

EPRI Update: Lens of the Eye Projects

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**2015 ISOE International
Symposium
May 2015**



Radiation Safety Program



Radiation Management

Low Level Waste

**Radiological Environmental
Protection**

**Low Dose Radiation Health
Effects**

2014 - 2015 Radiation Management Research Plan

Source Term and Radiation Field

- SRMP/BRAC Revision (completed 2014)
- Chemistry Impacts on Dose Rates (BWR completed, PWR in progress)
- See Carola's presentation for 2015+ source term projects

Optimization of High Dose Tasks

- Optimization of Cavity Decontamination w/EDF (in progress)
- Reactor Headset Optimization w/NMAC (in progress)
- Steam Generator Dose Optimization w/NDE and SGMP (in progress)

Improved Dosimetry and Planning

- EDEX Implementation Guide (in progress)
- **Guide for Improved Lens Dose Monitoring and Protection (in progress)**

2014 - 2015 Low Dose Health Effects Research Plan

Cancer Risks

- Evaluation of BEIR VII DDREF Analysis (completed 2014)
- Evaluate German DDREF Analysis (2015+)
- Mining of additional Animal and Human Datasets (2015+)

Non-Cancer Risks

- Scientific Appraisal of Lens Opacity and Cataract Health Studies (completed 2014)
- Investigate Cardiovascular Risks (2015+)

Support of NAS Cancer Study

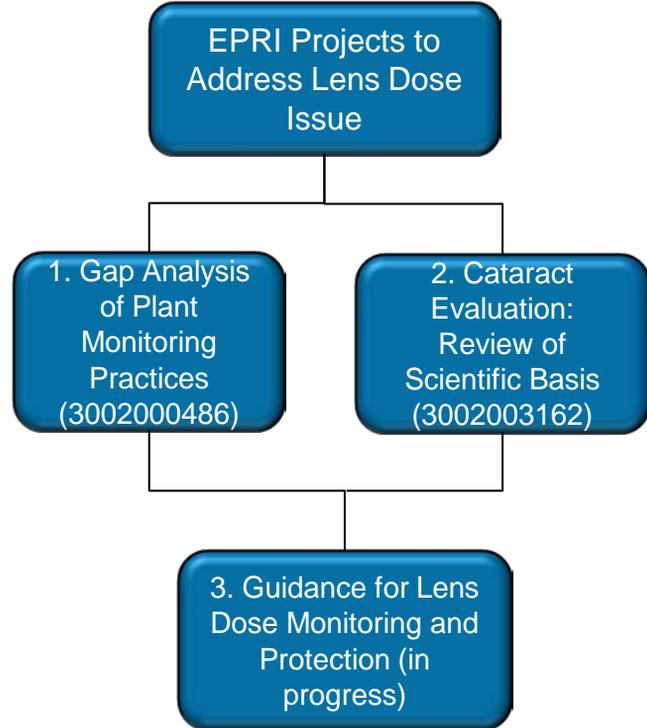
- Recommendations to the NAS Pilot Study Committee: Feasibility Study (completed 2014)
- Impacts from Transient Releases to Population Dose and Childhood Leukemia Risks (2015+)

Background: ICRP Recommendations

- “Statement on Tissue Reactions” issued Apr. 2011
- ICRP Publication 118 issued in 2012
 - Reduced lens dose limit to 20 mSv/yr (2 rem/yr), averaged over 5 years and no single year > 50 mSv (5 rem)
 - Previous limit 150 mSv/yr (15 rem/yr)
 - Nominal threshold dose considered to be 0.5 Gy for acute or protracted
 - Previous was ~5 Gy acute, ~8 Gy fractionated

Background: Regulatory Activities

- NRC currently evaluating with 10 CFR Part 20 potential changes
- Incorporated into IAEA Basic Safety Standards
- European Commission adopted new ICRP recommendations
- Canada proposing to lower dose limit to 50 mSv/yr (5 rem/yr), not to exceed 100 mSv (10 rem) in 5 years.
- Industry requested EPRI to conduct research in this area.



1. Gap Analysis of Lens Dose Monitoring Practices and Technologies (3002000486)

Project Objective:

- Develop a list of issues that utilities will need to consider if lower lens dose limits are adopted, including lens of the eye monitoring and protection.
- Identify R&D gaps and technological needs
- Survey
 - Obtain industry information relative to:
 - protection programs
 - monitoring programs
 - plant radiological conditions
 - 2/3 of U.S. sites responded + 7 responses from international utilities

Key Observations from Survey Results

- ✓ Some countries currently do not have to report lens dose (e.g. France, Spain, Korea, Canada)
 - Impact will be the greatest for these countries
- ✓ Administrative limit for lens dose varies or is non-existent
- ✓ Almost all use an algorithm that takes the shallow dose and deep dose dosimeter readings to calculate the lens dose.
 - Knowledge of algorithm will be required
 - Algorithms may need to be refined
- ✓ Most do not estimate lens dose in advance of work
- ✓ Report was published in 2013 (Product ID: 3002000486)

3. Guidance for Improved Lens Dose Monitoring and Protection to Meet Low Lens Dose Limit

Personnel Protection and Monitoring

- Review procedures and work situations
- Plant use of protective equipment (e.g. goggles, face shields)

Advanced Dosimetry

- Investigate what's available and in development
- May require some field testing

Industry Lens Dose Guidance

Plant Radiological Conditions

- Analyze data from plants to determine if beta or electrons of sufficient energy are present

3. Guidance for Improved Lens Dose Monitoring and Protection to Meet Low Lens Dose Limit (current)

Project Description/Tasks

- Guidance to help meet lower lens dose limit
- Practical method to determine which plant areas/situations require special monitoring and/or protection
- Investigate protection factors for protective eyewear
- Improve understanding of the capabilities of dosimetry systems in use to monitor the lens of the eye
- Workshop to communicate lens dose issues and enable better decision making by utilities, regulators, and vendors

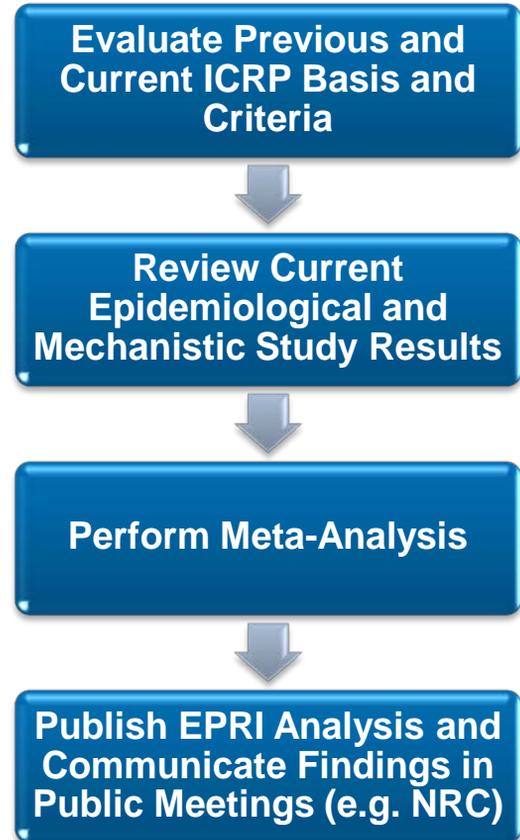
Breadth of Applicability

- ✓ Globally applicable to all Nuclear Steam Supply Steam (NSSS) types and personnel

2. Cataract Evaluation

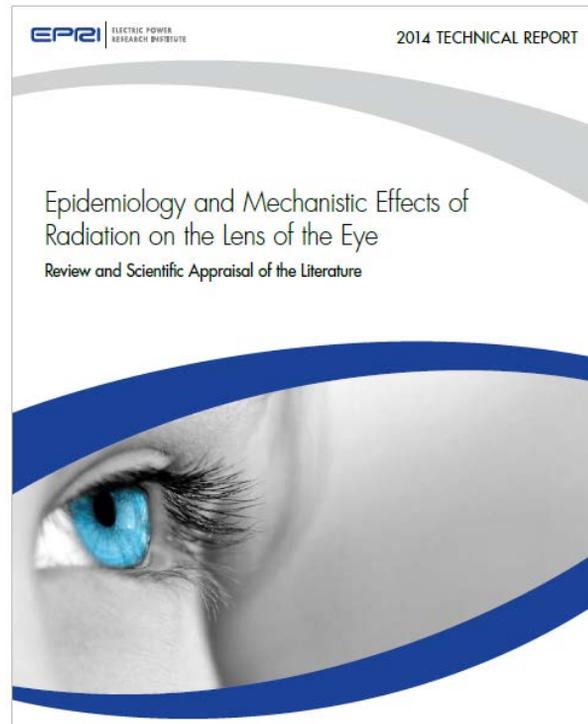
Objective:

- Perform an independent “state of the science” evaluation to understand the technical basis for the ICRP recommendations.
 - Include studies post-ICRP publication



EPRI Cataract Evaluation (3002003162)

- ✓ **Performed Literature Review (Identified and Reviewed in Detail):**
 - Evaluated > 300 studies, reviews, and other references
 - Larger number of studies evaluated than in previous reviews
- ✓ **Developed Assessment Matrix:**
 - Established 12 criteria based on EPA approach
 - Categorized human studies into 3 tiers:
 - Tier 1: Top Quality
 - Tier 2: Mid Quality
 - Tier 3: Lower Quality



Product ID: 3002003162,
publicly available

Key Conclusions

- **Shift in protection criteria and philosophy occurred for radiogenic cataracts**
 - Visually-impairing cataracts (before) vs minor lens opacifications (now)
- **There are limited, high quality, epidemiological studies available. However, meta-analysis suggests an association exists with some types of cataracts for a variety of exposure conditions and perhaps at doses lower than previously considered.**
 - Analysis suggests an association exists between radiation and initiation/development of posterior subcapsular, cortical, and mixed cataracts.

Posterior
Subcapsular
Cataract



Cortical Cataract

Key Conclusions (continued)

- **Quantitative estimate of a specific dose threshold (adverse effect dose) is not yet possible**
 - Limited available studies that evaluated thresholds
 - Uncertainties exists with the studies
 - Uncertainties with dose estimates
 - Lens opacity/cataract detection not standardized
 - Example: No statistical difference in the choice of a threshold for posterior subcapsular cataracts between 0 and 2.5 Sv (250 rem) from the A-bomb survivor study

EPRI Cataracts Evaluation (continued)

- ✓ Active Participation and Collaboration with the National Council of Radiation Protection and Measurements (NCRP) SC 1-23 Commentary
 - EPRI Team members on NCRP SC 1-23:
 - Dr . Eleanor Blakely (Lawrence Berkeley National Lab, Committee Chair)
 - Dr. Larry Dauer (Memorial Sloan-Kettering, Committee Co-chair)
 - Dr. David Hoel (University of South Carolina Medical School, Committee Member)
 - Phung Tran (Committee Consultant)
 - Don Mayer (Committee Member- Industry Representative)

Overall Summary and Next Steps

- ❑ Science for radiogenic cataracts is evolving but uncertainties in radiation biology and epidemiology still exist.
- ❑ Increased interest in improving monitoring and protection for dose to the lens of the eye. Tools and monitoring techniques are being developed.
- ❑ Continue working with industry group to develop lens monitoring and protection guide
- ❑ Continue collaboration with NCRP sub-committee (SC) 1-23 Commentary and draft manuscript for journal publication.

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