Radiological Protection Countermeasures after TEPCO Fukushima NPP Accident

－Who should play the role of risk communication－

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Applications of Radiation and Radioisotopes

- Radiation Medicine

  Diagnosis（discovery of X ray, 1895）,

  Therapy（discovery of Radium, 1898）

  Nuclear Medicine（discovery of radioactivity, 1896）

- Research in Life Sciences

- Industrial Use

- Application in Agriculture and Fishery

Radiation is a double-edged sword

1895 E.Grubbe describes x-ray dermatitis

W. Fuchs publishes advice for protection of hands

Golden rules of radiation protection:

Time, Distance Shielding

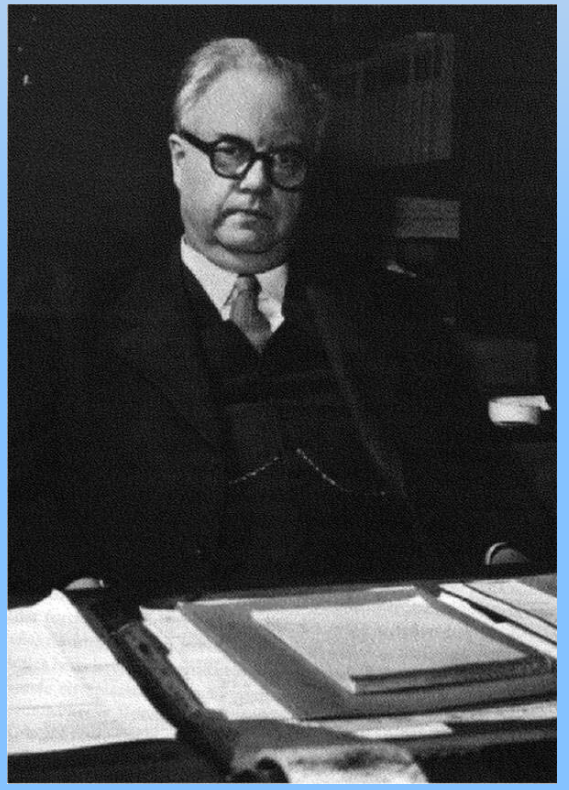
Protection of Workers（Professional Exposures）

1928 The Birth of ICRP（IXRPC）

At the 2nd International Congress of Radiology（ICR）

The International X ray and Radium Protection Committee was established

Chairman: Rolf Sievert



However, Things Changed

Accelerators, Reactors, Fallout from nuclear weapon testing

Managements of Radiation Exposures of the General Public

UNSCEAR（United Nations Scientific Committee on Effects of Atomic Radiation）established in 1955

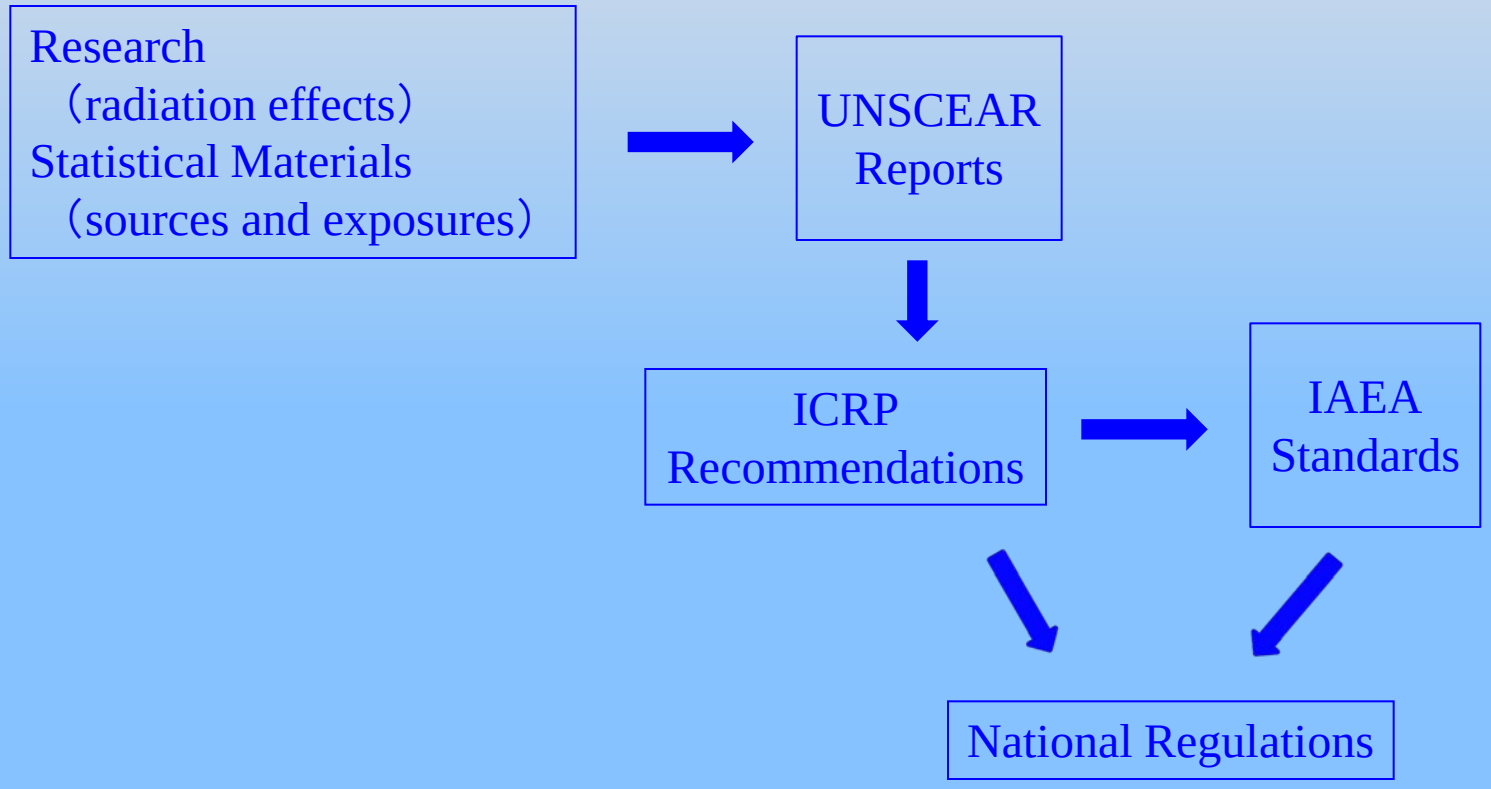
IAEA was established in 1957

IXRPC was renamed as XCRP in 1950

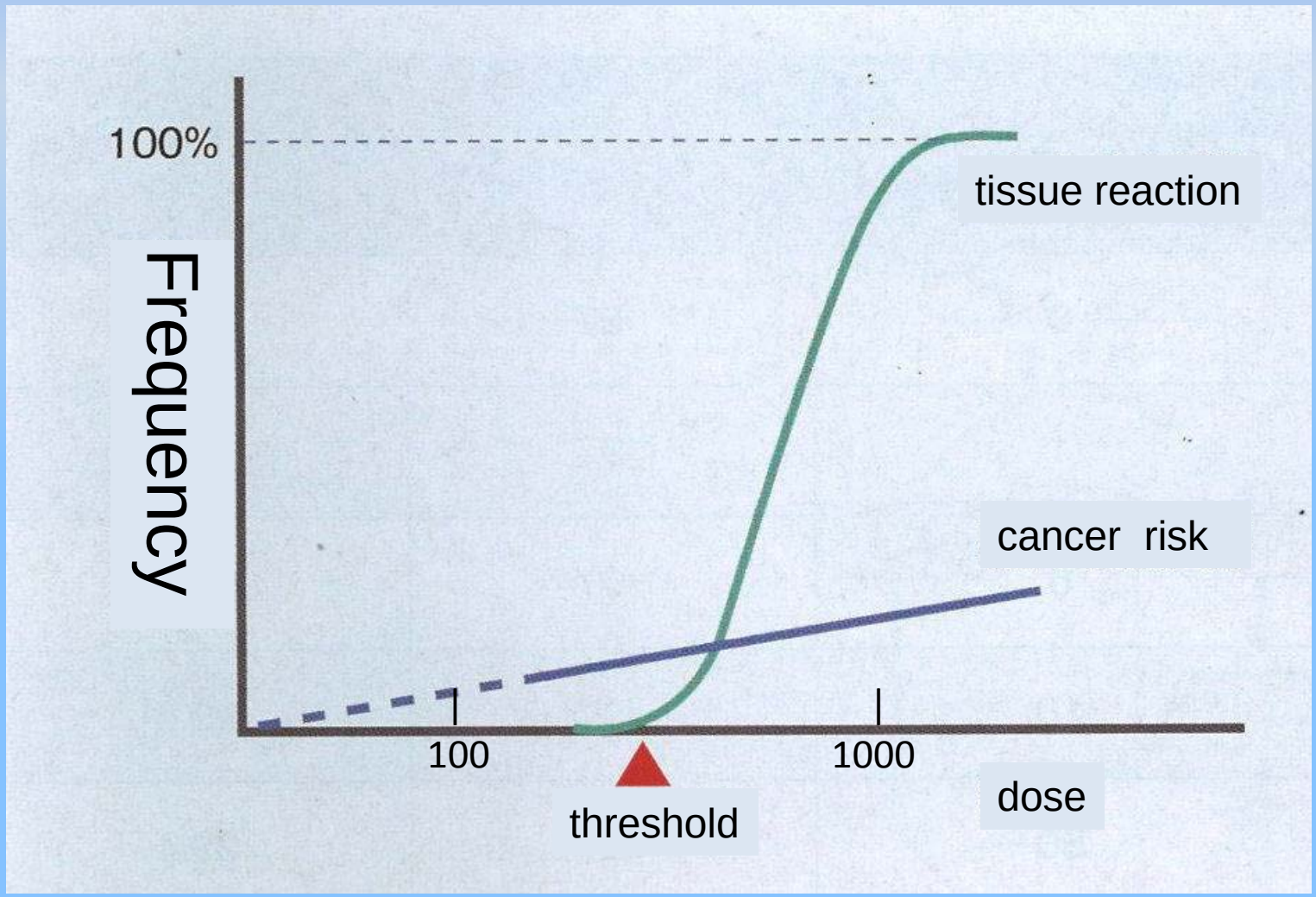
Excess leukemia and later solid cancers observed in A-bomb survivors

Stochastic Effects（cancer and hereditary effects）was recognized

International Framework of Radiological Protection and Regulation



Two Types of Radiological Effects
Dose-Effect Relation



Changes of Radiological Protection Standards

Past	→	Present
Protection of workers in medicine	All workers	All exposures
protection of human	assume environments are protected	protection of environments（non-human biota）
avoid deterministic effects	recognize stochastic effects	avoid deterministic effects, minimize stochastic effects
practical advices	dose limitation	optimization constraints and reference levels

Recent Recommendations of ICRP (translation by JRIA)

Publ. 103 The 2007 Recommendations of the International Commission on Radiological Protection

Publ. 109 Application of the Commission's Recommendations to the People in the Emergency Exposure Situation

Publ. 111 Application of the Commission's Recommendations to the Protection of People Living in Long-term Contaminated Areas after a Nuclear Accident or a Radiation Emergency

Publ. 96 Protecting People against Radiation Exposure in the Event of a Radiological Attack

System of RP of Humans based on the 2007 ICRP Recommendations

3 Types of Exposure Situations

Planned
Emergency
Existing

→ Exposure Situations

3 Categories of Exposures

Occupational Exposures
Public Exposures
Medical Exposures of Patients

（ICRP Publ.103）

Principles of Radiological Protection

- Justification
- Optimization

  as low as reasonably achievable（ALARA）
- Individual Dose limit

  Dose Limit does not apply to medical exposure of patients

Recommended dose limits in planned exposure situations

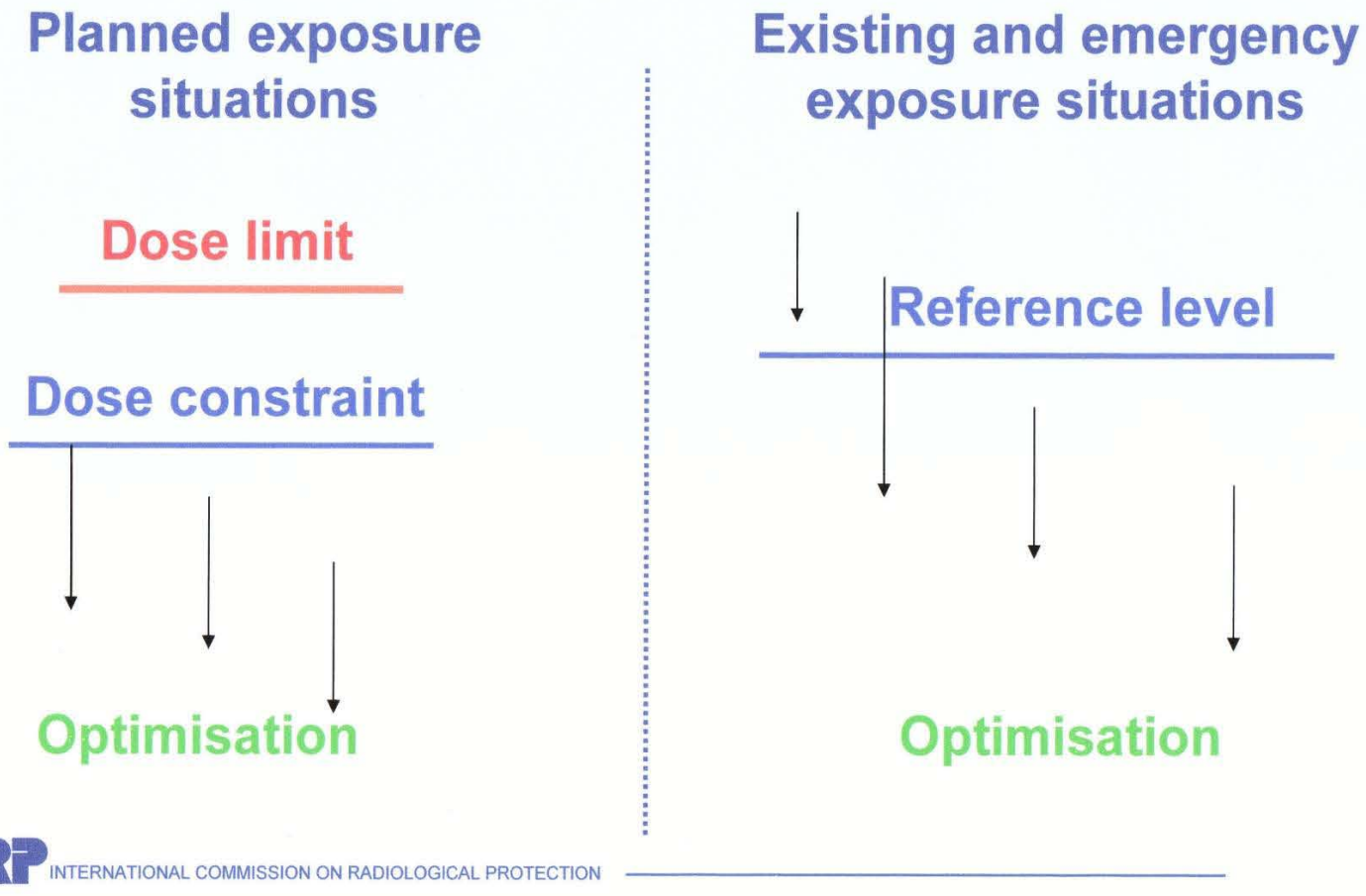
Type of Limit	Occupational	Public
Effective dose	20mSv per year, averaged over defined periods of 5 years	1mSv in a year
Annual equivalent dose in:		
Lens of the eye	150mSv	15mSv
Skin	500mSv	50mSv
Hands and feet	500mSv	—

The dose constraints and reference levels used in the Commission's system of protection

Type of situation	Occupational exposure	Public exposure	Medical exposure
Planned exposure	Dose limit Dose constraint	Dose limit Dose constraint	Diagnostic reference level （Dose constraint）
Emergency exposure	Reference level	Reference level	N.A.
Existing exposure	N.A. *	Reference level	N.A.

* Exposures resulting from long-term remediation operations or from protracted employment in affected areas should be treated as part of planned occupational exposure, even though the source of radiation is "existing".

Optimisation and Source-related Restrictions



3 Bands to be used for Optimisation of protection

mSv acute or annual dose	Example
Greater than 20 to 100	Reference level set for the highest planned residual dose from a radiological emergency
Greater than 1 to 20	Constraints set for occupational exposure in planned situation Reference level set for the residual dose from existing exposure situation
1 or less	Constraints set for public exposure in planned situation

Response to Emergency Exposure Situation

Aims of protection : Avoidance of severe deterministic effects

Initial response : Reference levels for workers in rescue and early response actions

Reference levels for members of the public

Choose appropriate reference level within the band of 20-100 mSv

recovery phase $\Longrightarrow$ existing exposure situation

Choose appropriate reference level within the band of 1-20 mSv

Managements of Aftermath of Radioactive Contamination

- Measurements of level of contamination: evacuation, off-limit, decontamination
- Estimation of level of human exposures
- Estimation of health effects caused by the exposures
- Rapid and rational plan and implementation of countermeasures
- Transdisciplinary cooperation and stake holder involvements

Establishment of Modern Science

Coinage of “scientist” by W. Hewell in 1843

“ ---ist ” is a person dedicated to a specific narrow area like pianist vs musician

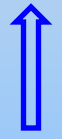
Changes of Knowledge Producing Modes

Mode 1.	Mode 2.
Curiosity driven research	Mission oriented R&D
Closed circle of specialists	Interaction between specialists and citizens
Disciplinary	Transdisciplinary
Peer review	Stake holder involvement

Various Trials

- Proposals to mass media how to communicate with members of the public in regard to radiation and its health effects, especially low dose radiation effects and its protection.
- Lectures for mass media : frame work of radiological protection in ICRP recommendations
- Panel discussions open to the general public
- Outreach through HP
- Mini-meeting and chatting at nursery schools located in slightly contaminated areas such as Kashiwa and Nagareyama cities.

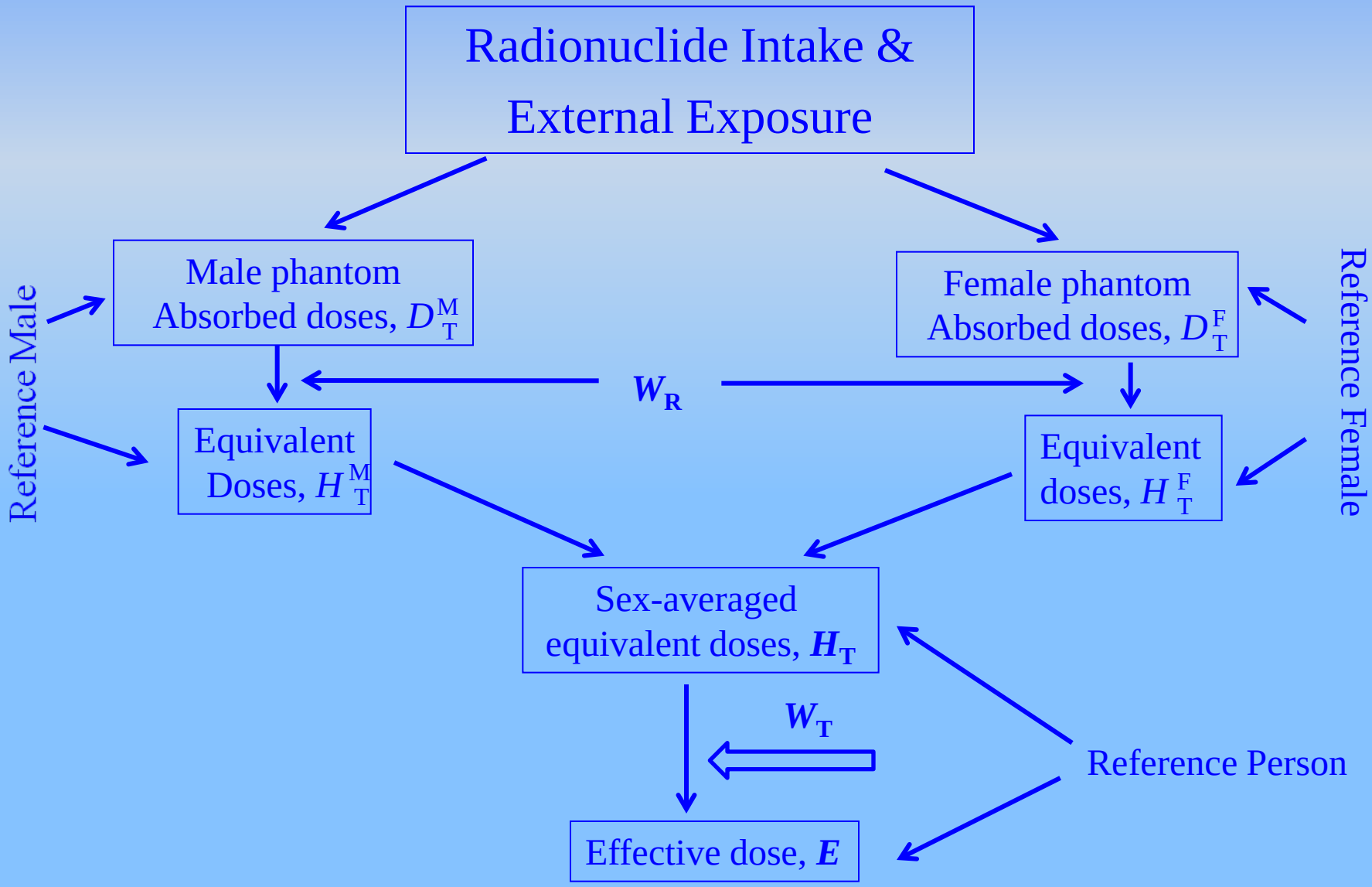
Speciality + Transparency = Trust



Interpreter・Communicator ⟹ Comprehension

Reference materials

Sex averaging to obtain the effective dose



Equivalent dose

$$H_{T,R} = \sum_{R} w_R \cdot D_{T,R}$$

unit : Sv

Effective dose

$$E = \sum_{T} w_T \cdot H_T = \sum_{T} w_T \sum_{R} w_R \cdot D_T$$

unit : Sv

Recommended tissue weighting factors

Tissue	W_T	ΣW_T
Bone-marrow（red）, Colon, Lung Stomach, Breast, Remainder tissues*	0.12	0.72
Gonads	0.08	0.08
Bladder, Oesophagus, Liver, Thyroid	0.04	0.16
Bone surface, Brain, Salivary glands, Skin	0.01	0.04
	Total	1.00

* Remainder tissues: Adrenals, Extrathoracic（ET）region, Gall bladder, Heart, Kidneys, Lymphatic nodes, Muscle, Oral mucosa, Pancreas, Prostate（♂）, Small intestine, Spleen, Thymus, Uterus/cervix（♀）

Use of Effective Dose

- Should be used for prospective panning for radiological protection
- Should not be used for retrospective risk assessment of specific individuals who were exposed to radiation
- Should not be used for epidemiological studies