

# **Methodology for Dose Assessment due to Controlled Discharges in Belarus**

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*EMRAS II Working Group 1 Meeting  
21 - 23 September 2010, Kiev, Ukraine*

# Scenario A - Inputs

- **Radionuclides:** Co-60, Cs-137, I-131, Kr-85
- **Atmospheric release:**  $10^{12}$  Bq/y
- **Effective release height:** 19 m
- **Critical group:**
  - adult
  - 300 m from the site
  - 20 % of total time outdoors
  - local food consumption (cow milk, cow meat, sheep meat, fruit, green and root vegetables)
  - Inhalation rate  $8400 \text{ m}^3/\text{y}$

# PC-CREAM 08

## ASSESSOR –

individual and collective doses from routine releases

Activity concentrations from a number of pathways are combined with habit data either from defaults or user defined for the assessment

The screenshot displays the PC-CREAM 08 software interface. The main window is titled "CREAM: Global Project" and contains a tree view on the left with the following structure:

- Models
  - Atmospheric dispersion
  - External exposure model
  - Foodchain model
  - Resuspension model
  - Marine model
  - River model
- ASSESSOR
  - Atmospheric collective dose
  - Atmospheric individual dose
    - Plume model
  - Marine collective dose
  - Marine individual dose
  - River individual dose

The "Active viewers:" section at the bottom left is empty. A dialog box titled "Atmospheric individual dose (Plume model)" is open, showing a "Name" field and a "Description" field. Below these fields are several expandable sections:

- Supporting Models
- Stack Details
- Stack Discharges
- Receptor Points
- External, Inhalation & Ingestion Pathways
- Ingestion Data
- Occupancy & Inhalation rates
- Met data

At the bottom of the dialog are three buttons: "Step Through", "Run", and "Close".

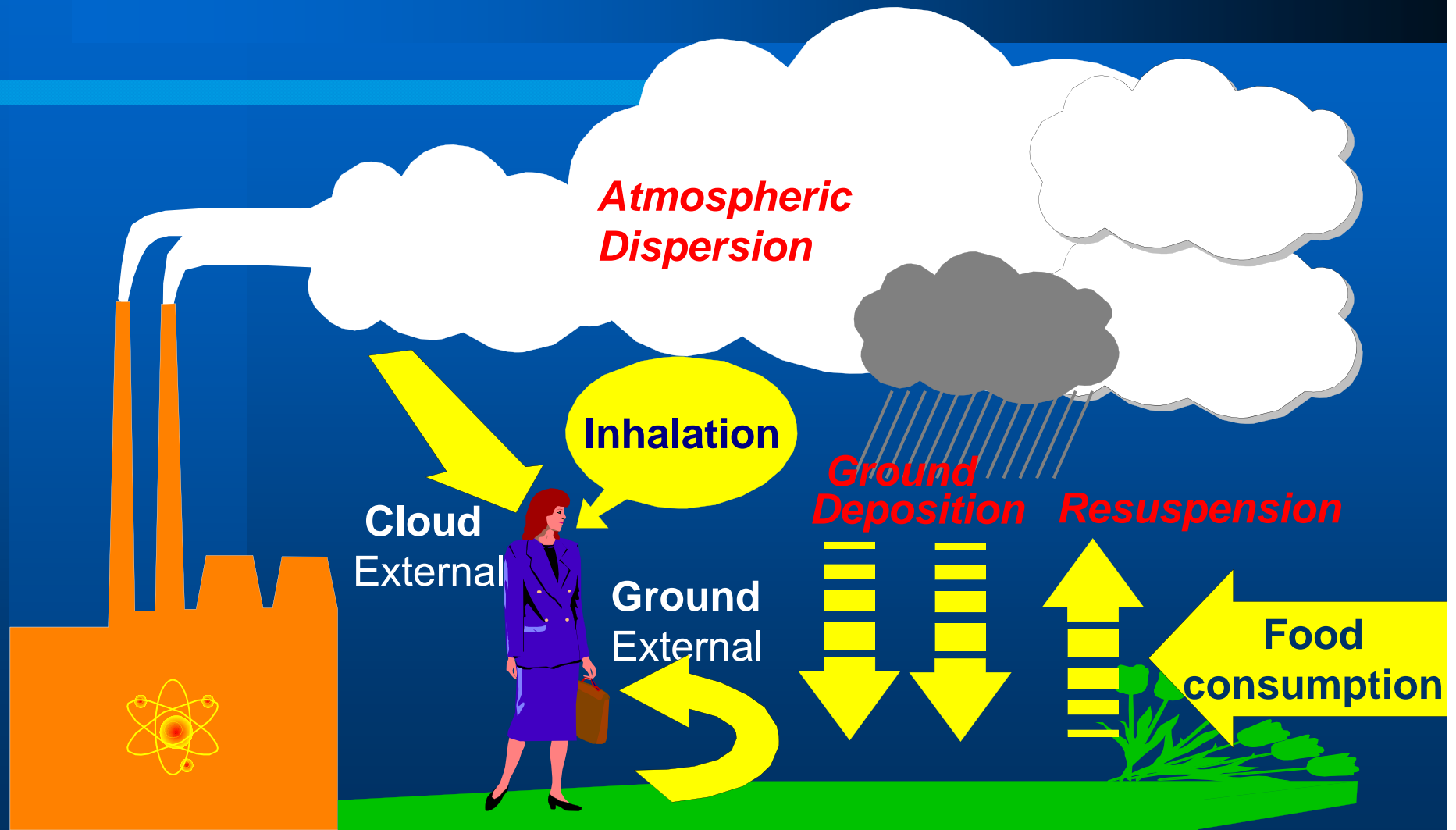
At the bottom of the main window, there is a table with the following data:

Calculations in progress	Name	Description
	Atmospheric individual dose (Plume model)	

# Supporting Models

- ✓ **PLUME** – Gaussian plume model: activity concentrations in air, deposition rates and cloud gamma dose rates for specified release rate.
- ✓ **FARMLAND** – Compartmental model for soil, vegetation and animals: activity concentrations in foods per unit deposition rate.
- ✓ **GRANIS** – Compartmental model for soil and gamma dose from infinite plane: time integrated ground gamma dose per unit deposition rate over one year.
- ✓ **RESUS** – Garland model for resuspension: time integrated activity concentration in air per unit deposition rate over one year.

# Exposure Pathways



# Typical applications

- **PC CREAM uses effective dose**
  - as defined in ICRP Publication 60
  - dose coefficients from ICRP Publication 72
  - committed to age 70
  - 3 age groups
    - 1 year old infants
    - 10 year old children
    - Adults



# External Dose

Dose rate, Sv/y	Co-60	Cs-137	I-131	Kr-85
Air immersion (Cloudshine)	1.16E-07	5.95E-09	1.89E-08	—
Groundshine	1.57E-04	9.40E-05	4.01E-06	—
Direct radiation	3.78E-08	1.18E-10	6.21E-09	4.37E-10

# Internal Dose

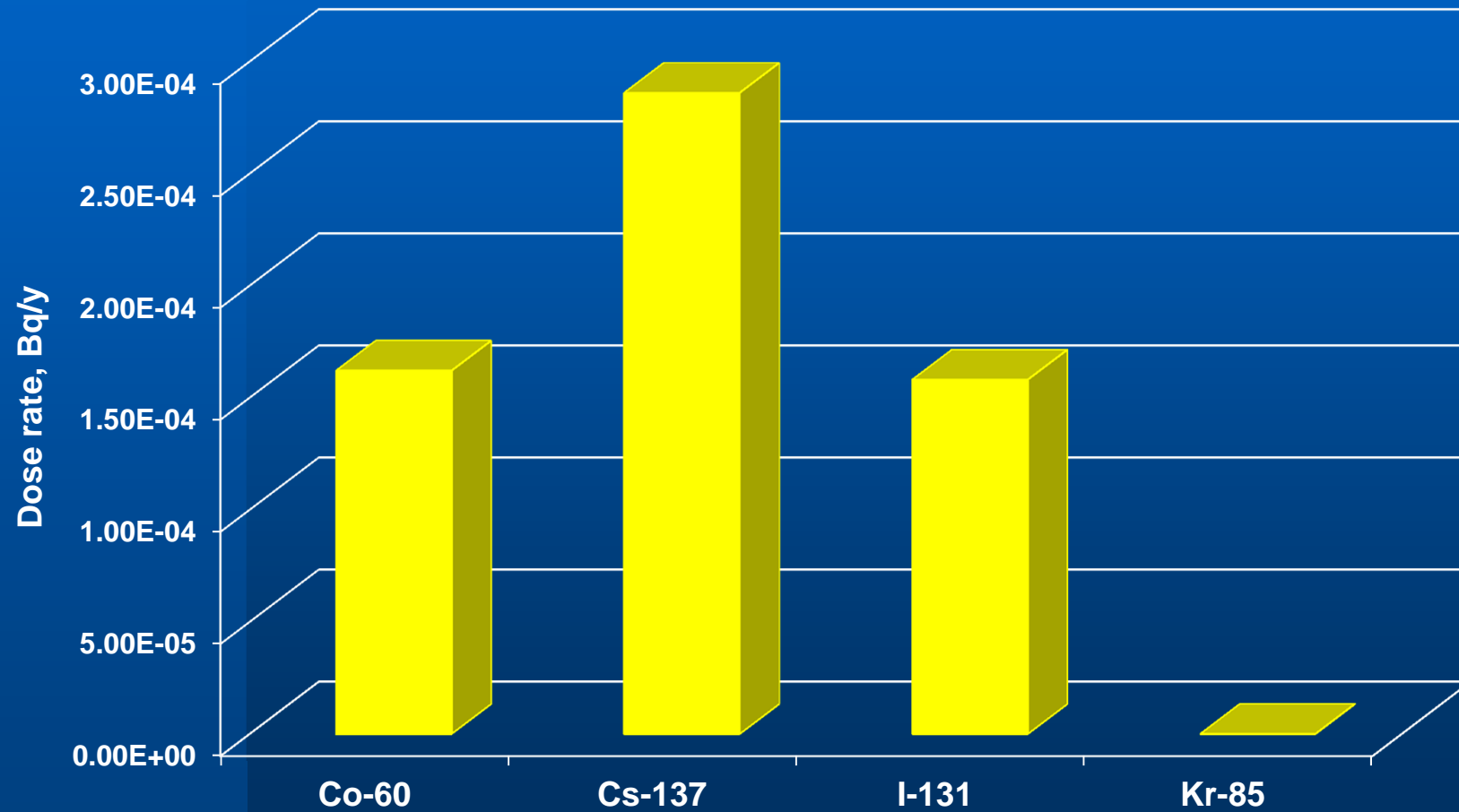
Dose rate, Sv/y	Co-60	Cs-137	I-131	Kr-85
Green vegetables	8.35E-07	4.83E-06	1.29E-05	—
Root vegetables	2.02E-07	4.54E-05	3.80E-05	—
Fruits	1.65E-07	5.83E-06	6.12E-06	—
Cow milk	1.72E-07	7.68E-05	8.96E-05	—
Cow meat (beef)	1.90E-08	5.28E-05	3.95E-06	—
Sheep meat	1.30E-09	4.27E-06	2.26E-07	—
Inhalation	4.02E-06	1.93E-06	3.09E-06	1.90E-10



# Total Dose

Radionuclide	Dose rate, Sv/y
Co-60	1.62E-04
Cs-137	2.86E-04
I-131	1.58E-04
Kr-85	2.47E-10
<b>Total</b>	<b>7.14E-04</b>

# Total Dose (2)

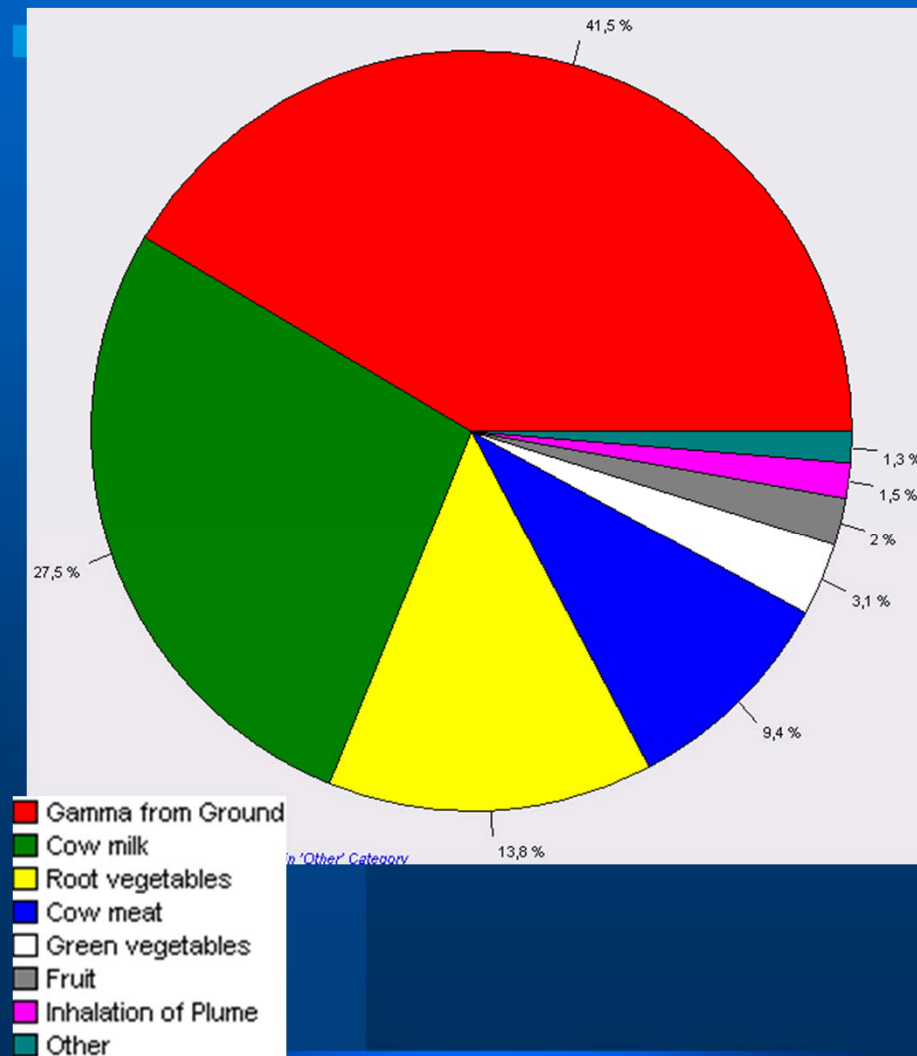


Total dose for the member of the critical group – 7.14E-04

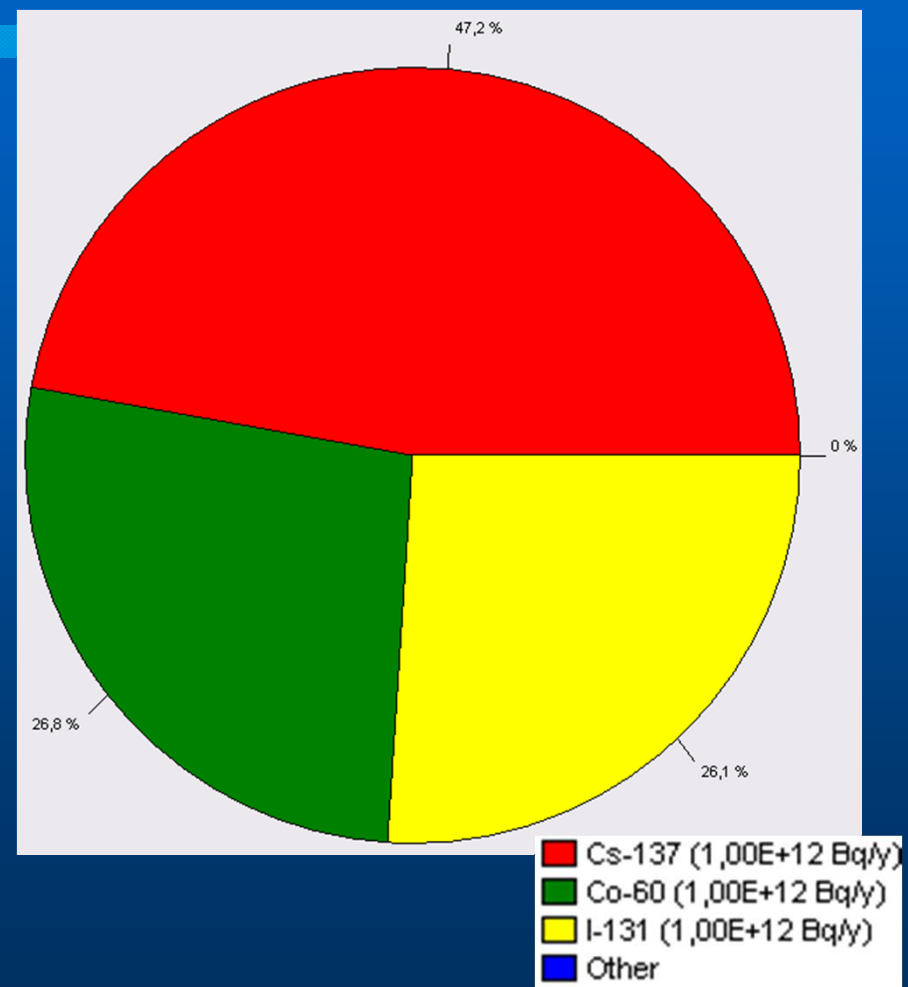


# Critical Radionuclide and Pathway

## Pathway breakdown



## Radionuclide breakdown



# The Concept of 'Critical Group'

- The 'critical group' concept is used for the purpose of protection of the public in Belarus to characterize an individual who is representative of the most highly exposed individuals in the population
- **It is important to consider some aspects :**
  - The location and age distribution of the potentially exposed group
  - Dietary habits
  - Special occupational habits
  - The type of dwelling
  - Behavior factor

# The Concept of the 'Representative Person'

- For the purpose of protection of the public, it is necessary to characterize an individual who is representative of the most highly exposed individuals in the population. This individual is defined as the 'representative person'.
- The representative person may be hypothetical. Nevertheless, it is important that the habits used to characterize the representative person are typical habits of a small number of individuals representative of those most highly exposed and not the extreme habits of a single member of population.

# The Concept of the 'Representative Person'

The Commission now recommends the use of the 'representative person' for the purpose of radiological protection of the public instead of the earlier critical group concept (ICRP, 2006b)

So

Today **Belarus revises National Standards** according to the new ICRP concept of the 'representative person'

Permissible Levels of  
Concentration of  
Radionuclides in Food  
Products

Standards of  
Radiation Safety-  
2000

Main Hygienic  
Rules and Norms-  
2002

# NPP in Belarus

- Type: NPP-2006
- Reactor: WWR (PWR)-1200;
- Planned construction time: 54 month
- Lifetime at 90% capacity factor : expected 50 years
- The WWR 1200 will produce:  
1200 MW(e) electric power  
3200 MW(th) heat power



General layout of Belarusian NPP was developed for 2 power units (2016 and 2018 years)



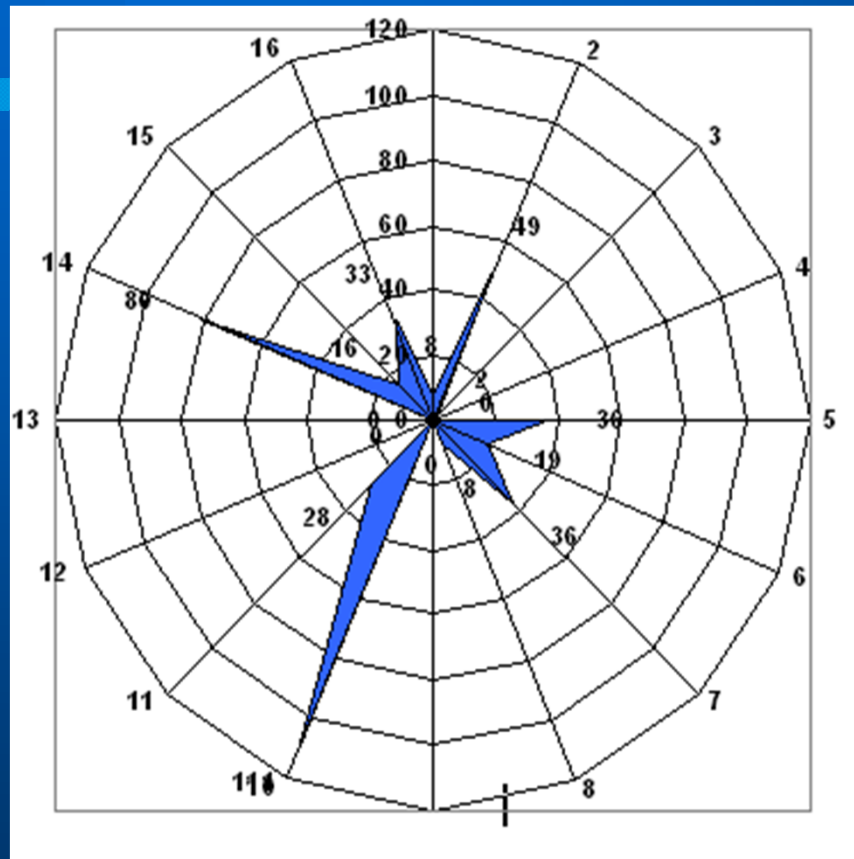
# NPP in Belarus (2)



City	Distance, km
Lithuanian boarder	20
Oshmyany (Belarus)	25
Smorgon (Belarus)	35
Vilnius (Lithuania)	50
Lida (Belarus)	100
Daugavpils (Lithuania)	150
Grodno (Belarus)	175
Suwalki (Poland)	200
Riga (Latvia)	300
Warsaw (Poland)	400
Lutsk (Ukraine)	450
Rivne (Ukraine)	
Kiev (Ukraine)	550
Vienna (Austria)	1000

 **Future location of the NPP**

# Population distribution around NPP

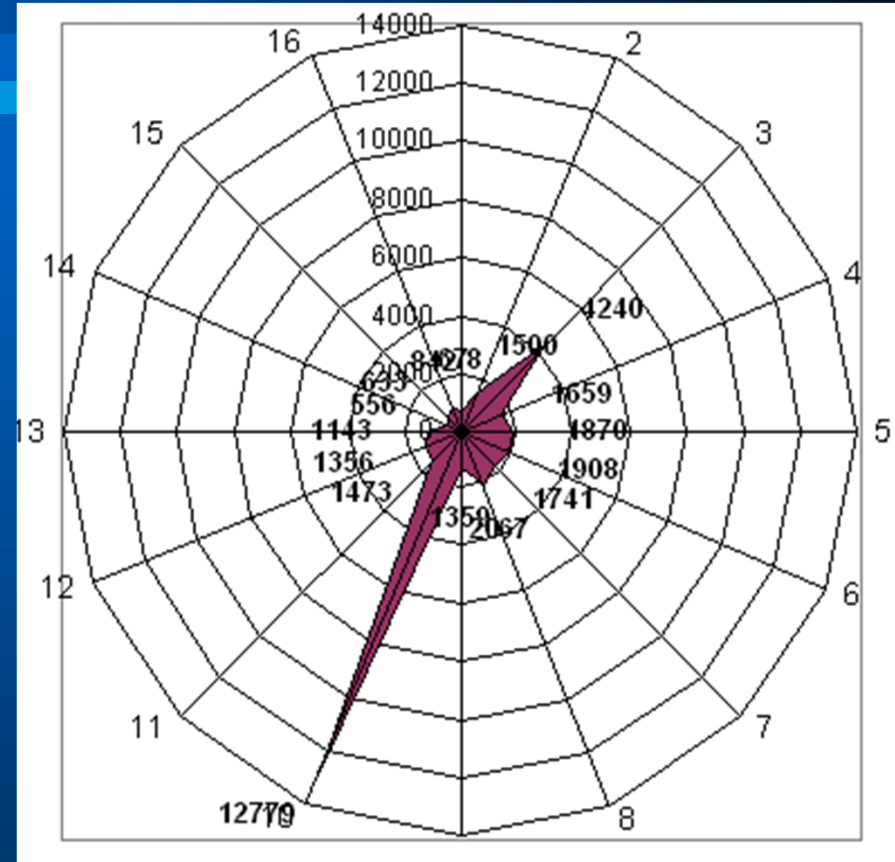


5 km from the site

Total population - 765 persons

N

S



30 km from the site

Total population – 35 682 persons

# Critical Group

- ✓ Real group
- ✓ Rural population
- ✓ Adults (>17 years)
- ✓ 50% of total time outdoors:
  - foresters
  - shepherds
  - retired people
- ✓ Local produced food consumers



# Consumption of Food

Product	Intake, kg/y (l/y)*
Cow milk	62.99
Cow meat	33.82
Sheep meat	0.35
Green vegetables	15.28
Root vegetables	82.03
Fruit	29.82

*\* Ministry of Statistics and Analysis of the Republic of Belarus  
Data Book, 2009*

# Inhalation

Age, years	Breathing rate, m <sup>3</sup> /h
<1	2.86
1-2	5.17
2-7	8.72
7-12	14.2
12-17	20.11
>17	22.22

**Thank you!**

