

## EAN - NORM

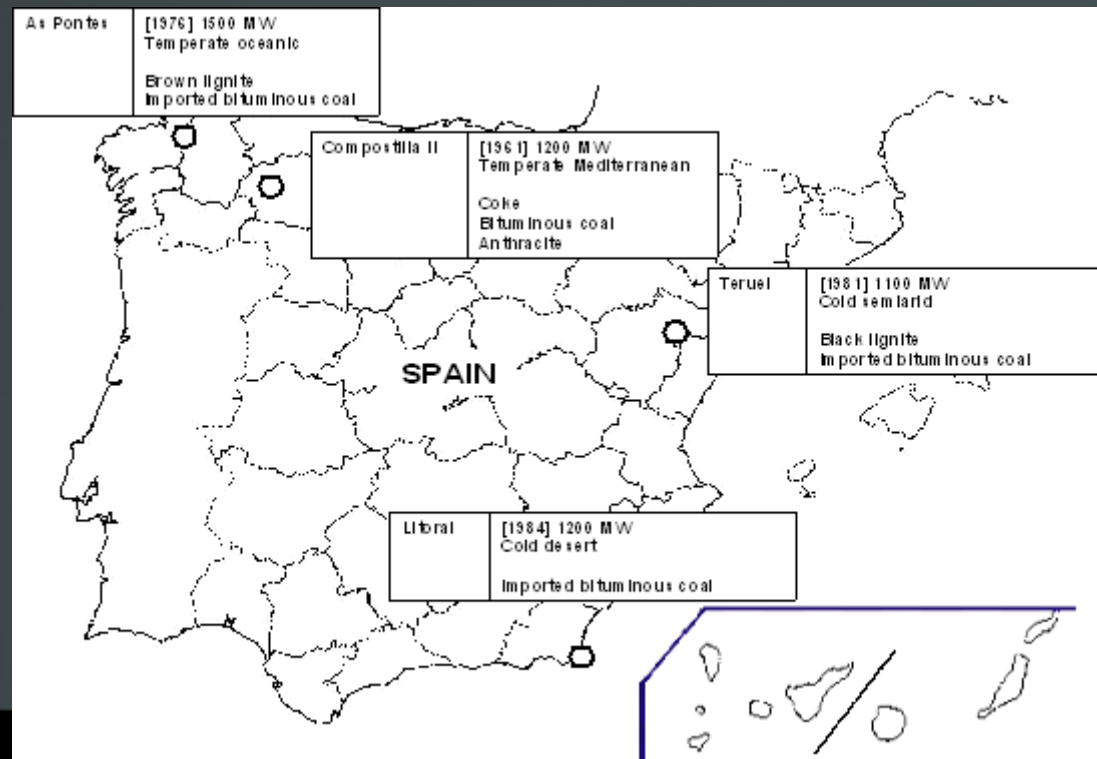
# Radiological impact of fly ashes from coal combustion

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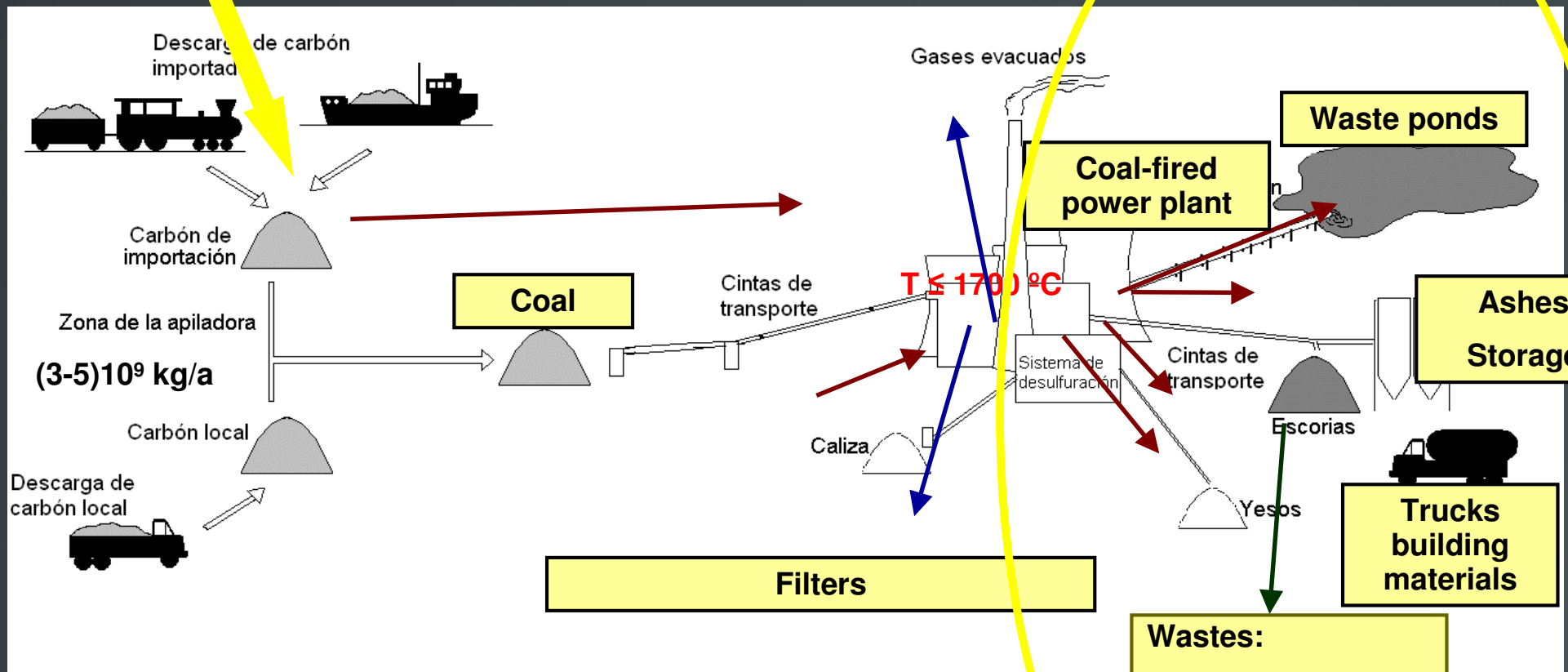


- Quantify activity concentrations of materials, wastes and co-products of the 4 biggest coal-fired power plants in Spain.
- Quantify as realistically as possible the effective doses on the workers and members of the public.
- Prepare a protocol to be used in further evaluations in other installations from the same industry.



## Origin of coals change quite every month

(2008) Southafrica, Russia, Colombia, Australia, Indonesia, USA, China, Canada, Poland and Ukraine ... Sometimes even from Spain



Activities where workers are present

- Wastes:**
- Fly ashes
  - Bottom ashes
  - Gypsum

- ✦ **Collect averaged data from the installations about the industrial process and tasks performed in each plant.**
- ✦ **To survey the real conditions of the tasks: use of Personal Protection Equipments, occupancy times in each zone affected by different materials, shields, quantities of each material...**
- ✦ **To measure the activity concentration of each material.**
- ✦ **To measure Ambient Dose Equivalent  $H^*(10)$  in each zone, mainly where different materials are involved.**
- ✦ **To sample and measure aerosols (PM10).**
- ✦ **To conservatively model resuspension of materials and  $H^*(10)$  when carrying out measurements was not feasible.**

## Workers

Group	Teruel	Litoral	Compostilla II	As Pontes
Maintenance operators	X	X	X	X
Truck drivers (fly ashes)	X	X	X	X
Truck drivers (other materials)	X	-	-	-
Train drivers	X	-	-	-
Boiler maintenance	-	-	X	X
Workers of ponds of wastes	X	X	X	X
Bulldozers drivers	X	X	X	-

## Public

Group	Teruel	Litoral	Compostilla II	As Pontes
Nearest villages	-	X	X	X
Point of maximum impact of the plume	X	-	-	X
Ponds	X	X	-	-

Group	Material	Occupancy times (h y <sup>-1</sup> )		Prot.
		Workers	Public	
Maintenance operators	All the materials	1696-1810		No
Truck drivers (fly ashes)	Fly ashes	848-905		Yes
Truck drivers (other materials)	All but fly ashes	848-905		Yes
Train drivers	Coal	905		Yes
Boiler maintenance	Scales in surfaces	320		Yes
Workers of residues ponds	All residues	169-848		No
Bulldozers drivers	Coal and residues	1810		No
Nearest villages	Fly ashes	8766		Yes
Point of maximum impact of the plume	Fly ashes	52		No
Ponds	All residues	52		No

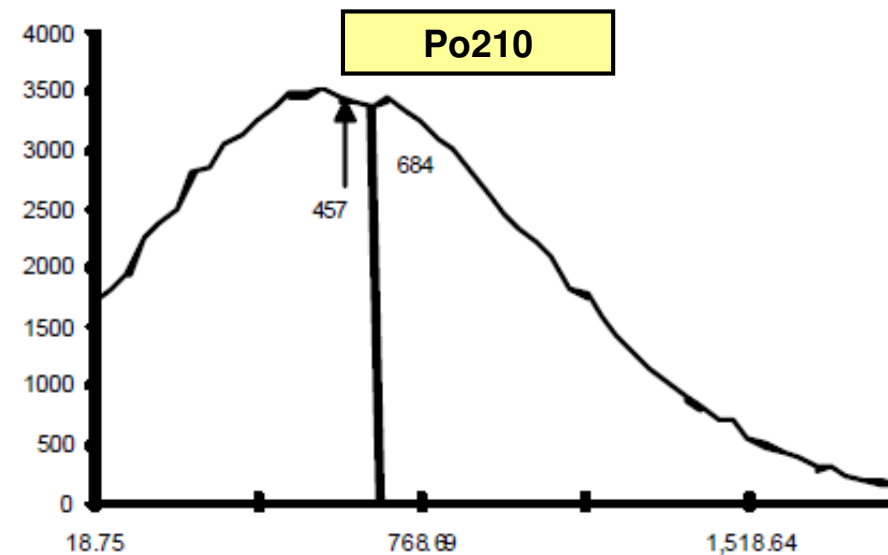
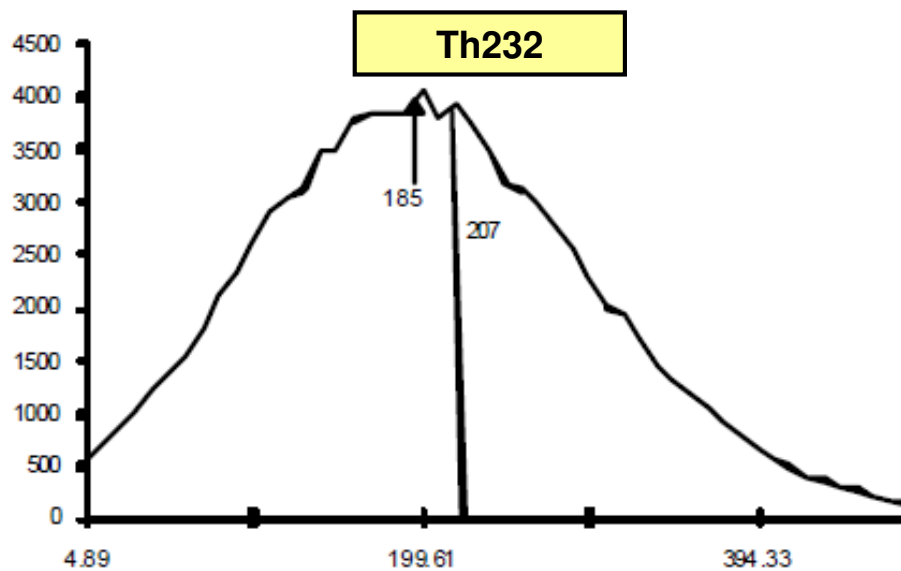
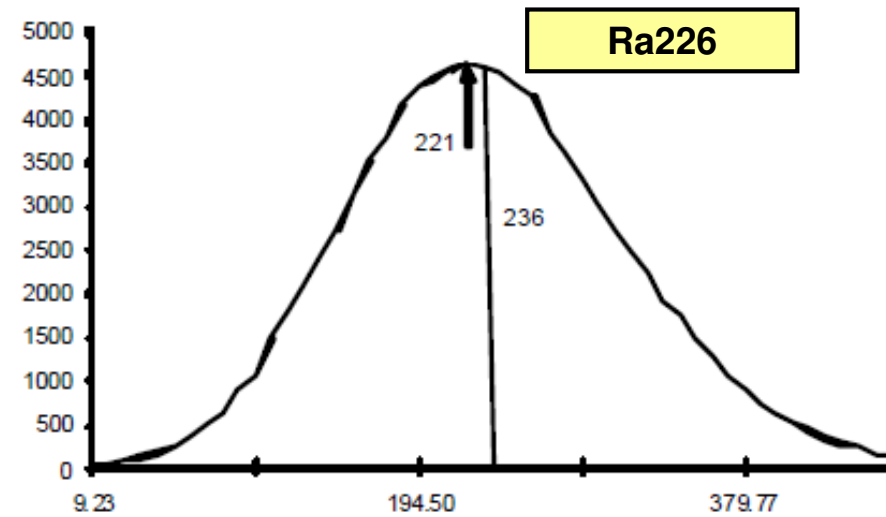
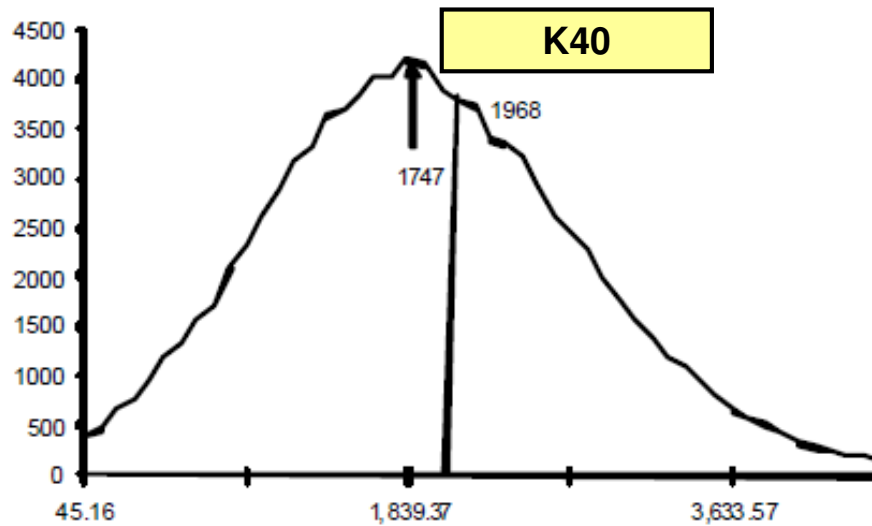
## Considered Pathways (fly ashes, trucks drivers)

- ◆ Inhalation of resuspended material (measured or modelled using a mass loading factor of  $12000 \mu\text{g m}^{-3}$ )
- ◆  $H^*(10)$  modelled using Microshield for the work conditions

Perception of the Risk

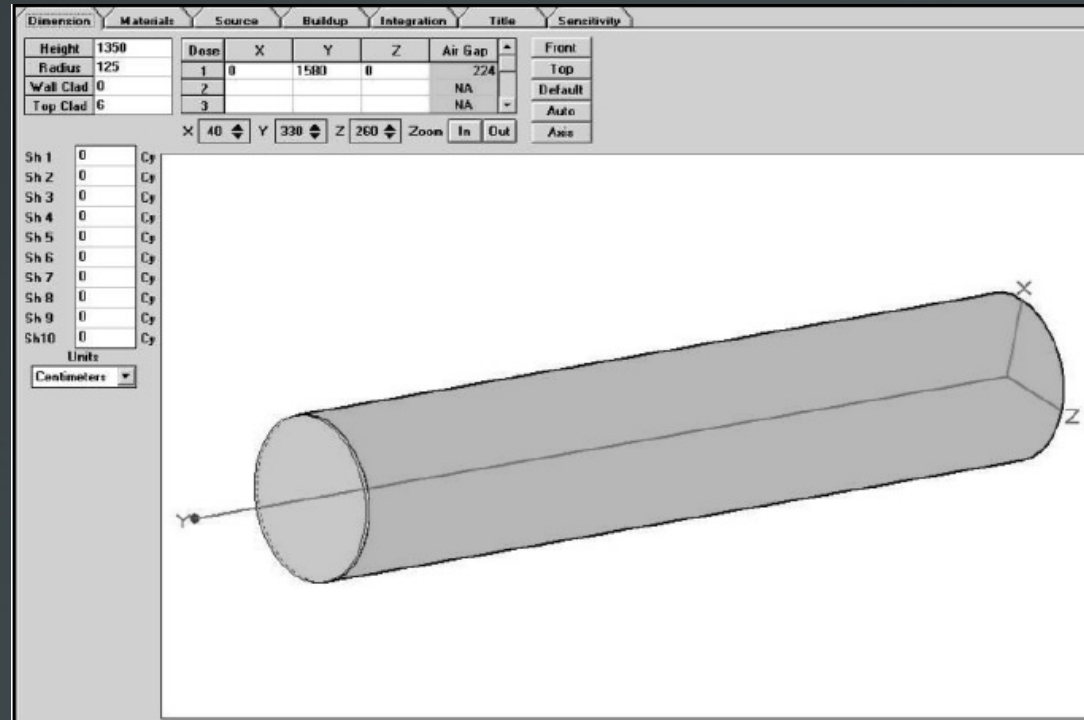


## Activity concentrations in fly ashes (Bq kg<sup>-1</sup> modelled)





## Dose conversion factors



Diameter (m)	Length (m)	Volume (m <sup>3</sup> )	Material	Thickness (mm)	Distance (m)
2.5	13.5	66.3	Al	6	2.3

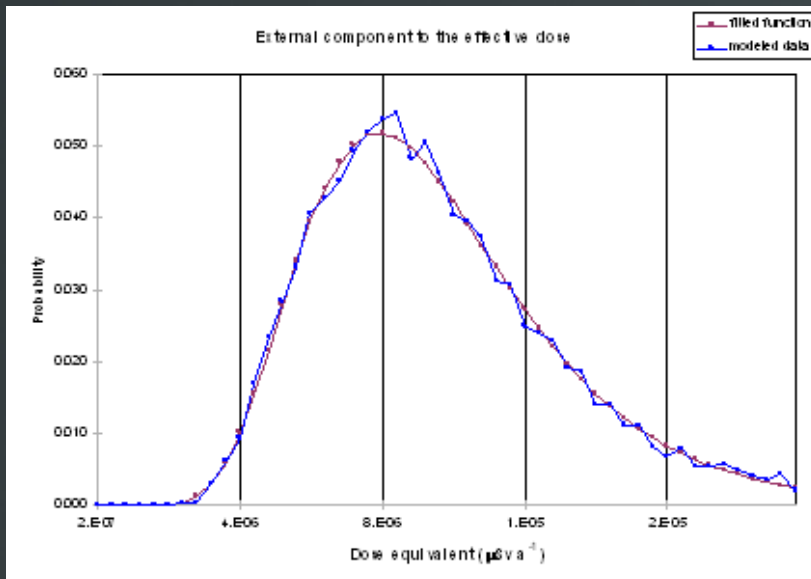
## Composition of fly ashes

O	Si	Al	Ca	Fe	K	Mg	Na	S	Ti
48.29	26.65	14.93	0.71	4.83	1.49	0.48	0.15	0.24	1.92

## Dose conversion factors (external exposure)

	Fly-ash truck (mSv h <sup>-1</sup> )	Plume Immersion (Sv Bq m <sup>-3</sup> a <sup>-1</sup> )	Deposit (Sv m <sup>2</sup> Bq <sup>-1</sup> a <sup>-1</sup> )	Fly-ash ponds (mSv h <sup>-1</sup> )
<sup>238</sup> U- <sup>226</sup> Ra	5,07E-005	2.81E-06	1.18E-07	6,47E-004
<sup>222</sup> Rn- <sup>214</sup> Po	0,00E+000	4.30E-06	2.07E-07	0.00E+00
<sup>210</sup> Pb- <sup>210</sup> Po	2,98E-009	9.59E-09	2.28E-09	2.31E-08
<sup>235</sup> U- <sup>223</sup> Ra	6,48E-006	7.95E-07	6.69E-08	1.52E-04
<sup>219</sup> Rn- <sup>207</sup> Tl	0,00E+000	2.98E-07	2.52E-08	0.00E+00
<sup>232</sup> Th- <sup>224</sup> Ra	2,52E-005	1.45E-06	2.12E-07	3.04E-04
<sup>220</sup> Rn- <sup>208</sup> Tl	0,00E+000	7.80E-06	2.70E-07	0.00E+00
<sup>40</sup> K	4,34E-006	2.50E-07	6.44E-09	1.84E-05

## External exposure



## Internal exposure

The committed effective dose, within a 99%, was always below 13  $\mu\text{Sv}$  per truck charge (10 trucks per day, 1 min exposed to the dust load by charge)

## Effective dose

Group	Teruel	Litoral	Compostilla II	As Pontes
Truck drivers (fly ashes)	11	150	24	7

## Some considerations of fly ashes as construction material:

- ◆ All radioisotopes, except Po210, with some probability, presented As  $< 1 \text{ Bq g}^{-1}$
- ◆ Fly ashes, used in the production of cements, are diluted (usually  $< 35\%$  is allowed to be used in cements), and further dilution is produced in building materials with other materials (in concrete, for example), so it is unlikely for those materials to be above the exemption level.
- ◆ The activity index (RP 112) is always  $I < 1$  (?)



## However:

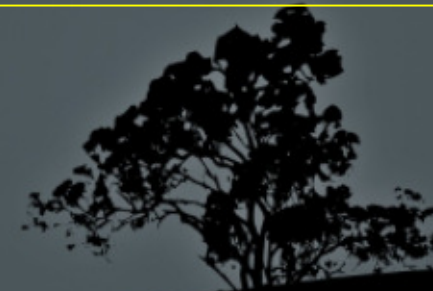
- ◆ **The activity index of RP 112 only considers gamma emitters.**
  - ◆ **Should somehow be reviewed?**
- ◆ **Secular equilibrium is considered in the decay chains for the calculation of the factor in the index.**
  - ◆ **This is not always true in NORM?**
- ◆ **Fly ashes contains extreme situations:**
  - ◆ **Specific enrichment in Po in fly ashes**
  - ◆ **Secular equilibrium cannot be considered in the whole decay chains**
- ◆ **This particular aspect should perhaps be important in relation with fly ash workers.**



## RD 1439/2010. 5th november of 2010

◆ **Undertakings of work activities, shall declare those activities before the competent organisms...and perform the studies needed in order to determine if there is a significant increase in the exposure to the workers or members of the public that should not be considered negligible.**

◆ **Those studies should be completed before november of 2011**

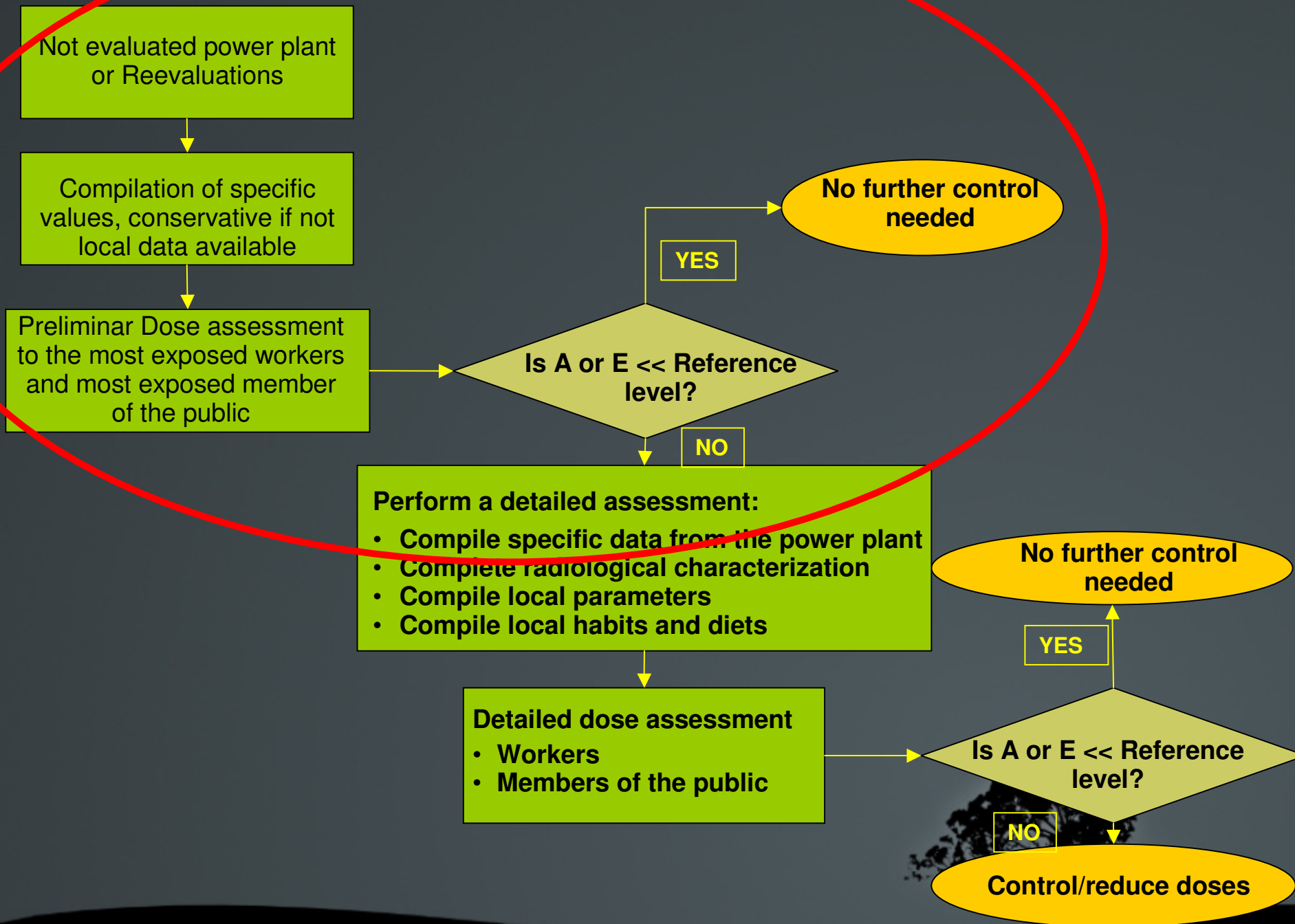


## Safety “instruction” on radiological criteria:

- ◆ Establishes dose values for workers.
- ◆ Establishes a positive list of NORM industries.

## “Guidance” on radiological criteria:

- ◆ Gives recommendations on the content of the radiological assessments.
- ◆ Gives exemption/clearance levels for individual radionuclides.





## ◆ Evaluate all the Spanish coal-fired power plants:

◆ MEIRAMA

◆ LA ROBLA

◆ ANLLARES

◆ VELILLA

◆ LADA

◆ NARCEA

◆ ABOÑO

◆ SOTO

◆ PASAJES

◆ ESCUCHA

◆ **CERCS**

◆ PUERTOLLANO

◆ LOS BARRIOS

◆ PUENTE NUEVO

◆ ALCUDIA

◆ ANDORRA

◆ LITORAL

◆ COMPOSTILLA

◆ AS PONTES





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y Tecnológicas

**Thank you!**

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**Theorem: To measure an effective dose  $E = 10 \mu\text{Sv}/\text{y}$  due to natural sources, as an increase over the natural background, is impossible.**

**Demonstration: Lets consider only the external deep component of  $E$ , measuring  $H^*(10)$ . Any complete result will be higher to this one.**

**A typical measurement of  $H^*(10) = 0.10 \pm 0.01 \mu\text{Sv}/\text{h}$ . To calculate the external component of  $E$ , a multiplication of the occupancy time should be used. Lets use 8 hours per day = 2920 h/y. Considering negligible the uncertainty of the occupancy time (what is incredibly optimistic), the result of propagating the uncertainties by the usual methods is  $E = 292 \pm 29 \mu\text{Sv}/\text{y}$ .**

$$29 \text{ (uncertainty)} > 10$$

**This show the impossibility of measuring an increase of  $10 \mu\text{Sv}/\text{y}$  due to a natural source as an increase to the background, as we wanted to demonstrate.**

