SEMIPALATINSK TEST SITE. PRESENT AND FUTURE.

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Belgium: $S \approx 30\,500\,\text{km}^2$

Israel: $S \approx 20\,800\,\text{km}^2$

STS:
- $P \approx 600\,\text{km}$
- $S \approx 18\,300\,\text{km}^2$
STS (456 tests)
Total area 18 500 km²
Main experimental areas
1 – Experimental field
   (air and ground, ≈100 expl.)
2 – Balapan
   (boreholes, ≈ 100 expl.)
3 – Degelen
   (tunnels, ≈ 200 expl.)
4 – Sary-Uzen
   (boreholes, ≈ 20 expl.)
Excavational explosions
(Atomic lake, Telkem)
Main areas of research at STS

- Inventory of radioactive facilities at STS.
- Further special studies.
- Comprehensive study of "conditionally clean" areas, with a view to their further transfer to the national economy.
- Investigation of dose loads to the population living in the area of potential STS impact.
Inventory of radioactive facilities at STS, "Experimental Field" site
Inventorying of the STS objects. Atomic lake
Inventorying of the STS objects. Atomic lake
Development of subaquatic gamma-spectrometric survey method

Detection limit for $^{137}$Cs - $< 200$ Bk/kg
STS (456 tests)
Total area 18 500 km$^2$
Main experimental areas
1 – Experimental field (air and ground, $\approx 100$ expl.)
2 – Balapan (boreholes, $\approx 100$ expl.)
3 – Degelen (tunnels, $\approx 200$ expl.)
4 – Sary-Uzen (boreholes, $\approx 20$ expl.)
Excavational explosions (Atomic lake, Telkem)
Main characteristics of the Test Areas. DEGELEN

<table>
<thead>
<tr>
<th>Main radionuclides</th>
<th>$^{90}\text{Sr}$, $^{137}\text{Cs}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum concentration:</td>
<td>$^{137}\text{Cs}$ $^{90}\text{Sr}$ $^{239+240}\text{Pu}$</td>
</tr>
<tr>
<td></td>
<td>$n \times 10^6$ $n \times 10^5$ $n \times 10^3$</td>
</tr>
<tr>
<td>Isotope ratio:</td>
<td>$^{137}\text{Cs}/^{90}\text{Sr}$ $^{239+240}\text{Pu}/^{137}\text{Cs}$</td>
</tr>
<tr>
<td></td>
<td>$10^{-3} - 10^2$ $n \times 10^{-4} - n \times 1$</td>
</tr>
</tbody>
</table>

Tunnel 176. Contamination of territory adjoing to the tunnel mouth
“Degelen” site. Tritium in air

**Inside the cavity of the tunnels**

**Tunnels near-mouth areas**

![Graph showing volumetric activity of tritium in air](image)

- **Inside the cavity of the tunnels**
  - Maximal destruction of the rock
- **Tunnels near-mouth areas**
  - Tritium in air

**In the location of vertical wells**

**Maximal destruction of the rock**

![Graph showing volumetric activity of tritium in wells](image)

- **In the location of vertical wells**
  - Prior to drilling
  - After drilling
- **Maximal destruction of the rock**
  - Tritium in air
Further special studies

«Degelen» test area
Further special studies, “Degelen” site

Tritium beyond "Degelen“boundary

Surface waters: 80÷400 kBq/l
Vegetation: 1÷300 kBq/l
Ground water: 15÷250 kBq/l
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   (boreholes, ≈ 20 expl.)
Excavational explosions
   (Atomic lake, Telkem)
“Balapan” site
Main characteristics of the Test Areas (Balapan, Sary-Uzen)

Main radionuclides (Bk/kg):
Am-241, Cs-137, Sr-90, Pu-239+240
– up to n\(^{*}10^{4}\)

Scheme of Exposure Dose Rate values distribution at the borehole № 101
"Balapan" site

**Borehole 1355**

**Borehole 1010**

**Borehole “Glubokaya”**

**Borehole 1361**
Main characteristics of the Test Areas. BALAPAN

Groundwater discharge at the Balapan Area

Tritium in Shagan river
Further special studies, Shagan River

2010 г

2011 г

2012 г
STS total area – 18 500 km²

The NNC RK have developed a plan of step-by-step investigation of the STS for the purpose of harmonization of the STS’ administrative border with it’s real radioecological status, as well as complete liquidation of the most radiation hazardous objects by the 2021 году, 30th anniversary of Independence of Kazakhstan.

In 2008–2013 a complex ecological survey of the territory with area of 6 060 km² have been performed, including:

• Northern part of the STS
  • in 2009 – 3 000 km²
• Western part of the STS
  • in 2010 – 560 km²
• South-Eastern part of the STS
  • in 2011 – 850 km²
  • in 2012 – 850 km²
  • in 2013 – 800 km²
  • in 2014 – 800 km² (southern part)

Survey of the south-eastern part have been started - 1 000 km²
Complex researches of the STS territory. Methodology

- revealing of technogenic objects at the studying territory (decoding of satellite images);
- estimation of possible contamination on the base of historical information;
- experimental investigation of radionuclide contamination of all media (soil, surface and underground water, vegetation, air);
- for soil. All possible artificial radionuclide are studied (fission products, activation isotopes, transuranium elements). Additionally species of radionuclides and vertical profile are under consideration;
- investigation of geological structure;
- prognosis of radioecological situation in future;
- dose assessment for the most conservative scenario “substantial farmer”;
- preparation of recommendation on possible use of investigated territories
Some characteristic parameters of background contamination at the STS

Average activities of $^{137}\text{Cs}$ and $^{241}\text{Am}$, and isotopic ratio of $^{239+240}\text{Pu}/^{241}\text{Am}$ in the STS studied areas

- $^{239+240}\text{Pu}/^{241}\text{Am}$: 5.5 Bq/kg
- $^{137}\text{Cs}$: 17.2 Bq/kg
- $^{241}\text{Am}$: < 0.8 Bq/kg

- $^{239+240}\text{Pu}/^{241}\text{Am}$: 4.9 Bq/kg
- $^{137}\text{Cs}$: 16.7 Bq/kg
- $^{241}\text{Am}$: < 0.9 Bq/kg

- $^{239+240}\text{Pu}/^{241}\text{Am}$: 5.1 Bq/kg
- $^{137}\text{Cs}$: 19 Bq/kg
- $^{241}\text{Am}$: < 0.7 Bq/kg
Species of radionuclides in soils of «background» territories («northern», «western» part)

- Cs\textsuperscript{137}: 3.9% (obmennoy), 2.9% (kislotorastvorimaya)
- Sr\textsuperscript{90}: 30.3% (obmennoy), 48.7% (kislotorastvorimaya)
- Pu\textsuperscript{239+240}: 0.7% (obmennoy), 0.9% (kislotorastvorimaya)
- Am\textsuperscript{241}: 45.8% (obmennoy), 26.0% (kislotorastvorimaya), 28.2% (prochnosvyazannaya)
Vertical distribution of radionuclides in chestnut soils of STS

\[ y = 125e^{-0.36x} \quad R^2 = 0.98 \]

\[ y = 85e^{-0.34x} \quad R^2 = 0.98 \]

\[ y = 70e^{-0.25x} \quad R^2 = 0.91 \]

\[ y = 126e^{-0.41x} \quad R^2 = 0.97 \]
Peculiarities of radionuclides’ accumulation by plants at conditionally «background» territories

Surveyed territories:
- «northern» part of the STS,
- «western» part of the STS,
- «south-eastern» part of the STS
Peculiarities of radionuclides’ accumulation by plants at conditionally «background» territories

Surveyed territories:
- «northern» part of the STS,
- «western» part of the STS,
- «south-eastern» part of the STS

<table>
<thead>
<tr>
<th>Radionuclides</th>
<th>n</th>
<th>min – max</th>
<th>GM</th>
<th>GSD</th>
<th>AM</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{137}\text{Cs}$</td>
<td>39</td>
<td>0.003 – 0.3</td>
<td>0.030</td>
<td>3.2</td>
<td>0.057</td>
<td>0.073</td>
</tr>
<tr>
<td>$^{90}\text{Sr}$</td>
<td>18</td>
<td>0.0079 – 1.73</td>
<td>0.25</td>
<td>4.1</td>
<td>0.45</td>
<td>0.42</td>
</tr>
<tr>
<td>$^{239+240}\text{Pu}$</td>
<td>32</td>
<td>0.00075 – 0.21</td>
<td>0.019</td>
<td>3.4</td>
<td>0.036</td>
<td>0.044</td>
</tr>
<tr>
<td>$^{241}\text{Am}$</td>
<td>39</td>
<td>Values are not specified</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n – number of cases; GM – geometric mean (GSD – standard deviation), AM – arithmetic mean. (SD – standard deviation)
Pu concentrations at the monitoring points

- <0.3 mBk/m³
- 0.3±0.1 mBk/m³
- 2.3±1.1 mBk/m³
- <0.3 mBk/m³
- 0.4±0.1 mBk/m³

The map shows various locations with Pu concentrations ranging from <0.3 mBk/m³ to 0.4±0.1 mBk/m³. The images on the right illustrate the monitoring equipment at these points.
“Subsistence farmer”
“Subsistence farmer”
“Experimental estimation of radionuclide transfer to agricultural products at the STS territory

Distribution of radionuclides \( \log K_n \) for agricultural plants at the «Experimental Field» test area
Transfer dynamics T into poultry products

At uptake with air  
At uptake with water  
At uptake with forage

**Chicken meat**

- **Kₙ = 2.4**

**Eggs**

- **Kₙ = 8.0**
- **Kₙ = 1.9**
- **Kₙ = 16.0**
In 2008–2013 a complex ecological survey of the territory of 6 060 km² have been performed

- 35 km² were not recommended for use
- About 300 km² were recommended only for industrial use
- About 5650 km² were recommended for use without any restrictions
“Topical issues of radioecology of Kazakhstan”, 4 issues

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Thank you for your attention!