Introduction to occupational exposure trends and problems to be solved

EUROPEAN STUDIES OF OCCUPATIONAL RADIATION EXPOSURE - E S O R E X

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Content

Optimisation by ICRP

How to evaluate optimisation?

European trends in occupational exposure

Questions, difficulties and problems
Optimisation by ICRP

- below the appropriate dose constraints
- As Low As Reasonably Achievable
- economic and social factors taken into account
Finding dose constraints

§210 and 211 from the new proposal of ICRP:

• Appropriate dose constraint by
  • … generic optimization
  • … national or regional attributes and preferences
  • … international guidance and good practice

• For planned situations: “level of individual doses … in well-managed operations”
Optimisation by ICRP

Targets of optimisation

- individual doses
- likelihood of exposure
- number of people exposed
Measuring optimization
focussing the individuum

Target parameters

- individual doses → $H_i$
- likelihood of exposure → $P_i(H>0) \sim \frac{N_{\text{exposed}}}{N_{\text{monitored}}}$
- number of people exposed → $N(H>0)$

not sufficient to evaluate optimisation measures
Statistical parameters

• measures of location and dispersion appropriate to the question
  
  mean, mode, median, collective dose,
  range, percentiles,
  n of exposed, n of exceeded dose limits,

• combined change analysis
  
  shift or change of dose distributions
  analysis of gradients (e.g. $\Delta CD / \Delta t$ vs. $\Delta N(H>0) / \Delta t$)
Statistical evidence of optimisation

Criteria on national and international level:

- lower average dose
- less collective dose
- less cases with high exposures
- change of dose distribution
- ...

ESOREX

- European Studies on Occupational Radiation Exposure
- by order of the European Commission
- executed by German BfS in co-operation with Czech SUJB
  and vice versa
- 30 European countries involved
- Part I – country reports
- Part II – dose distribution data
- www.esorex.cz
Countries participating in ESOREX
Radiation workers in Europe
Workforce officially monitored for radiation exposure in 2000

"As many as reasonably affordable?"
Radiation workers by work sectors in Europe


Medical Sector
Nuclear Sector
General Industry
Natural Sources
Research & Education

Monitored Workers

200,000
100,000
0


Bundesamt für Strahlenschutz
3rd ESOREX Workshop Prague, 2/3 Dec. 2004
Analysed work sectors

<table>
<thead>
<tr>
<th>Nuclear sector</th>
<th>Medical sector</th>
<th>General industry</th>
<th>Research and education</th>
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<td>United Kingdom</td>
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Austria, Czech Republic, Germany, Switzerland, Denmark, Spain, Finland, Greece, Hungary, Latvia, Netherlands, Norway, Romania, Sweden, Slovenia, United Kingdom.
Average doses in Europe
(Individual doses of measurably exposed workers)

Average personal dose in Europe in 2000: ca. 1.3 mSv
Collective doses in Europe

Total collective dose in Europe in 2000: ca. 450 Pers.-Sv
Exposures above 20 mSv/a in Europe

N of cases per 10,000 monitored radiation workers

Average in Europe in 2000: ca. 7 cases per 10,000 monitored workers
Dose distributions in nuclear sector 1996 - 2000

Nuclear Fuel Cycle

Countries: BG, CH, CY, CZ, DE, EE, ES, FI, GR, HU, LV, NL, NO, RO, SE, SI, SK, UK

Monitored Workers [%]

Personal Dose [mSv]

< 0.1  ( 0.1 - 1.0 ]  ( 1.0 - 2.0 ]  ( 2 - 5 ]  ( 5 - 10 ]  ( 10 - 20 ]  > 20


17
Dose distributions in medical sector 1996 - 2000

Medical Sector

Countries: AT, BG, CH, CY, CZ, DE, DK, EE, ES, FI, GR, HU, IE, IS, LI, LU, LV, MT, NL, NO, RO, SE, SI, SK, UK
### Dose distributions in general industry 1996 - 2000

#### General Industry

**Countries:** AT, BG, CH, CY, CZ, DE, DK, EE, ES, FI, GR, HU, IE, IS, LI, LU, LV, MT, NL, NO, RO, SE, SI, SK, UK

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<th>Year</th>
<th>Personal Dose [mSv]</th>
<th>&lt; 0.1</th>
<th>(0.1 - 1.0]</th>
<th>(1.0 - 2.0]</th>
<th>(2 - 5]</th>
<th>(5 - 10]</th>
<th>(10 - 20]</th>
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Dose distributions in research & education 1996 - 2000

Monitored Workers [%]

Personal Dose [mSv]

Countries: AT, BG, CH, CZ, DE, DK, ES, FI, GR, HU, IE, LI, LV, NL, NO, RO, SK, UK
Dose distributions in sector natural sources 1996 - 2000

Natural Sources
Countries: AT, CZ, DE, NL, NO, RO, SE, SI, UK
Shape of dose distributions in work sectors
# Trends and changes 1996 - 2000

<table>
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<tr>
<th></th>
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<td>↘</td>
<td>↔</td>
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<td>↘</td>
<td>↘</td>
<td>↘</td>
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<td>Cases with high doses</td>
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<td>↔</td>
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When to optimize?

- What is „Good practice“ or „State of the art“?
- What level is „normal“?
- What level have „the others“?
- What level have we now and what before (e.g. 10 years ago)?

Level:
any appropriate statistic parameter (e.g. man-Sv per reactor unit and year)
What is difficult to judge

• Has the “reasonably achievable” level been reached?

• Have “economical and social factors” been taken into account?
Decision-aiding techniques

- Linear optimisation
- Cost-benefit analysis
- Monetary value of the man-Sievert
- Cost-effectiveness analysis
- Multi-attribute utility analysis
Cultural climate of comparison and competition

ICRP
Optimisation process

EU Networks

Stakeholder involvement

ALARA Practices
Areas of „suboptimal” solutions

A view from the European perspective:

• dose limit exceedings of transnationally active outside-workers (multiple radiation passbooks)

• inhomogeneous characterization of workers

• dosemeter evaluation: with/without background subtraction

• dosemeter position: above / below the lead apron
http://www.esorex.cz