RISK ASSESSMENT

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TOMSK -2015

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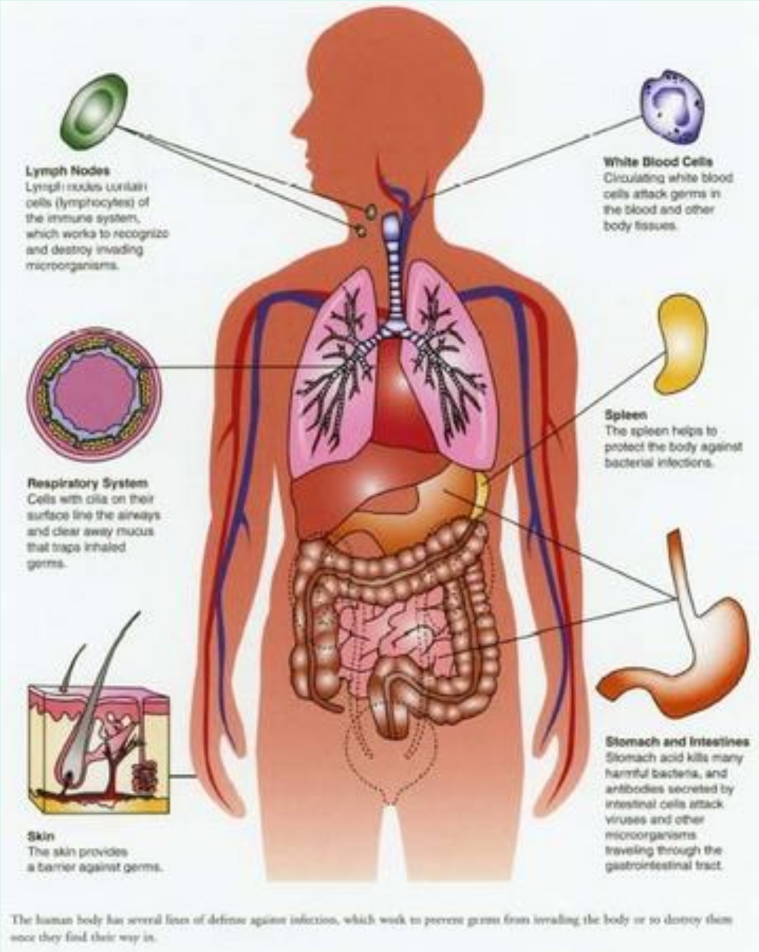
Human health risk assessment

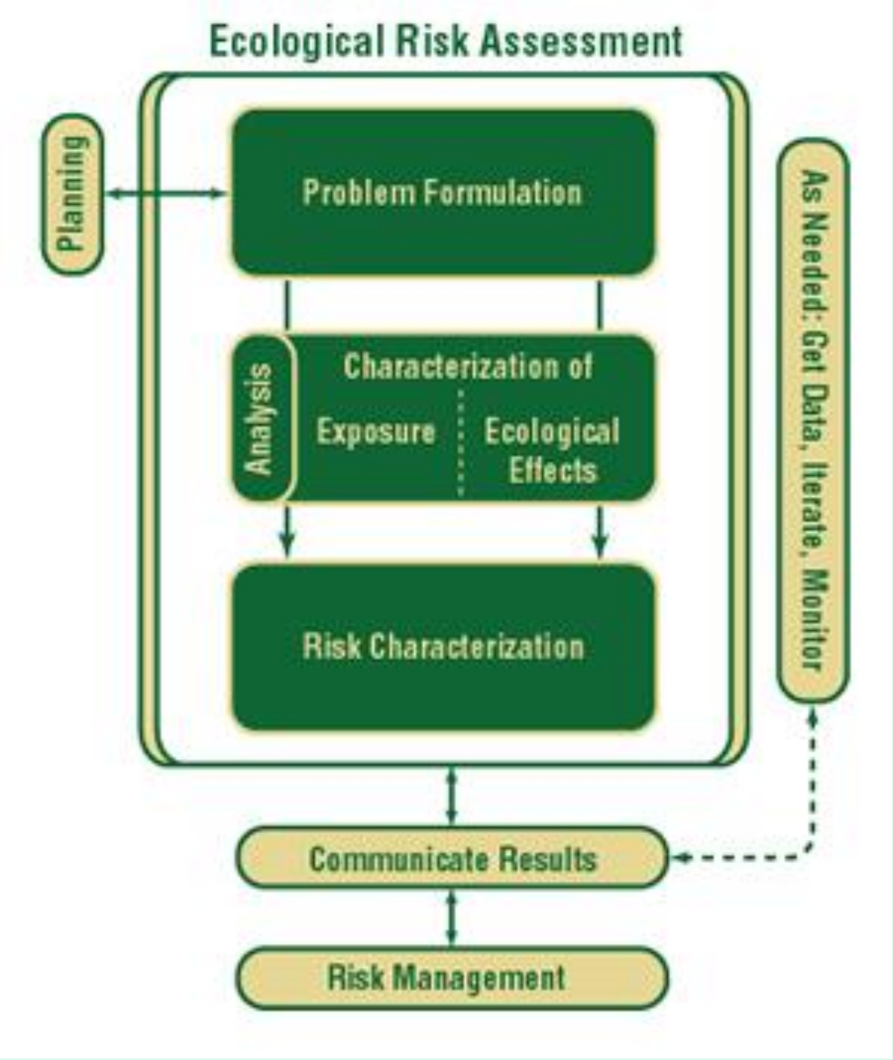
- Human health risk assessment is the process for determining potential health effect on people exposed to environmental pollutants and potentially toxic materials



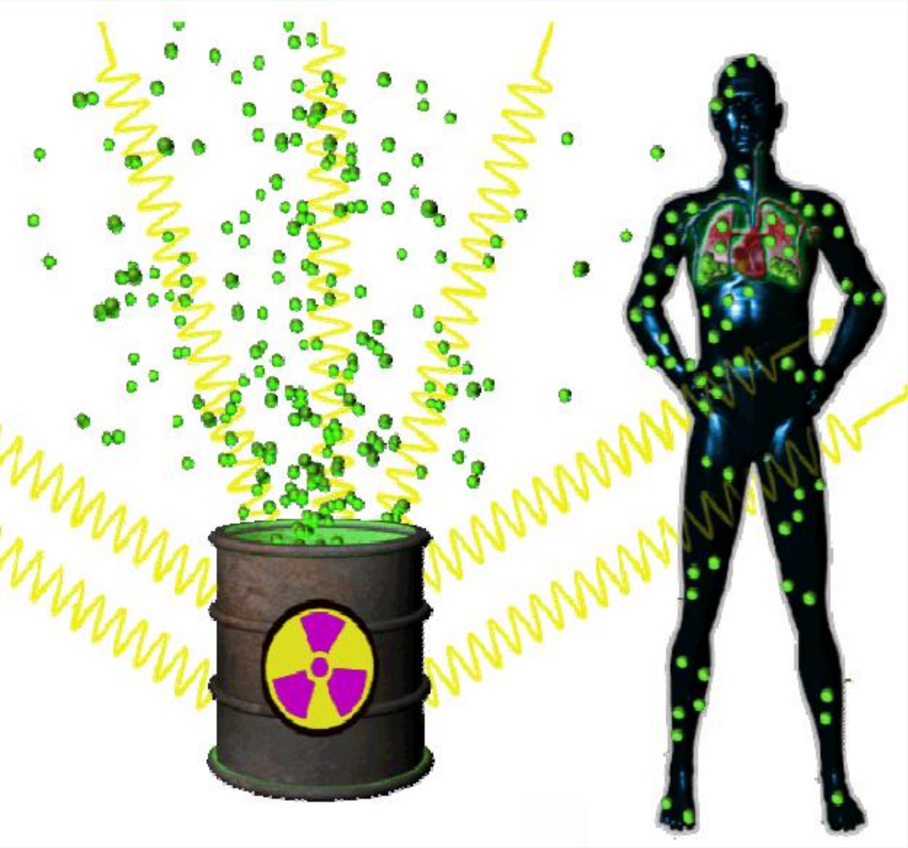
The human body has several lines of defense against infection, which work to prevent germs from invading the body or to destroy them once they find their way in.

So what is risk assessment?

- Ecological risk assessment (ERA) is a process for collecting, organizing, and analyzing information to estimate the likelihood of undesired effects on nonhuman organisms, populations, and ecosystems



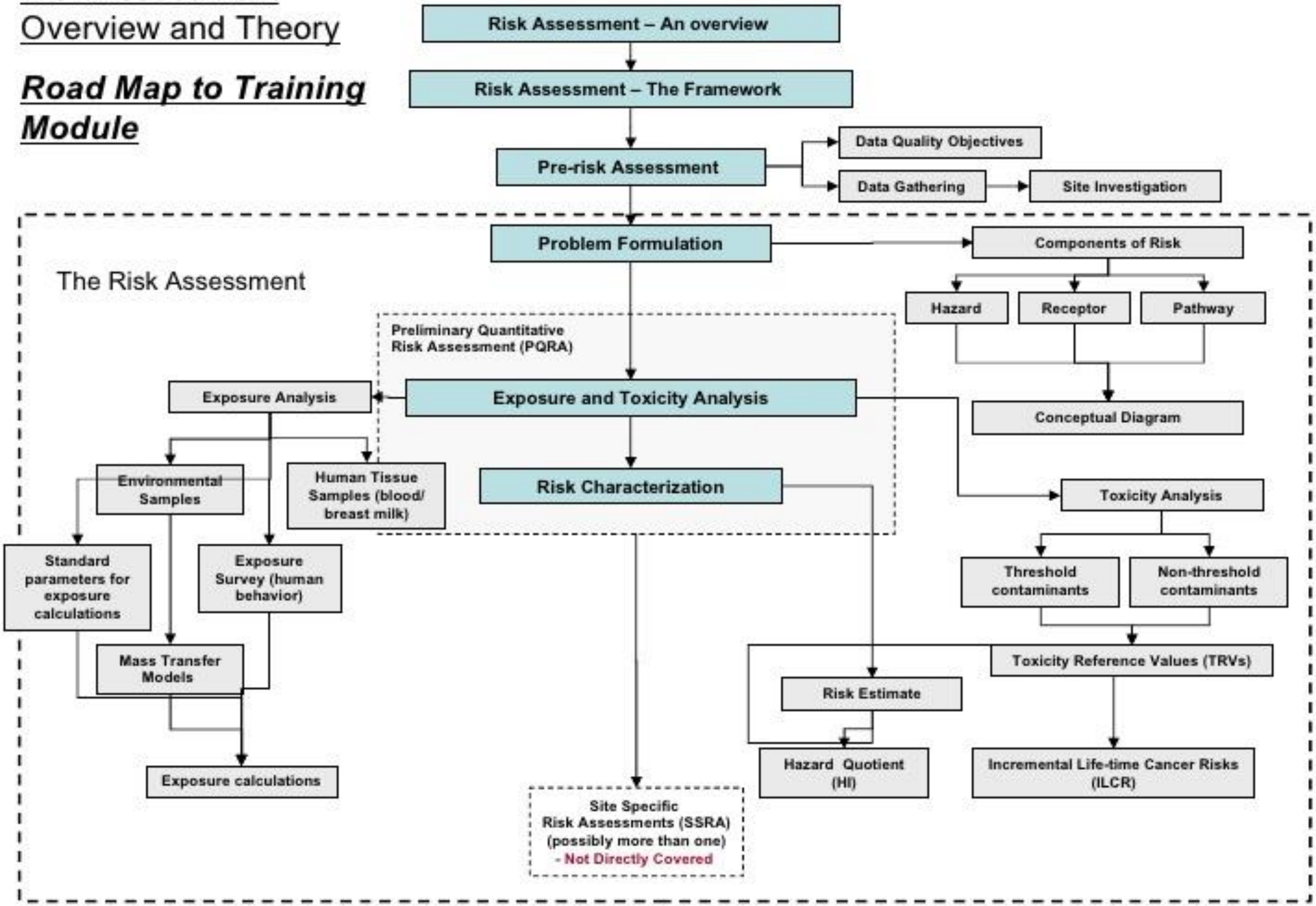
Radiation risk assessment



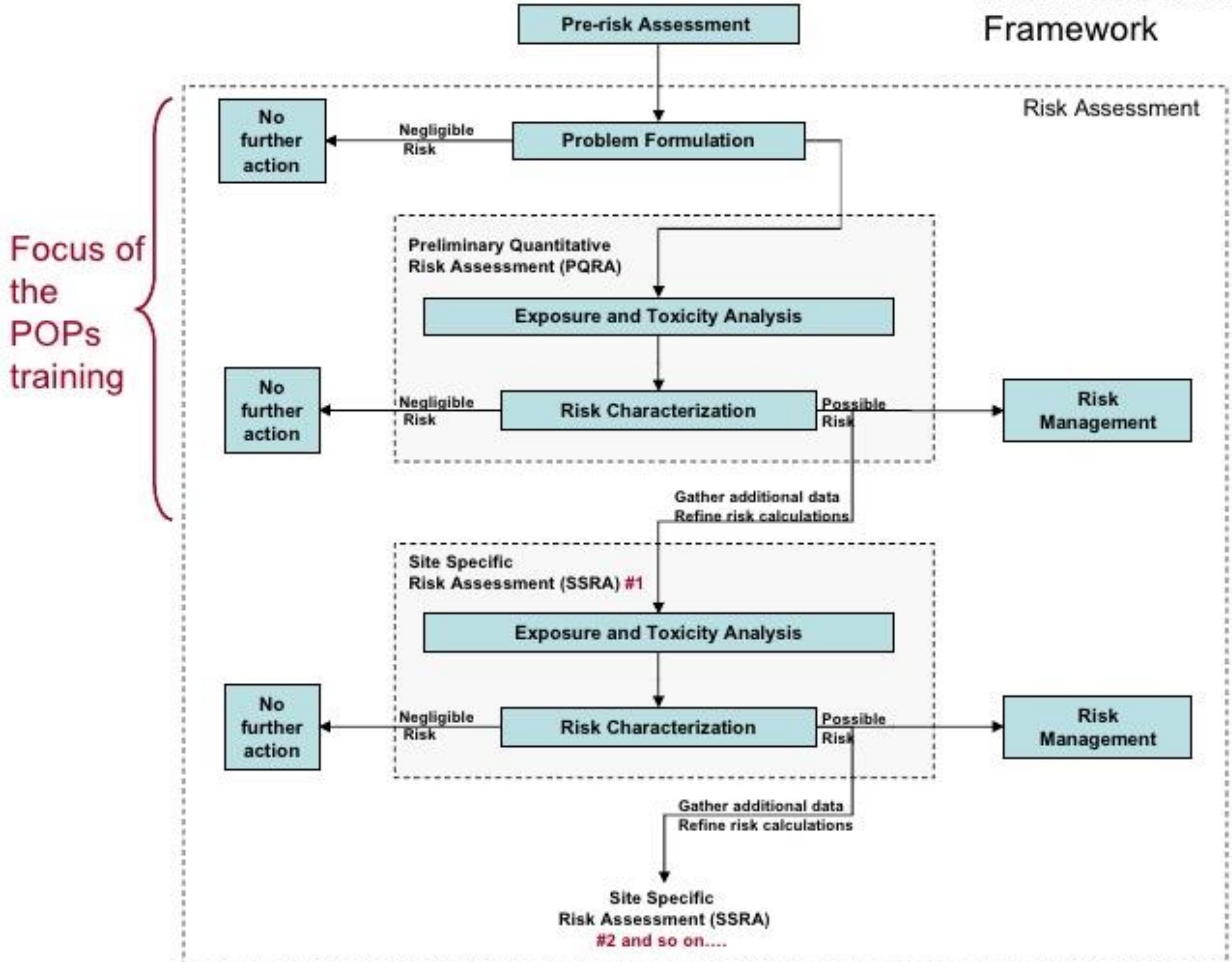
- **Radiation risk assessment is** the process of estimating the type and level of **risk** to human health from exposure to **radiation**. Scientists have learned much about how **radiation** exposure can harm humans

<u>Risk Assessment Overview and Theory</u>

<u>Road Map to Training Module</u>



Risk Assessment Framework



key questions that will need to be addressed in the new century are:

What is the dose-response relationship at low doses of radiation exposure?
How do laboratory observations in vitro compare to what actually is happening in a complex organism in vivo?
How can we improve internal dosimetry models and better account for radiation dose distribution as a function of age, gender, and body type ?
How do we account for radiosensitive subpopulations?

the four basic steps in the risk assessment process:

- 1. Data Collection and Evaluation
- 2. Exposure Assessment
- 3. Toxicity Assessment
- 4. Risk Characterization

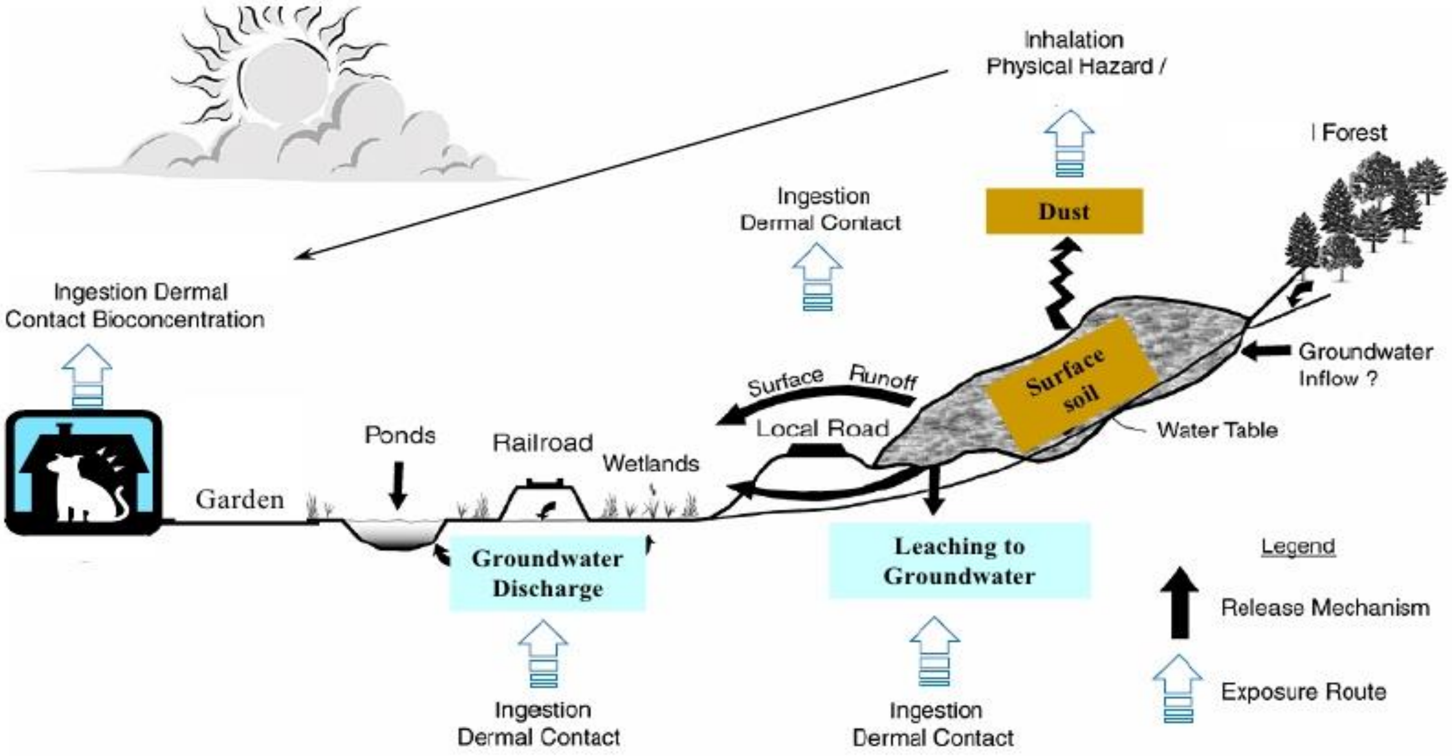
1.DATA COLLECTION AND EVALUATION

- **Data Quality Objectives (DQO)**
- **Data Quality Objectives provide the criteria that a data collection design should satisfy, including: when to collect samples, where to collect samples, the maximum level of error for the study, and how many samples to collect. Using the DQO Process will assure that the type, quantity, and quality of environmental data used in the risk assessment and/or risk management will be appropriate, resulting in decisions that are technically and scientifically defensible.**

- 1.

What strategy and key information should be considered during the initial planning stage for radiological data collection?

Conceptual Site Model



Typical Radionuclide Exposure Pathways

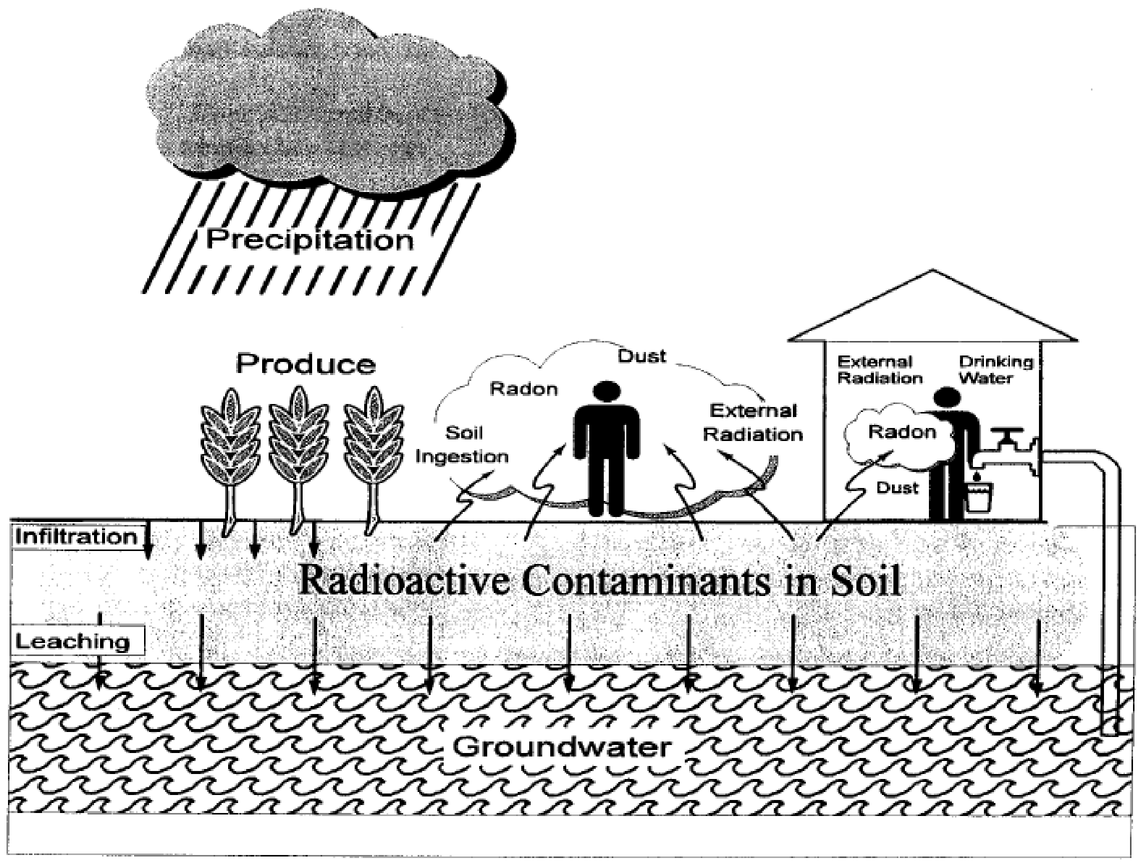


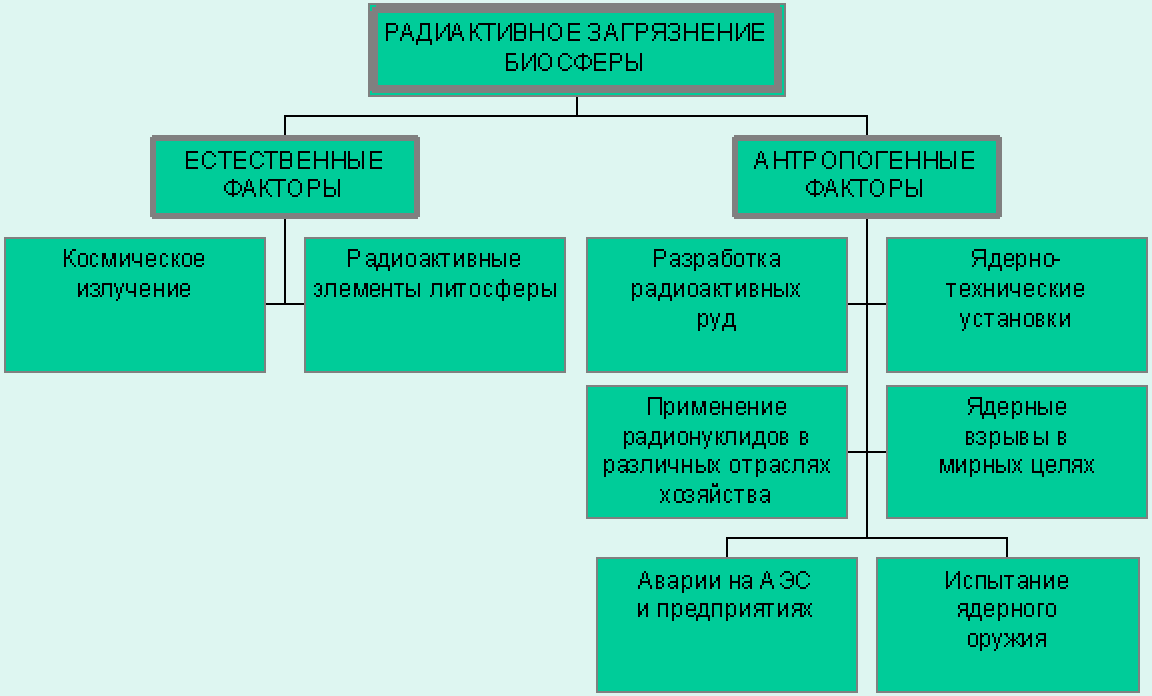
Figure 1. Typical Radionuclide Exposure Pathways

At a minimum, site characterization should include the following key information and considerations:

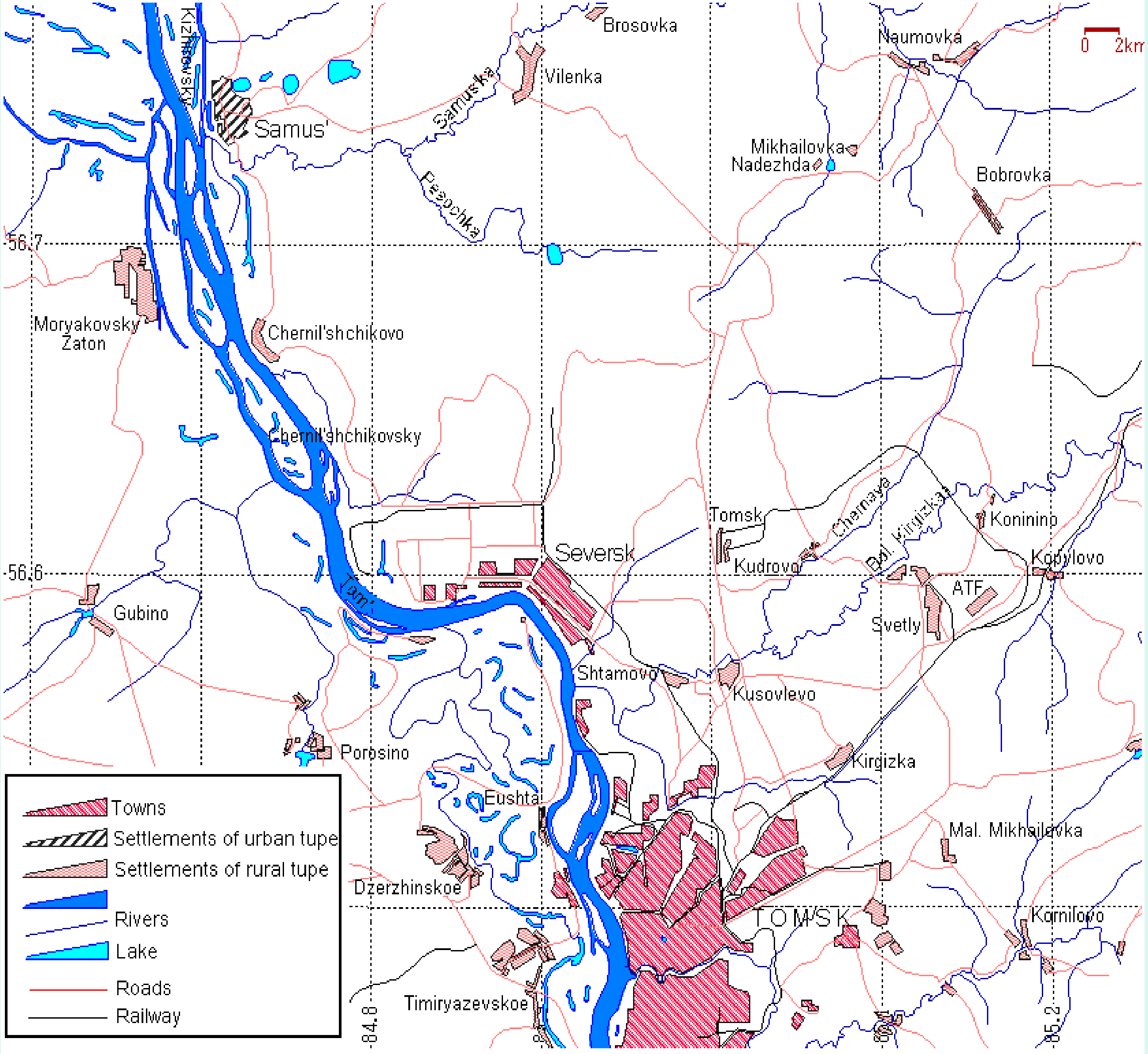
- past site operations
- types and quantities of radioactive material used or produced
- radioactive waste stream characteristics
- disposal practices and records
- previous radiological characterization data and environmental monitoring data
- physical site characteristics (hydrology, geology,
- meteorology, etc.)
- demography
- current and potential future land use .

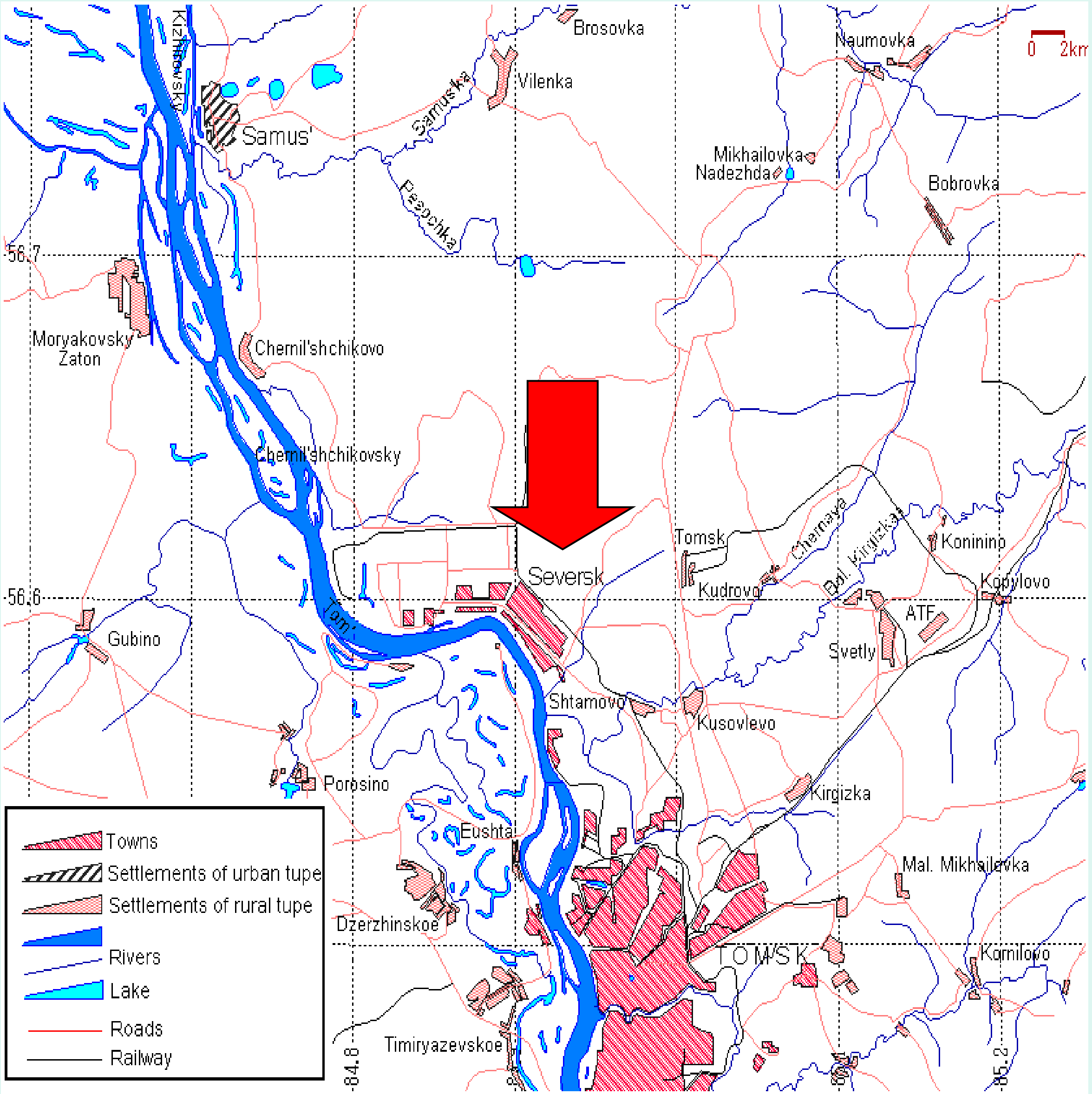
previous radiological characterization data and environmental monitoring data

The sources of radioactivity



Siberian Chemical Combine





Specific of Tomsk region is that in the direct proximity of Tomsk there is one of the largest in the world **nuclear complex**, well-known under the name of **Siberian Chemical Combine** (SCC).

It is situated in **10-15** km from Tomsk.

Seversk is a closed city in Tomsk Oblast located 15 kilometers northwest of Tomsk on the right bank of the Tom River

Founded in 1949, it was known as Pyaty Pochtovy until 1954

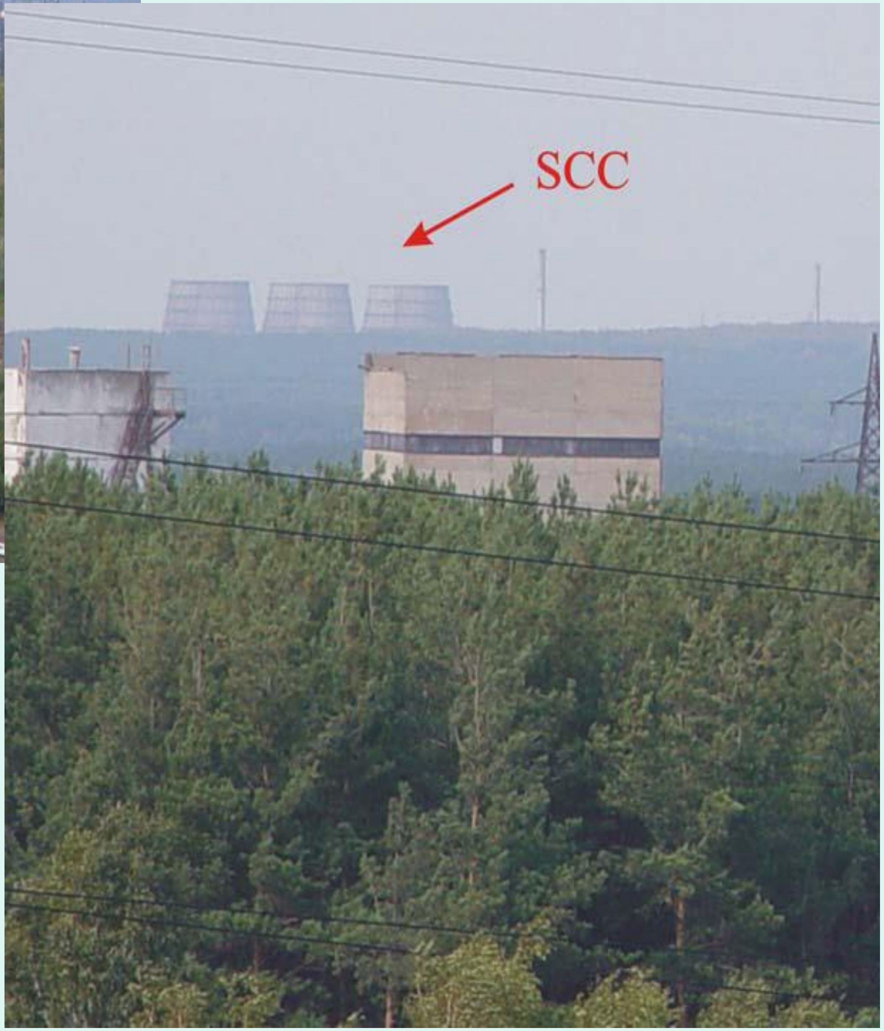
and as Tomsk-7 until 1992

Enterprises founded in 1954

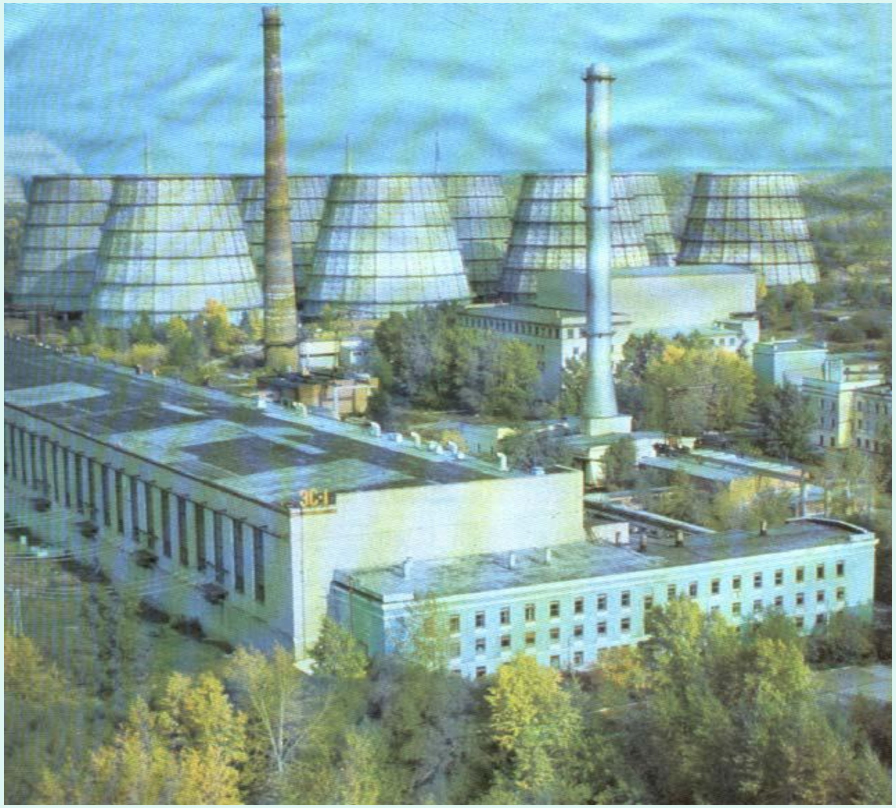
Seversk Central control

- It comprises several nuclear reactors and chemical plants for separation, enrichment, and reprocessing of uranium and plutonium.
- Nuclear warheads are produced and stored on the premises.
- Following an agreement in March 2003 between Russia and the United States to shut down Russia's three remaining plutonium-producing reactors, two of the three plutonium producing reactors (the two that are sited at Seversk) have now been shut down.

Siberian Chemical Combine (SCC)



Complex of industrial nuclear reactors



Plant for isotopic division

Siberian Chemical Combine on 1993

- A tank exploded while being cleaned with nitric acid.

  The explosion released a cloud of radioactive gas.

  TIME magazine has identified the Tomsk-7 explosion as one of the 10 world's "worst nuclear disasters".

The Worst Nuclear Disasters

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Tomsk-7 Explosion, April 6. 1993

The accident in the Siberian city of Tomsk took place after a tank exploded while being cleaned with nitric acid. The explosion released a cloud of radioactive gas drifting from the Tomsk-7 Reprocessing Complex.

- A Brief History of the Exxon Valdez Disaster

Tomsk region is a place for storage of nuclear waste


Radioactive waste disposal
On January 20, 2010, the State Duma passed the first version of a bill to regulate radioactive waste management in Russia
Types of Russian radioactive waste in terms of storage requirements:
2009
47.1%
35.9%
2.8%
14.2%
2025*
89.5%
2.4%
8%
0.016%
Safe storage
Inside industrial tanks (requiring permanent supervision)
Not isolated from the environment
Inside temporary storage facilities
* If law is passed and the program implemented
Sources of radioactive waste:
90% Production and processing of raw materials with high natural radionuclide content
5% Nuclear power industry
4% Defense industry
1% National economy
The accumulation of radioactive waste in Russia
Annually: 550 mln metric tons Formed
3 mln metric tons Processed
2009: 550 mln metric tons
1989: 470 mln metric tons
The adoption of laws on radioactive waste management
1980s
2009
RIANOVOSTI © 2010

The U.S.A. satellite-born photo of the SCC and adjacent area

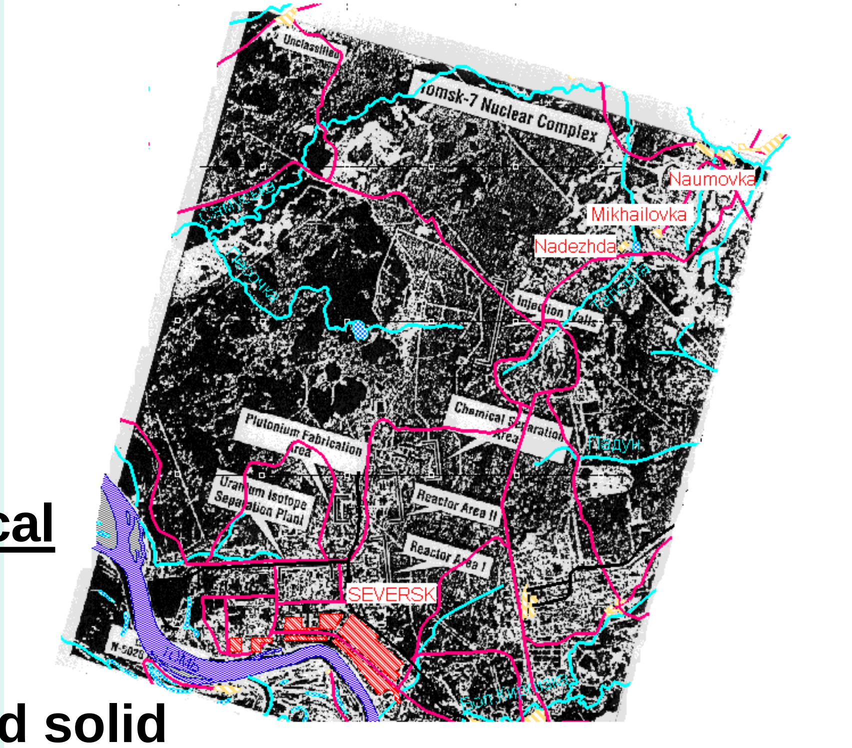
1. <u>The reactor plant (RP)</u>

<u>2.The isotope separation plant (ISP)</u>

3. <u>The sublimate plant (SP)</u>

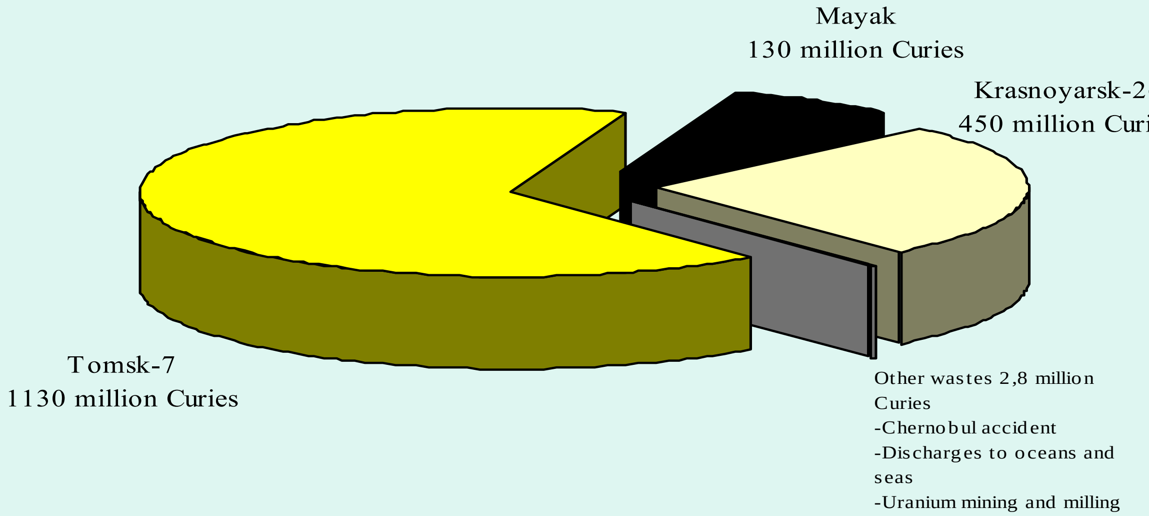
4. <u>The radiochemical plant (RCP)</u>

5. <u>The chemical-metallurgical plant (CMP)</u>



6. 50 storages of liquid and solid radioactive wastes

Radioactive materials released to the environment by the Russian enterprises



Formulation of a conceptual site model to:

- identify radionuclides of concern
- identify the time period for assessment
- Identify potentially contaminated environmental media
- identify likely release mechanisms and exposure pathways
- identify potential human and ecological receptors
- focus initial surveys and sampling and analysis plans

Development of comprehensive sampling plans based on the conceptual site model and available historical

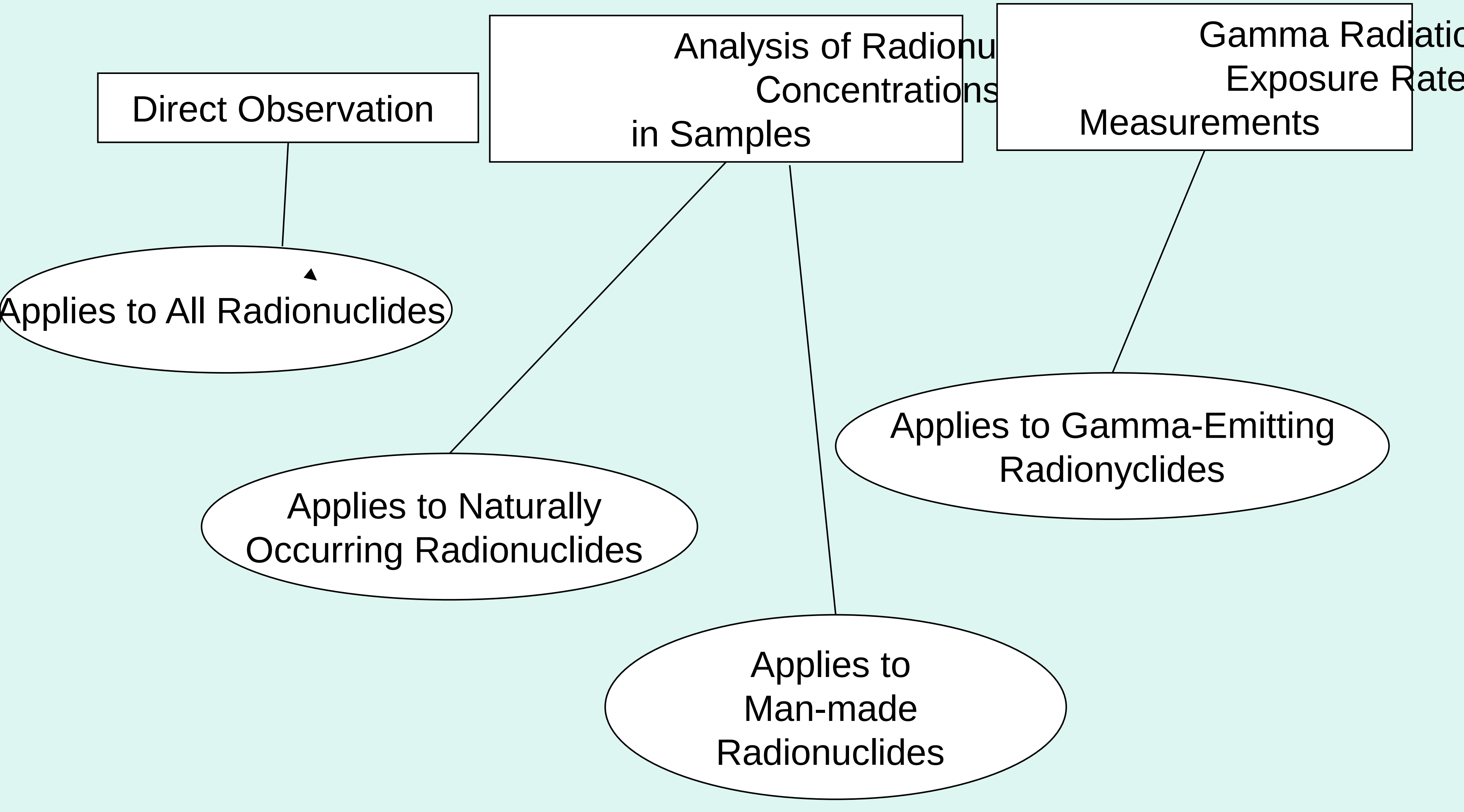
Information to

- confirm the identities of radionuclide contaminants
- confirm release mechanisms and exposure pathways
- measure or model exposure point concentrations and point exposure rate (as appropriate for the type of radioactive decay)
- confirm human and ecological receptors
- specify cleanup levels or develop preliminary remedia-
- tion goals
- establish DQOs **Data Quality Objectives**

2.How should a list of radionuclides of concern be constructed?

- all radio-nuclides used or produced at the site should be included on the list.
- If appropriate, the list should also include all radioactive decay products that may have formed since disposal or termination of operations.
- Radionuclides with short half-lives and no parent radionuclide to support ingrowth may be considered for exclusion from the list.

3.What criteria should be used to determine areas of radioactive contamination or radioactivity releases



What field radiation survey instruments should be used and what are their lower limits of detection?

How should the areal extent and depth of radioactivity contamination be determined?

What sample measurement units for radiation risk assessment are typically used?

ACRONYMS, SYMBOLS, AND UNITS

- A(t) = Activity at Time t
- Bq = Becquerel
- Ci = Curie
- D = Absorbed Dose
- DCF = Dose Conversion Factor Per Unit Intake
- HE = Effective Dose Equivalent
- HT = Dose Equivalent Averaged Over Tissue or Organ T
- HE,50 = Committed Effective Dose Equivalent Per Intake
- HT,50 = Committed Dose Equivalent Averaged Over Tissue T
- LET = Linear Energy Transfer
- LLD = Lower Limit of Detection
- MeV = Million Electron Volts
- N = Modifying Factor in the Definition of Dose Equivalent
- pCi = PicoCurie (10-12 Ci)
- Q = Quality Factor in Definition of Dose Equivalent
- RBE = Relative Biological Effectiveness
- SI = International System of Units
- Sv = Sievert
- T = Tissue or Target Organs

  wT = Weighting Factor in the Definition of Effective Dose Equivalent and Committed Effective Dose Equivalent

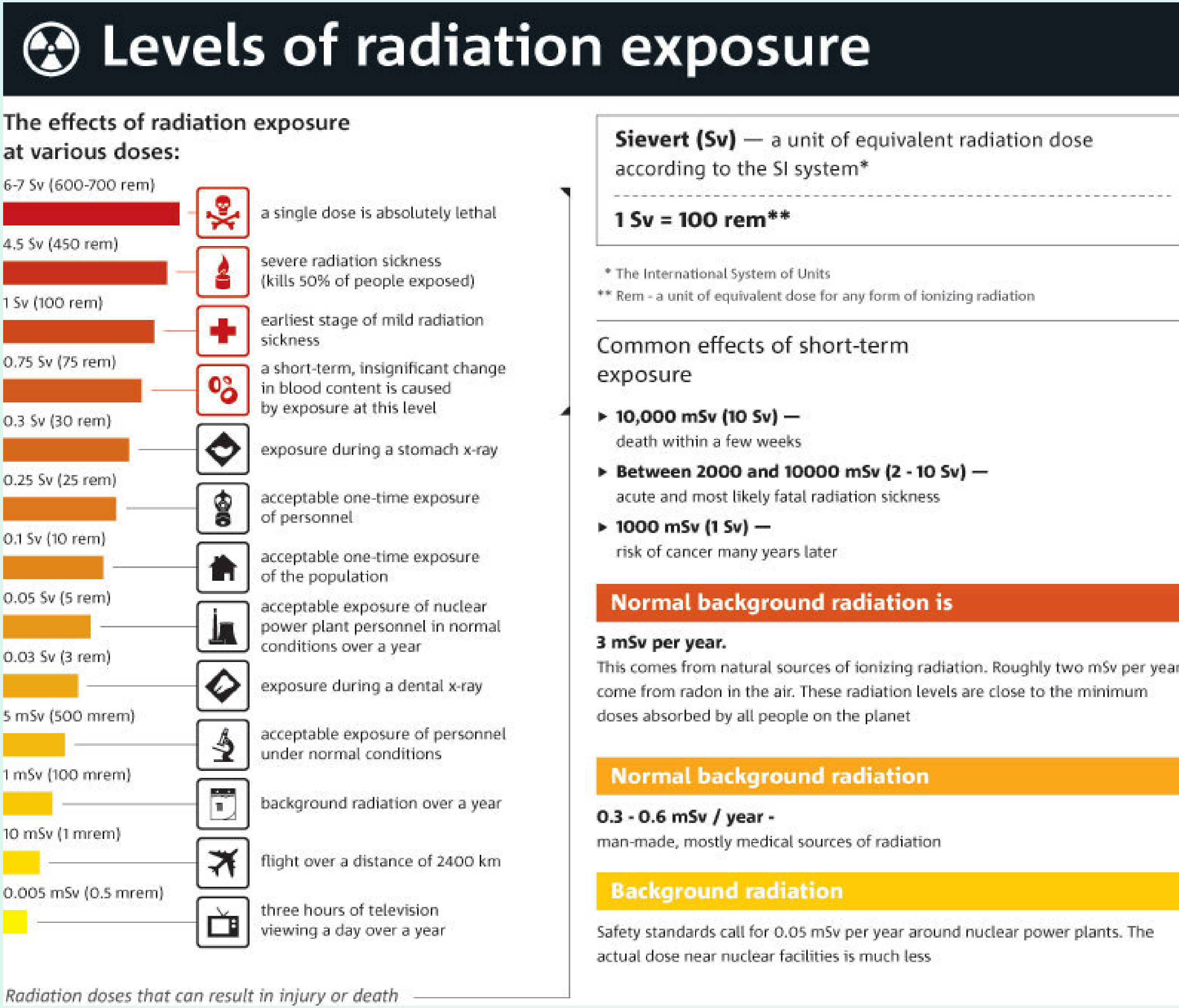
- (

$$mg/kg_{soil} = (2.8 \times 10^{-12}) \times A \times T_{1/2} \times pCi/g$$

$$mg/l_{water} = (2.8 \times 10^{-15}) \times A \times T_{1/2} \times pCi/l$$

$$ppm_{soil} = (2.8 \times 10^{-12}) \times A \times T_{1/2} \times pCi/g$$

$$ppm_{water} = (2.8 \times 10^{-15}) \times A \times T_{1/2} \times pCi/l$$

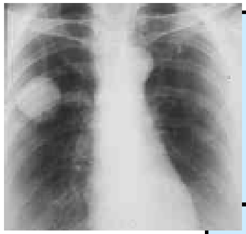


Rem- the dose of ionizing radiation that produces the same effect in man as one roentgen of x- or gamma-radiation

Danger level	Radiation dose	Effect
	2 millisieverts per year (mSv/yr)	Typical background radiation experienced by everyone (average 1.5 mSv in Australia, 3 mSv in North America)
	9 mSv/yr	Exposure by airline crew flying New York-Tokyo polar route
	20 mSv/yr	Current limit (averaged) for nuclear industry employees
	50 mSv/yr	Former routine limit for nuclear industry employees. It is also the dose rate which arises from natural background levels in several places in Iran, India and Europe
	100 mSv/yr	Lowest level at which any increase in cancer is clearly evident.
	350 mSv/lifetime	Criterion for relocating people after Chernobyl accident
	400 mSv/hr	The level recorded at the Japanese nuclear site, 15 March

Radiation risks

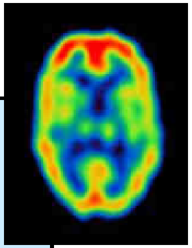
Effect	Population	Exposure period	Probability
Hereditary effects	Whole population	Lifetime	1 %/Sv (all generations)
Fatal cancer	Whole population	Lifetime	5 %/Sv
Fatal cancer	Working population	Age 18-65	4 %/Sv
Health detriment	Whole population	Lifetime	7.3 %/Sv
Health detriment	Working population	Age 18-65	5.6 %/Sv



RADIATION RISKS IN X-RAY EXAMINATIONS

Examination	Skin dose (mGy)	Effective dose (mGy)	Risk (%)
Urography	30	8	0.04
Lumbar spine	40	5	0.025
Abdomen	10	2.5	0.013
Chest	2	0.25	0.0013
Extremities	3	0.025	0.00013

RADIATION RISKS IN NUCLEAR MEDICINE



Examination	Radiopharmaceutical	Effective dose (mSv)	Risk (%)
Myocardium	Tl-201 chloride	23	0.12
Bone	Tc-99m MDP	3.6	0.018
Thyroid	Tc-99m pertechnetate	1.1	0.006
Lungs	Tc-99m MAA	0.9	0.005
Kidney clearance	Cr-51 EDTA	0.01	0.00005

Thank for your attention!