RADIATION LEVEL IN CHINA AND PROTECTION STANDARDS

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1. Radiation levels in China

   (no citation for being unpublished)

   – Natural radiation level
   – Public exposure
   – Occupational exposure
   – Medical exposure
   – Detriments caused by accidents

2. Problems to be studied in protection standards

1. Radiation level in China

Annual effective dose to the public in China from natural radiation exposure（μSv）

Ray sources			China		Worldwide
			Current	1980's	
External	Cosmic rays	Ionizing component	260	260	280
		Neutron	100	57	100
	Terrestrial γ radiation		540	540	480
Internal	Rn-222 and progenies		1560	916	1150
	Rn-220 and progenies		185	185	100
	^{40}K		170	170	170
	Other nuclides		315	170	120
Total			~3 100	~ 2 300	2 400

1. Radiation level in China

Rn-222 concentration

70% higher in the start of 21st century than in late-1980's

Analysis of causes:

- Error caused by measuring methods: grab sampling and accumulation
- Reuse of slag for building material
- Wide use of air-conditioner

1. Radiation level in China

- Differences in diet with western countries

1. Radiation level in China

Collective effective dose to China's populations during 1986-2005 from artificial radiation (man·Sv)

Year	1986 -1990	1991 -1995	1996 -2000	2001 -2005
Nuclear weapon test	9.48×10^{3}	4.10×10^{3}	3.13×10^{3}	2.95×10^{3}
Nuclear fuel cycle	7.74×10	8.52×10	7.92×10	7.43×10
Nuclear technology application			8.05×10^{-1}	1.51
Research	1.87	1.19	0.92	3.16

1. Radiation level in China

Variation trend in occupational exposure countrywide

Indicator	Year	Nuclear fuel cycle		Nuclear/radiation technology application	NORM radiation exposure
		Other stages than uranium mining	Uranium mining		
Annual average monitored persons (thousand)	1986-1990	9.91	6.80	189.90	
	1991-1995	12.20	4.43	114.2	
	1996-2000	11.82	1.78	140.3	10588.4
Annual collective effective dose （man·Sv）	1986-1990	22.51	117.38	372.37	
	1991-1995	17.71	104.31	164.17	
	1996-2000	15.59	23.89	193.17	22347.7
Average annual effective dose (mSv)	1986-1990	2.27	17.26	1.96	
	1991-1995	1.45	23.53	1.44	
	1996-2000	1.32	13.46	1.38	2.1

1. Radiation level in China

Listing of occupational exposures countrywide during 1996-2000 (1)

Practices and/or activities		Annual average monitored persons, thousands	Average collective effective dose (man·Sv)	Average annual effective dose (mSv)
Nuclear fuel cycle				
Mining		1.80	27.67	15.35
	Milling	1.04	1.83	1.75
	Enrichment	3.39	0.78	0.23
	Fabrication	1.10	2.19	1.99
	Nuclear power	2.93	2.03	0.69
	reprocessing and waste management	1.30	4.06	3.13
	Research	2.06	4.70	2.28
	Sub-total	11.82	8.65	1.32

1. Radiation level in China

Listing of occupational exposures countrywide during 1996-2000 (2)

Practices and/or activities	Annual average monitored persons (thousands)	Average collective effective dose (man·Sv)	Average annual effective dose (mSv)
Nuclear/radiation application			
Medical uses	114.74	161.8	1.41
Industrial uses	24.00	28.22	1.18
Radioisotope production	1.56	3.15	4.90
Sub-total	140.3	193.17	1.38
Natural radiation			
Coal mine	6500	14600	2.4
Metal mine	1000	5532	5.53
Other types of mines	3000	2060	0.688
Underground workplaces other than mines	50	78	1.56
Aircrews	38.4	77.7	2.0
Sub-total	10588.4	22347.7	2.1

1. Radiation level in China

X-ray diagnosis-caused exposure

Year	Examinations, 10^6	Annual frequency, 10^{-3}		
		X ray	CT	Total
1984-1987	150.9	145.1	<0.01	145
1997-1998	247	180.7	15.5	196.2

1. Radiation level in China

Number of patients receiving radiotherapy

Year	Tele-radiotherapy per year		brachy-radiotherapy per year		Total	
	10^6	10^{-3}	10^6	10^{-3}	10^6	10^{-3}
1987	0.053[1]	0.048	-	-		
1998	0.335[2]	0.279[2]	-	-		
2006	0.409[3]	0.314	-	-		

Notes 1: The population, 590 million, for 17 provinces was estimated based on the countrywide population, 1.08 billion, in 1987; 2: This is the statistical result from 17 provinces; 3: This is an estimate from Chinese Cancer Association. Additionally, no data on number of patients receiving brachy-radiotherapy is available.

1. Radiation level in China

Accidental exposure-caused number of injuries during 1954-2007

Practice or activity	Death	Acute radiation sickness	Skin injury
Nuclear industry	0	0	52
Nuclear/radiation application	10	49	16
Nuclear test	-	2	-
Total	10	51	68

1. Radiation level in China

Radiation accident in medicine

Radiation accident	Case	Death
^{60}Co therapy unit in Wuhan, in 1972	12	3
Medical accelerator in 1985	24	13
^{60}Co therapy unit in 1992	15	2

1. Radiation level in China

Main conclusions

- Natural background 3.1 mSv/a
- Elevated Rn concentrations

1. Radiation level in China

- Nuclear power plants, and their fuel cycle facilities, contribute very low dose to workers and the public.
- Attention should be paid to reducing the dose to uranium workers.

1. Radiation level in China

- Artificially enhanced natural radiation is the major reason to result in the public exposure and occupational exposure in China.
- The resultant collective effective dose is 2-3 orders of magnitude higher than that from man-made radiation.

1. Radiation level in China

- Radiological diagnosis is the greatest contributor to the radiation dose to the public in China.
- CT examination causes far higher doses to the public than those from routine X ray examination.

2. Problems to be studied in protection standards

GB18871, 2002

Basic Safety Standards against Ionizing Radiation Protection and Radiation Source Safety

2. Problems to be studied in protection standards

- Detailed guidance needing to be set
- No revision plan until now

2. Problems to be studied in protection standards

NORM

- Management scope

2. Problems to be studied in protection standards

Rn-222, Rn-220

- Rn-220 dose conversion coefficient
- No epidemiological investigation data for Rn-220
- Current epidemiological investigation relating to Rn-222 includes the contribution from Rn-220 to some extent.

2. Problems to be studied in protection standards

- Standards on NORM-related waste
- Not completely same as the requirements for artificial radioactivity

2. Problems to be studied in protection standards

DOSE CONSTRAINT

- Established principle
- Depending on the nature of work

Thank you