Radon gas intercomparisons

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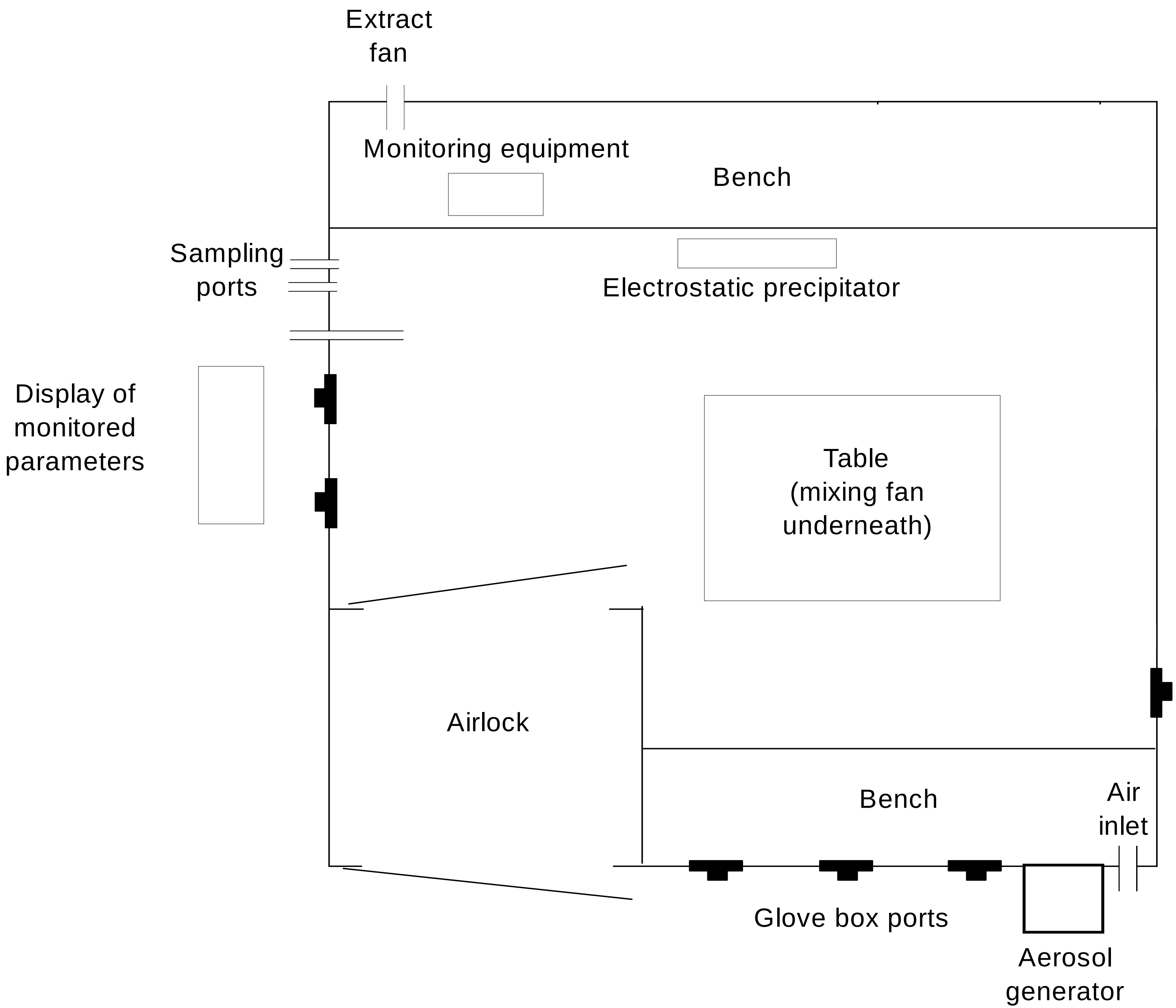
History of NRPB/HPA radon intercomparisons

1981 – NRPB constructed radon chamber for calibration of instruments

1982 - Commission of the European Communities sponsored intercomparison of passive detectors

Intercomparisons continued most years since, now paid for by participating laboratories

HPA radon chamber


Extract fan
Monitoring equipment
Bench
Sampling ports
Electrostatic precipitator
Display of monitored parameters
Table (mixing fan underneath)
Airlock
Bench
Air inlet
Glove box ports
Aerosol generator

Parameters monitored and/or controlled

- Radon concentration
- Radon decay product concentrations (hence equilibrium factor)
- Temperature
- Pressure
- Humidity
- Radon-220 decay product concentrations
- Aerosol concentration/size distribution

Radon chamber characteristics

- Steady state (constant emanation) type
- Volume 43 m^3
- Radon concentration 400 – 8000 Bq m^{-3}
- Equilibrium factor (F) 0.1 – 0.9 (approximately)
- Unattached fraction (fp) up to 0.3
- Aerosol concentration 2000 – 70 000 particles cm^{-3}, MTD 90 -120 nm
- Temperature, pressure, humidity monitored but not controlled

Equilibrium factor (F)

F controlled by use of aerosol generator and electrostatic precipitator

Exposures carried out at low, medium and high F

Results show that closed detectors not affected, open LR-115 detectors have response closer to radon exposure than EER exposure

Neutron response

- Two intercomparisons included exposure to a simulated cosmic field, to determine neutron sensitivity
- 2001 and 2003
- Detectors exposed in pairs at CERF, Switzerland
- All detectors showed some response
- Response was variable both between and within individual detector types and designs

Non-laboratory exposures

Some intercomparisons included extra non-laboratory exposures, to determine whether there are any extra problems in home exposures

- 1982 exposure in NRPB office
- 1984 exposure in UK home
- 1987 exposure in UK home
- 1995 exposures in Italian, Swedish and Luxembourg homes

Logistics of intercomparisons

- 40 detectors per laboratory, 10 transit and 10 for each of 3 exposures
- 30 detectors for exposure randomised
- 10 detectors from each laboratory exposed at the same time
- Participants don't know which detectors exposed together
- Participants report results before exposures are calculated
- Arrangements different for charcoal and electret

Packaging of detectors between exposures and for return

- Detector casings can absorb radon and later release it
- Allow 3 days for outgassing before packaging
- Seal in radon-proof bag
- Seal in second bag

Storage of detectors

- In case packaging is not a perfect radon barrier, store in low-radon environment
- Wooden shed (effectively outdoors)
- Alternative - Container with activated charcoal

Detector types

- Closed, filtered etched-track
- Closed, slow diffusion entry etched track
- Open LR-115 etched track
- Open CR-39 etched track
- Charcoal
- Electret


70
60
50
40
30
20


1 2 3 4 5
6 7 8 9 10

Lessons about detector types and laboratories

All detector types can produce accurate results from laboratory exposures, if produced and processed by a competent laboratory.

All detector types can produce very bad results if not processed by a competent laboratory.

All laboratories, even very good ones, make mistakes sooner or later.

How can participants rely on results?

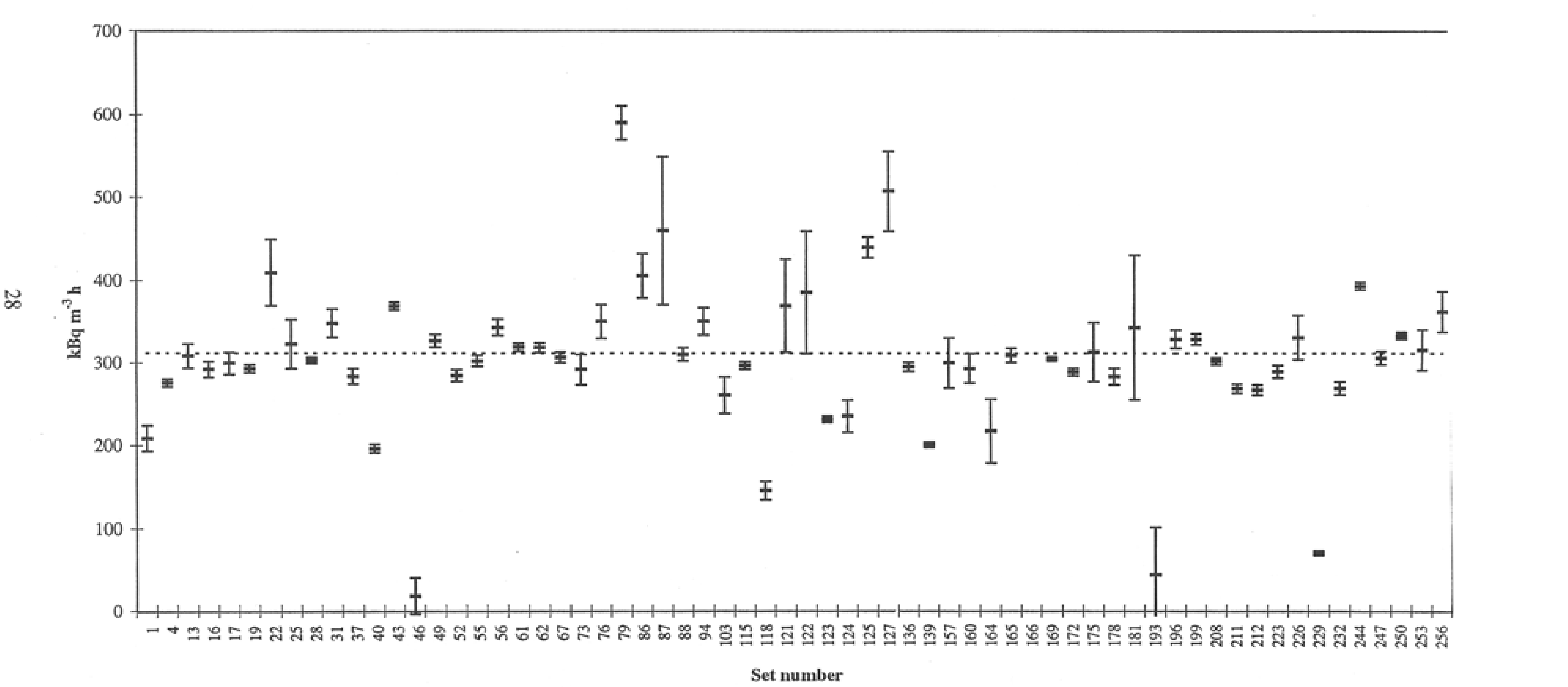
Traceability of radon standards to national laboratory

Documented procedures

Comparison with results from other laboratories

Graph of results can be very useful

Figure10.Passive detector results with standard errors: radon, exposure 1



Best accuracy by detector type

Holder	Detector material	Minimum % standard deviation
Canister	Activated charcoal	1.0
E-Perm L	Electret	2.3
NRPB/SSI	CR-39	2.7
Karlsruhe FN	Polycarbonate	4.3
NRPB	CR-39	4.6
ANPA	Cellulose nitrate	4.7

Lessons from outside the laboratory

- Open LR-115 detectors fade in sunlight
- Thoron exposures affect open detectors and closed detectors with filters
- Closed detectors with long half-time for radon entry work the same in homes as in laboratories

Closed etched-track

- Ones with filters respond to thoron as well as radon
- Ones without filters respond only to radon
- Long half-time for radon entry does not affect integration over varying concentrations

Very short exposures

FRED – Fast Radon Exposure Device

60 – 80 kBq m^{-3}

Exposure times down to 30 minutes

Charcoal detectors

Have to be returned to originating laboratory quickly, so not 'blind'

Generally accurate results for period of exposure

Only monitor short exposures

Do not correctly integrate over varying concentrations

Electret detectors

Generally accurate results

Uncertainty caused by sensitivity to gamma exposure

Dropping can cause error in estimated exposure

Trends over time

- Open detectors used much less
- Most detectors now small
- Most detectors now standard designs
- Most now made of conducting plastic
- Most now without filter

Value of intercomparisons

- Improve accuracy and traceability
- Cheap calibration and quality control
- Opportunity to try new designs
- Chance to learn from colleagues