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Remediation of a former gas mantle factory contaminated with radioactive thorium-232

Adam Lowe
Operational Services Department
Cookridge, Leeds

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Former industrial use

- Manufacture thorium gas mantles:
  - Past practice – not regulated historically
  - Different site usage prior to remediation
  - Remediation for residential use

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Establishing radiological conditions

Comprehensive radiological survey AND review of historical information

1. Feed materials
    - Quantities, Bq/g and chain equilibrium (then and now)
    - Physical and chemical properties
        - Internal dosimetry, and possible spread on site
2. Processes
    - Effect on individual radionuclides
    - Localised accumulation and contamination
3. Historical waste management strategy
    - Especially any on-site disposals

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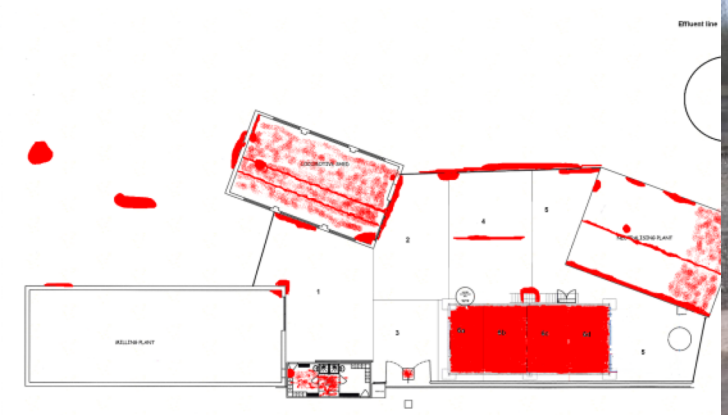
Pre-remediation survey methods

- Gamma “walk-over” survey
  - Detect “hidden” contamination
  - Contamination mapping and marking with paint
  - Dose rates for prior risk assessment
- Surface contamination measurements
  - Only for specific surfaces (and low background)
  - Can accurately delineate contamination
- Trial excavations (boreholes and pits)
- Sampling and gamma spectrometry
  - Empirical calibration of site measurements
  - Bq/g for prior risk assessment




HOLROYD


Legend
cps
0 - 100
100 - 150
150 - 300
300 - 500
500 - 750
750 - 1000
1000 - 2000
2000 - 3000
> 3000
Jessica House


Genie Z-60/34
Genie
BOOM

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Pre-remediation results

1. Activity concentrations
   - Th-232: 0 – 100 Bq/g (500 Bq/g max)
   - Outside and inside buildings
   - On the surface, in the surface, and under the surface
   - On and under the ground – up to 3 m depth
2. Gamma dose rates
   - Up to 20 µSv/h in contact
   - Up to 5 µSv/h whole body
   - Can increase during remediation

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Radiological end-points

- Dose constraint (NORM) = 300 μSv/y per site
  - Optimise below dose constraint
- Need to convert to Bq/g (residual)
  - Consistent with generic regulatory exclusion levels
- In practice, the following was agreed:
  - Residential use: <0.1 Bq/g (0.4 Bq/g max)
- Need to agree policy on AVERAGING

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Radiation Protection Programme

- Prior risk assessment
  - External doses: 0.1 – 1 mSv
  - Internal doses (no RPE): 0.2 – 2 mSv
- Protection measures
  - Training (initial, plus regular “tool-box”) and supervision
  - Written “Method Statements”
  - Dust suppression (containment, extraction, damping down)
  - Entry/exit controls (barriers, PPE, change, “wash”, monitor and record)
  - “Industrial” PPE, including RPE when required
  - Individual dosemeters (TLD, Category B workers)
  - Periodic air sampling (mostly static samplers)
  - Contingency Plans for wounds and unexpected contamination

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RP Programme: Results

- External and internal doses: <0.1 mSv
- Exit monitoring (over 1000 “exits”)
  - 66 (5%) - contaminated gloves
  - 2 (0.2%) - skin contamination (wrists – poorly fitted PPE)
  - 1 (0.1%) – contaminated shoes
- Site monitoring
  - No spread of contamination beyond designated areas
  - No increase in ambient Th air concentration at perimeter
  - Negligible doses to members of the public in vicinity of site
- Observation
  - Doses were negligible, but did we go beyond ALARA?

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Waste Management Programme

- Site issued with waste permit (authorisation)
- Permit requires minimisation of active waste ("BAT")
- General requirement to re-use and recycle materials
  - Need to segregate active and non-active waste
  - Practical waste screening strategy and methods
- Within UK regulatory structure

> 5 Bq/g	Dispose to authorised disposal site
0.5 – 5 Bq/g	Exempt NORM waste – general landfill
<0.5 Bq/g	Out of scope – leave, re-use, recycle

- Waste inventory records (Bq, Bq/g, volume, mass)

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Waste screening methods

- Important pre-segregation via initial survey
  - Clear marking of contaminated materials
- Rapid screening measurements (as waste is produced)
  - Individual waste bags and drums (from buildings)
  - Excavator buckets, waste skips and trucks
  - Based on gamma emission computer modelling
- Confirmatory measurements
  - Sampling and gamma spectrometry
  - Rotating drum monitor (gamma spec)
  - Inter-comparisons with “test sources”


GRUNDON
Direct to Landfill
Direct to Landfill


RON SMITH
624

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Incidents!

- Radiological incidents
  - 4 small wounds – no contamination
  - 1 misuse of PPE – prompted refresher training

- Mechanical incidents
  - Detached grinding wheel
  - Projectile rubble!

- Observation
  - Going beyond ALARA increases exposure to significant conventional risks

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Conclusions

- Must agree in advance:
  - Radiological end-point (Bq/g) and averaging methods
  - Waste management strategy, and screening methods
- Do a comprehensive site survey AND historical review
- Gamma monitoring is best all-round tool
  - But use other techniques as well
- Buried contamination is common on industrial sites
  - Do boreholes/trial pits
- Assume that more contamination will be found
  - Regular repeat surveys during remediation

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Conclusions cont.

- Do a realistic prior risk assessment
  - Use proportionate controls, adapting existing methods
  - <<1 mSv is readily achievable
- Training is important – but should be practical
- It's not always possible to fully decontaminate buildings
  - Cannot be demolished without precautions
  - Need to mark up contaminated materials, recover and screen post-demolition.
- Going beyond ALARA can increase exposure to significant conventional risks!

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And finally: The site today