Scotland's Nuclear Waste Policy

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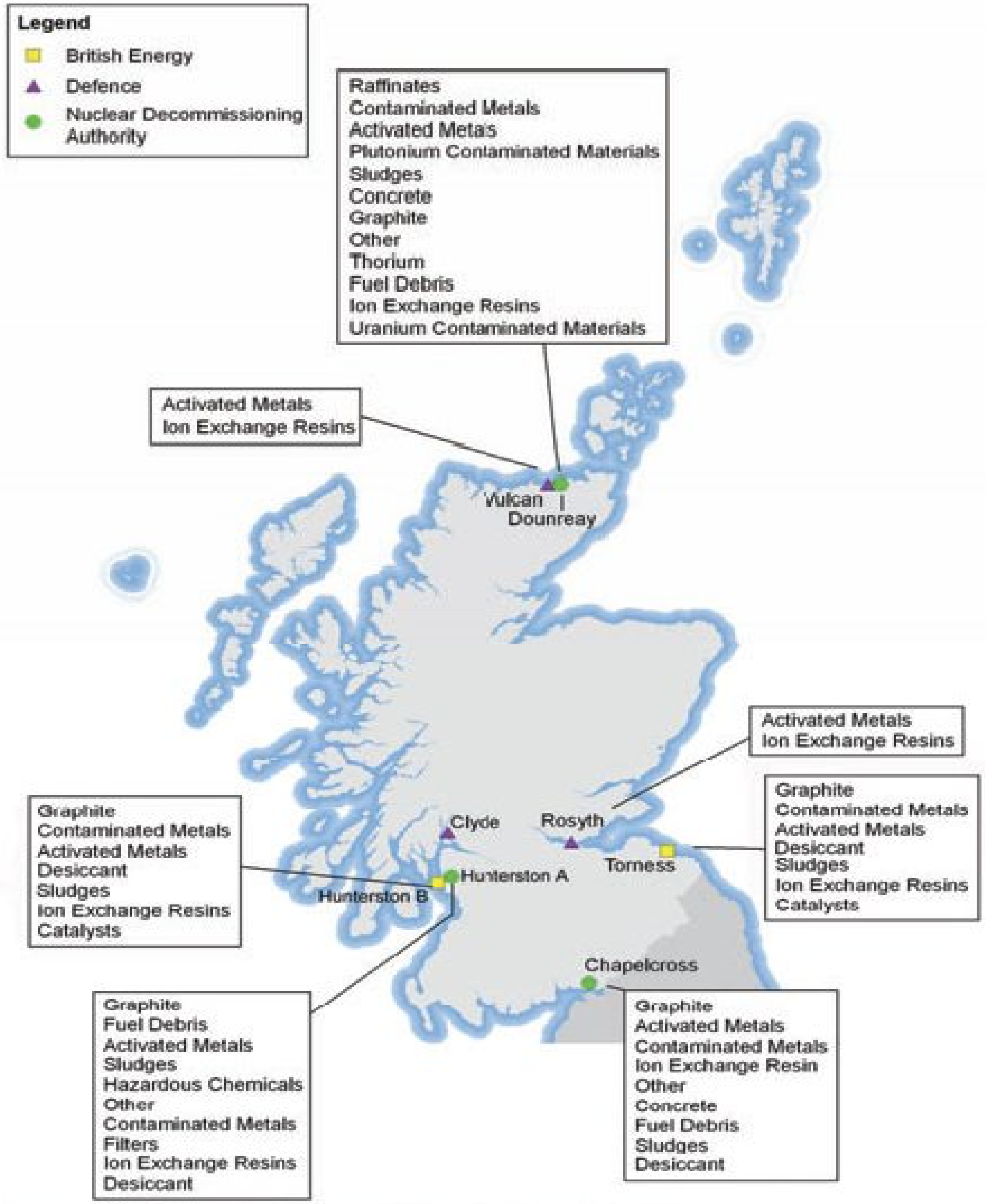
Scottish Nuclear Wastes

- Where?
- How much?
- What kinds?
- Any special problems?
- Is it safe to “dispose” of ILW nuclear waste?
- What about the polluter pays principle?



Legend
British Energy
Defence
Nuclear Decommissioning Authority
Raffinates
Contaminated Metals
Activated Metals
Plutonium Contaminated Materials
Sludges
Concrete
Graphite
Other
Thorium
Fuel Debris
Ion Exchange Resins
Uranium Contaminated Materials
Activated Metals
Ion Exchange Resins
Vulcan
Dounreay
Activated Metals
Ion Exchange Resins
Graphite
Contaminated Metals
Activated Metals
Desiccant
Sludges
Ion Exchange Resins
Catalysts
Clyde
Rosyth
Hunterston A
Hunterston B
Torness
Graphite
Contaminated Metals
Activated Metals
Desiccant
Sludges
Ion Exchange Resins
Catalysts
Chapelcross
Graphite
Fuel Debris
Activated Metals
Sludges
Hazardous Chemicals
Other
Contaminated Metals
Filters
Ion Exchange Resins
Desiccant
Graphite
Activated Metals
Contaminated Metals
Ion Exchange Resin
Other
Concrete
Fuel Debris
Sludges
Desiccant

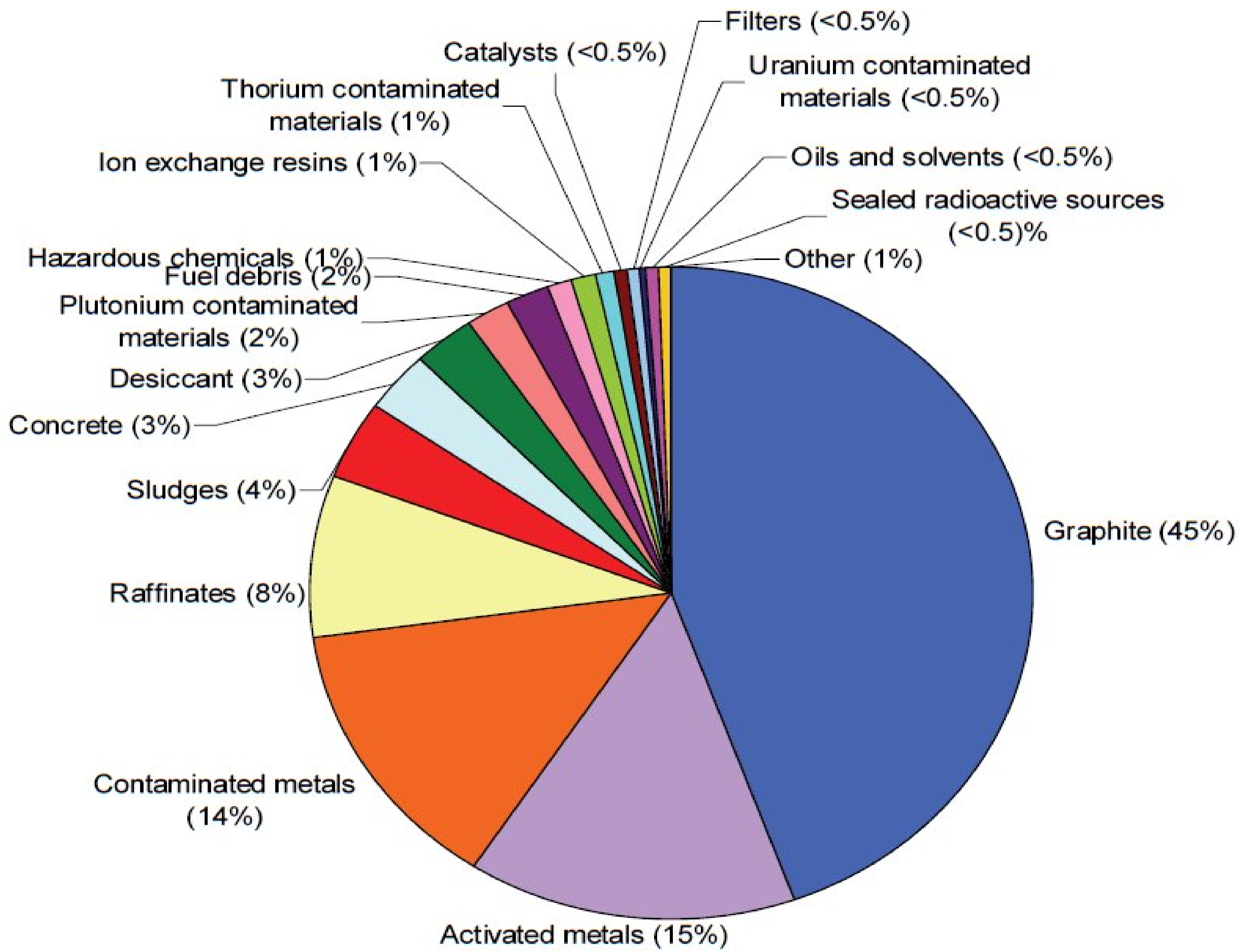
How Much?
Packaged Waste Volumes m^3

Graphite	21,000
Activated Metals	7,000
Contaminated Metals	6,000
Raffinates	4,000
Short-lived wastes	9,000
Total	**47,000**

ie 500 doubledecker buses

ie 10 x ILW stores

What kind of nuclear waste?



3 Main Nuclear Wastes

- Graphite ~0.2 TBq/m^3
- Activated metals = 0.02 to 200 TBq/m^3
- Contaminated metals = 10^{-6} to 1 TBq/m^3

(1 TBq = 10^{12} Bq = 1,000,000,000,000 Bq)

Graphite – the big issue (a) physical problems

- ~half (46%) of the ILW
- sudden Wigner energy (heat) release
- redox gases (CO_2, CH_4) are created
- which means >pressure
- easily combustible
- galvanic reactions? Like a huge battery

Graphite – the big issue (b) radioactivity problems

- very radioactive ~200,000 MBq/m^3
- most radioactivity from C-14
- C-14 half-life = 5,730 years
- mostly low-range beta emitters
- + penetrating gamma from Co-60

Graphite Radioactivity

Hunterston B: Waste Stream 4B313: ILW Graphite

Nuclide	Half life -y	Decay	Activity MBq/m^3	%
C 14	5,730	β-	203,000	98
Ni 63	100	β-	2,300	1.1
Cl 36	301,000	β-	1,800	0.9
H 3	12.3	β-	560	0.3
Ca 41	103,000	β-	76	-
Ni 59	76,000	β-	26	-
Tc 99	211,000	β-	5.2	-
Co 60	5.3	β- γ	0.57	-
Total			**208,000**	**100**

data source http://www.nda.gov.uk/ukinventory/documents/index.cfm

Existing Scottish Policy 1

- In 2007, Scottish Ministers said:

"…*we do not accept that it is right to seek to bury nuclear waste, which will remain radioactive for thousands of years, in underground sites. This out of sight, out of mind policy should not extend to Scotland*"'

Existing Scottish Policy 2

"…. using long-term near surface, near site storage facilities so that waste is monitorable and retrievable and the need for transporting it over long distances is minimal""

Scottish Waste and Pollution Reduction Division 2010: Main Proposed Changes

- storage and disposal of long-lived ILW
- near-site and near-surface disposal
- near site = ie nearest suitable facility
- near surface = ie 100 metres deep
- waste to be exported for “processing”
- retrievability a requirement

Is it “safe” to dispose ILW?
It depends on

- how much radioactivity may escape

  - how much radioactivity in the facility
  - which radionuclides
  - how good the geological barrier
  - how good the containment packaging

Safe? It also depends on

How large are the resulting radiation doses to people nearby or downwind?

- much computer modelling is required
- hard to verify predicted outcomes
- still at early stages of finding out
- more R&D is required to increase our confidence in predicted safety margins

Radiation risks

- estimates of radiation doses and risks contain big uncertainties: unreliable
- no “safe” dose of radiation
- new non-targeted effects of radiation have led to a paradigm shift among radiation biologists

Uncertainties in radiation dose/risk estimates: why?

- nuclide evolution models (in waste facility)
- environmental models (behaviour of nuclides in environment)
- biokinetic models (uptake and retention of nuclides in humans)
- dosimetric models (convert Bq to mGy: mSv)
- weighting factors (tissue W_T and radiation W_R)
- apply a risk model (from Japanese bomb data)

Conclusion: RADIATION ESTIMATES HAVE MANY UNCERTAINTIES (CERRIE Report) www.cerrie.org

Uncertainties in Dose Estimates

Goossens LHJ, Harper FT, Harrison JD, Hora SC, Kraan BCP, Cooke RM (1998) Probabilistic Accident Consequence Uncertainty Analysis: Uncertainty Assessment for Internal Dosimetry: Main Report. Prepared for U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, USA. And for Commission of the European Communities, DG XII and XI, B-I049 Brussels Belgium. NUREG/CR-6571 EUR 16773.

Nuclide	Intake	Organ	U Range = (ratio of $95^{th}/5^{th}$ percentiles)
Cs-137	ingestion	red bone marrow	4
I-131	inhalation	thyroid	9
Sr-90	ingestion	red bone marrow	240
Pu-239	ingestion	red bone marrow	1,300
Sr-90	inhalation	lungs	5,300
Ce-144	inhalation	red bone marrow	8,500
Pu-239	ingestion	bone surface	20,000

Difference between Disposal and Storage?

- storage - intent to retrieve wastes later
- disposal- no intent to retrieve wastes later
- but retrievability a requirement for both? And disposal facilities can be backfilled and sealed?
- regulators to decide when a disposal facility is capable of closure
- better to have substantive norms, eg degree of institutional control, existence of monitoring

Which wastes to be stored or disposed?

- 75% of wastes are graphite and metals
- "options might be developed that could in principle allow potential for (their) near-surface disposal in the future" (CoRWM2)
- little explanation given

Designation of long-lived ILW wastes for disposal

Near Surface Disposal Facilities on Land for Solid Radioactive Waste
Guidance on Requirements for Authorisation 2009

- SEPA's draft GRA explicitly excluded long-lived ILW wastes for disposal
- but the final GRA included it
- no rationale or explanation
- reasons should be explained

New ILW Store at Hunterston A

- capacity = 4,800 m^3
- need more descriptions of existing stores

Only 2 Principles mentioned in Scottish Consultation

- protection levels now and in future to be consistent with current standards
- developers and operators to engage with stakeholders throughout the process of managing wastes

Other Principles?

- IAEA’s 9 Principles of Radioactive Waste Management (1995)
- HSE’s 7 radwaste Safety Assessment Principles for Nuclear Facilities (2006)
- The ‘Polluter Pays’ Principle

HSE Guidance on Radwaste Strategy (2006)

- b) ... demonstrate that rad'n hazards from historic wastes are reduced progressively;
- c) include dutyholder's policy and objectives for managing radioactive waste;
- e) cover current and future inventory of radioactive waste including from new facilities;
- f) encompass anticipated timescales from production to disposal
- t) describe significant assumptions, uncertainties and project risks and how these will be managed

Conclusion:
- much more information is needed

- rationale for proposed policy change (the justifying science and R&D on disposal)
- radionuclide compositions of waste forms
- radioactivity inventories and
- radioactive concentrations (Bq/m^3)

Conclusion:
- more information needed 2

- proportions of conditioned/unconditioned wastes
- costs of proposed policy and who pays
- future R&D needs
- future public engagement on waste policy

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