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United Nations Scientific Committee
on the Effects of Atomic Radiation



ISOE International Symposium

Tours, 21 – 23 June 2022

Occupational exposure to ionizing radiation: UNSCLEAR Global Survey and ISOE DATA

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- Established by UN General Assembly (GA) resolution in 1955
- Scientists from 31 UN Member States
- Assess levels, effects & risks of ionizing radiation
 - identify emerging issues
 - improve knowledge
 - identify areas for future research
- Disseminate findings to UN GA, scientific community and public



Scientists from 31 UN States Members

- Algeria
- Argentina
- Australia
- Belarus
- Belgium
- Brazil
- Canada
- China
- Egypt
- Finland
- France
- Germany
- India
- Indonesia
- Iran (IR)
- Japan
- Mexico
- Norway
- Pakistan
- Peru
- Poland
- Rep. of Korea
- Russia
- Slovakia
- Spain
- Sudan
- Sweden
- Ukraine
- UAE
- UK
- USA



Input: Other Member States and international organizations provide relevant data and technical input



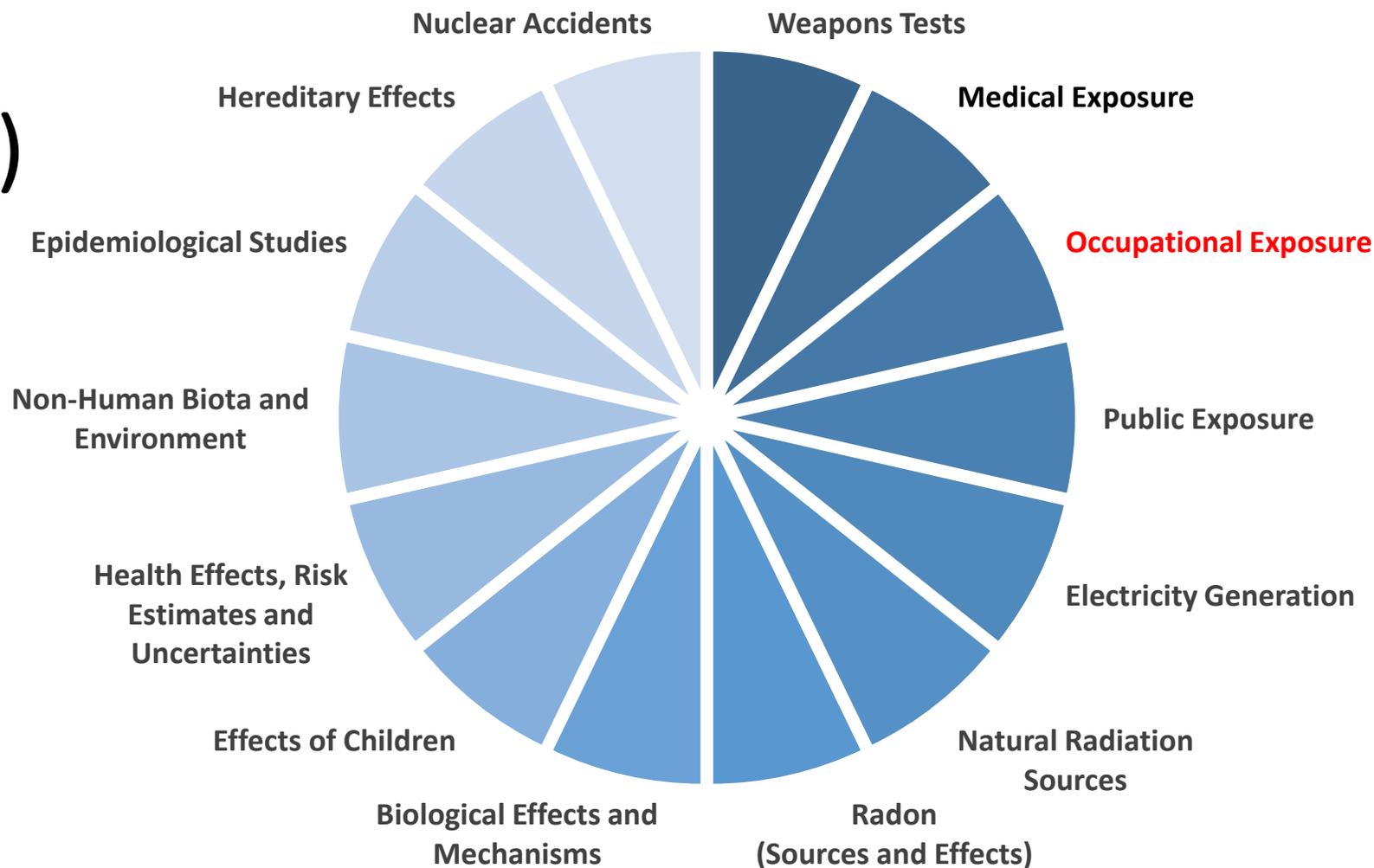
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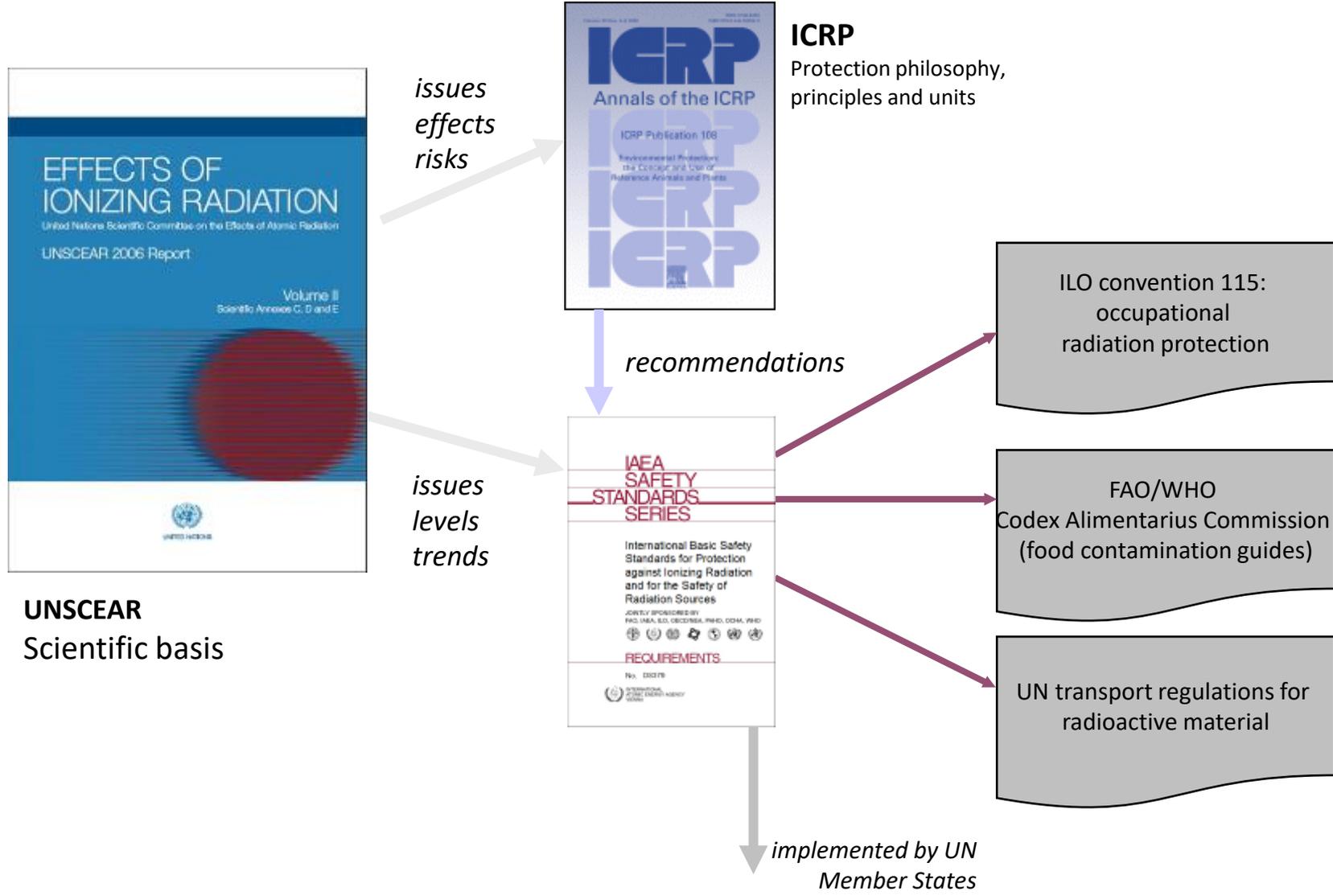
UNSCLEAR (key work areas)





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issues effects risks

issues levels trends

recommendations

ICRP
Protection philosophy,
principles and units

UNSCLEAR
Scientific basis

*implemented by UN
Member States*

ILO convention 115:
occupational
radiation protection

FAO/WHO
Codex Alimentarius Commission
(food contamination guides)

UN transport regulations for
radioactive material



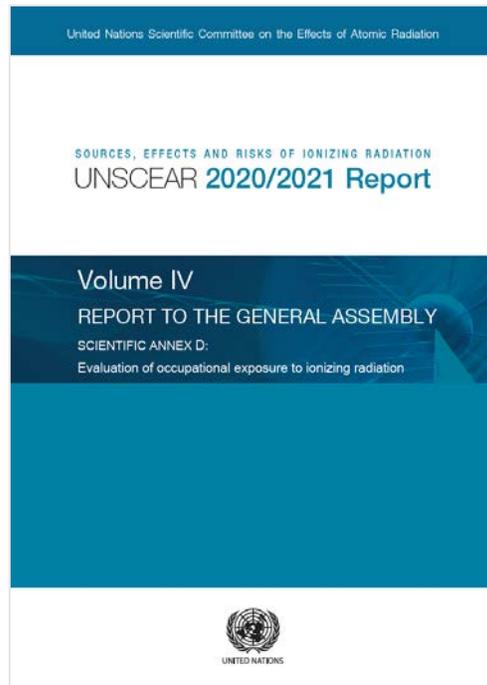
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UNSCLEAR 2020/2021 REPORT VOLUME IV: “Evaluation of occupational exposure to ionizing radiation”



Timelines

- 2014: Committee endorsed the project plan
- 2016–2019: Secretariat conducted Global Occupational Exposure Survey
- 2021: Committee adopted the report
- 2022: Publication planned (Q3/Q4)



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Sources of Information

- **UNSCLEAR Global survey**
- **ISOE database (first agreement in 2011)**
- IAEA Power Reactor Information System
- World Nuclear Association
- National Reports
- Peer-reviewed literature





Evaluation of Occupational Exposure to Ionizing Radiation (2022)

- A major source of occupational exposure in the nuclear fuel cycle is the operation of nuclear reactors to generate electrical energy.
- Thirteen countries responded to the UNSCEAR Occupational Exposure Survey and provided occupational exposure data for operating commercial nuclear power reactors (2000–2014).
Additional data on exposure of workers at operating nuclear power reactors was obtained from ISOE.
- The annex provides estimates of the magnitude of and temporal trends in the average annual collective effective dose and per capita effective doses, and the numbers of monitored workers.
- Very little extrapolation was needed for operating NPPs, as the data on annual collective effective dose were substantially complete; close to 100% for PWRs and GCRs, about 94% for BWRs, and 88% for HWRs.
- Overall, the estimated worldwide levels of average annual collective effective dose is fairly certain for much of the nuclear fuel cycle.



Dosimetry related questions for Member States

Recorded	HE:	DOE; NRC	E:	DOE; NRC	Hp:
Factor used to convert WLM to effective dose:					
Type of dosimeter mainly used:	DOE and NRC: TLD				
Value of minimum detectable level MDL (mSv):	DOE and NRC: Site dependent				
Value of recording level (mSv):	0.01-0.1 mSv				
Radiation background subtracted?	DOE and NRC: site dependent				
Are the external monitoring laboratories accredited by the accreditation body or authorized by the regulatory authority?			DOE: YES, DOELAP; NRC: YES, NAVLAP		
Are the internal monitoring laboratories accredited by the accreditation body or authorized by the regulatory authority?			DOE: YES, DOELAP; NRC: none available		



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International
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YEAR		United States of America												
2014		Workforce											Dose	
Work sectors and categories		NUMBER OF WORKERS IN DOSE INTERVALL											Collective dose (man Sv)	
Work sectors	Work Categories	< MDL	MDL-1	>1-5	>5-10	>10-15	>15-20	>20-30	>30-50	>50	Number All	Number >MDL		Number Female Workers
NUCLEAR FUEL CYCLE	Total Nuclear Fuel Cycle	96450	39350	17459	2549	607		58	0	0	156473	60023		78.70
	Uranium mining													
	Underground mine													
	Openpit mine													
	Uranium milling													
	Uranium conversion	70	531	264	16	0		0	0	0	881	811		0.85
	Uranium enrichment	2447	86	0	0	0		0	0	0	2533	86		0.01
	Fuel fabrication	1503	1948	753	75	2		0	0	0	4281	2778		2.77
	Reactor operation	73451	32932	15507	2380	589		58	0	0	124917	51466		71.27
	Permanent staff													
	Contractors													
	Decommissioning	2884	574	201	44	16					3719	835		1.11
	Fuel reprocessing	664	181	13	0	0		0	0	0	858	194		0.07
	Research in nuclear fuel cycle													
	Waste management	3920	1160	371	4	0		0	0	0	5455	1535		1.13
Safety and safeguards inspections														
Transport within nuclear fuel cycle														
All other activities in nuclear fuel cycle	11511	1938	350	30	0		0	0	0	13829	2318		1.49	



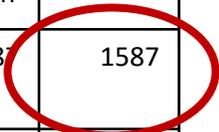
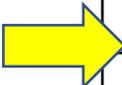
Occupational Exposure Data available in ISOE Database

Country	Plant unit	Type:	Utility	Year	Status	Validation
Switzerland	Beznau 1	PWR	AXPO	2014	Operational	Validated
Switzerland	Beznau 2	PWR	AXPO	2014	Operational	Validated
Switzerland	Gösgen 1	PWR	KKG	2014	Operational	Validated
Switzerland	Leibstadt 1	BWR	KKL	2014	Operational	Validated
Switzerland	Mühleberg 1	BWR	BKW	2014	Operational	Validated



Calvert Cliffs 1 & 2 USA Calendar Year 2014					
Distribution of annual effective external dose					
Dose Interval (mSv)		Number of individuals in dose interval exposed to external radiation			
Lower Bound >	Upper bound <=	Plant personnel	Outside personnel	No breakdown	Total
Not measurable (dose = 0)				1587	1587
Meas.	1.000			392	392
1.000	2.500			122	122
2.500	5.000			59	59
5.000	7.500			11	11
7.500	10.000			2	2
10.000	20.000				
20.000	30.000				
30.000	40.000				
40.000	50.000				
50.000	100.000				
Total				2173	2173

Recording level – 0.100 mSv





Challenges Using Data in the Evaluation of Occupational Exposure to Ionizing Radiation (2020/2021)

- Several challenges with integrating the two data sources:
 - Understanding differences in dosimetry reporting
 - Formatting responses (different exposure intervals)
 - Accounting for not measurably exposed workers
 - Accounting for transient (temporary) workers
- Some extrapolations required to account for unreported exposures
Break down of exposure by reactor type (not requested or supplied)
- Incomplete data sets (e.g., decommissioning)



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Summary

- The number of workers and the collective effective dose at civilian nuclear power plants is increasing, but the average annual effective dose for measurably exposed workers decreased for the time period 2000-2014.
- Data for this time period was substantially complete for NPP operation because of data available from ISOE.
- Greater uniformity of data reporting would improve data interpretation.
- Extension of ISOE/UNSCEAR agreement planned for 2023.



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Thank you!

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