# Chernobyl, its role during past 30 Years and at present

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# 26 April, 1986: Chernobyl NPP reactor #4 exploded

- This happened when operator pushed a “Shut Down” button
- Operators were accused of safety rules violation
- Reactor staff claimed that reactor design was not safe, but instructions to operators did not contain this warning
- This presentation will not attempt at clarifying the issue of who is guilty; this is **a story of 30 difficult years of my country after disaster**

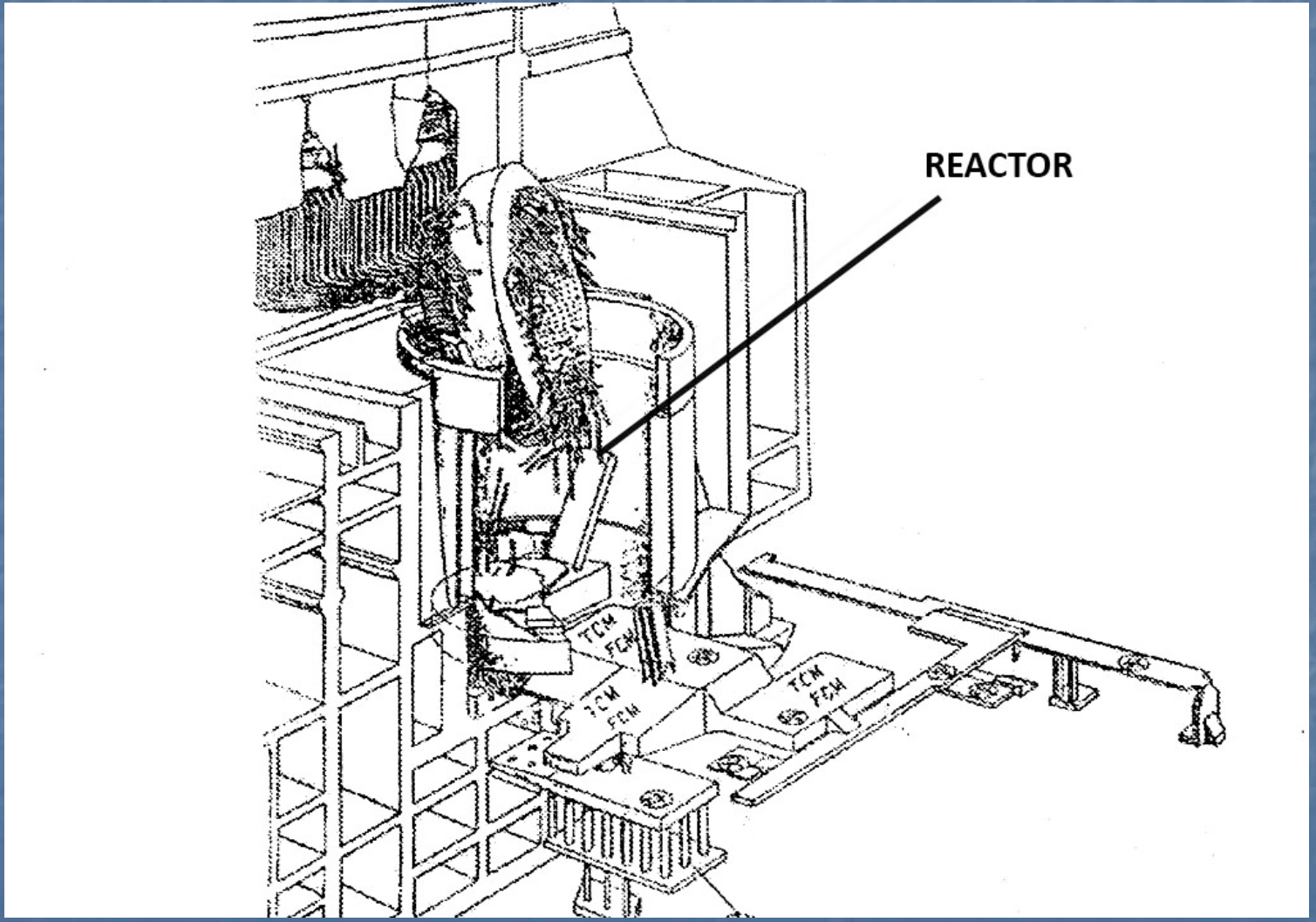
# First days, first reaction

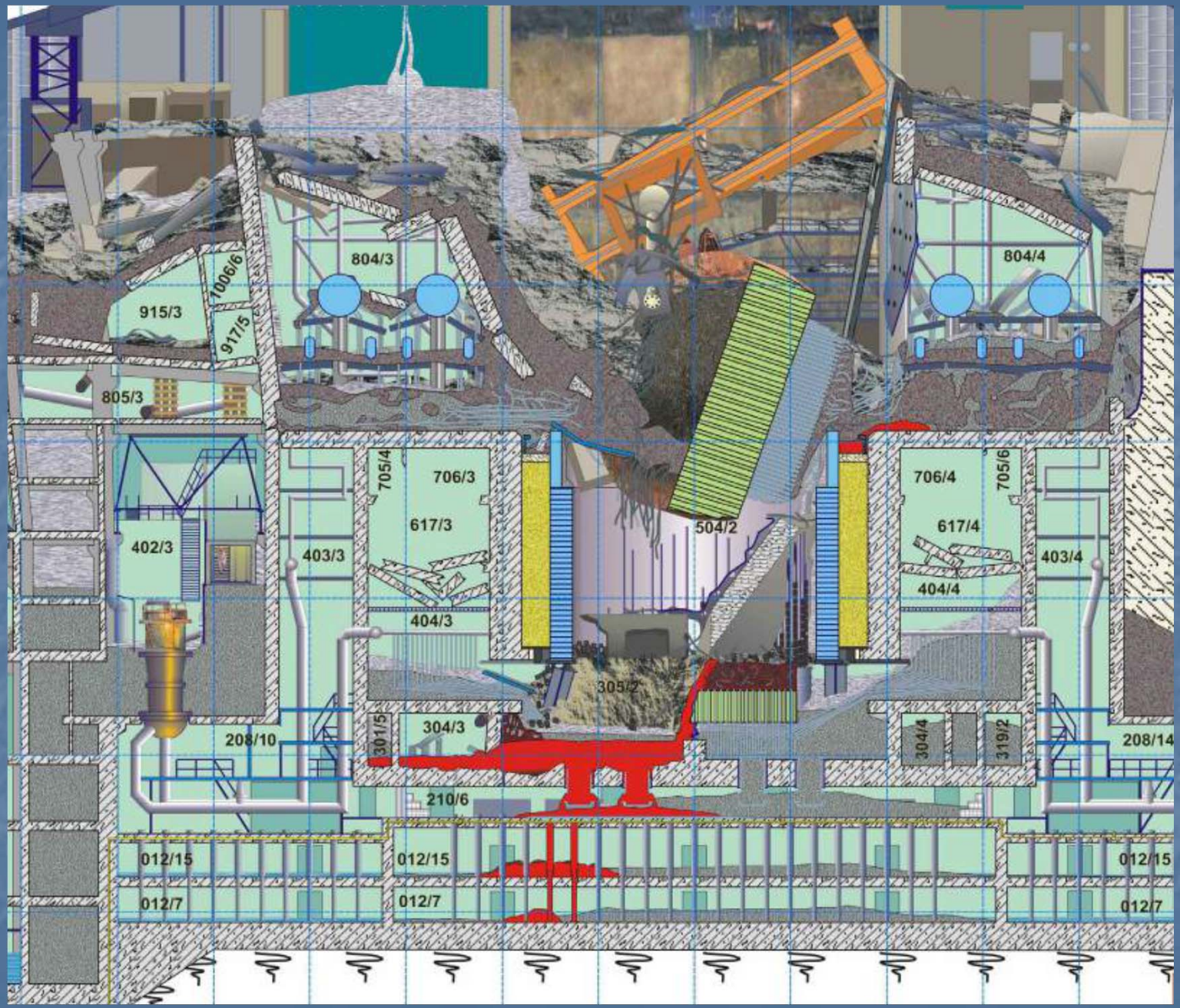
- We should distinguish what we know NOW, and what we KNEW at that time
- At that time we (the public) only knew that something **bad** or **very bad** had happened at ChNPP (real information was “secret”);
- What had been done right away (*assessment based on our present knowledge*):
  - **Evacuation of Pripiat city** in the afternoon of 27th April was a **very timely decision** (45,000 people evacuated);
  - **No warning** to villages around ChNPP and to the **city of Kyiv** until beginning of May – was **very bad decision**; very high AVOIDABLE doses were received by population

# First days, first weeks

- It was not clear, what physical processes go on in the reactor; there was fear that reactor bottom would be destroyed, and all fuel will explode
- There was an idea that graphite is burning
- Now it is believed (not all agree!) that after first melting of nuclear fuel, local criticality was achieved from time to time and hence local nuclear explosions occurred; by these explosions almost all graphite and fuel (and r/a substances!) were thrown away from reactor by 7 May 1986

# Damaged reactor # 4 of Chernobyl NPP (reactor is now covered by “Shelter”, or “Sarcophagus”)

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# First weeks and months, evacuation

- 27 April – Pripiat city evacuated
- by 5 May: villages and towns around ChNPP evacuated – about 10,000
- summer of 1986: all 30-km exclusion zone evacuated (Ukraine and Belarus)
- by the end of 1986 – total of 91,000 people evacuated (Ukraine)
- by the end of 1991 - about 59,000 people independently moved from contaminated areas (Ukraine)

# ChNPP: first period after the accident

- First months: emergency measures at damaged reactor; work in areas/buildings with high radiation, **hundreds of thousand** of civilian and military obtained very high doses
- October 1986: reactors #1 and #2 of ChNPP restarted.
- **December 1986:** a shelter over damaged reactor - “Sarcophagus” built
- 1987: twin-city of ChNPP - *Slavutych* built, personnel of ChNPP moved from Kyiv to *Slavutych*
- **December 1987: reactor #3 restarted** (NB: decision to restart reactor #3, located on the same site with damaged reactor #4, was highly criticized, because it required immense works to separate communications in very high radiation)
- **1991: reactor #1 stopped forever after turbine fire**

# Excessive irradiation of people:

- Many people in affected areas were not properly informed (there was even 1-May parade in Kyiv)
- After the secrecy around Chernobyl disaster was lifted, data about high doses and numerous cases of acute radiation syndrome among people from villages and towns around ChNPP were reported;
- Extremely high doses were received by participants of liquidation of disaster at ChNPP - *liquidators* (over 600,000 participated during first weeks and the following years, from all USSR)

# Country context: USSR, 1985-1991

- Export revenues fell due to  sharp fall of oil prices (1985)
- Huge expenses, military losses and frustration during Soviet war in Afghanistan (79 - 89)
- Huge expenses caused by Chernobyl disaster (86-90)
- In January 1987 Soviet leader Gorbachev launched the process of reforms – *perestroika,* which opened the door to *glasnost,* thus public and political activity became possible after years of suppressions
- *Perestroika* revealed economic decline of the country and disillusionment of people
- August 1991: Unsuccessful Coup d'etat in Moscow - and soon disintegration of the USSR (December, 1991)

# 1986-1991, Conclusions (Ukraine)

- With great efforts and sacrifices damaged reactor was isolated, and three other reactors restarted
- 1986-1990: “Business as usual” in atomic industry of the USSR – 6 new reactors commissioned in Ukraine
- August 90: Ukrainian Parliament passed a 5-year moratorium on further development of nuclear energy (lifted in 1993)
- Key law providing compensations and benefits for Chernobyl sufferers passed
- Ukraine became independent country and since 1992 all burden of Chernobyl-related measures fell on Ukrainian people, politicians, budget and economy

# 1986-1991, Conclusions (international)

- Significant slow-down of nuclear energy growth (in September 1990 Switzerland voted for a 10 year moratorium)
- International community (IAEA, WHO) accepted Soviet version - that disaster occurred because of safety rules violation; in this way, the damage to reputation of Western nuclear industry was minimized
- During first years, WHO/IAEA was not involved into research work on health consequences of Chernobyl disaster; international organizations simply supported Soviet prognoses
- Only in 1990 an International Chernobyl Project was launched, but it's conclusion in 1991 was: "There were significant non-radiation-related health disorders... due to anxiety and stress " (NB: *very questionable*)

# International

- Powerful public protests against nuclear energy in many Western countries (Germany, Netherlands, Sweden, UK etc.); “Green movements” gained momentum
- Many countries and NGOs provided humanitarian aid to liquidators and sufferers (treatment in hospitals, sanatoria, medical consultations, summer holidays for children etc.)
- During 1990s, a lot of various diseases and deaths among liquidators were reported; it is hardly possible to prove for sure which were definitely caused by Chernobyl.

# Personal experience (1)

- 86, May-July: Modeling contamination of Dnieper river with r/a fallouts (the team was later awarded National Prize)
- 86-89: Field investigations of r/a contamination in the 30-km zone and the town of Poliske (“participant of liquidation of consequences of Chernobyl disaster”)
- 89-90: Investigation of damages to cells by heavy particles (irradiation at cyclotron was planned)
- 88-93: Active member of NGOs - “Greenworld” and Greenpeace; protests again Chernobyl secrecy
- 91-93 Director of “Greenwold”/Greenpeace laboratory conducting investigations in contaminated areas

ПРОПУСК Ф-3

№ 032455 *

г. ПРИПЯТЬ

НА ПРАВО ВЪЕЗДА В ЗАКРЫТУЮ ЗОНУ (КРОМЕ ТЕРРИТОРИИ ЧАЭС)

Организация Укр ЦНИИКИВР Минводхоза СССР

(личная подпись)

Ф. Тихий

Срок действия до «31» дек. 1987 г.

И. Владимир

О. Алексеевич

ВРЕМЕННЫЙ Ф-4

№ 008047 *

Ф. Тихий

И. Владимир

О. Алексеевич

Организация УфНИИКИВР

Подразделение Минводхоза СССР

Должность ст. научн. сотр.

Действителен до «1» июля 1988 г.

ПОСВІДЧЕННЯ

учасника ліквідації наслідків аварії на Чорнобильській АЕС у 1987 р.

(Категорія 2)

Серія А № 510444 *

Прізвище Тихий

Ім'я Володимир

По батькові Олексійович

Підпис

Дата видачі „13" січня 2000 р.

М. П.

Затверджене постановою Кабінету Міністрів України від 20 січня 1997 р. № 51

Пред'явник посвідчення має право на пільги і компенсації, встановлені Законом України „Про статус і соціальний захист громадян, які постраждали внаслідок Чорнобильської катастрофи".

А. Муховиков 10.02.97 р.

Посвідчення безстрокове і діє на всій території України

ЗАРЕЄСТРОВАНО Київська міська державна адміністрація 10

(установа, яка видала посвідчення)

А. Муховиков

(підпис керівника)

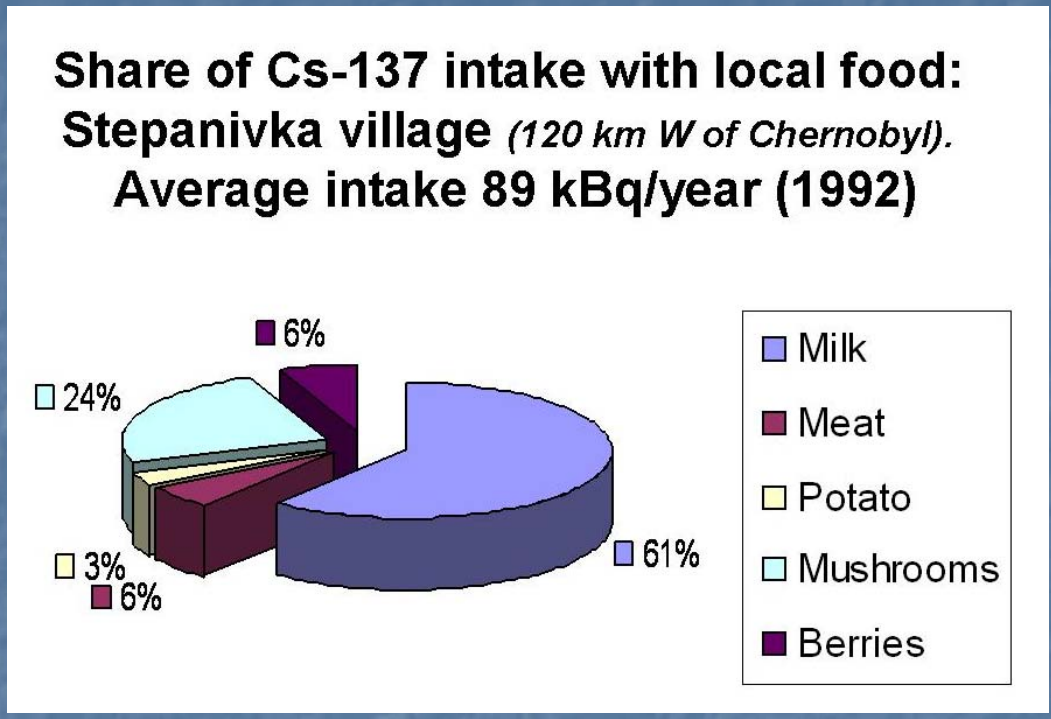
М. П.

# Personal experience (3)

Left: November, 1989, city of Korosten, Zhytomyr province, Ukraine. Rally against Chernobyl secrecy

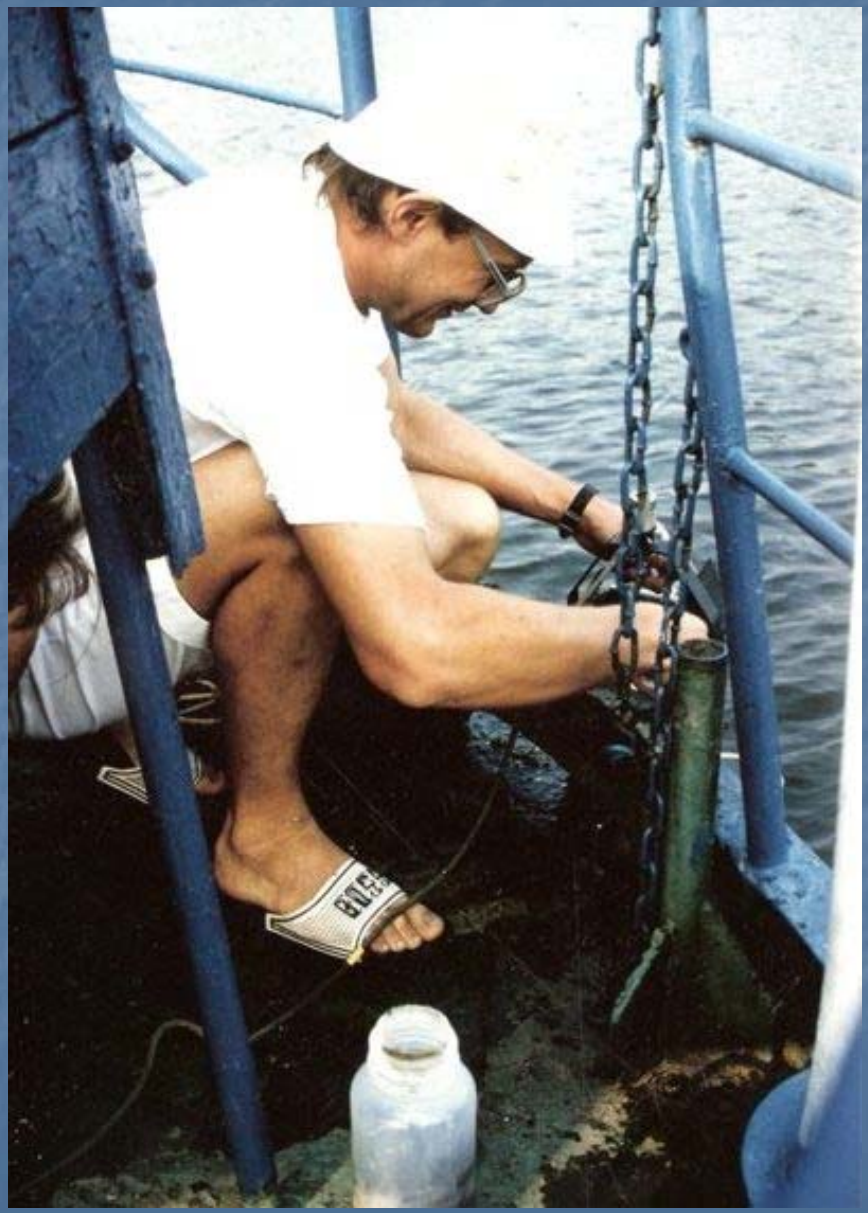
Right: December, 1989, Moscow. Signatures against Chernobyl secrecy are passed to MPs of the Parliament (Supreme Soviet) of the USSR

# Personal experience (4)


- Left: 1991 “Greenworld”/Greenpeace lab near ChNPP after the hydrogen explosion and fire at ChNPP unit #1
- Right: 1992, results of investigation of intake of r/a substances with food in Stepanivka village, Zhytomyr province

# Personal experience (5)



- Over: 1990, meeting with Minister of Health to discuss humanitarian aid project proposed by Munich University
- Right: 1992, sampling bottom sediments at Kyiv reservoir

# How many people had suffered from Chernobyl disaster?

- Categorization of sufferers (those who lived/lives in affected areas) was based on surface density of contamination of the area with r/a substances (**not on expected doses for different groups**)
- Participants of clean-up works at ChNPP (*liquidators*):
  - Worked in 1986-1987 (category 2) and in 1988-1989 (category 3)
- 3,096,814 – total number of sufferers (2002), of them:
  - 1,048,628 children:
  - 336,000 clean-up workers (*liquidators);*
  - 96,000 persons with established (?) causal connection with Chernobyl.
- **In 2002, 13,027 families were receiving compensation due to loss of provider**

# 1991-2000: Ukraine under pressure

- In 1991-2000, after Ukraine became independent, it took responsibility for financial and other burdens of liquidation of consequences of Chernobyl disaster
- In the beginning of 1990s, several highly populist laws for protection of sufferers were passed: they established payments for **very low risks** and they did not have time limits
- Special commissions were established to document "*causal relation*" of diseases with Chernobyl (*Order of MoH of 1997*). Not only ARS, cancers and thyroid pathologies, but a list of other *60 diseases in 7 groups*
- However, scientific justification of this list was not clear, and many commissions were corrupt.

# Ukraine budget expenditures, million USD

| *Year* | *1992* | *1996* | *2000* |
|---|---|---|---|
| Social protection | 197 | 546 | 290 |
| Special medical care | 6.3 | 19 | 6.4 |
| Radiation monitoring | 2.0 | 4.4 | 2.7 |
| Radiological rehabilitation and radioactive wastes | 0.3 | 0.2 | 0.05 |
| Resettling, housing | 276 | 194 | 14 |
| TOTAL | 511 | 835 | 332 |

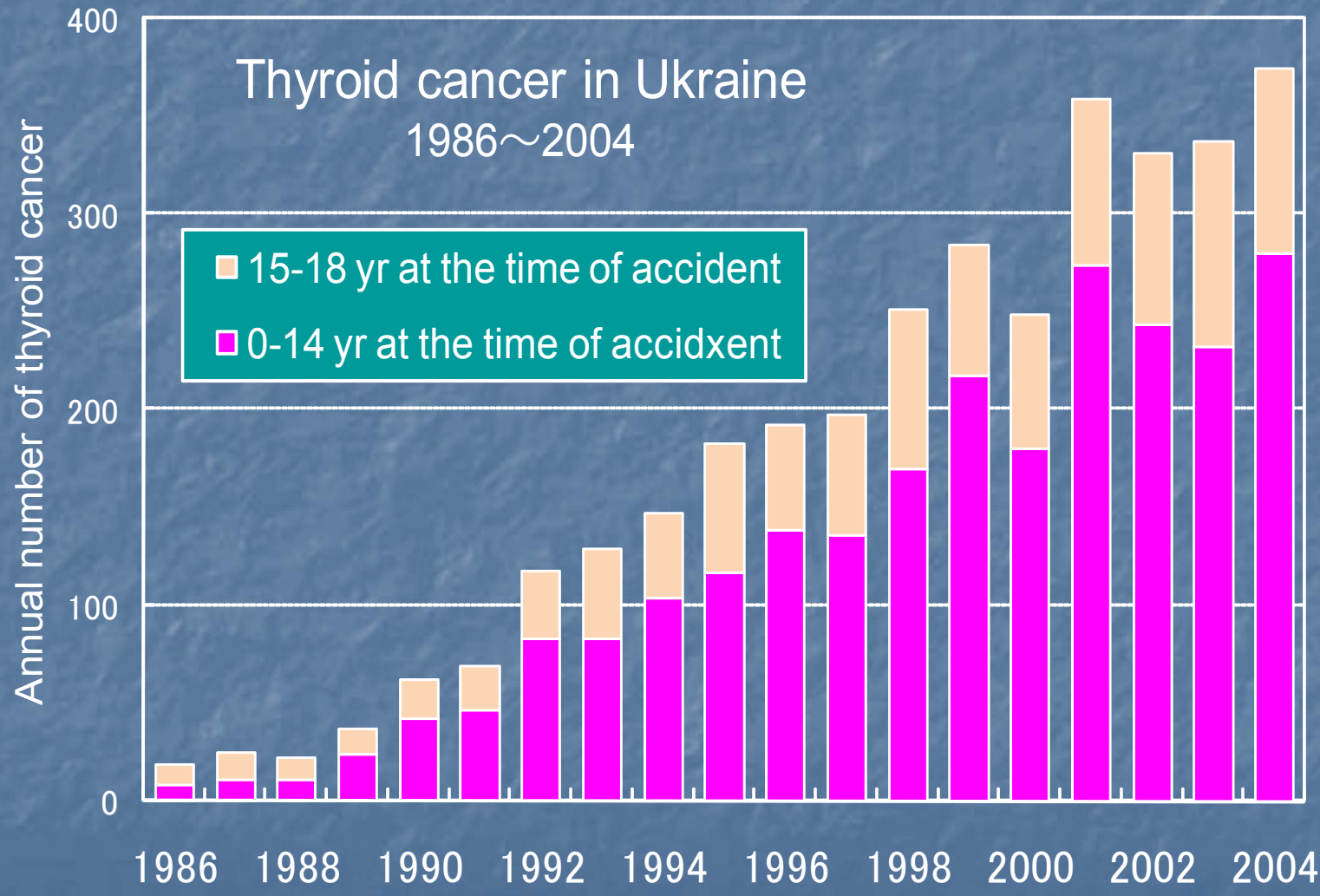
- Share of Chernobyl expenses in the state budget of Ukraine comprised from 10 % in 1992 to 4.6 % in 2000

*On average, after 1999 only 25-27 % of funding required by Law was allocated in the budget*

# Economic lossess of Ukraine as a result of Chernobyl disaster (*as estimated in 2010*)

| Type of losses | mln USD |
|---|---|
| **Direct losses (1986-2010):** | |
| – within 30-km zone | **1 385** |
| – outside 30-km zone | **840** |
| **Financing liquidation of consequences** | |
| – Soviet period (1986-1991) | **5 723** |
| – independent Ukraine (1992-2010) | **12 194** |
| **Indirect lossess (1986-2015)** | |
| – agriculture, forestry, water resources | **68 370** |
| – early decommisioning of ChNPP | **28 050** |
| – moratorium on new units of NPPs | **67 320** |

# Thyroid data, *("National Report of Ukraine")* (published in 2006)

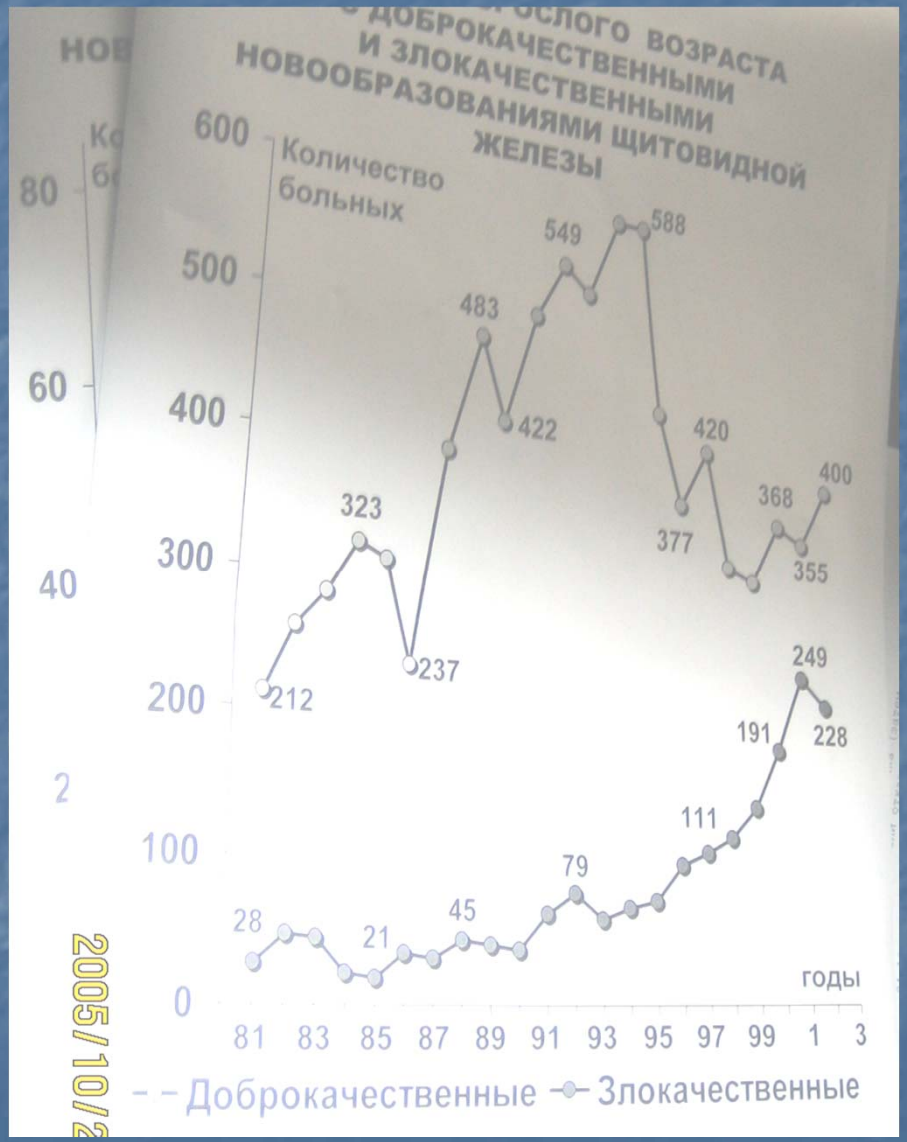


# Number of adults who underwent thyroid gland surgery at the Kyiv Institute of Endocrinology

- Upper graph: benign tumors
- Lower graph: malignant tumors

***These data were first published only in the beginning of 2000s.***

***As Prof. Komissarenko (Head of the Surgery Division of the Institute) explained, there was no information on where operated patients lived or worked or what doses they may had obtained after Chernobyl disaster.***



# Thyroid cancer

- Total number of thyroid cancers recorded in the National Registry of Ukraine during 1986-2009 - **6448**
- ***WHO, 23 April 2011:*** Radiation dose exposures to the thyroid were particularly high in children and adolescents living in Belarus, Ukraine and affected regions of the Russian Federation. By 2005, more than **6,000 thyroid cancer cases had been diagnosed in this group**. It is most likely that a large fraction of these thyroid cancers are attributable to radioiodine intake.
- ***WHO:*** Furthermore, it is expected that increases in thyroid cancer incidence due to the Chernobyl accident will continue for many more years, although long-term increases are difficult to quantify

# 1991-2000 Chernobyl and international science

- *IAEA/WHO* : “number of non-specific health effects other than cancer among exposed populations, and particularly liquidators, have been reported... However, *if real*, they might also reflect effects of stress and anxiety“.
- Western science often rejected reports published in the USSR and post-Soviet countries: “they were in foreign language, not peer-reviewed, biased etc.”
- In fact, it is difficult to judge, because in the equation *N=D*Q(D/E)* we do not know doses: measurements and reporting of doses were extremely bad. In reality, doses D might had been ten times higher than reported by the USSR.
- Anyway, “stress and anxiety” produced similar effects, and they were also **result of Chernobyl**

# 1991-2000, ChNPP under pressure

- 1992 - negotiations began between Ukraine and Western countries: West wanted shutting ChNPP down, Ukraine demanded financial compensation (shutting down was a huge economic loss)
- A special fund managed by EBRD was established; in 1997, a list of facilities to be funded by the West was agreed (spent fuel storages, New Safe Confinement, monitoring)
- American Government funded construction of the power plant to provide heat and electricity to ChNPP (June 2001)
- **15 December, 2000**: last operating unit #3 of ChNPP was **turned off forever**.

# Chernobyl and international nuclear energy development, 1991-2000

- Closure of ChNPP was due mainly to political pressure from the West on weak Ukrainian government **(15 RBMK reactors are still in operation in Russia!)**
- In 1994, the Dutch Parliament voted to phase out nuclear energy; in 1997, the Austrian Parliament
- Green movements became very strong in European countries, using anti-nuclear rhetoric and Chernobyl disaster as an argument
- At the end of 1990s, Green parties entered governments of Belgium and Germany; with their pressure, Belgium decided on phasing out nuclear energy in 1999, and Germany in 2000

# After 2000: Chernobyl problems

- Chernobyl legislation **does not have any time limits**, so number of sufferers has been going up every year
- **Crisis of payments** of Chernobyl pensions and payments for medicines: number of pensioners and people with approved “causal relation with Chernobyl accident” increased many-fold, there was no money in the state budget; lawsuits followed (several billion UAH)
- Parliament has been making only small changes to the law (20 amendments in 2000-2015!)
- Law of 28 December 2014: “zone 4” liquidated; authority for establishing rates of additional pensions and medical payments delegated to the Cabinet of Ministers **“to be allocated in accordance with available budget”**

# ChNPP and exclusion zone **now**

- For Ukraine:
  - site for spent nuclear fuel storages;
  - employment for ChNPP personnel (decommissioning, maintenance)
  - very complicated task of managing the 30-km zone (e.g., to reduce risk of forest fires, EU funded 1.7 MW incinerator for r/a contaminated wood)
  - President of Ukraine ordered creation of nature reserve in 30-km zone in 2016
- For international atomic energy community:
  - testing range for new technologies of NPP decommissioning (New Safe Confinement etc.)

# New Safe Confinement

# Chernobyl and international nuclear energy industry after 2000

- **New start for nuclear energy projects:**
  - 2004 – Finland EPR (not yet in operation; 3.9 billion Euro over the budget)
  - In the USA - 2005 Energy Policy Act: incentives for establishing new-generation power reactors, first four AP1000 reactors are under construction plus e.g.:
  - China: 30 reactors in operation, 24 under construction and more planned; China has become largely self-sufficient in reactor design and construction
- **After 2011**, Fukushima took the place of Chernobyl in international discourse on the nuclear energy future; climate change issues are also seriously considered.

# Thank you for your atteention!

**Дякую за увагу!**

ご清聴ありがとうございました