Green Cross Russia
Nuclear and Radiation Safety Programme

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Contemporary state of safety at Russian nuclear installations

The Russian nuclear complex (1)

- 213 nuclear installations (industrial reactors, nuclear reactors at nuclear power plants, research installations, civilian and military fleet, etc.);

The Russian nuclear complex (2)

- 454 storage sites for nuclear materials and radioactive wastes;
- 16‘675 radiation sources in use in the national economy;
- 1‘508 storage sites for radioactive materials and radioactive wastes from the national economy;
- 1‘226 transport containers.

Accidents and incidents at nuclear facilities

Date	Installation	Type of incident	Injured people	Consequences
April 1993	Siberian Chemical Combine, Seversk (Tomsk Oblast)	Explosion with ensuing release of radio-nuclides	None	Nuclear contamination in a radius of about 15 km
August 1993	NIIAR Research Institute for Nuclear Reactors, Dimitrovgrad (Ulyanovsk Oblast)	Violation of safety rules	1	Burn and amputation of fingers
May 1995	Smolensk NPP	Violation of safety rules	1	Burn of fingers
May 1997	Novosibirsk Plant for Chemical Concentrates	Violation of safety rules	None	Without consequences
June 1997	Sarov all-Russian Research Institute for Experimental Physics	Violation of safety rules	1	Fatal outcome
June 1999	Siberian Chemical Combine, Seversk (Tomsk Oblast)	Violation of safety rules	None	Two hospitalised, without consequences
Sept. 2000	„Mayak“ (Chelyabinsk Oblast), Beloyarsk NPP	Breakdown of electricity supply in the South-Urals Region	None	Without consequences

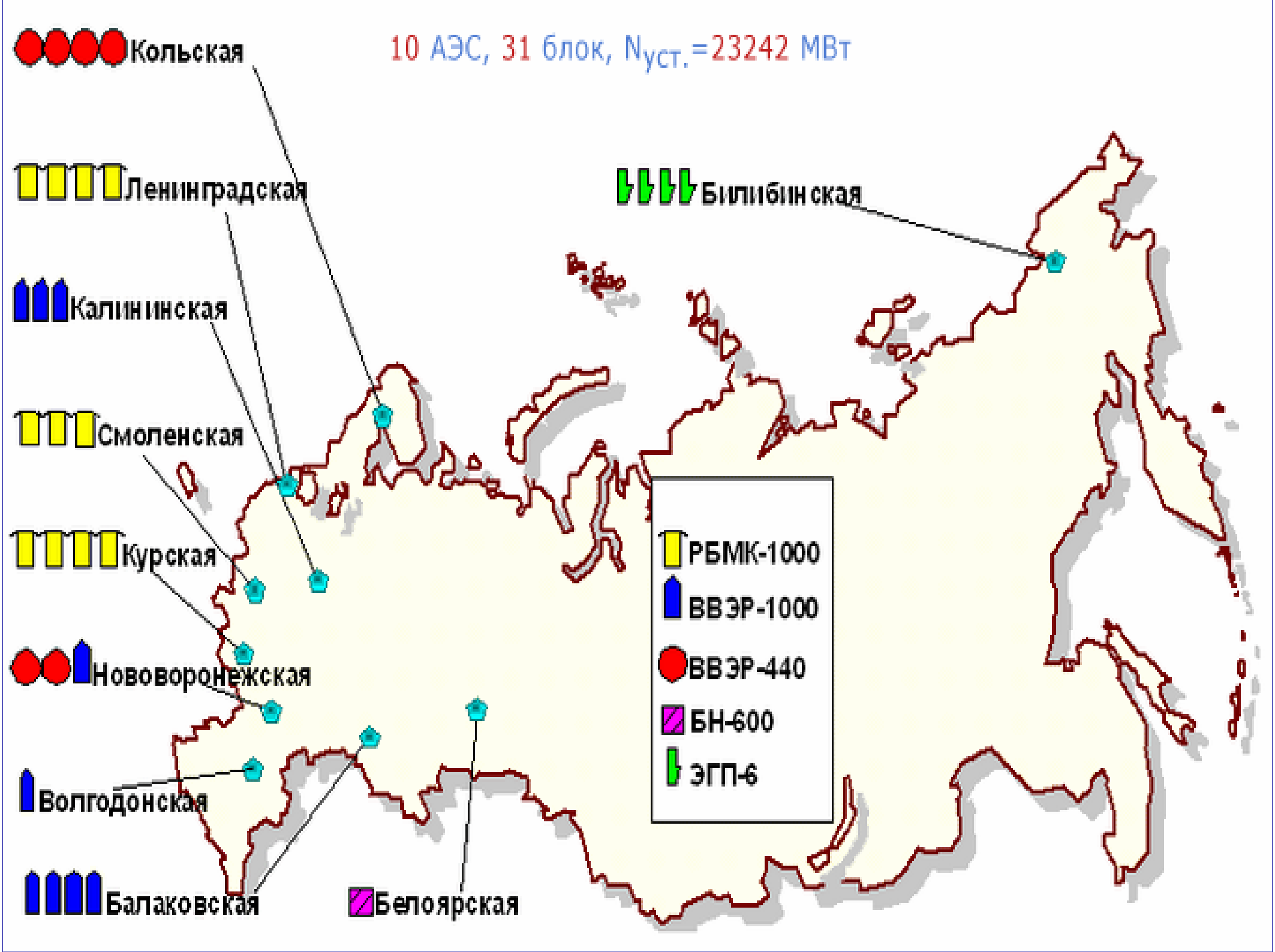
Potential threat

In Russia, about 1‘300 settlements with 4 million people are located either within a 30-km zone around a NPP or near enterprises of the nuclear fuel cycle.

(Source: Russian Ministry for Civil Defence, Emergencies and the Elimination of Consequences of Natural Disasters)


Nuclear Power Plants

Russia has 10 nuclear power plants (NPPs) with a total of 31 reactors. Responsible for NPP operation is the state company „Rosenergoatom“.
In 2004, the NPPs had a total generation capacity of 23‘242 MW and produced 15.6 % of all electricity in Russia.


10 АЭС, 31 блок, Nуст.=23242 МВт
Кольская
Ленинградская
Калининская
Смоленская
Курская
Нововоронежская
Волгодонская
Балаковская
Белоярская
Билибинская
РБМК-1000
ВВЭР-1000
ВВЭР-440
БН-600
ЭГП-6

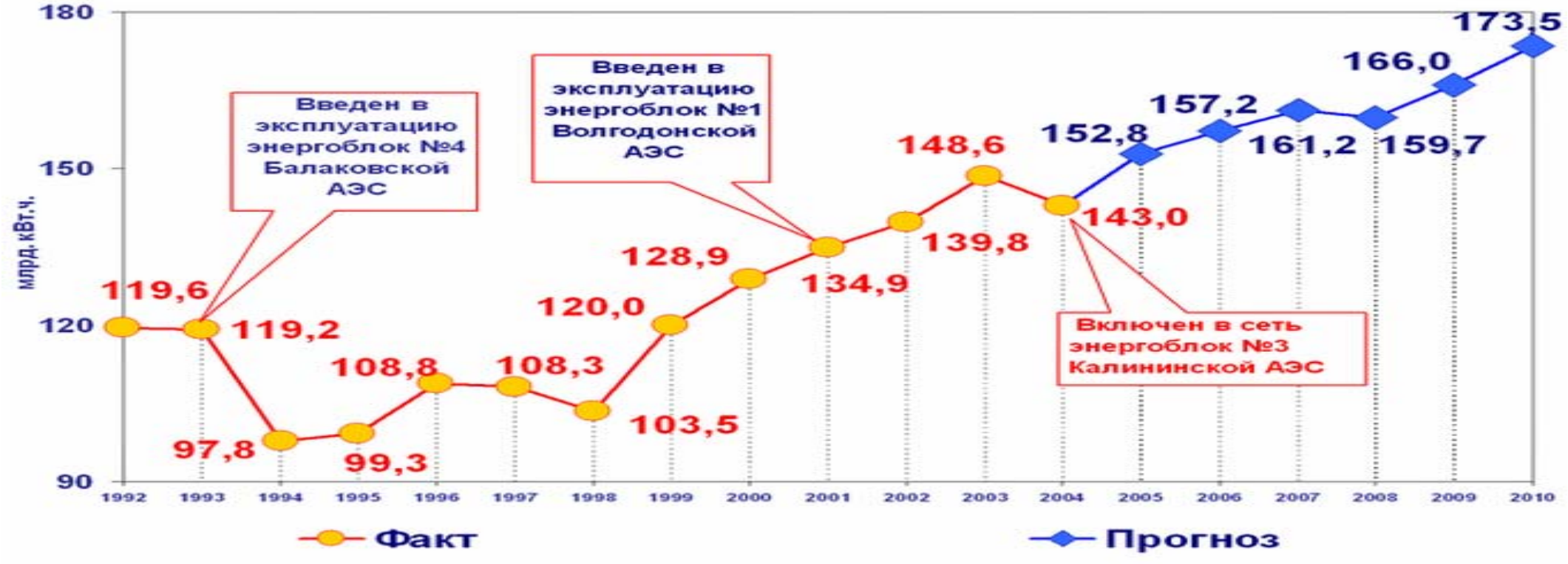
NPP	Number of reactors	Reactor type
1st generation		
Novovoronezh (block 1,2)	2 (out of operation)	VVER-1; V-3M
Novovoronezh (block 3,4)	2	VVER-440 (V-179)
Kola (block 1,2)	2	VVER-440 (V-230)
Leningrad (block 1,2)	2	RBMK-1000
Kursk (block 1,2)	2	RBMK-1000
Bilibinsk(block 1-4)	4	EGP-6
Beloyarsk (block 1,2)	2 (out of operation)	AMB-100,200
Total:	**16**	**Total power: 6‘537 MW**
2nd generation		
Novovoronezh (block 5)	1	VVER-1000 (V-187)
Kola (block 3,4)	2	VVER-440 (V-213)
Kalinin (block 1,2,3)	3	VVER-1000 (V-338, V-320)
Smolensk (block 1,2,3)	2	RBMK-1000
Leningrad (block 3,4)	2	RBMK-1000
Beloyarsk (block 3)	1	BN-600
Balakovo (block 1-3)	3	VVER-1000 (V-320)
Total:	**17**	**Total power: 16‘480 MW**
3rd generation		
Balakovo (block 4)	1	VVER-1000 (V-320)
Volgodonsk (block 1)	1	VVER-1000 (V-320)
Total:	**2**	**Total power: 2‘000 MW**

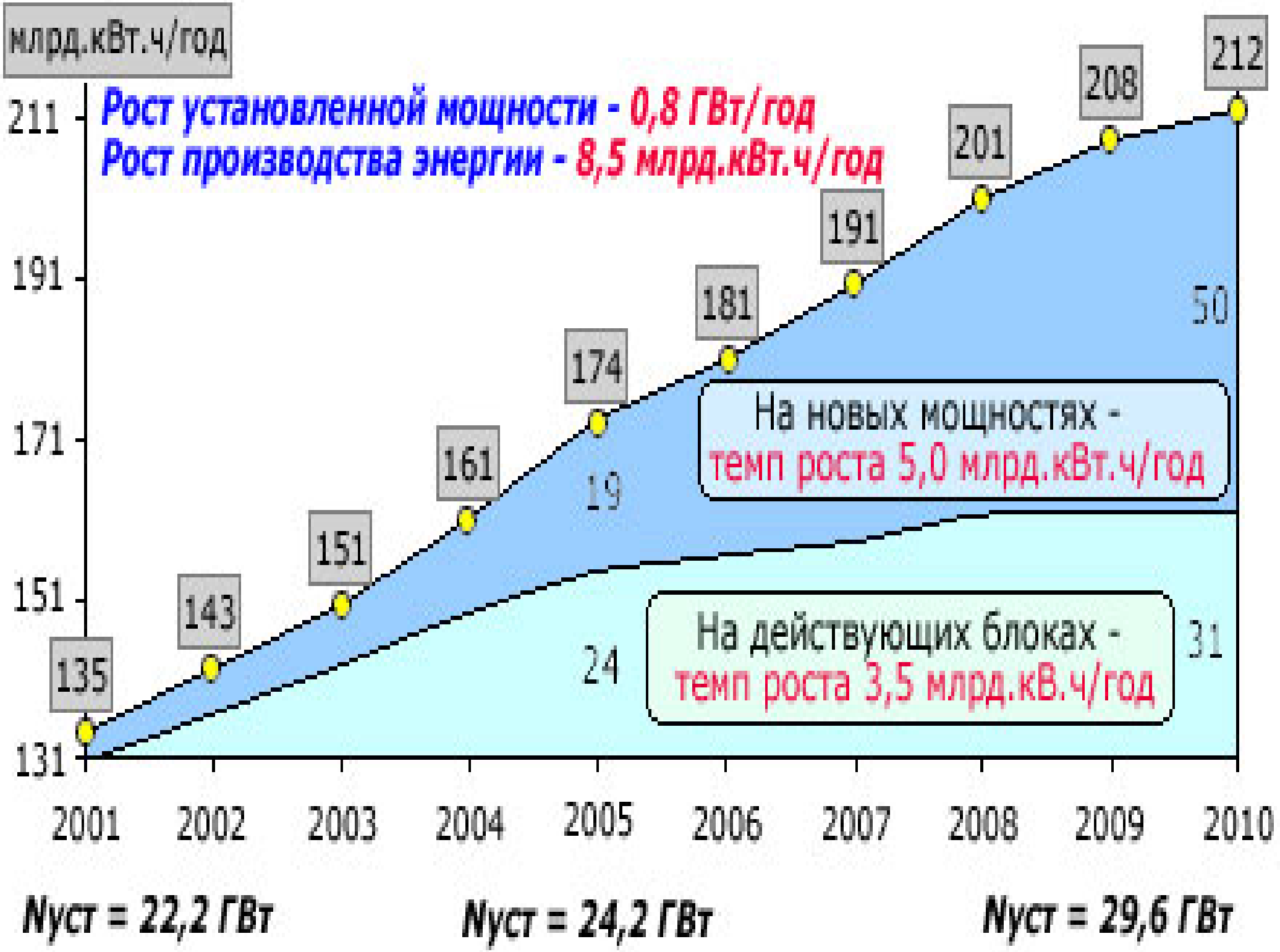
Energy production and capacity factor of Russian NPPs

2003:
Production of 148,6 billion kWh (an increase of 8.8 billion kWh or 5% compared to 2002), capacity factor of 76.3% (71.7% in 2002) (In the West: >90%).

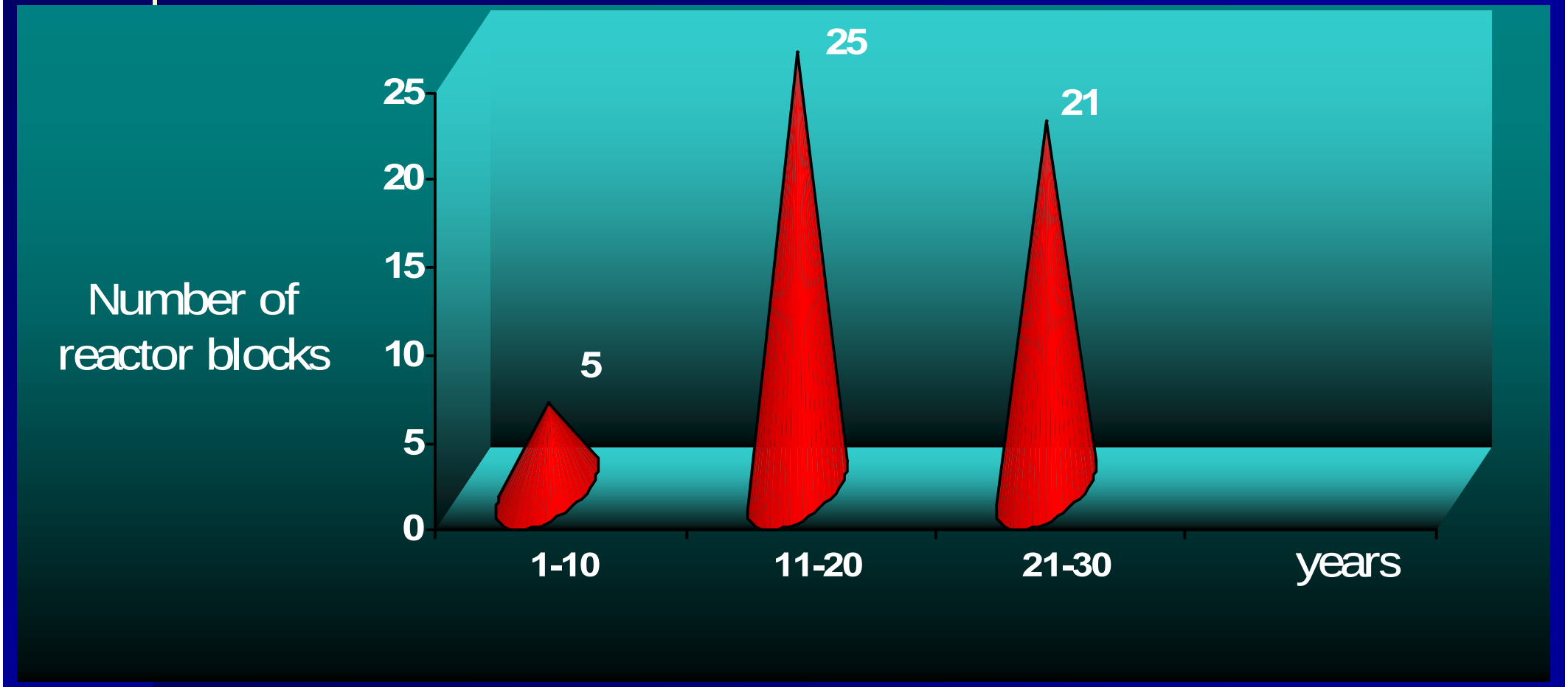
2004:
142.96 billion kWh (96.2% of 2003 level), capacity factor of 73.2%.

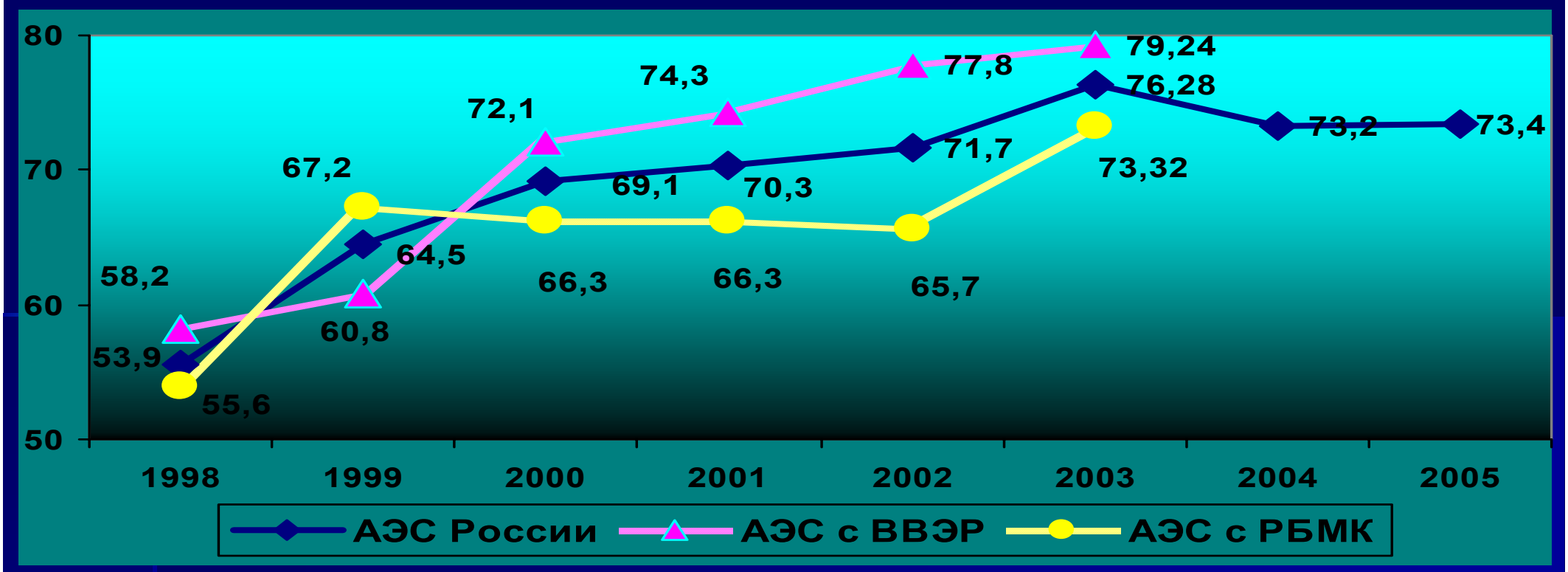
2005:
147.7 billion kWh with a capacity factor of 73.4%. This is less than the anticipated 152.8 billion kWh.

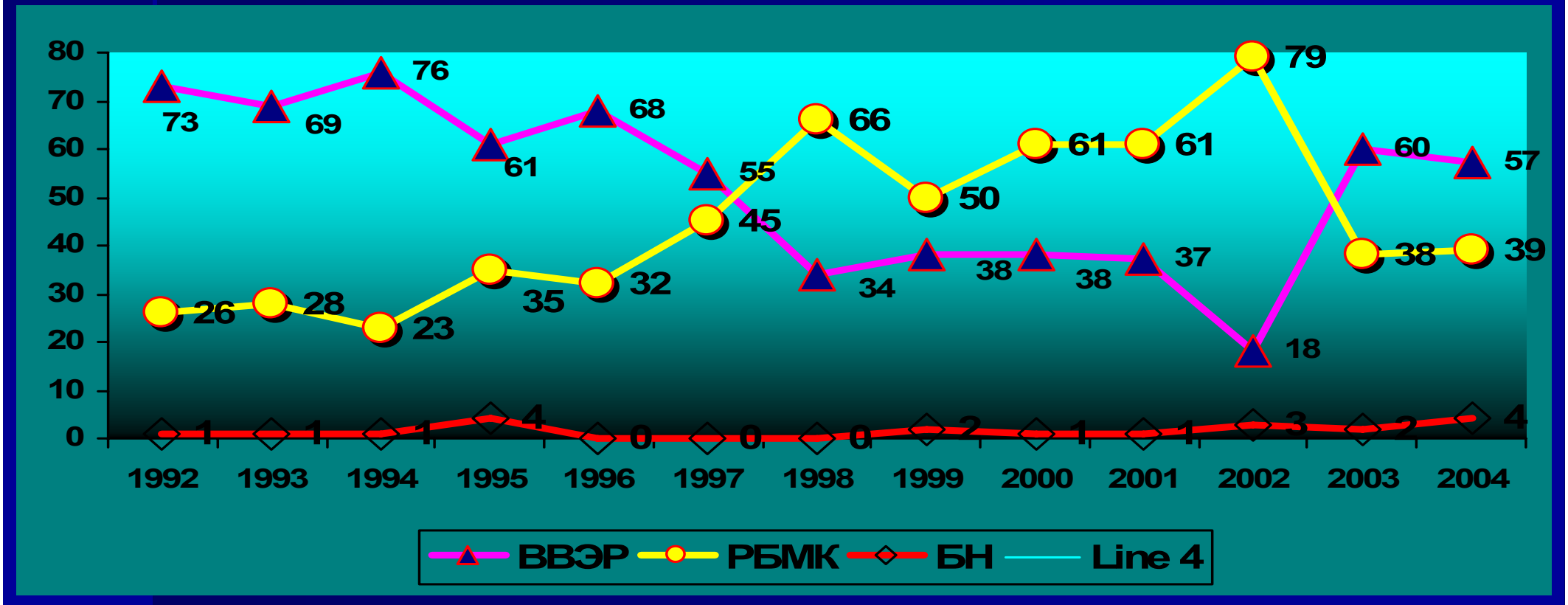



млрд.кВт.ч/год
Рост установленной мощности - 0,8 ГВт/год
Рост производства энергии - 8,5 млрд.кВт.ч/год
211
191
171
151
131
135
143
151
161
174
181
191
201
208
212
50
19
24
31
На новых мощностях -
темп роста 5,0 млрд.кВт.ч/год
На действующих блоках -
темп роста 3,5 млрд.кВ.ч/год
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Nуст = 22,2 ГВт
Nуст = 24,2 ГВт
Nуст = 29,6 ГВт

Service life of NPPs on the territory of the former USSR




80
70
60
50
58,2
53,9
55,6
67,2
64,5
60,8
72,1
74,3
66,3
69,1
66,3
70,3
77,8
79,24
65,7
71,7
76,28
73,32
73,2
73,4
1998
1999
2000
2001
2002
2003
2004
2005
АЭС России
АЭС с ВВЭР
АЭС с РБМК


80
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73
69
76
61
68
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34
45
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61
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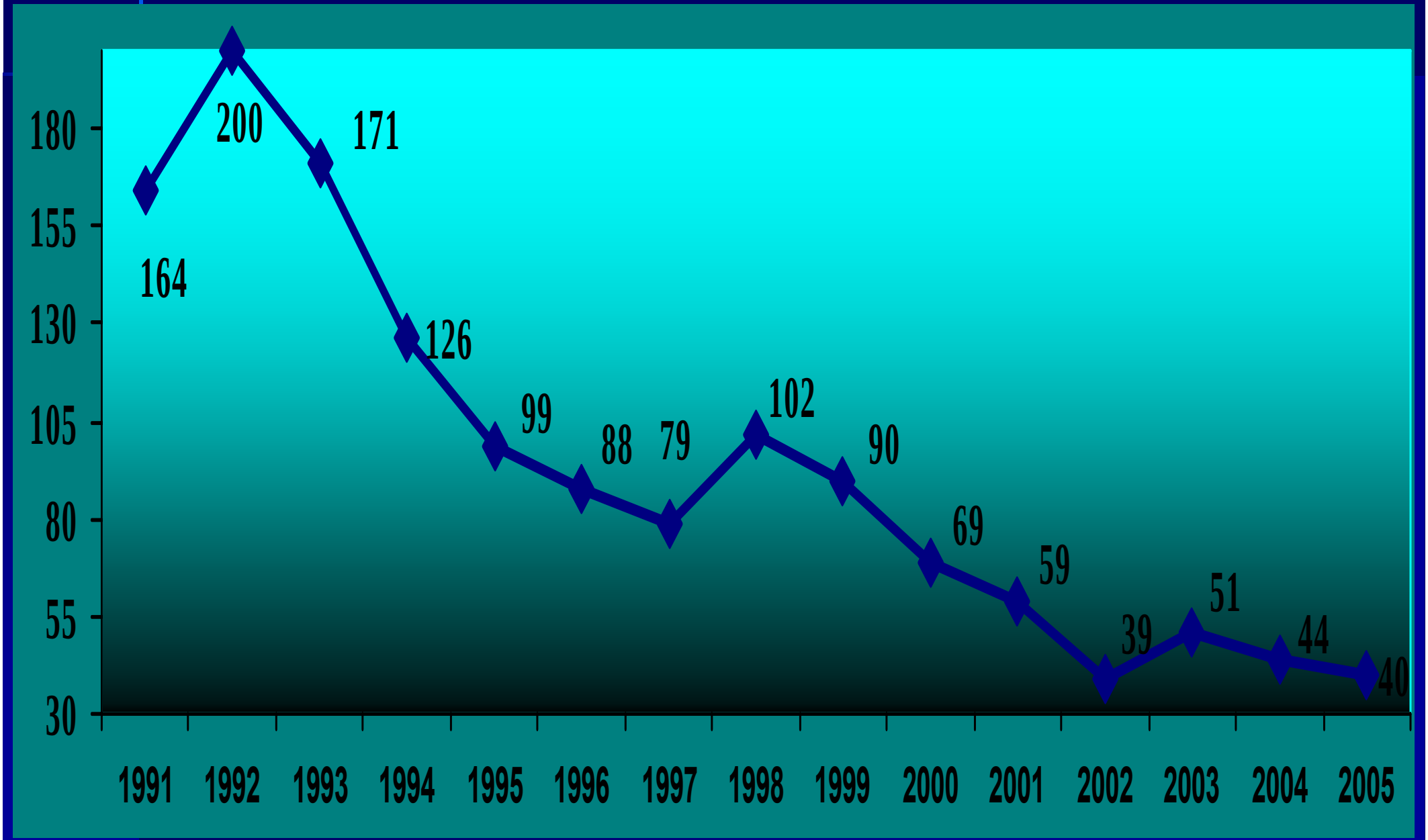
38
38
37
18
60
57
79
38
39
26
28
23
35
32
1
1
1
4
0
0
0
2
1
1
3
2
4
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
ВВЭР
РБМК
БН
Line 4

Incidents at Russian NPPs between 1. 1. 1991 and 31. 12. 2004



Spent nuclear fuel

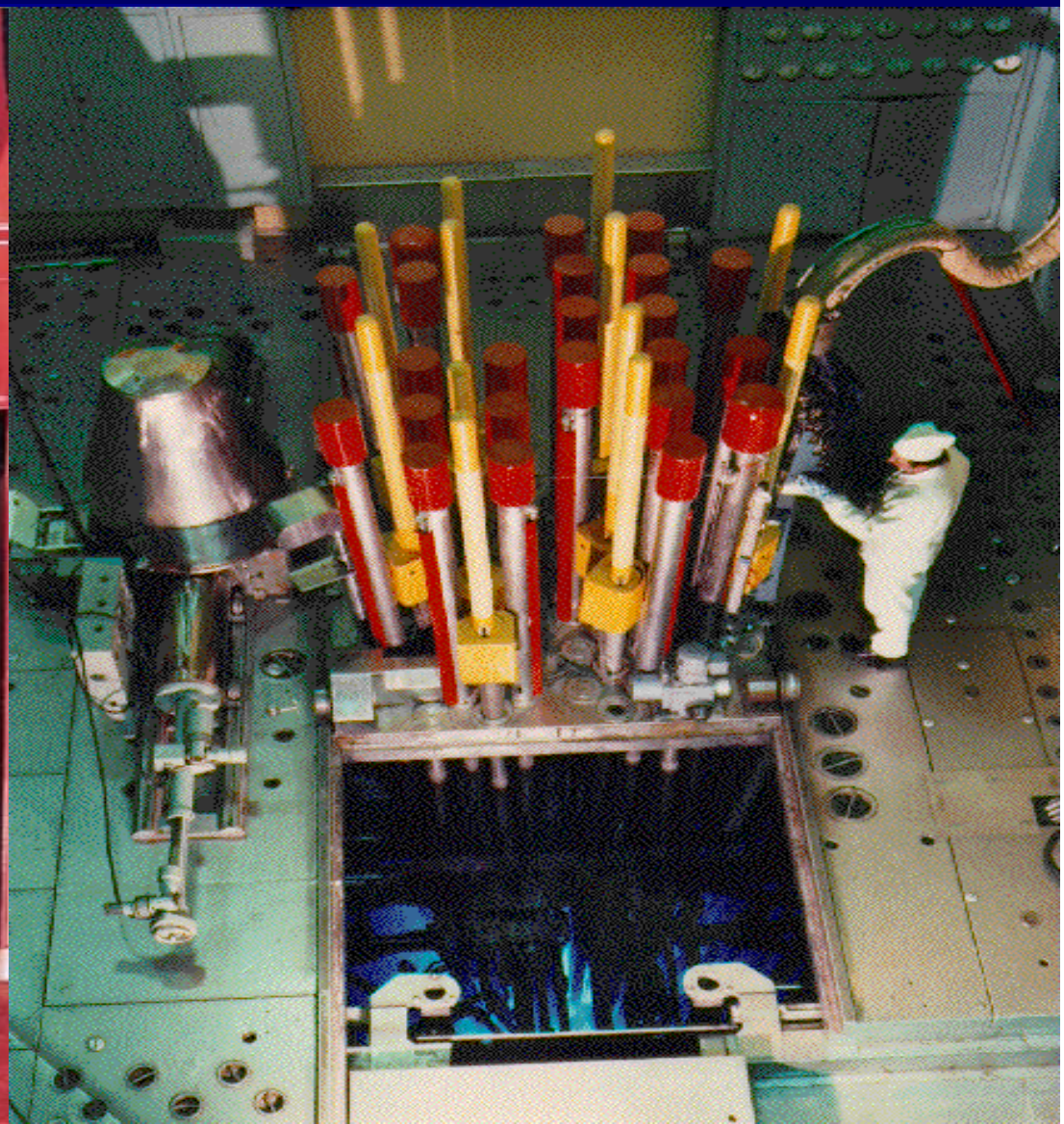
- As of year end 2005, 17-17‘500 t of spent nuclear fuel (SNF) was stored either at NPPs or at radio-chemical factories.
- SNF volume continues to grow steadily, about 850 t per year in Russia resp. 11-12‘000 t per year globally.
- SNF storage sites almost full (80-97%), which might force NPPs to shut down.
- The amount of plutonium contained in Russian SNF is about 175 t.

Radioactive wastes from NPPs

- Storage sites for liquid nuclear wastes (LNW) located at the different NPPs are filled 67% on average.
- The LNW storage sites at the Kola and Leningrad NPPs are filled 80% and 95%, respectively.

- Storage sites for low-level and intermediate-level solid nuclear wastes (SNW) at the different NPPs are filled 90.3% on average (excluding the Rostov NPP which is a new NPP.
- Storage sites for high-level solid nuclear waster are filled 37.1% on average (exceptions: Kursk NPP 95.4%, Smolensk NPP 84.4%.
- Remaining storage space at the NPPs allows continued operation for another 8 years, storage space for solid wastes will be exhausted in 5 years.

Nuclear research facilities



In 2006, 93 nuclear research reactors are operating, down from 116 installations in 1993.

Safety problems at nuclear research facilities

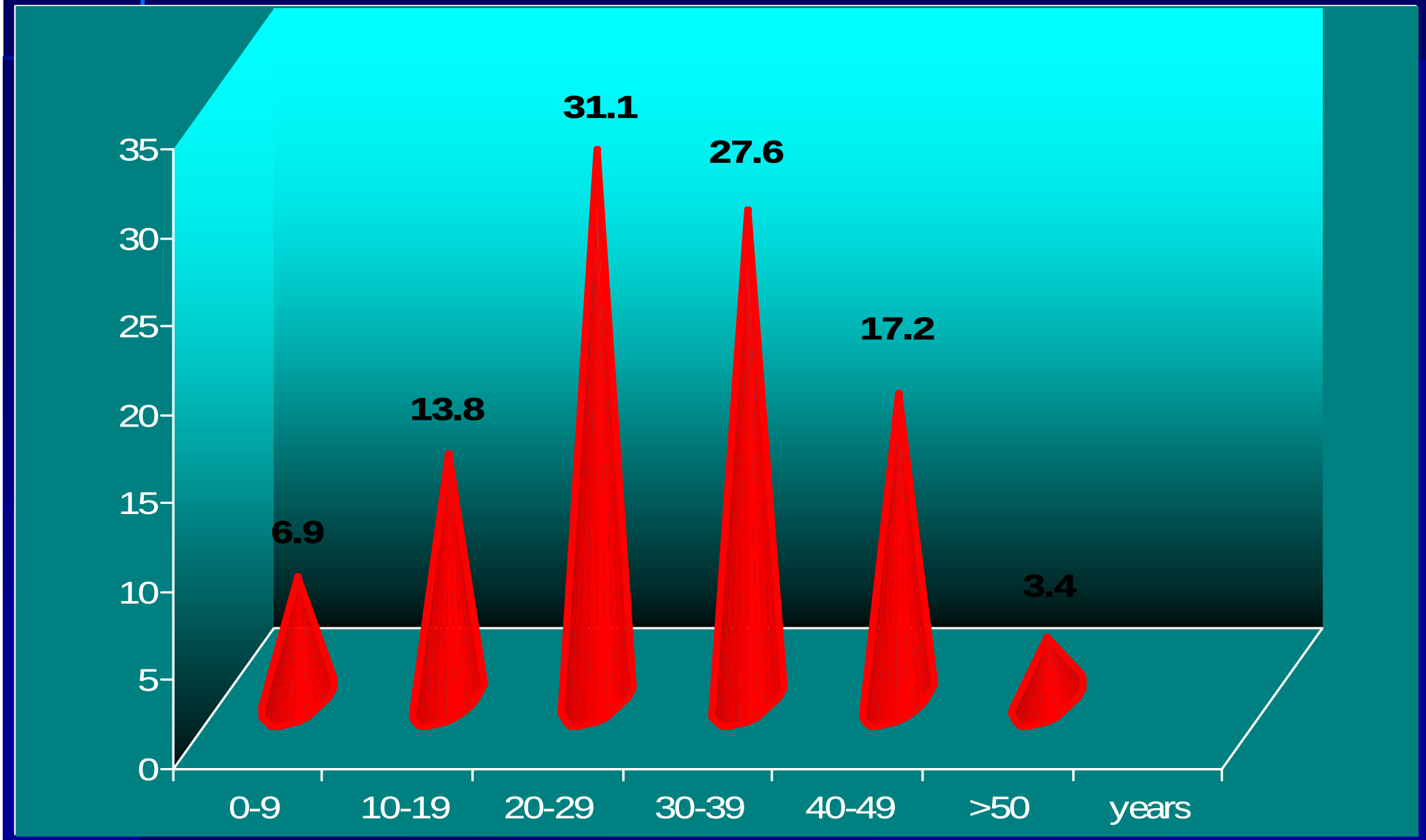
As all nuclear installations, also research facilities are a source of risks. Despite their low capacity and the generally small amounts of radioactive substances used during operation, their specific mode of operation poses serious safety challenges.

Challenges are:

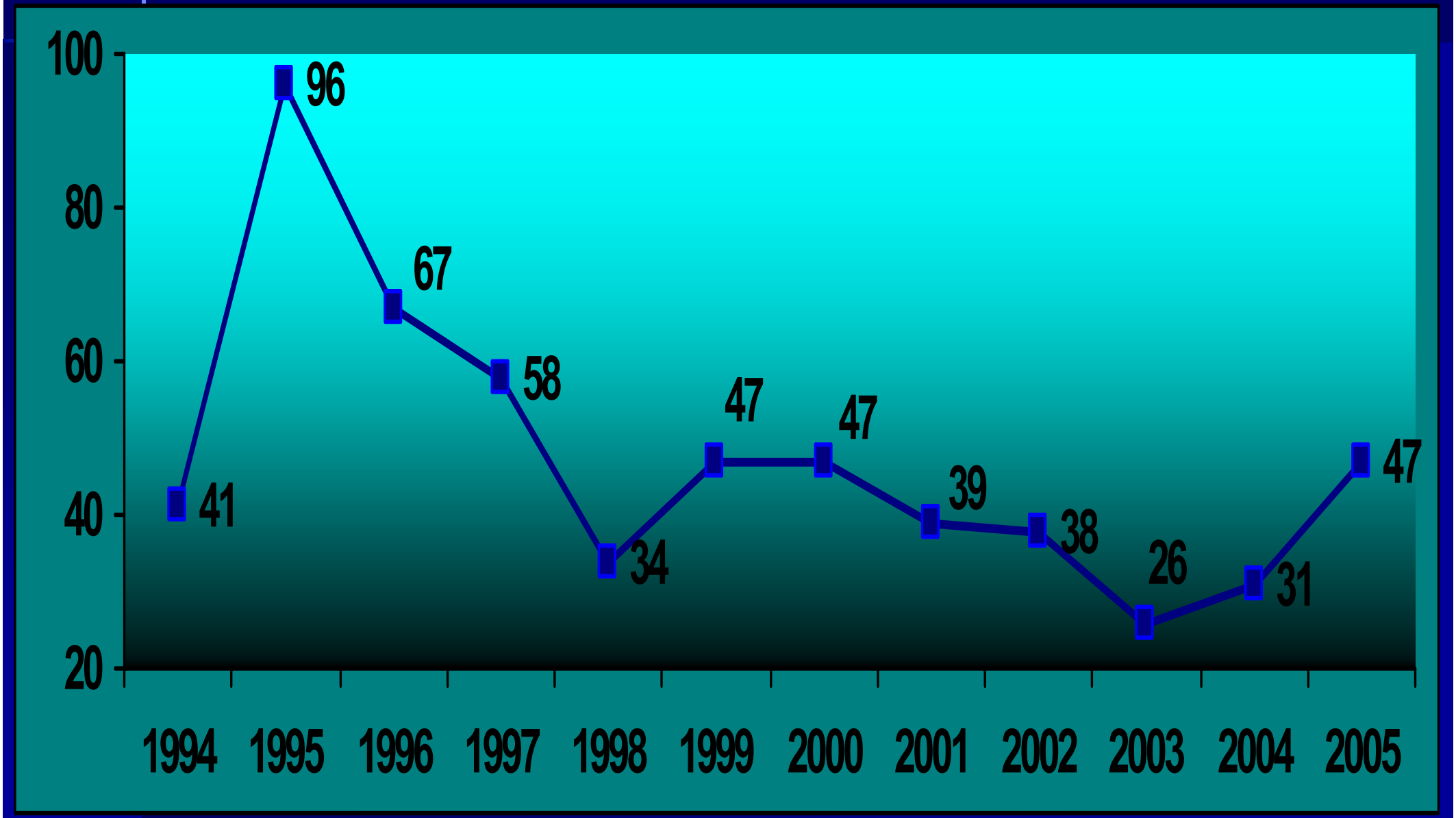
- Most research reactors have been built in the 1950-1970. At many of these facilities, no equipment upgrades have been made during the last twenty years due to a lack of funding.
- The frequent change of operation modes (start-up and stop of reactor, changes of capacity over a wide range, dynamic experiments), often in combination with unintentional infringments of safety regulations;
- Frequent reloading of the active zone;

- Frequent movement of irradiated materials (for analysis, to cooling ponds, to storage sites, for reprocessing, etc.);
- Large load on materials in the reactor zone and the first cooling circuit;
- Fatigue of materials due to the large neutron streams in the active zone of research reactor;
- The presence of highly-enriched fuels presents a proliferation risk and demands an effective system of accounting and physical protection;
- All research reactors have no containment;
- Many nuclear research facilities are located in large cities with a million-strong population.

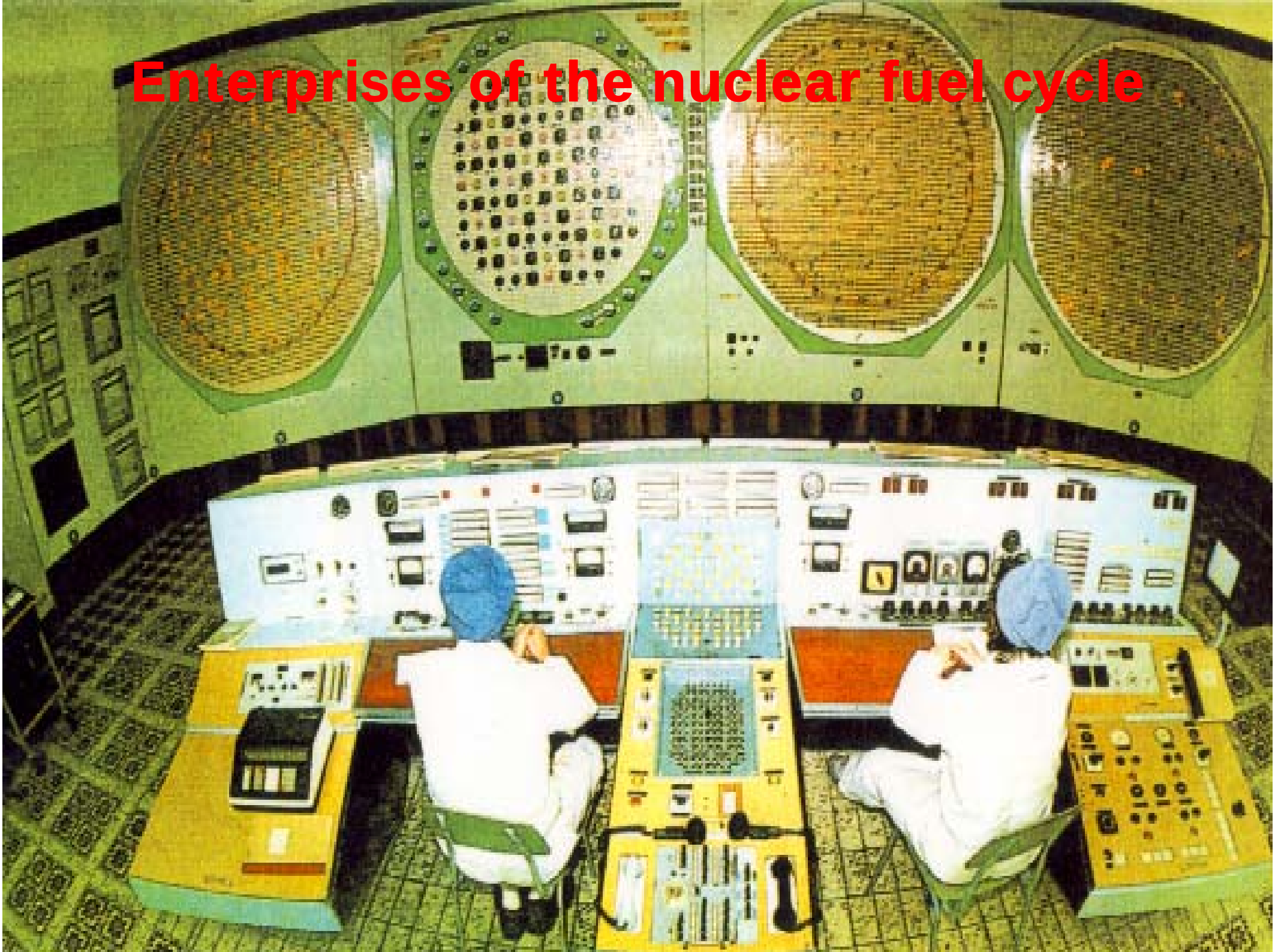
Service life of operating research reactors



Incidents at working nuclear research facilities

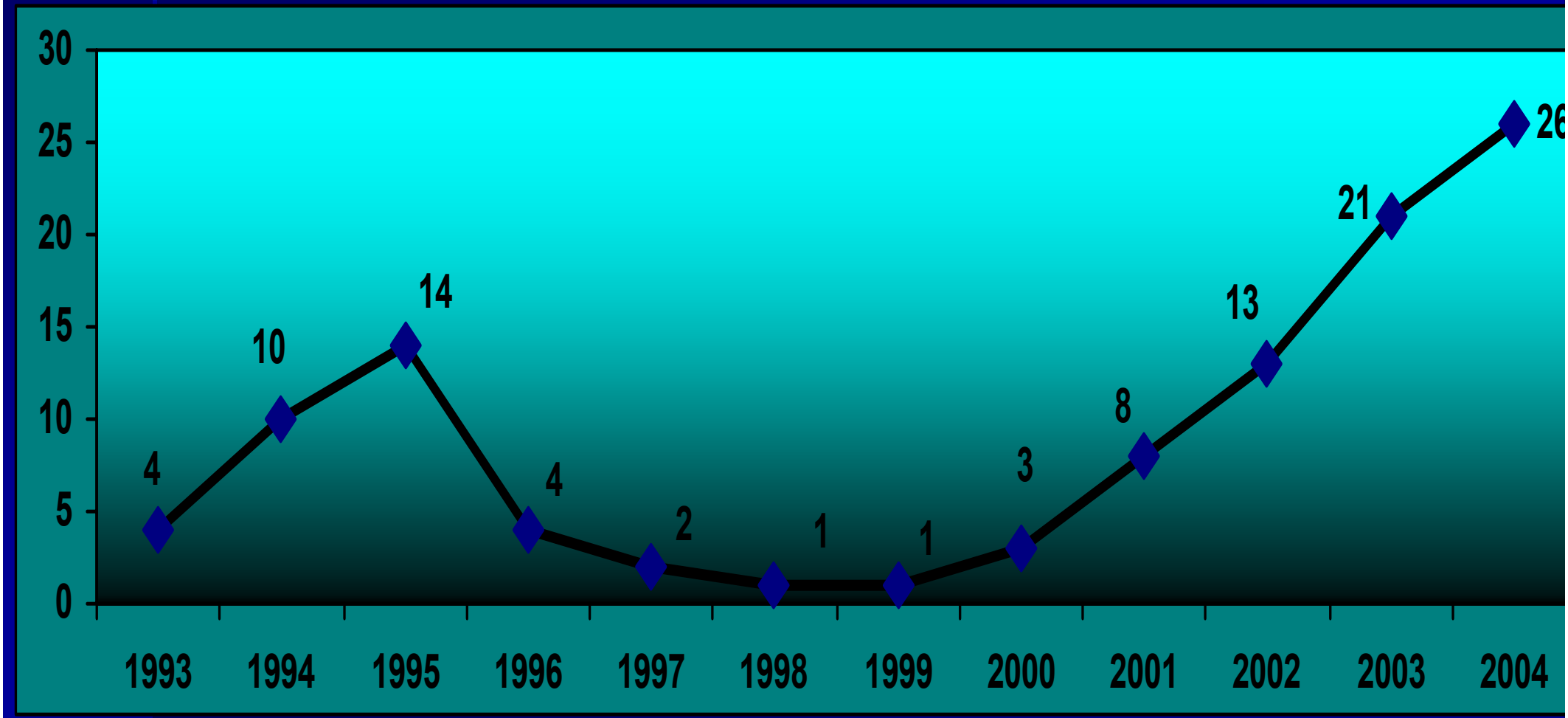


Enterprises of the nuclear fuel cycle



Incidents at enterprises of the nuclear fuel cycle

Since 1949, more than 250 incidents took place at enterprises of the nuclear fuel cycle.



Challenges are:

- Old equipment;
- Nuclear contamination of the environment;
- Final storage of plutonium, highly-enrichend uranium, etc.;
- Many nuclear facilities, first of all radiochemical plants, are potential targets for terrorists. Therefore, additional physical protection is needed.

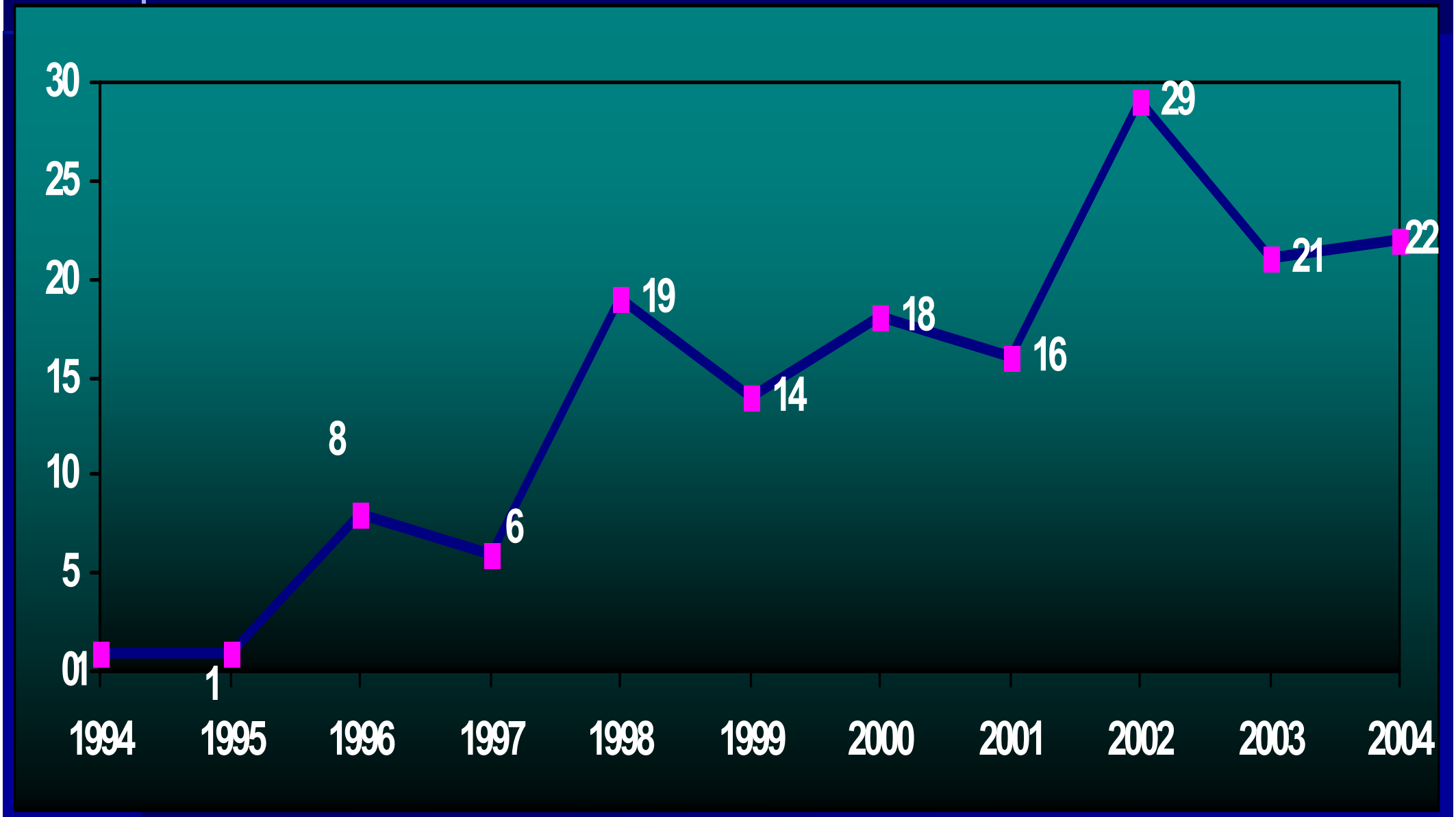
Nuclear surface ships

Overview on the nuclear fleet

- 9 ships with a total of 15 water-water pressure reactors (WWER):
  - 6 icebreakers “Lenin”, “Arctica”, “Sibir”, “Rossia”, “Sovietskii Soyuz” and “Yamal”;
  - 2 light icebreakers “Taimyr” and “Vaigach”, and
  - the lighter-containership “Sevmorput”.
- 5 nuclear servicing ships:
  - Two storage ships for fresh and spent nuclear fuel (“Imandra” and “Lotta”);
  - Two storage ships for general nuclear wastes (“Volodarskii” and “Serebryanka”); and
  - One nuclear monitoring ship (“Rosta-1”).

Name of ship	Projekt	Year	Reactor type	Number of reactors	Reactor generation	Condition today
Nuclear icebreaker „Lenin“	92M	1959	OK-150 OK-900	3 2	1 2	Out of operation
Nuclear icebreaker „Arctica“	1052-1	1975	OK-900A	2	2	Working reserve
Nuclear icebreaker „Sibir“	1052-2	1977	OK-900A	2	2	Working reserve
Nuclear icebreaker „Rossia“	10521-1	1985	OK-900A	2	2	In operation
Nuclear icebreaker „Sovietskii Soyuz“	10521-2	1989	OK-900A	2	2	In operation
Nuclear icebreaker „Yamal“	10521-3	1992	OK-900A	2	2	In operation
Nuclear icebreaker „Taimyr“	10580-1	1989	KLT-40M	1	3	In operation
Nuclear icebreaker „Vaigach“	10580-2	1990	KLT-40M	1	3	In operation
Nuclear lighter „Sevmorput“	10081	1988	KLT-40	1	3	In operation

Incidents with the ship nuclear reactors



Safety problems on nuclear surface ships

- Initially, reactors on surface ships were designed for a total lifetime of 25‘000 hours. Currently, the reactor on the icebreaker „Arctica“ operated 150‘000 hours. Research is ongoing to extend the lifetime to 175-200‘000 hours for both the vessel and the nuclear reactors.
- Weakest element: the steam generators (In 2002, 17 out of 29 incidents were related to leaks in the steam generator).

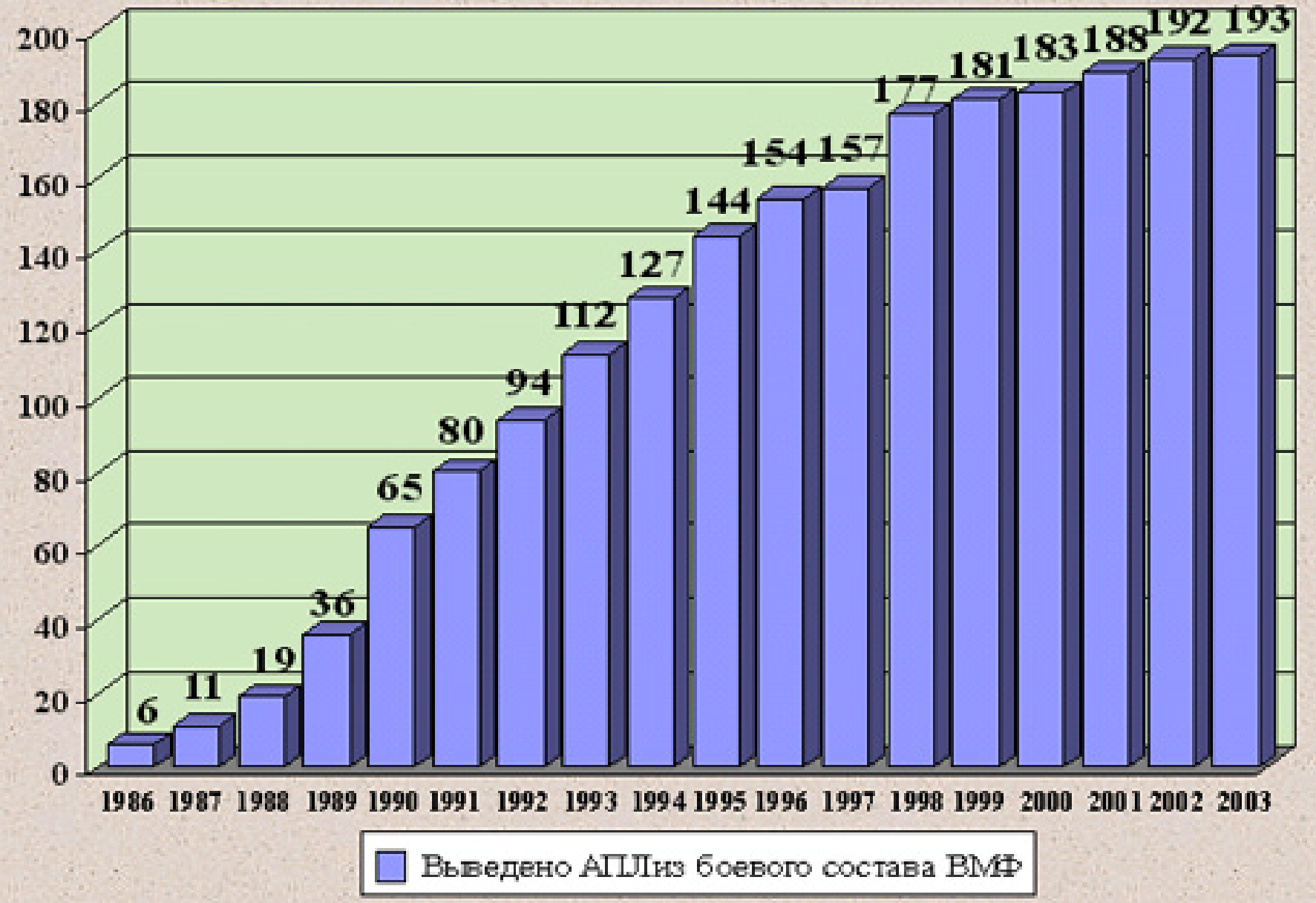
Nuclear submarines

- Between 1955-1996, five nuclear navy ships and 248 nuclear submarines were built in Russia.
- In early 1996, 242 nuclear submarines were still in service (57 first-, 142 second-, and 36 third-generation submarines and in addition seven submarines with liquid-metal cooled reactors).
- 5 special submarines completed the military fleet.
- A total of 441 nuclear reactors were in operation on submarines and 8 reactors on navy ships.
- In total, the nuclear fleet of Russia (military and civilian) consisted of 30 types of ships.

Failures and casualties

- Since the launching of the first Soviet nuclear submarine in August 1957, 26 accidents on Soviet and Russian nuclear submarines were described in open sources.
- In addition, at least another 19 accidents have been reported, but additional information is still classified.
- A total of five nuclear submarines with 405 crew was lost.

Динамика вывода АПЛ из боевого состава ВМФ



Состояние утилизации АПЛ на 01 апреля 2004 г.

	ВСЕГО	СФ	ТОФ
Выведено из боевого состава ВМФ	**193**	**117**	**76**
Утилизировано	**96**	**63**	**33**
В процессе утилизации	**35**	**22**	**13**
Ожидают начала утилизации	**62**	**32**	**30**
С ОЯТ	**55**	**27**	**28**

Challenges

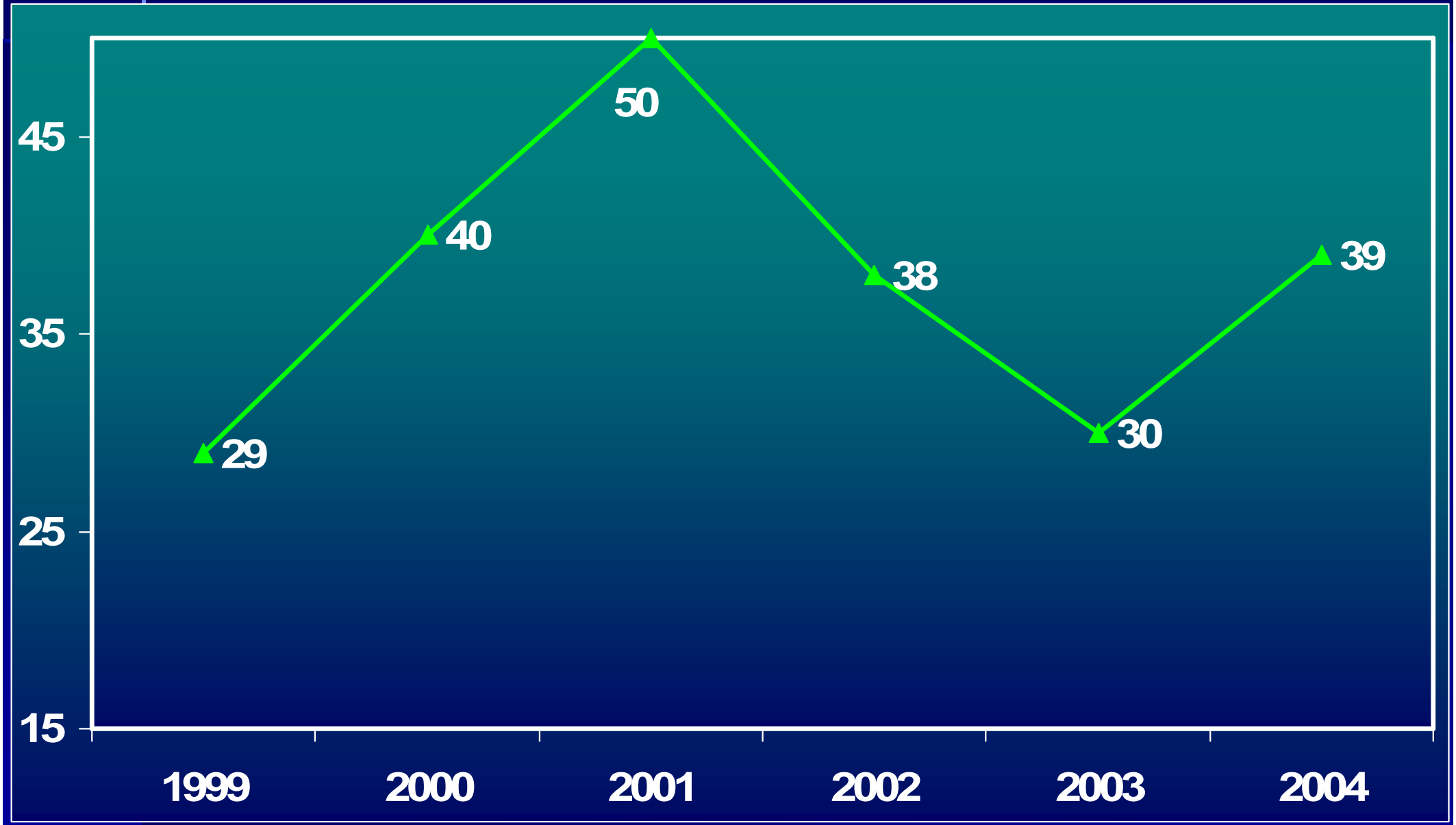
- The total activity of spent nuclear fuel from nuclear submarines exceeds 500 million Ci.
- Half of this activity still remains in reactors of decommissioned nuclear submarines.
- The decommissioning of the nuclear submarine fleet will produce about 1.5 million t of activated (radioactive) metal. In addition, 600‘000 t of spent fuel and non-metal radioactive wastes must be treated.

Sources of ionising radiation in the national economy

Problems with sources of ionising radiation and nuclear wastes

- In the 60s, the Soviet Union built a network of 16 enterprises for treating and storing low- and intermediate-level civilian nuclear wastes (System „Radon“).
- In the early 90s, responsibility was transferred from the federal to the regional authorities.
- Since then, investments into safety or upgrades have come to a stop due to a lack of regional finances.
- Most storehouses are almost full, technical equipment obsolete.
- Insufficient safety and security.

Incidents while working with sources of ionising radiation and nuclear wastes



Final observations

- To date, the government of the Russian Federation has provided only 12.5% of the planned financing for the Federal Programme „On nuclear and radiation safety in 2001 – 2006“.
- Operation and safety procedures at NPPs are dating from the time when they were built. However, these norms have not been updated and do not meet modern safety standards.

- With the current rate of accumulation of nuclear wastes at NPPs in service, the locally available storage capacity will be exhausted in 5-7 years. Controlling these volumes of spent fuel and nuclear wastes is a major national safety problem.
- Today, “Rosatom” finances the development of numerous next-generation nuclear projects, some of them questionable. It would be wiser to focus financial, scientific and technical efforts on the development of inherent safe and “wasteless” nuclear technologies, where Russia still has a real scientific potential.

Thank you for your attention