Existing exposure situations: intervention in practice

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Case 1 – radon exposures

Small site, not in a “radon affected area”

High radon levels discovered in PADC survey

- 40,000 Bq m^{-3} (low occupancy)
- 2500 Bq m^{-3} (high occupancy ~ 15 mSv y^{-1})
- 800 Bq m^{-3} (high occupancy ~ 5 mSv y^{-1})

Radon actions

- removal of workers from 2500 Bq m^{-3} area
- reduce 800 Bq m^{-3} areas on 6-month timescale

Why were the radon levels high?

Case 1 – radon exposures

Gamma radiation survey found radium-226 contamination

- external areas to ~ 10 microSieverts per hour
- internal areas including under floors
- external doses unlikely to exceed 1 mSv y^{-1}
- restricted access to one area with buried radium

Would normal remediation approach (sumps) work?

- yes in buildings with no radium-226 contamination
- additional risk to workers installing these in radium contaminated buildings
- concern about placement of sumps

Case 1 – radon exposures

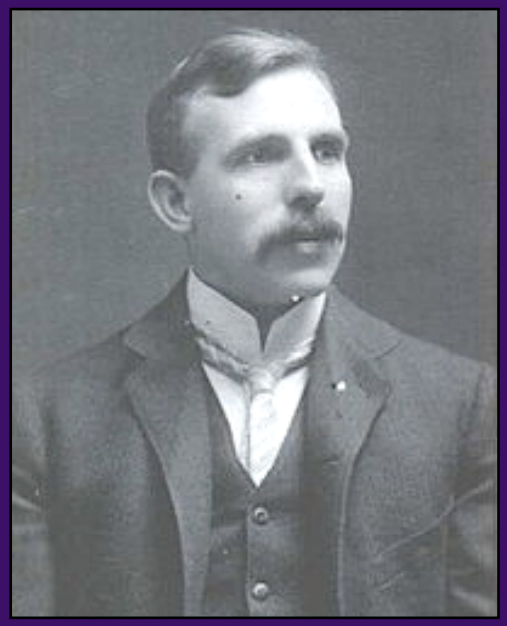
Removal of internal radium contamination

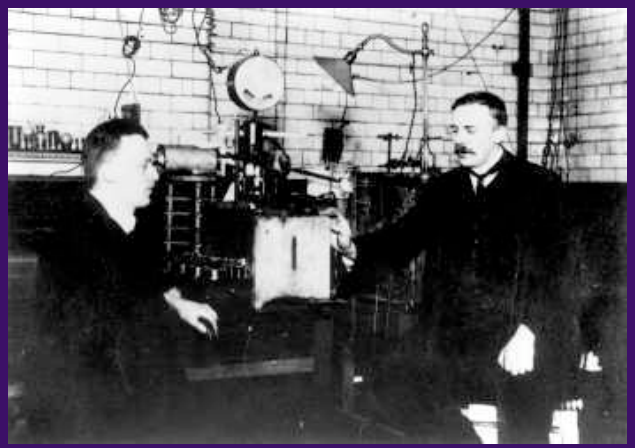
- radon gas levels down to ~ 100 Bq m^{-3} in treated areas
- some remaining areas still above 400 Bq m^{-3} probably due to further radium contamination under floors

Lessons:

- radium can cause radon levels that require remediation
- remediation is much more difficult (and expensive) than “normal” radon
- how much radium to remove?

Case 2 – looking for radium and other things





Ernest Rutherford

b.1871 New Zealand

1895 - 1898 Cambridge University

1898 - 1907 McGill University, Montreal

1907 - 1919 Manchester University

1919 - d.1937 Cambridge University

Case 2 – looking for radium and other things

Concerns about contamination at Manchester

Retrospective assessment of doses to former building occupants (RPD-EA-5-2010)

- limited records of historic measurements of contamination
- radioactive remediation work around 2000-2004
- assessed maximum effective dose ~ 75 mSv over the period 1950-1989

Case 2 – looking for radium and other things

Old Cavendish Laboratory (Cambridge)

- similar history to Manchester (limited historic records)
- several campaigns of remediation

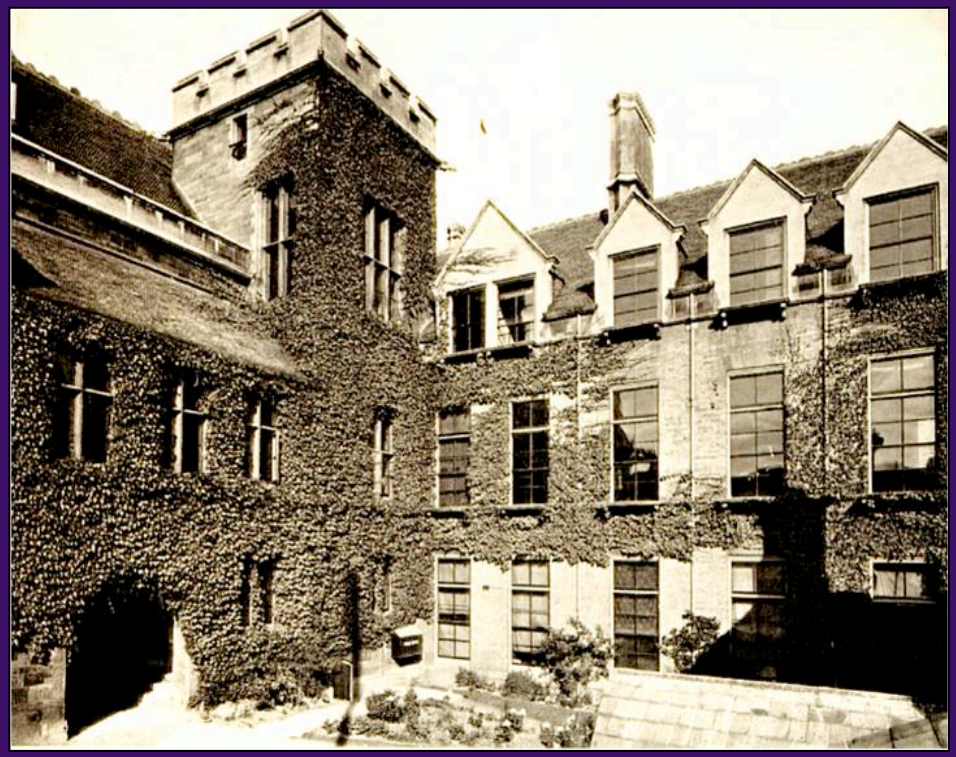
Radiological survey

- gamma radiation
- unusual isotopes

  ^{230}Th, ^{227}Ac, ^{210}Pb
- dust samples with analysis including ^{210}Po

Case 2 – looking for radium and other things

The Tower



Case 2 – looking for radium and other things

Concern raised about possible residual contamination of premises supplying radium to Rutherford and others

- initial identification of radium “shops”
- survey visits
- very limited (or no) contamination found
- no intervention

Case 2 – looking for radium and other things

Lessons

- difficulty of keeping historic records
- fears of “contamination” can be a significant public health issue, irrespective of what is *actually* there
- concerns can be addressed with good measurements and dose assessments

Case 3 – dealing with thorium contamination

Former gas mantle manufacturing site

Limited current exposure pathways

Site to be developed – future pathways

Case 3 – dealing with thorium contamination

Case 3 – dealing with thorium contamination

Agreed end-point 0.1 Bq g^{-1} above nominal background

- thorium-232 chain in equilibrium
- was this optimised?

Application of NRPB-W36 to housing development scenario

- HPA "change of use" constraint 300 microSievert y^{-1}
- 20 microSievert y^{-1} lower bound on optimisation

Distribution of contamination	Uniform (no cover)	Uniform (covered)	Uniform (covered, disturbed)	Patchy (no cover)	Patchy (covered)	Patchy (covered, disturbed)
Bq/g for 300 microSv/y	0.25	1.1	0.62	1.2	2.0	1.8
Bg/g for 20 microSv/y	0.017	0.074	0.041	0.081	0.13	0.12

UK regulatory definitions

EPR2011 (with amended RSA93 in Scotland)

No permitting of in-situ contamination but future liability in relation to wastes which may arise in future

RP-122 derived thresholds for NORM and man-made radionuclides to be “in scope” of regulations

Radionuclide	Threshold (Bq/g)	Maximum W36 dose (microSv/y)
Thorium-232 chain	0.5	600
Radium-226 chain (inc. ^{210}Pb)	~ 0.45	~ 540
Cobalt-60	0.1	90
Caesium-137	1	180
Carbon-14	10	*(not in W36)*
Tritium	100	0.07

Conclusions

Role for optimisation in decontamination actions

Determining the optimum solution is difficult - many factors

- Cost of remediation (including wastes)
- Non-radiological detriments (other risks)
- Difficulty of predicting doses (including radon) and detriment mean difficult to apply CBA techniques and uncertainties over the “right” end point to use
- Perception of “contamination”
- Importance of regulatory thresholds – definition of “radioactive” for the purposes of regulations