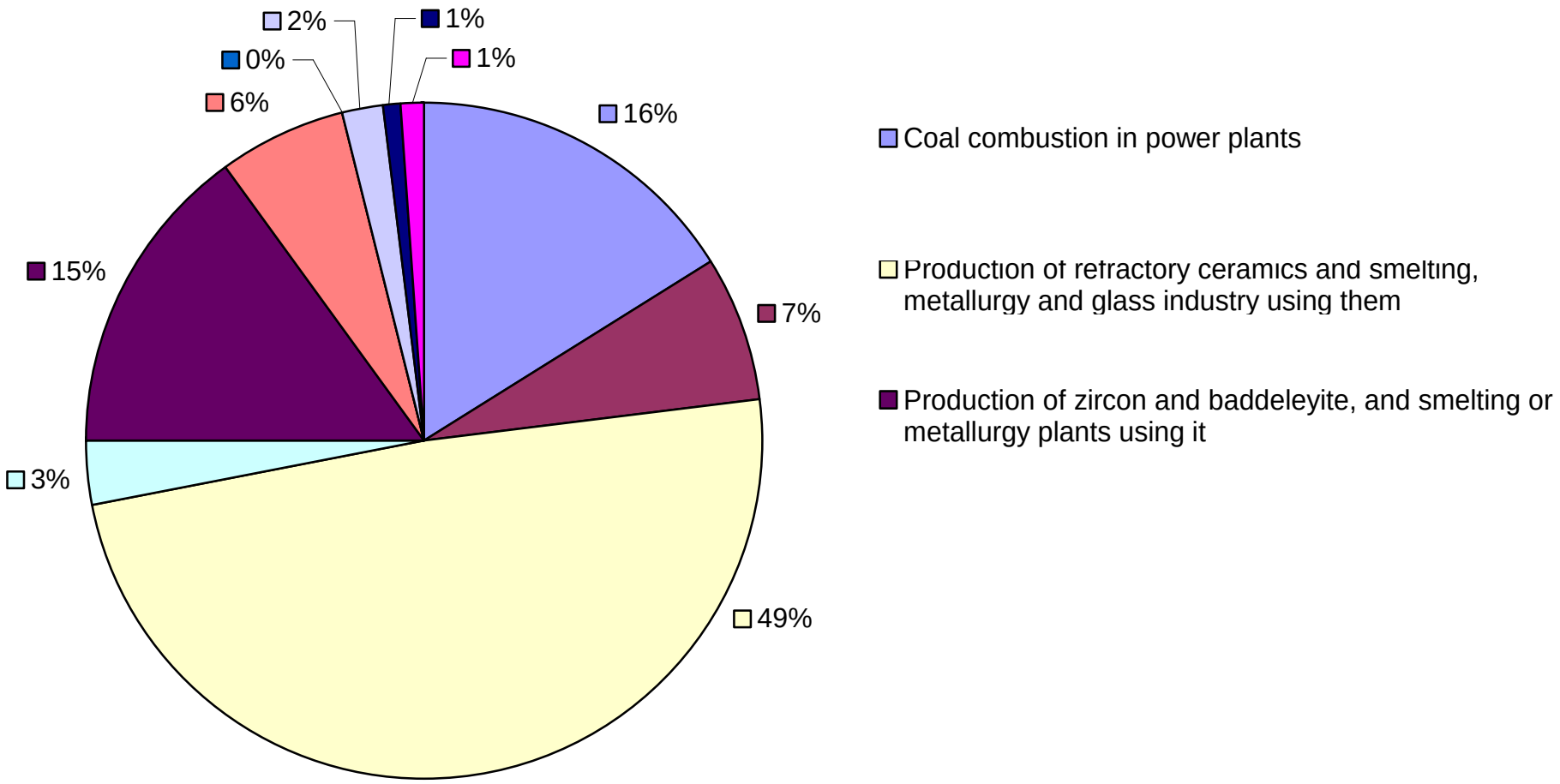
- Example of ^{210}Pb in excess in dust from refractory industry





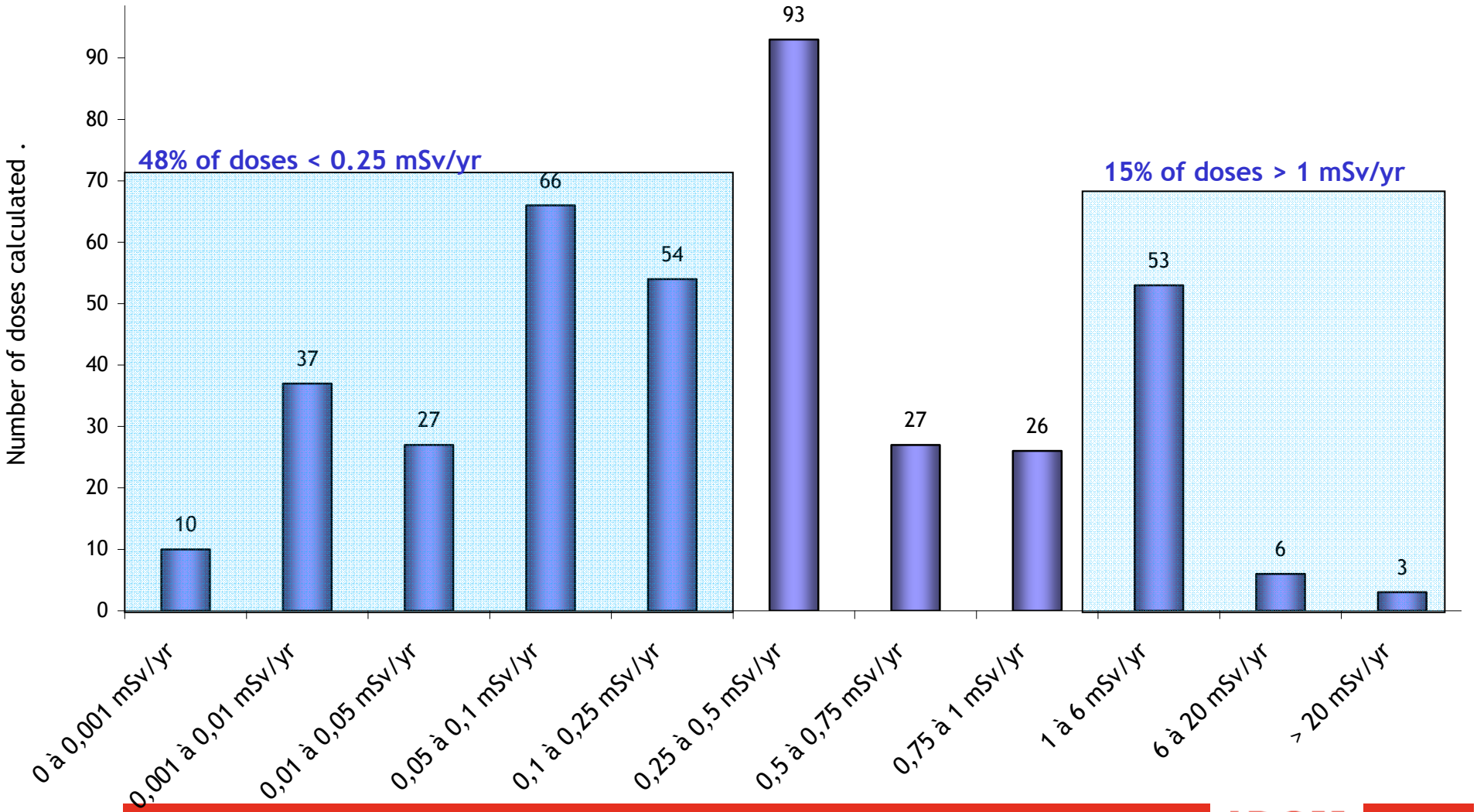
The studies received

- 90 studies received at the end of 2009
  - 91% of them present an occupational dose
  - 9 types of industrial facilities



Doses presented by operators (1/2)

- ~400 workplaces

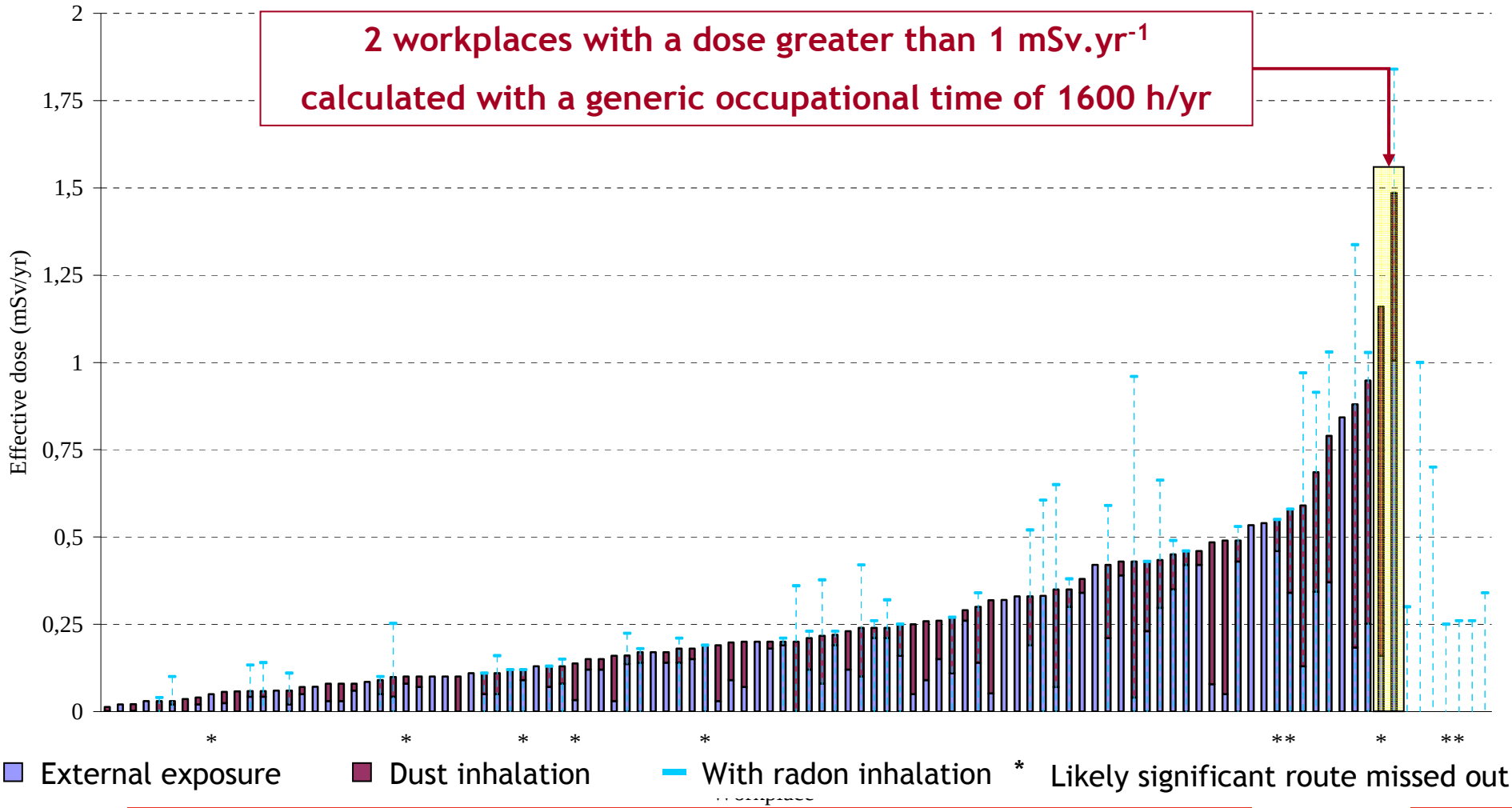


Doses presented by operators (2/2)

- **Difficulties to compare these doses**
  - Routes of exposure
    - Some doses take into account:
      - External exposure
      - Internal exposure by inhalation of dust
    - Some doses do not take into account one of these routes of exposure even it could be significant
    - Some doses take into account internal exposure by inhalation of radon progeny
  - Natural background
    - Some doses take into account the exposure due natural radioactivity present in the environment
    - From others doses, the natural background have been subtracted
  - Wide variability according to the industrial activity
- **To compare, for each industrial activity defined in French regulation:**
  - Calculation of doses in excess of the natural background
  - Exposure due to radon have been considered specifically
  - Identification of doses likely underestimated

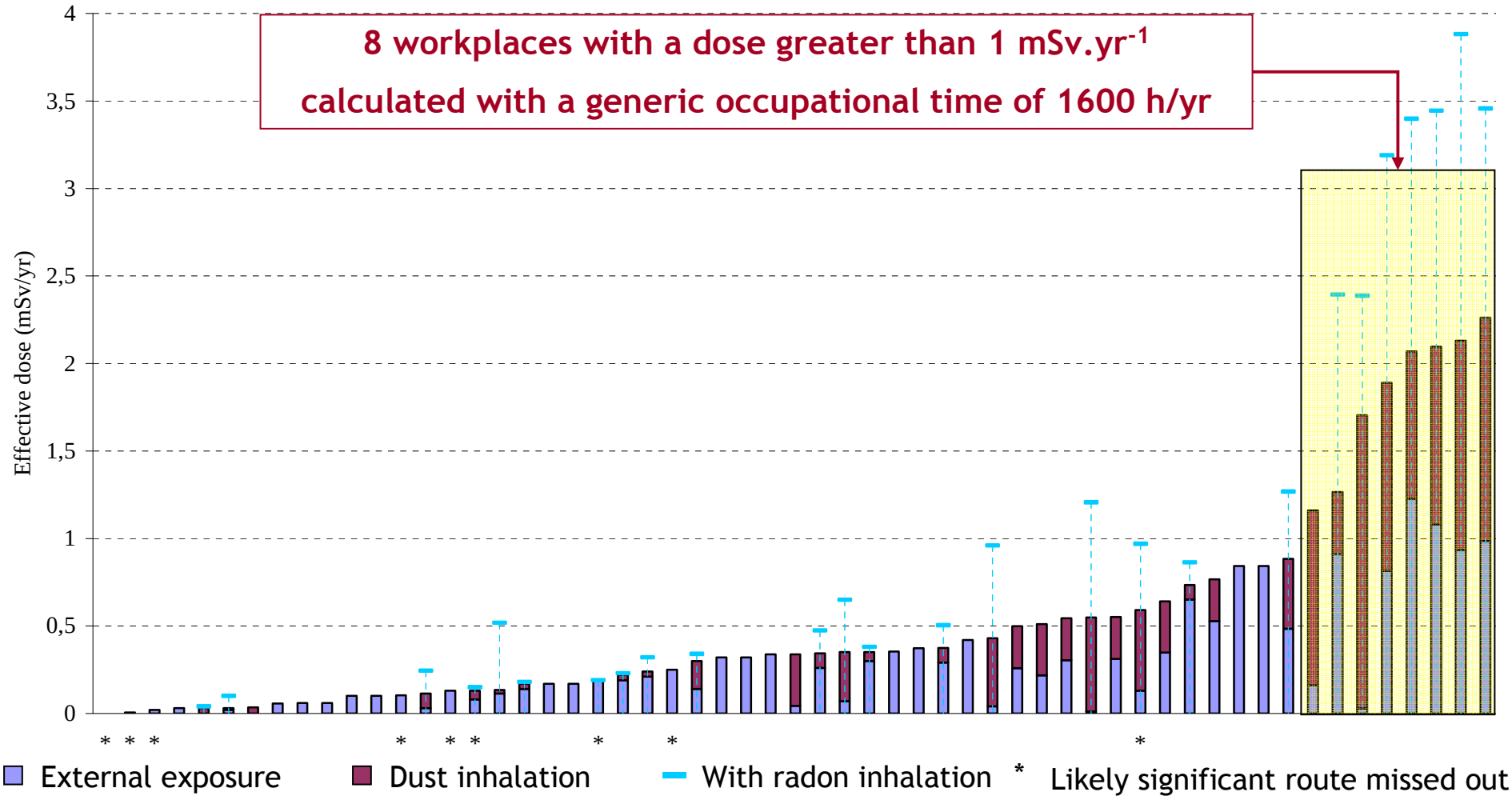
Refractory industry

- ~ 100 workplaces evaluated
- Maximum effective dose ~ 1.5 mSv.yr^{-1} ➔ Consistent with literature



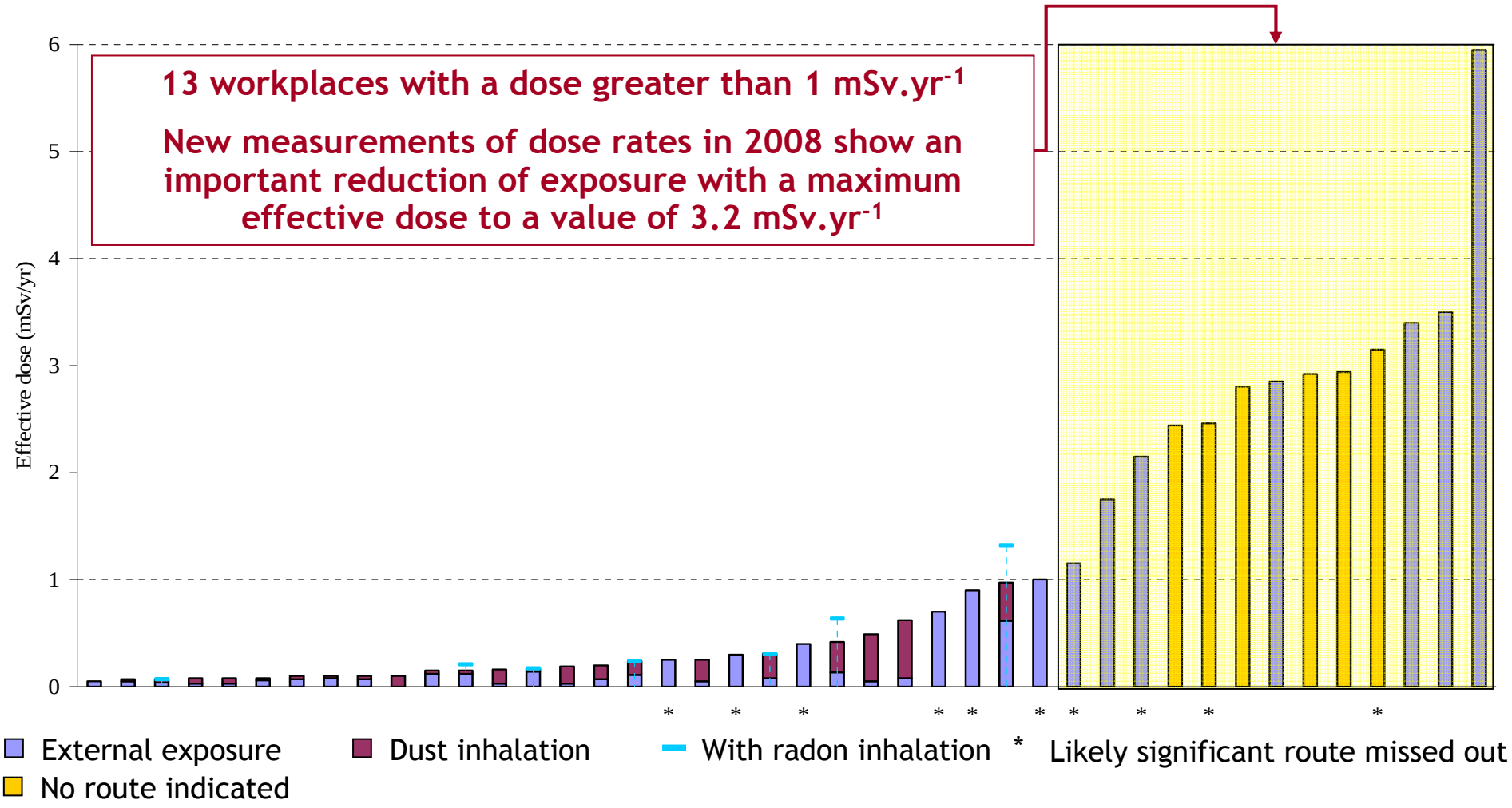
Zircon industry

- ~ 60 workplaces evaluated
- Maximum effective dose ~ 2.3 mSv.yr^{-1} ➔ Consistent with literature



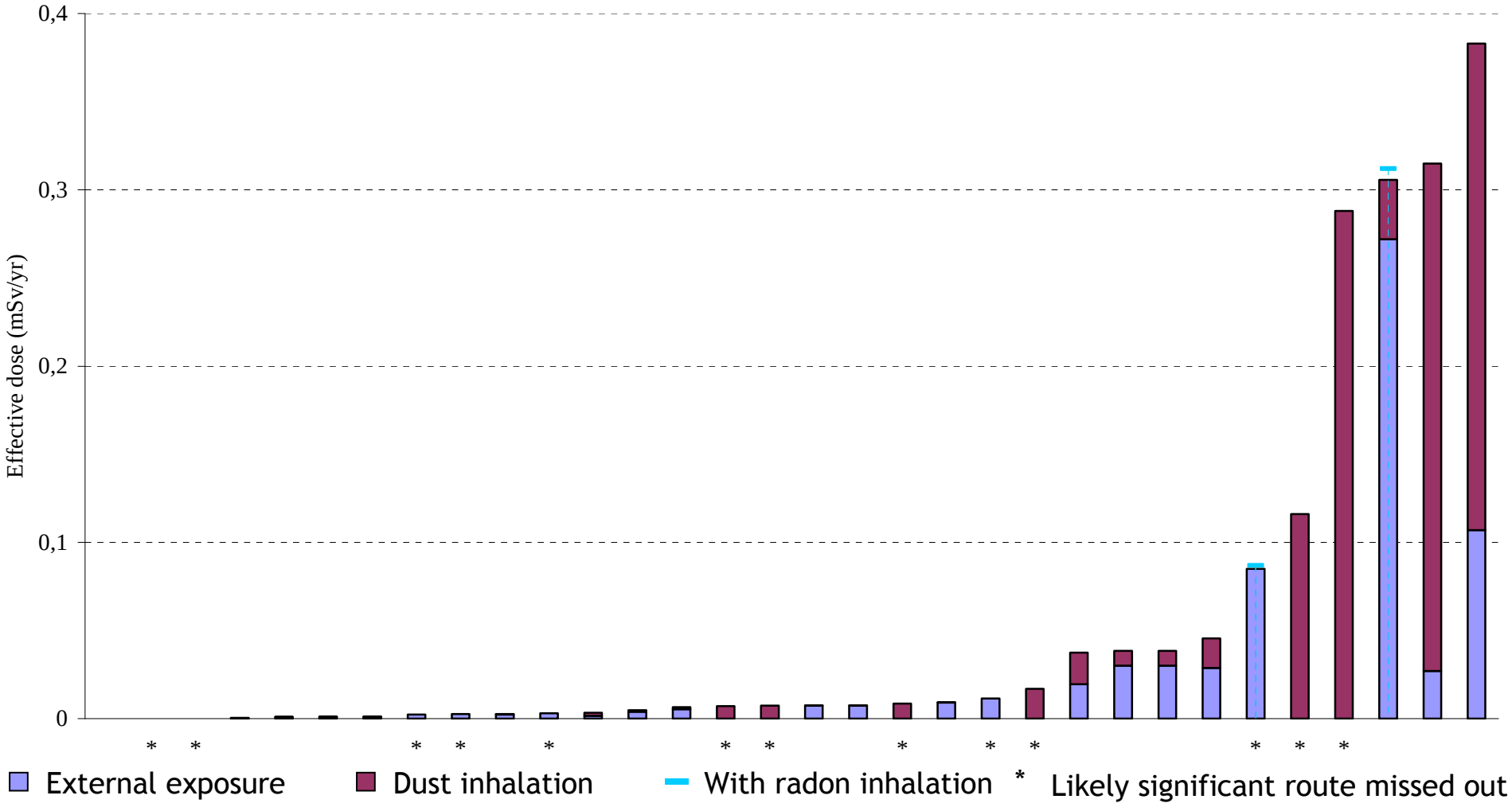
Treatment of Sn, Al, Ti and Nb ores

- ~ 40 workplaces evaluated
- Maximum effective dose ~ 6.0 mSv.yr^{-1} ➔ Consistent with literature



Coal combustion

- ~ 30 workplaces evaluated
- Maximum effective dose ~ 0.4 mSv.yr^{-1} ➔ Consistent with literature

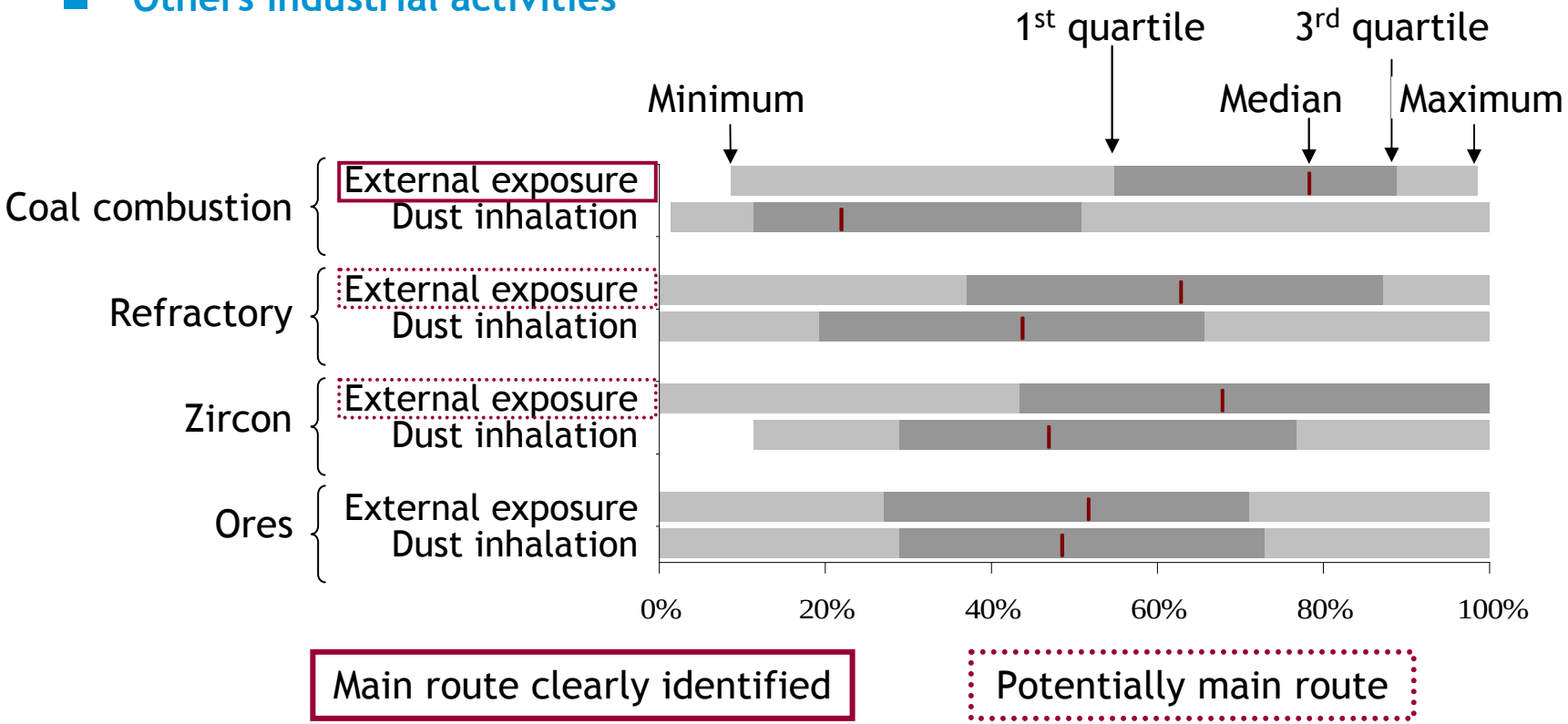


Others industrial activities

- **Production of phosphated fertilizers**
  - 6 workplaces
  - All doses are below 1 $mSv.yr^{-1}$
  - Maximum dose = 0.5 $mSv.yr^{-1}$
  - Consistent with literature
- **Treatment of lanthanides series**
  - 3 workplaces
  - All doses are below 1 $mSv.yr^{-1}$
  - Maximum dose = 0.3 $mSv.yr^{-1}$
  - Consistent with literature
- **Production or use of compounds with thorium**
  - 6 workplaces
  - Except two doses, all doses are below 1 $mSv.yr^{-1}$
  - Maximum dose = 82 $mSv.yr^{-1}$ mainly due to dust inhalation
  - Actions of exposure reduction presented by the operator:
    - Use of personal protective equipment
    - Periodically cleaning of dust in his installation
    - Installation of an equipment of air filtration
    - ➔ A significant reduction of doses is expected but IRSN and French authorities have not yet received the new study

Route of exposure

- **Not enough data for these activities to conclude:**
  - Production of phosphated fertilizers
  - Treatment of lanthanides series
  - Production or use of compounds with thorium
- **Others industrial activities**



Conclusions

- 10% of dose in excess of the natural background (without the contribution of radon) are still greater than 1 $mSv.yr^{-1}$
- Assessments are still expected
  - For example, studies dealing with occupational exposure due to underground water treatment by filtration
- Highest doses were found in facilities which:
  - Produce materials involving thorium (82 $mSv \cdot yr^{-1}$)
  - Treat tin, aluminium, titanium and niobium ores (6 $mSv \cdot yr^{-1}$)
- External and internal exposure are often of the same order of magnitude
  - Except for coal combustion
- Some types of industrial facilities currently not included in the French regulation
  - Modification of the list of industrial facilities set by the Ministerial order of May 25, 2005
    - By addition
    - By deletion
  - e.g. paper mills

IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Thank you for your attention

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