The United Nations Scientific Committee on the Effects of Atomic Radiation

- Occupational Exposure of Lens of the Eye-

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“Regulatory implementation of equivalent dose limit for the lens of the eye for occupational exposure”
The eye is considered a relatively radiosensitive organ mainly because of the frequent development of posterior subcapsular cataracts.

There have been “dramatic improvements” in the understanding of acute effects long-term local radiation injuries due to irradiation.

It was thought that single acute doses of low-LET radiation of 2 Gy or more and for fractioned exposure, vision-impairing damage to the retina and the optic nerve may require a cumulative dose of the order of 50–60 Gy.

Majority of opacities after radiation do not impair vision, however above 7 Gy severe visual impairment.

In 2008 it was suggested that the lens of the eye may be more radiosensitive than previously considered.

For occupational exposure and accidents a few observations have been made for different medical procedures and after accidents.
## Planned exposure activities

<table>
<thead>
<tr>
<th>Workers</th>
<th>Procedures</th>
<th>Equivalent dose (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 vascular surgeons*</td>
<td>47 consecutive endovascular aortoiliac aneurysm (over 1 year)</td>
<td>7.8 (primary surgeon)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.7 (first assistant)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (second assistant)</td>
</tr>
<tr>
<td>10 specialists</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>Interventional radiologists</td>
<td>a) Vascular intervention radiology</td>
<td>0.04 - 2.1 (per procedure)</td>
</tr>
<tr>
<td></td>
<td>b) Interventional cardiology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- With and without lead screen</td>
<td>0.04 – 1 (per procedure)</td>
</tr>
<tr>
<td></td>
<td>- With lead screen</td>
<td>0.05 - 0.5 (per procedure)</td>
</tr>
<tr>
<td></td>
<td>- Without lead screen</td>
<td>0.03 – 1 (per procedure)</td>
</tr>
</tbody>
</table>

*Other procedures are also presented in UNSCEAR 2008, Annex B report*
<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Type</th>
<th>Main cause</th>
<th>Persons</th>
<th>Eye exposure (Gy)</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>USSR</td>
<td>1966</td>
<td>X ray equipment</td>
<td>Poor maintenance</td>
<td>1</td>
<td>20</td>
<td>1 Death after 7 years and loss of left eye*</td>
</tr>
<tr>
<td>Peru</td>
<td>1977</td>
<td>$^{192}$Ir source</td>
<td>Untrained personnel; not registered equipment</td>
<td>3</td>
<td>0.9</td>
<td>No eye effects reported**</td>
</tr>
<tr>
<td>USSR</td>
<td>1978</td>
<td>Siberian Chemical Complex</td>
<td>$Pu$ deficient glovebox</td>
<td>1-7</td>
<td>2.5 (whole body) 0.05 and 0.6</td>
<td>Eyesight impairment occurred some time later*</td>
</tr>
<tr>
<td>Argentina</td>
<td>1982</td>
<td>X therapy facility</td>
<td>Operator’s failure</td>
<td>1</td>
<td>5.8</td>
<td>Cataracts on both eyes**</td>
</tr>
<tr>
<td>USSR</td>
<td>1980</td>
<td>$^{60}$Co irradiation facility</td>
<td></td>
<td>1</td>
<td>50</td>
<td>No eye effects reported**</td>
</tr>
</tbody>
</table>

*2008 Report
** 2000 Report, Annex E
Chernobyl accident

- Ukrainian–American Chernobyl Ocular Study
  - Two ophthalmological examinations 12 and 14 years after the accident - 8,607 workers in six cities located in five Ukrainian oblasts
  - Modelling revealed data not compatible with a dose–effect threshold of more than 700 mGy, and that the lower boundary of the estimated dose threshold was close to 150 mSv with uncertainties

- ARS workers (15 years of clinical observation of 77 workers)
  - 11 cases of clinically significant cataracts were observed
  - among persons who survived doses from 2.6 to 8.7 Gy
  - latent period varied from 1.5 years (for the most exposed person) to 12 years (for the least exposed person)

- Ukrainian studies of cataracts among the ARS survivors and the recovery operation workers were underway since 2008.
Fukushima accident

**2013 Report**

- No direct information on beta-radiation fields at FDNPS was available to the Committee.
- Priorities for research identified included estimation of doses to the lens of the eye for workers involved in the on-site mitigation strategies.

**2020/2021 Report**

- TEPCO determined the personal dose equivalent (March 2011-March 2012)
  - 77 workers more than 100 mSv; 10 of these were estimated to have received more than 150 mSv
- Discernible risk of cataracts is uncertain; some estimates of dose to the lens of the eye have become available.
- Remains to be established whether full-face masks
- The worker epidemiology study includes plans, but no results are published.
Further research areas and next steps

• Planned exposure
  • The Committee notes that data on the equivalent doses to the lens of the eye reported until 2019 is limited. It is expected that for the Committee’s next evaluation of occupational exposure, more countries will be in the position to provide reliable data on this topic.

• Accidents
  • Critical analysis to better understand of existing knowledge from the Chernobyl accident. Need to better evaluate latency and cataract progression, and to better characterize the risk to the lens of the eye from exposure to low-to-moderate radiation doses.
  • Beta dose to the lens of the eye of workers was identified as a research need in the UNSCEAR 2013 Report (Fukushima) but an assessment of these doses had not been reported/published until 2019.

UNSCERAR new evaluation planned for 2023

• Welcome feedback and cooperation on this topic for the new evaluation
Further information

- Printed version can be ordered from https://unp.un.org

- Electronic version for free download www.unscear.org

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