Soviet Nuclear Power in Space

The Soviet Union Orbited Nuclear Power Systems in Space for More Than 20 years (1965-1988)

The known number include:

- **2 RTG's**
- **2 RHU's**
- **31 (+2 reentered +2 aborts) Fission Reactors**

Radioisotope Generators

Spacecraft	Mission	Launch	Status
Cosmos -84	*Navigation*	*9/3/65*	*Still in Orbit*
Cosmos -90	*Navigation*	*9/18/65*	*Still in Orbit*
Luna -17	*Lunar Rover (Lunokhod -I)*	*11/10/70*	*Shutdown on Moon*
Luna -21	*Lunar Rover (Lunokhod-II)*	*1/8/73*	*Shutdown on Moon*

See Graphs of Reactor Launch Frequency and Lifetime of Orbiting Systems

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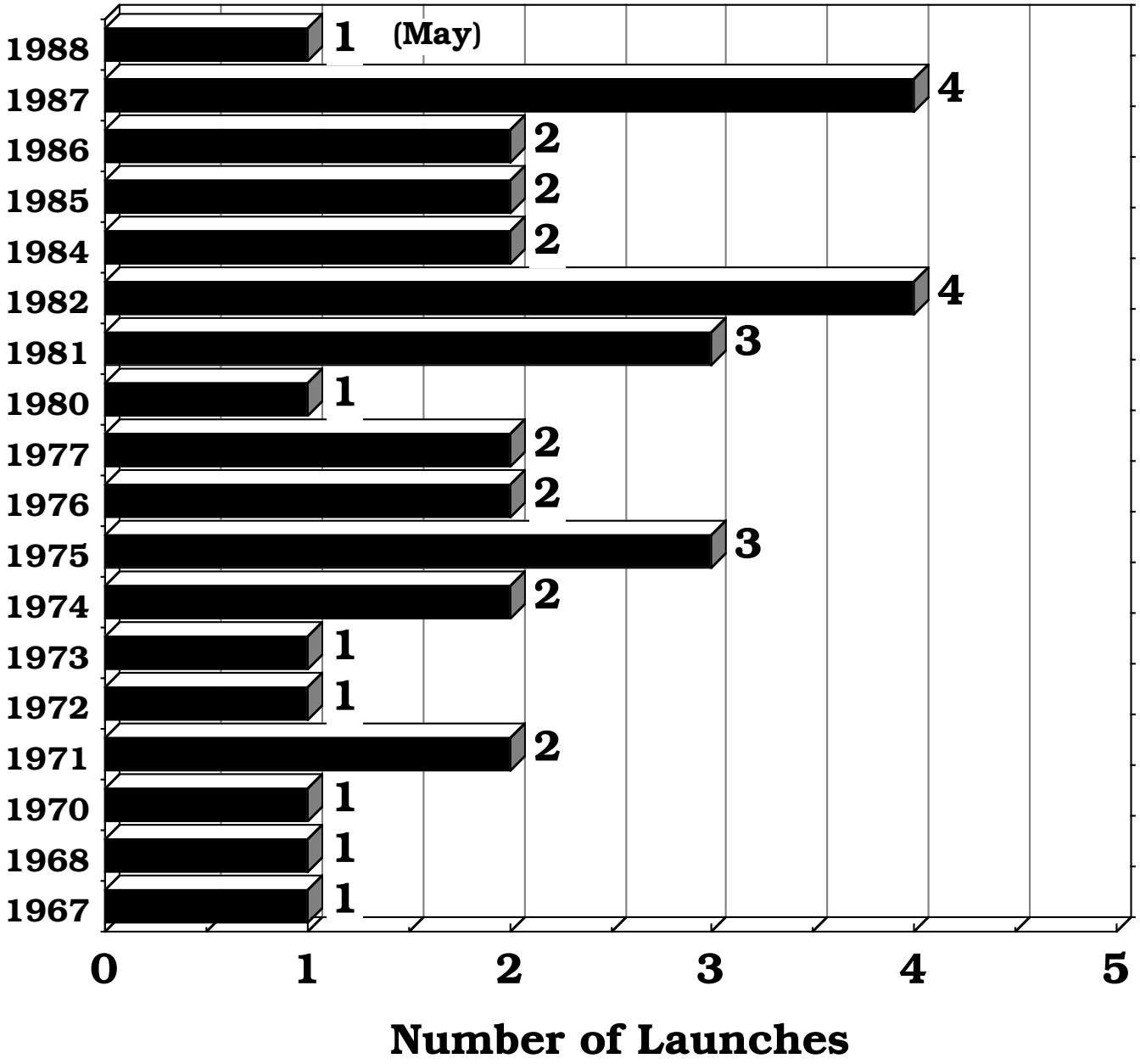
Frequency of Soviet Fission Reactor Launches



Duration of Soviet Fission Power Reactors in Space

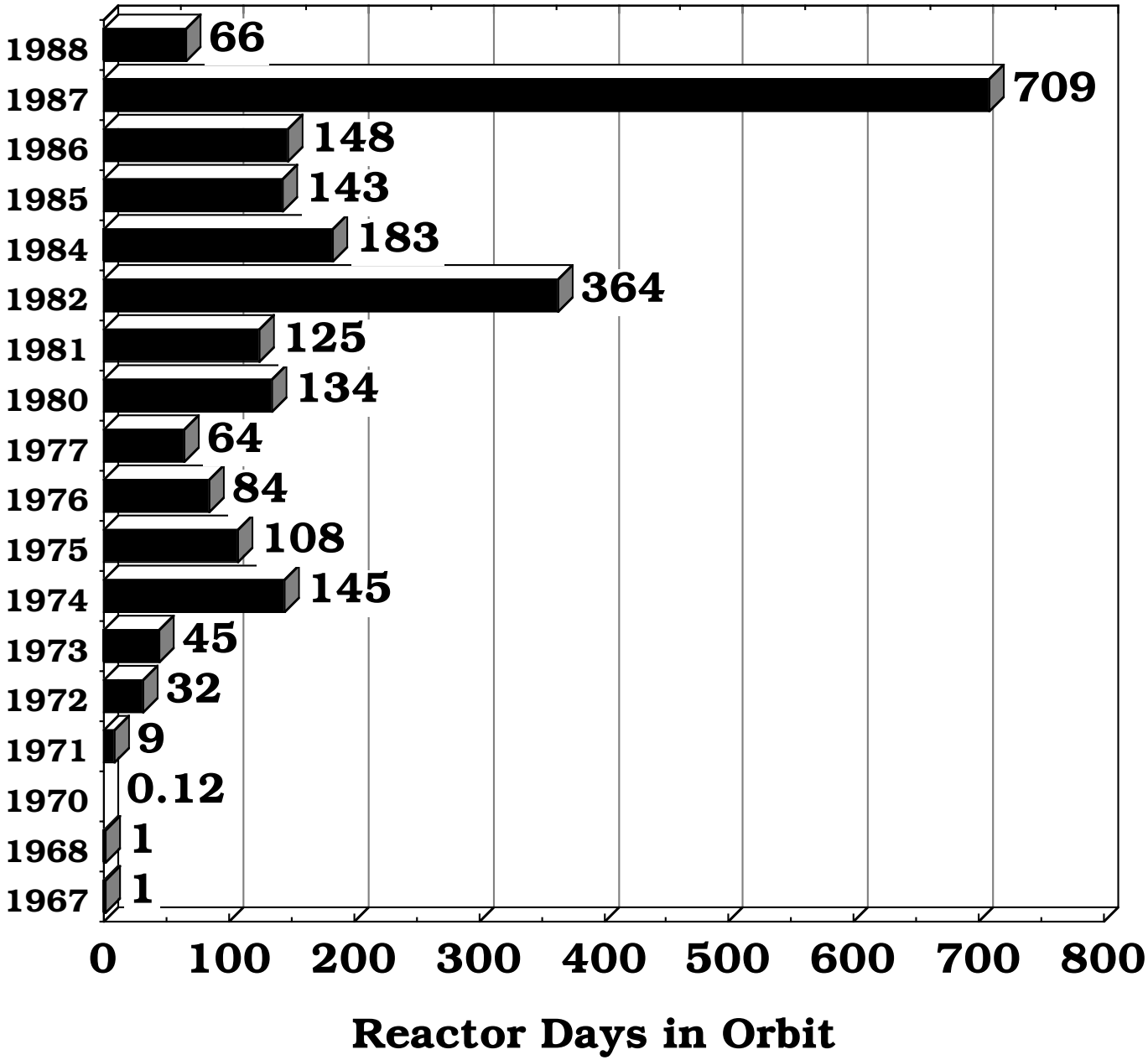


TABLE 4
SOVIET ORBITAL REACTOR PROGRAM HISTORY*

Number	Name	Launch Date	Termination Date	Lifetime
1	Cosmos 198	27 Dec 67	28 Dec 67	1 da
2	Cosmos 209	22 Mar 68	23 Mar 68	1 da
3	Cosmos 367	3 Oct 70	3 Oct 70	< 3 h
4	Cosmos 402	1 Apr 71	1 Apr 71	< 3 h
5	Cosmos 469	25 Dec 71	3 Jan 72	9 da
6	Cosmos 516	21 Aug 72	22 Sep 72	32 da
7	Cosmos 626	27 Dec 73	9 Feb 74	45 da
8	Cosmos 651	15 May 74	25 Jul 74	71 da
9	Cosmos 654	17 May 74	30 Jul 74	74 da
10	Cosmos 723	2 Apr 75	15 May 75	43 da
11	Cosmos 724	7 Apr 75	11 Jun 75	65 da
12	Cosmos 785	12 Dec 75	12 Dec 75	< 3 h
13	Cosmos 860	17 Oct 76	10 Nov 76	24 da
14	Cosmos 861	21 Oct 76	20 Dec 76	60 da
15	Cosmos 952	16 Sep 77	7 Oct 77	21 da
16	Cosmos 954	18 Sep 77	~31 Oct 77	~43 da
17	Cosmos 1176	29 Apr 80	10 Sep 80	134 da
18	Cosmos 1249	5 Mar 81	18 Jun 81	105 da
19	Cosmos 1266	21 Apr 81	28 Apr 81	8 da
20	Cosmos 1299	24 Aug 81	5 Sep 81	12 da
21	Cosmos 1365	14 May 82	26 Sep 82	135 da
22	Cosmos 1372	1 Jun 82	10 Aug 82	70 da
23	Cosmos 1402	30 Aug 82	28 Dec 82	120 da
24	Cosmos 1412	2 Oct 82	10 Nov 82	39 da
25	Cosmos 1579	29 Jun 84	26 Sep 84	90 da
26	Cosmos 1607	31 Oct 84	1 Feb 85	93 da
27	Cosmos 1670	1 Aug 85	22 Oct 85	83 da
28	Cosmos 1677	23 Aug 85	23 Oct 85	60 da
29	Cosmos 1736	21 Mar 86	21 Jun 86	92 da
30	Cosmos 1771	20 Aug 86	15 Oct 86	56 da
31	Cosmos 1818	1 Feb 87	~ Jul 87	~6 mo — Topaz
32	Cosmos 1860	18 Jun 87	28 Jul 87	40 da
33	Cosmos 1867	10 Jul 87	~ Jul 88	~1 yr — Topaz
34	Cosmos 1900	12 Dec 87	~14 Apr 88	~124 da**
35	Cosmos 1932	14 Mar 88	19 May 88	66 da

* Sources include references 10, 11, 12, 13, and 14.

**Note: The Cosmos 1900 reactor continued to operate past the 124-day mission lifetime.

The Soviets use fission reactors for;

Radar Ocean Reconnaissance Satellites (RORSAT)

Two kinds of reactors have been flown:

- **Romashka (Thermoelectric)**
- **Topaz (Thermionic)**

Romashka

• First unveiled at the 1964 Third U. N. Conference on the Peaceful Uses of Atomic Energy

• Looks like the reactor analog of an RTG because the T/E elements are placed next to core like in the SNAP -10. However, the US later abandoned that concept in favor of NaK coolant (SNAP -10A)

<u>Key</u> <u>Features</u>

• Fast Spectrum Graphite Reactor (See Figure)

• Fuel- UC2

*** Enrichment- 90% U-35**

• Control- Be Reflector

*** Converters--Si -85%, 15%-Ge**

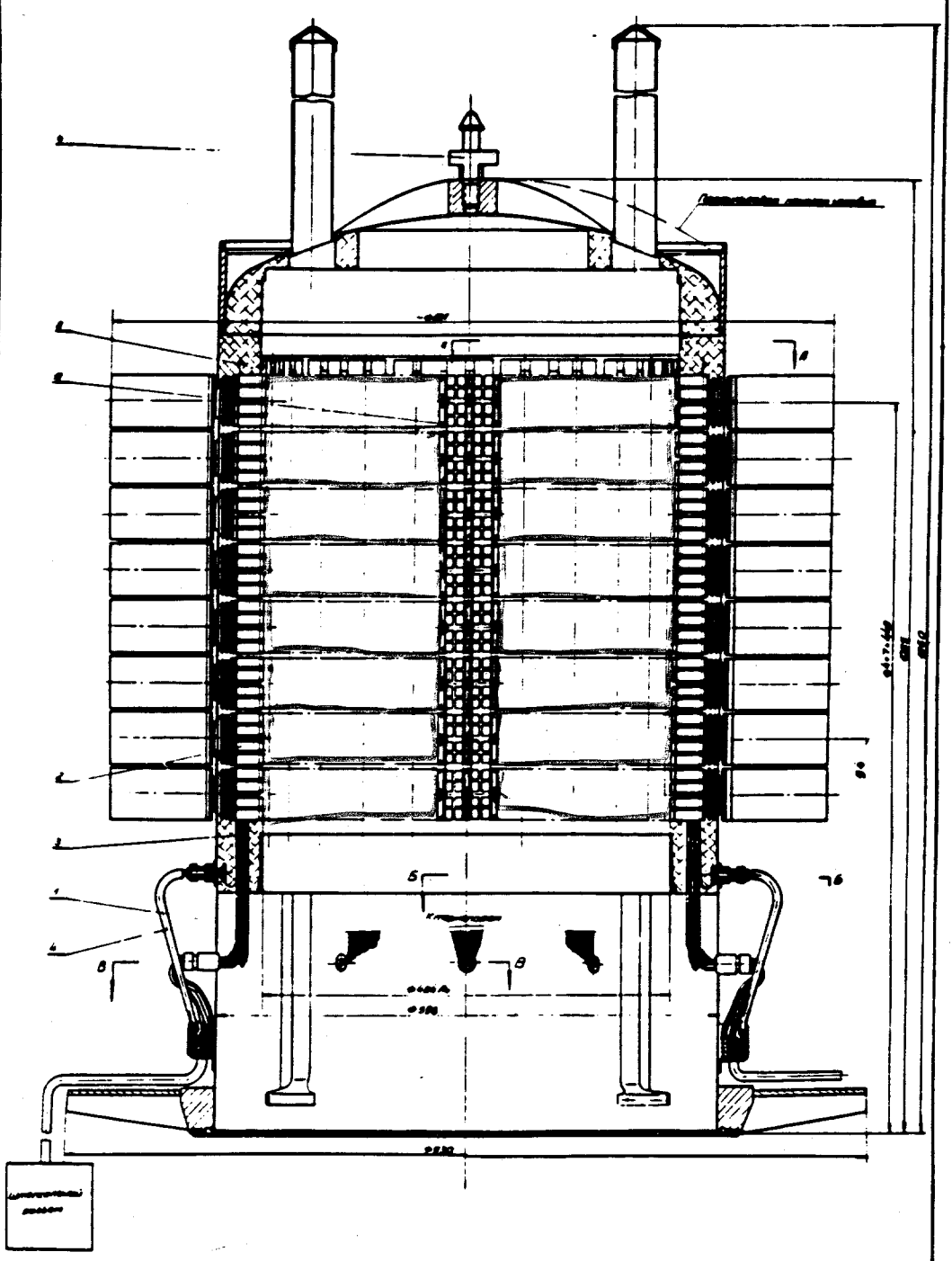


FIGURE 1. Reactor of the Installation "Romashka"

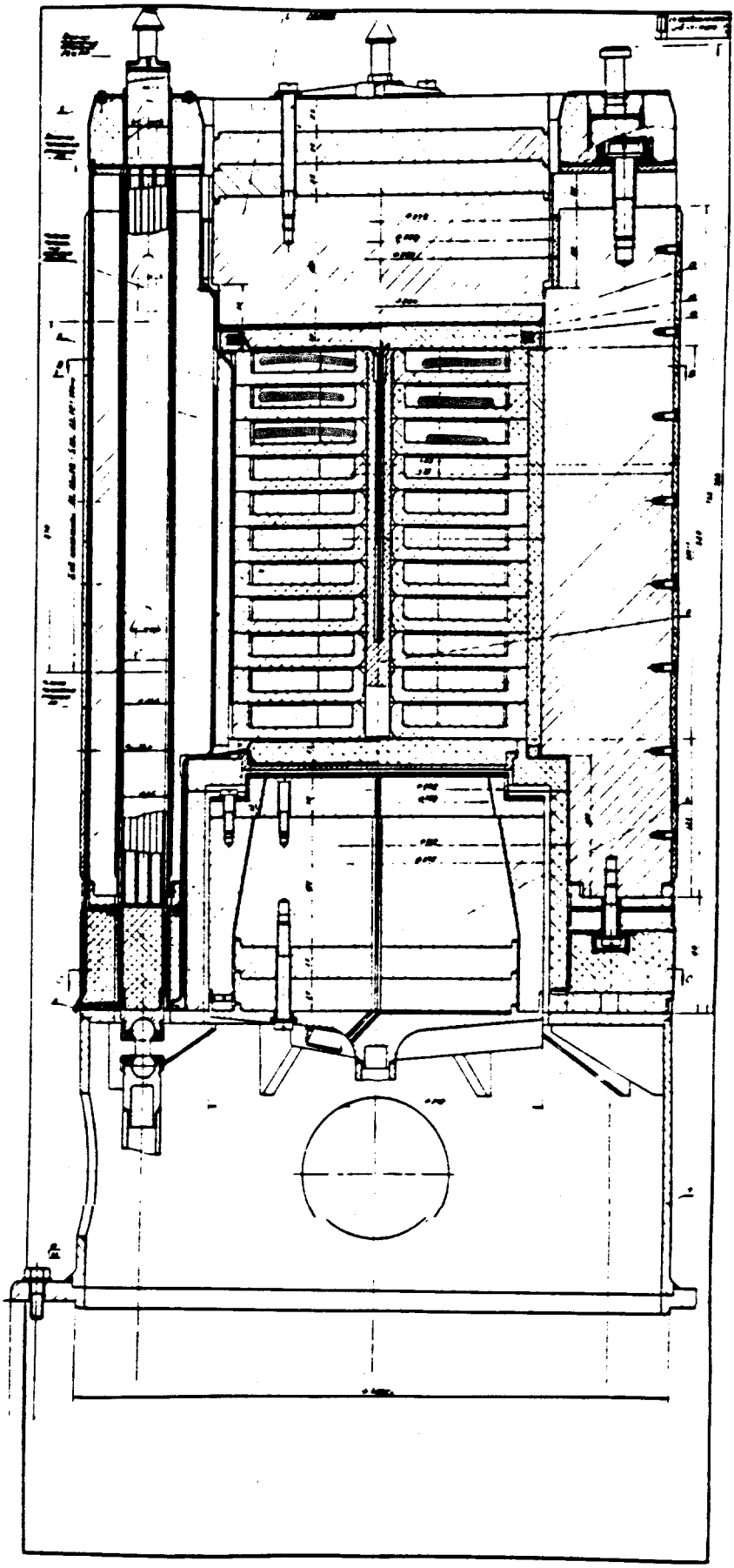


FIGURE 2. Converter of the Installation "Romashka"

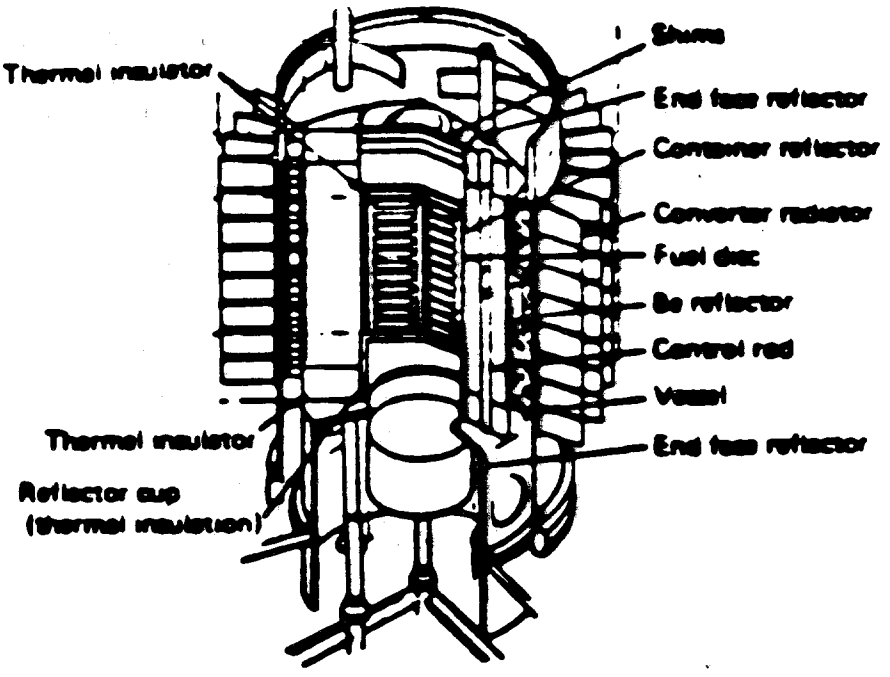


Figure 1. Cutaway view of an early ground-based Romashka reactor showing 11 fuel disk

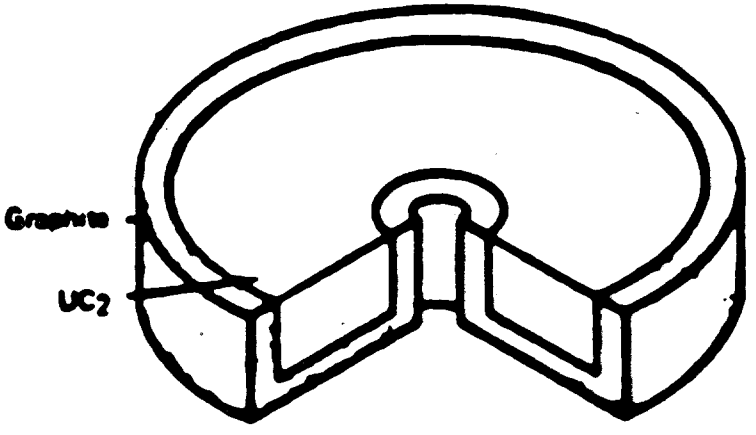


Figure 2. Cutaway view of a Romashka fuel disk.

RORSAT's

- When reactor is needed no more, the core is separated from the rest of the system and then 'parked ' in a 500 km orbit

- Probably was the 'workhorse' in the 1970's and 1980's

- Probably copied the US SNAP-10A design but was able to get higher performance.

- Long life was important, i.e., fast spectrum, low burnup

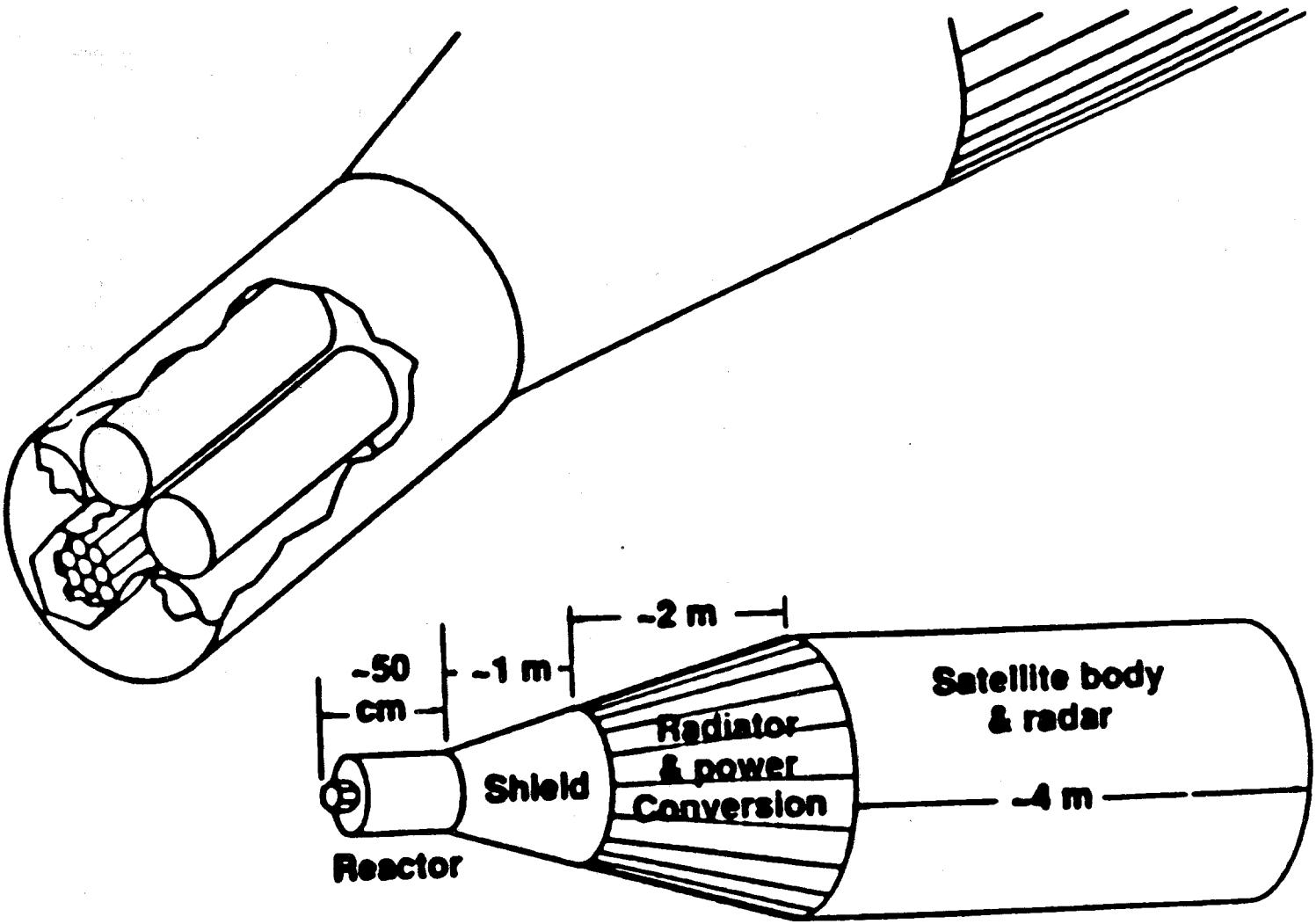


Figure 6. Artist's concept of Cosmos 954 showing the reactor (courtesy LLNL).

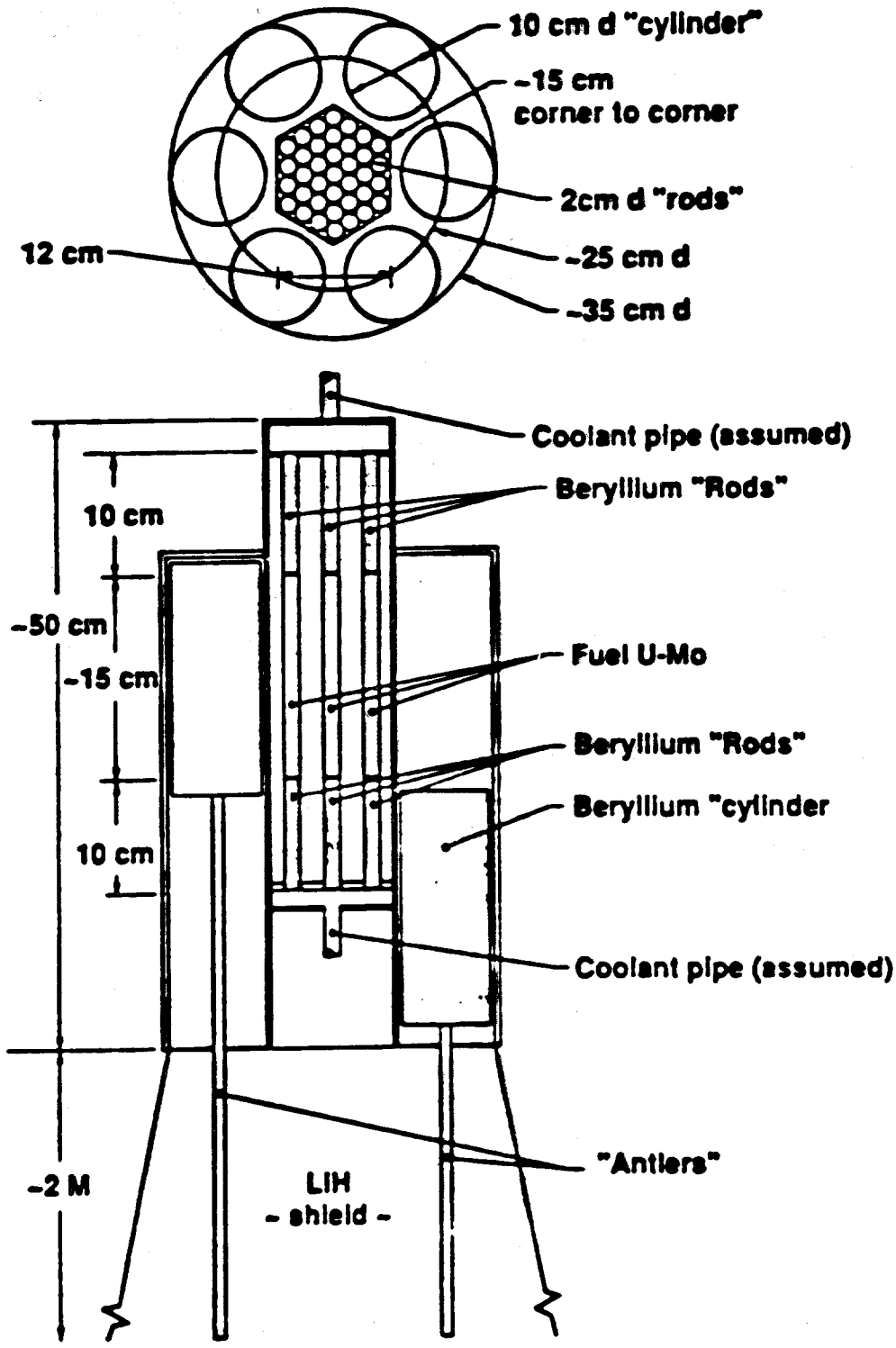


Figure 7. Engineer's sketch of Cosmos 954 reactor (courtesy LLNL).

Soviet Accidents in Space

- **Thus far;**
  - **Two RTG's carrying Po-210 source have reentered**
  - **Two RORSAT's have been lost on the "Pad"**
  - **Two RORSAT's have reentered, Cosmos -954, and Cosmos -1402**
  - **One RORSAT has failed and consequently been boosted into a ≈700 km orbit**

TABLE 5
REENTRIES OF SOVIET SPACE NUCLEAR POWER SOURCES[13]

lame	Launch Date	Reentry Date	Type of Power Source	Comments
-	25 Jan 1969	25 Jan 1969	Reactor	Possible launch failure of RORSAT.
Cosmos 300	23 Sep 1969	27 Sep 1969	Radioisotope	One or both of these payloads may have been a Lunokhod and carrying a ^{210}Po heat source. Upper stage malfunction prevented payloads from leaving Earth orbit.
Cosmos 305	22 Oct 1969	24 Oct 1969		
-	25 Apr 1973	25 Apr 1973	Reactor	Probable launch failure of RORSAT.
Cosmos 954	18 Sep 1977	24 Jan 1978	Reactor	Payload malfunction caused reentry near Great Slave Lake in Canada.
Cosmos 1402	30 Aug 1982	23 Jan 1983 (spacecraft) 7 Feb 1983 (reactor core)	Reactor	Payload failed to boost to storage orbit on 28 Dec 1982. Spacecraft structure reentered at 25°S, 84°E. Fuel core reentered at 19°S, 22°W.

USSR SPACE POWER FLIGHT EXPERIENCE
(TO AUGUST 1989)

TYPE	NAME	MISSION	No. OF MISSIONS	LAUNCH DATES	STATUS	FAILURES
RTG	-	NAVIGATION SATELLITES	2	9/65	IN ORBIT	NONE KNOWN
RHU	-	LUNAR ROVERS	4	9/69 TO 1/73	TWO SHUTDOWN ON MOON	TWO REENTRIES AFTER UPPERSTAGE MAL-FUNCTIONS (1969)
REACTOR	RORSAT	OCEAN SURVEILLANCE	35	12/67 TO 3/88	31 SHUTDOWN AND BOOSTED TO HIGH ORBITS	• TWO LAUNCH ABORTS (1969, 1973) • TWO REENTRIES AFTER BOOST FAILURE (1977, 1982)
REACTOR	TOPAZ	EXPERIMENTAL OCEAN SURVEILLANCE	2	1/87 TO 10/87	SHUTDOWN AND BOOSTED TO HIGH ORBITS	NONE KNOWN