Practical implementation of anticipated radon dosimetry changes in the mining industry

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Views expressed in this presentation are those of the author alone and may not be construed as having any bearing on those of his employer.
Radon Decay Product (RDP) exposure is measured in terms of PAEC (Potential Alpha Energy Concentration) in (mJ m\(^{-3}\)) and time.

\(^{222}\)Rn exposure is measured in terms of activity concentration in (Bq m\(^{-3}\)) and time.

Effective dose is calculated from a recommended dose conversion factor (DCF)

Currently:  \(\text{DCF} = 1.4 \text{ mSv per (mJ h m}^{-3}\)
Why the change?

Epidemiology

ICRP 60 and 65

Radon risk: 8 x 10^{-5} per (mJ h m^{-3})
Effective dose risk: 5.6 x 10^{-5} per mSv
Equating risks: DCF: 1.4 mSv per (mJ h m^{-3})
→ Increase: 2.4 times

ICRP 103 and 115

Radon risk: 8 x 10^{-10} per (Bq h m^{-3})
Effective dose risk: 4.2 x 10^{-5} per mSv
Equating risks: DCF: 3.4 mSv per (mJ h m^{-3})

(Dose conversion convention)

Dosimetric modelling

Statement on Radon^{†}
→ Increase: 2.2 times

^{†}Move to dosimetric modelling

DCF: 3.0 mSv per (mJ h m^{-3})^{*}

(Dose coefficient)

^{*}Draft OIR Part 3 – for mines
What to do?

Need for review:
- Assess effective doses using the new DCF;
- Review the adequacy of the dose assessment program;
- Review the optimization of protection of the workforce; and
- If necessary, take action to reduce exposure to radon.

Anticipate the change:
- Be prepared: all of the above can be assessed in advance;
- Engage with the workforce: explain what is likely to happen;
- Engage with the regulatory body: agree on the strategy; and
- If necessary, source equipment suppliers and service providers, and develop drafts of new procedures.
Review dose assessment

Greater accuracy needed?

- Does the current procedure make conservative assumptions which could be reduced? For example, is time in air-conditioned cabins taken into account?
- Will some (or more) workers need to be assessed through personal monitoring?
- If doses are high, is characterization of the mine atmosphere needed? For example, would amendment of the DCF for particle size be implied?
- Note that dose records will need to include the DCF used.
Nominal risks* from natural background and from 0.5 μJ m⁻³ at work

*risk coefficients from ICRP103 and ICRP115; cosmic, terrestrial and ingestion global average doses from UNSCEAR 2008; radon: 50 Bq m⁻³ at home, 0.5 μJ m⁻³ at work; approximate non-smoker risk (avg /6) and regular (>25 cig/day) smoker risk (avg x5).
Optimize protection

- Do the changes imply a need to reduce exposure?
  E.g. Could the most exposed workers exceed dose constraints?

- Review mine ventilation, especially underground.
  E.g. More clean air? (Watch out for unattached fraction.)

- Are there sources that can be better controlled?
  E.g. Dewatering? Control of other pathways?

- Apply engineering controls where possible.
  E.g. Air-conditioned cabins on mobile equipment. Automation/robotics?

- Apply administrative controls.
  E.g. Review reference levels for mine clearance, etc.

- Use personal protective equipment.
  E.g. Respirators, filtered-air hardhats.
Increase in assessed doses

- Dose constraint exceeded?
- Dose limit exceeded?
Optimize protection

- Do the changes imply a need to reduce exposure?
  - E.g. Could the most exposed workers exceed dose constraints?

- Review mine ventilation, especially underground.
  - E.g. More clean air? (Watch out for unattached fraction.)

- Are there sources that can be better controlled?
  - E.g. Dewatering? Control of other pathways?

- Apply engineering controls where possible.
  - E.g. Air-conditioned cabins on mobile equipment. Automation/robotics?

- Apply administrative controls.
  - E.g. Review reference levels for mine clearance, etc.

- Use personal protective equipment.
  - E.g. Respirators, filtered-air hardhats.
Engineered controls

Some examples

Air-conditioned cabins

Before

After
Optimize protection

- Do the changes imply a need to reduce exposure?
  E.g. Could the most exposed workers exceed dose constraints?
- Review mine ventilation, especially underground.
  E.g. More clean air? (Watch out for unattached fraction.)
- Are there sources that can be better controlled?
  E.g. Dewatering? Control of other pathways?
- Apply engineering controls where possible.
  E.g. Air-conditioned cabins on mobile equipment. Automation/robotics?
- Apply administrative controls.
  E.g. Review reference levels for mine clearance, etc.
- Use personal protective equipment.
  E.g. Respirators, filtered-air hardhats.
ICRP126: use the default DCF!

Theoretically, the DCF may need to be modified to take account of mine air characteristics, such as particle size.

Note: filtering out radon decay products may also reduce the concentration of nucleation sites, resulting in a higher unattached fraction.
Planned vs. Existing Exposure Situations

Mines currently treated as existing exposure situations
- Review the radon reference level value: decrease by 2?
- Continue to optimize protection below the new reference level.
- If not possible, consult with the regulatory body: the requirements for planned exposure situations may need to be applied.

Mines regulated as planned exposure situations (summary)
- Review dose assessment and optimization of protection.
- Minor improvements, as outlined, are likely to be adequate to continue to meet regulatory requirements.
- In some cases of high radon or RDP concentration, significant reduction of exposure may be needed.