For participants only
30 November 2005

English
Original: Russian

Committee on the Peaceful Uses of Outer Space
Scientific and Technical Subcommittee
Forty-third session
Vienna, 20 February-3 March 2006
Item 9 of the provisional agenda*
Use of nuclear power sources in outer space

Joint United Nations/International Atomic Energy Agency technical workshop on the objectives, scope and general attributes of a potential technical safety standard for nuclear power sources in outer space (Vienna, 20-22 February 2006)

Ongoing, planned and currently foreseeable nuclear power source applications in outer space and their scope and rationale (including rationale for use of space nuclear power rather than other space power sources)

Working paper submitted by the Russian Federation

Note by the Secretariat

1. In accordance with paragraph 16 of General Assembly resolution 60/99 of 8 December 2005, the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space will organize, jointly with the International Atomic Energy Agency, a technical workshop on the objectives, scope and general attributes of a potential technical safety standard for nuclear power sources in outer space, to be held in Vienna from 20 to 22 February 2006.

2. The working paper contained in the annex to the present document was prepared for the joint technical workshop in accordance with the indicative schedule of work for the workshop, as agreed by the Working Group on the Use of Nuclear Power Sources in Outer Space during the intersessional meeting held in Vienna from 13 to 15 June 2005 (A/AC.105/L.260).

* A/AC.105/C.1/L.283.

V.05-91337 (E)

Annex I

Ongoing, planned and currently foreseeable nuclear power source applications in outer space and their scope and rationale (including rationale for use of space nuclear power rather than other space power sources)

Working paper submitted by the Russian Federation

1. The prospects for the use of nuclear power sources in outer space depend on the availability of the required level of electrical capacity on board spacecraft and the space rocket technology resources assigned to missions foreseen in both the short and the long term (table 1).

Table 1

Space programmes using nuclear power sources

Activities	*Nature of activity*	*Required electrical capacity (kilowatts)*
Short term Communications and television, inter-orbital space tugs.	Radar monitoring; communications and data relay; high-capacity communication satellite systems; mobile global communication systems; high-performance information systems; live television broadcasting, high-definition multi-channel television; use of transport energy modules to decrease launch vehicle dimensions when transporting spacecraft to high orbits.	20-100
Long term Environment, power engineering production in outer space, scientific research.	Global environmental monitoring; removing space debris from circumterrestrial space; protection of spacecraft from space debris; outer space production; distance refuelling of spacecraft and space production centres.	50-250
	Pure research, including: - Earth research from space, asteroids, comets and planets of the solar system; - Transportation to and from the lunar base; - Mars mission.	50-500

2. Figure 1 shows the specific characteristics (kg/kW) of space radioisotope and reactor nuclear power sources (operational and planned) as compared to the

characteristics of standard solar-powered space systems, for which the specific masses in near-Earth orbit conditions are as follows: solar panels—30 kg/kW; solar panels with frame—80 kg/kW; solar power station, including accumulator battery and navigation and heat regulation systems—240 kg/kW.

3. Results confirm the advantages of reactor nuclear power sources with electrical capacity greater than 20 kW where they are used on board spacecraft, even in near-Earth orbits and on flights to the outer planets of the solar system, where it is practically impossible to use solar-powered systems, given the solar constant for each planet: Earth—1; Mars—1/23; Jupiter—1/27; Saturn—1/91; and Uranus—1/368.

4. Where the required electrical capacity on a spacecraft exceeds 20 kW, and the spacecraft is required as a long-term resource, the use of the following two types of reactor nuclear power source would be most effective:

- Nuclear power units for supplying spacecraft with power and, in combination with a low-thrust electroreactive (electrorocket) propulsion unit, for transporting spacecraft into higher orbits from low intermediate orbits, which can be achieved with existing and future generations of launch vehicles and other space rocket technology;

- Nuclear power propulsion units that use nuclear rocket propulsion technology and turbo-generator conversion systems, which will provide spacecraft with energy supplies and significant thrust to transport them from low intermediate orbits to high orbits or to interplanetary trajectories, and to manoeuvre spacecraft between orbits.

5. The main types of advanced reactor space nuclear power source (nuclear power units and nuclear power propulsion units) under development are as follows:

- Nuclear power units based on thermal-emission converter reactors (figure 2) for power systems, and nuclear power units with electroreactive (electrorocket) propulsion units for propulsion systems;

- Nuclear power propulsion units based on nuclear rocket propulsion technology (figure 3) for propulsion systems and with a turbo-generator conversion system based on Brayton and/or Rankine cycles for power systems.

6. The best course of action, because the technique has proved effective, would be to use nuclear power units with thermal-emission converter reactors on board orbital and interplanetary spacecraft and transport energy modules in order to launch spacecraft, with the help of electroreactive propulsion units, to high working orbits. Nuclear power units on board transport energy modules using forced power would feed the electroreactive propulsion units and in a prolonged nominal regime would provide power for spacecraft systems and equipment.

7. Such a system of using modern launch vehicles and applying space rocket technology resources to launch spacecraft into geostationary orbit would make it possible to increase two- or threefold the mass of special-purpose equipment on spacecraft and to increase on-board power consumption ten- to twentyfold.

8. The use of nuclear power units would open up a whole new range of possibilities: 24-hour, all-weather radar monitoring and the creation of global telecommunication systems, including mobile communication systems, as well as various security-related activities.

9. The advanced nuclear power units and nuclear power propulsion units currently under development will be of suitable mass, size and power to be integrated, together with spacecraft, into existing equipment for the insertion of spacecraft into the required near-Earth orbits and onto interplanetary flight trajectories.

10. Two future activities that may be carried out by spacecraft with nuclear power units and/or nuclear power propulsion units (figure 4) are under consideration: radar monitoring of ground-based objects from geosynchronous Earth orbit and a global communications system using spacecraft in geostationary Earth orbit.

11. Such activities require a power supply capacity, during insertion of the spacecraft into operational orbit, of 100-400 kW for the first six months and 50-150 kW for operation of the spacecraft over a period of 5 to 20 years. Roughly the same electrical capacity is required for spacecraft with nuclear power units and nuclear power propulsion units during outer space flights.

12. Where radioisotope nuclear power sources are required on board spacecraft, existing radioisotope thermoelectric generators and autonomous heat units will be used; these have been tested on missions such as those of the Cosmos-84, Cosmos-90, Lunokhod-1 and Lunokhod-2 satellites and the Mars-96 spacecraft, with nuclear power sources on board small stations and penetrators designed for landing on the surface of Mars (figures 5 and 6).

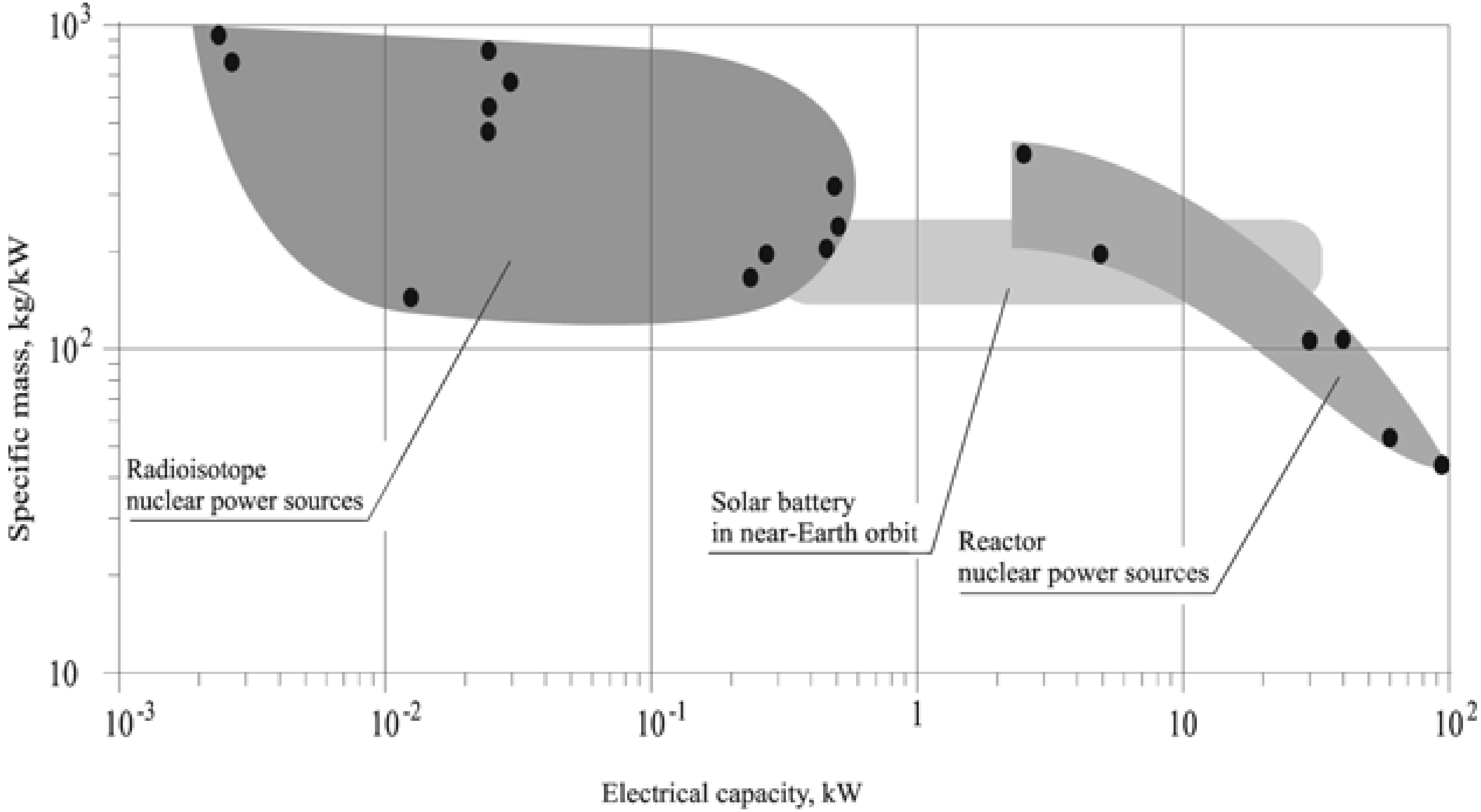

Figure 1- Diagram showing distribution of specific masses of space nuclear power sources

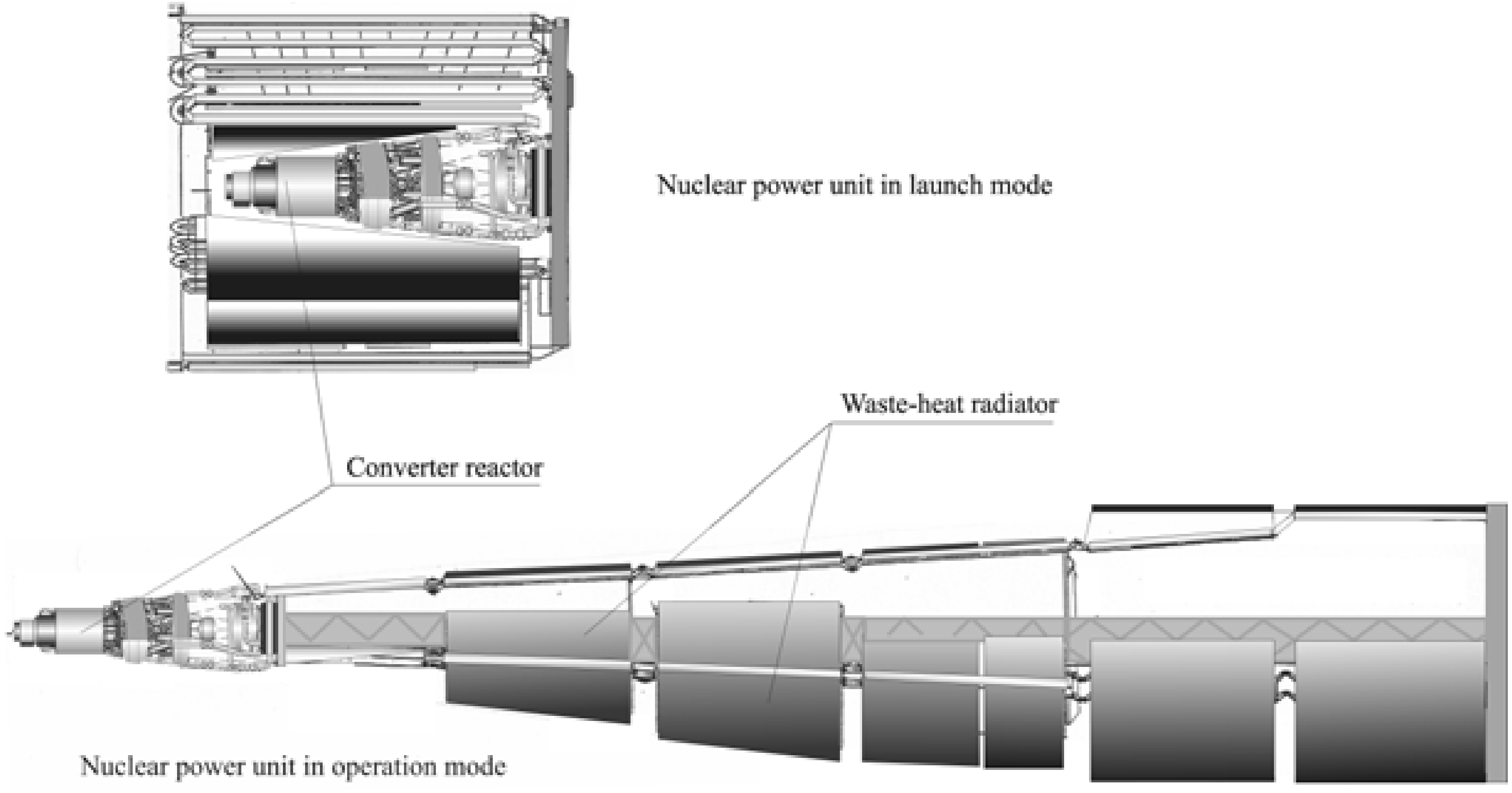

Figure 2 - Nuclear power unit

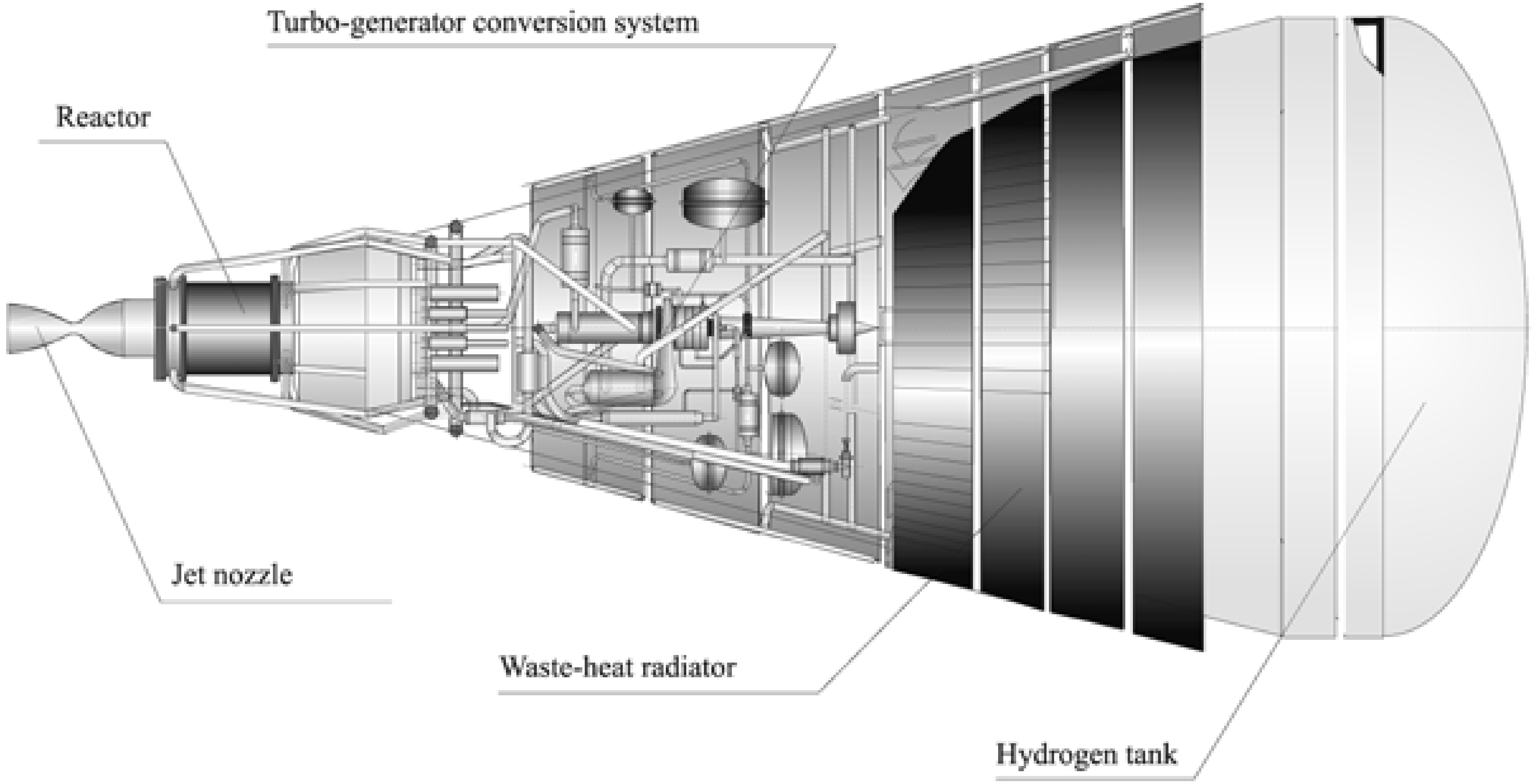

Figure 3 - Nuclear power propulsion unit

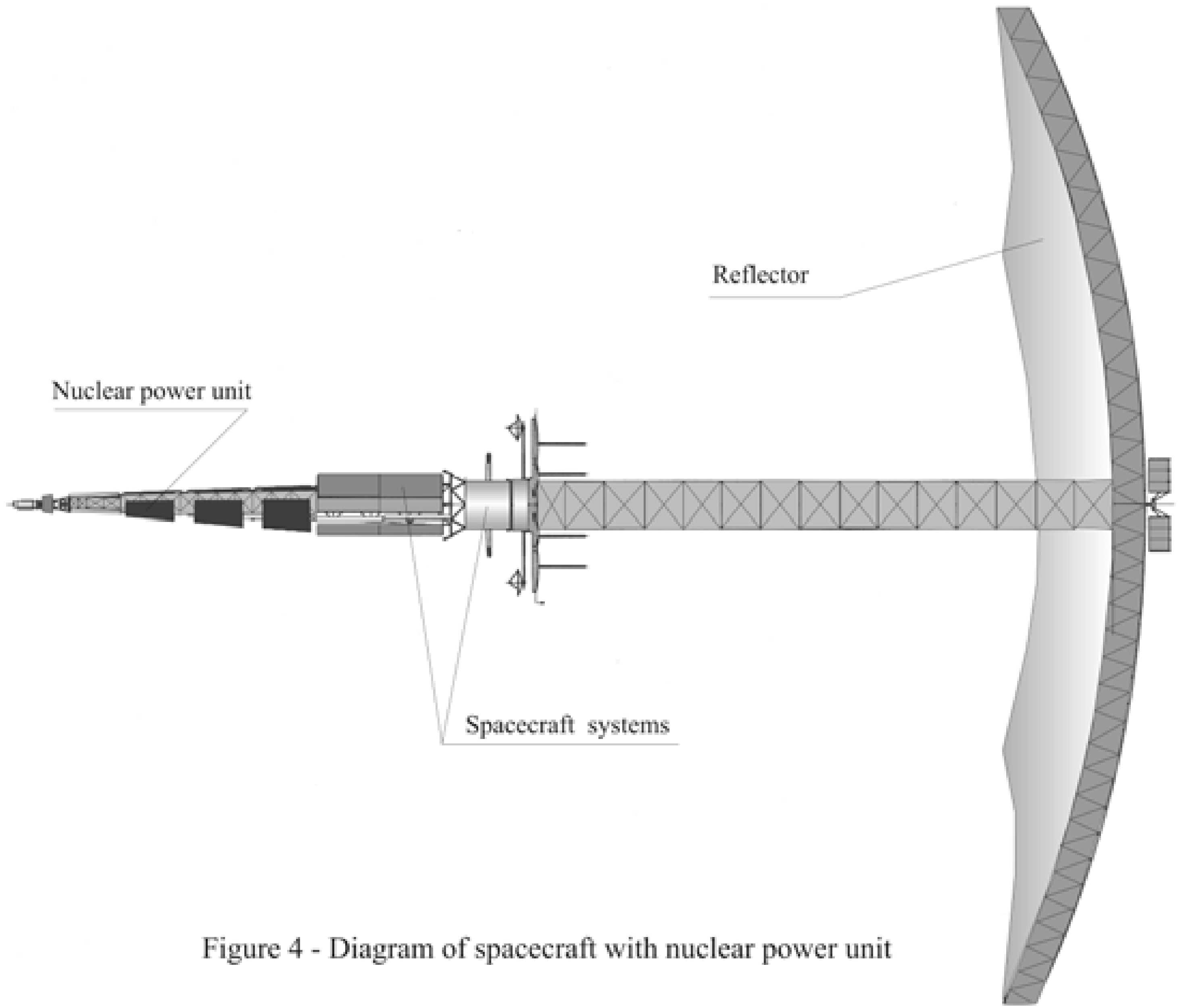

Figure 4 - Diagram of spacecraft with nuclear power unit

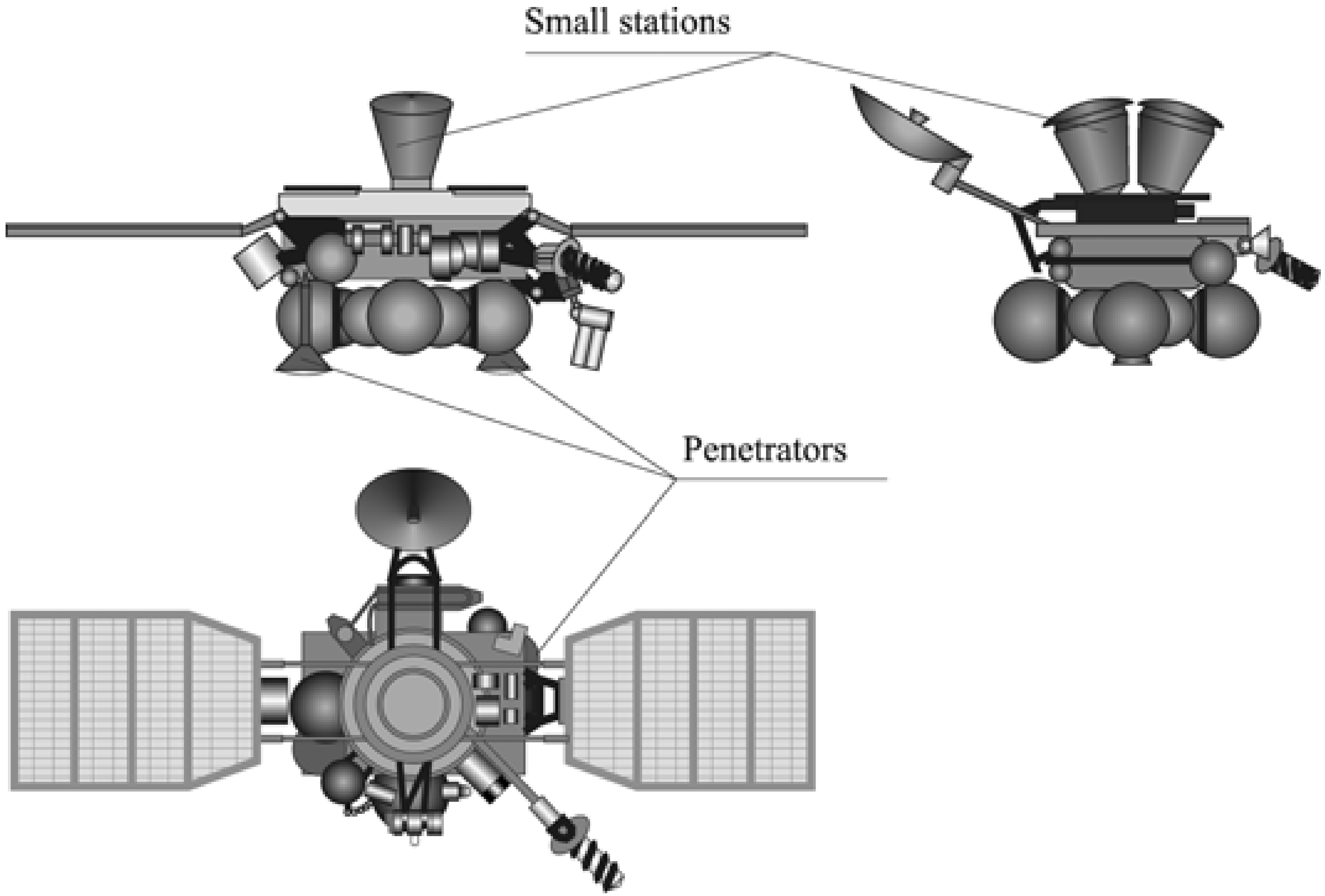

Figure 5 - Mars-96 spacecraft

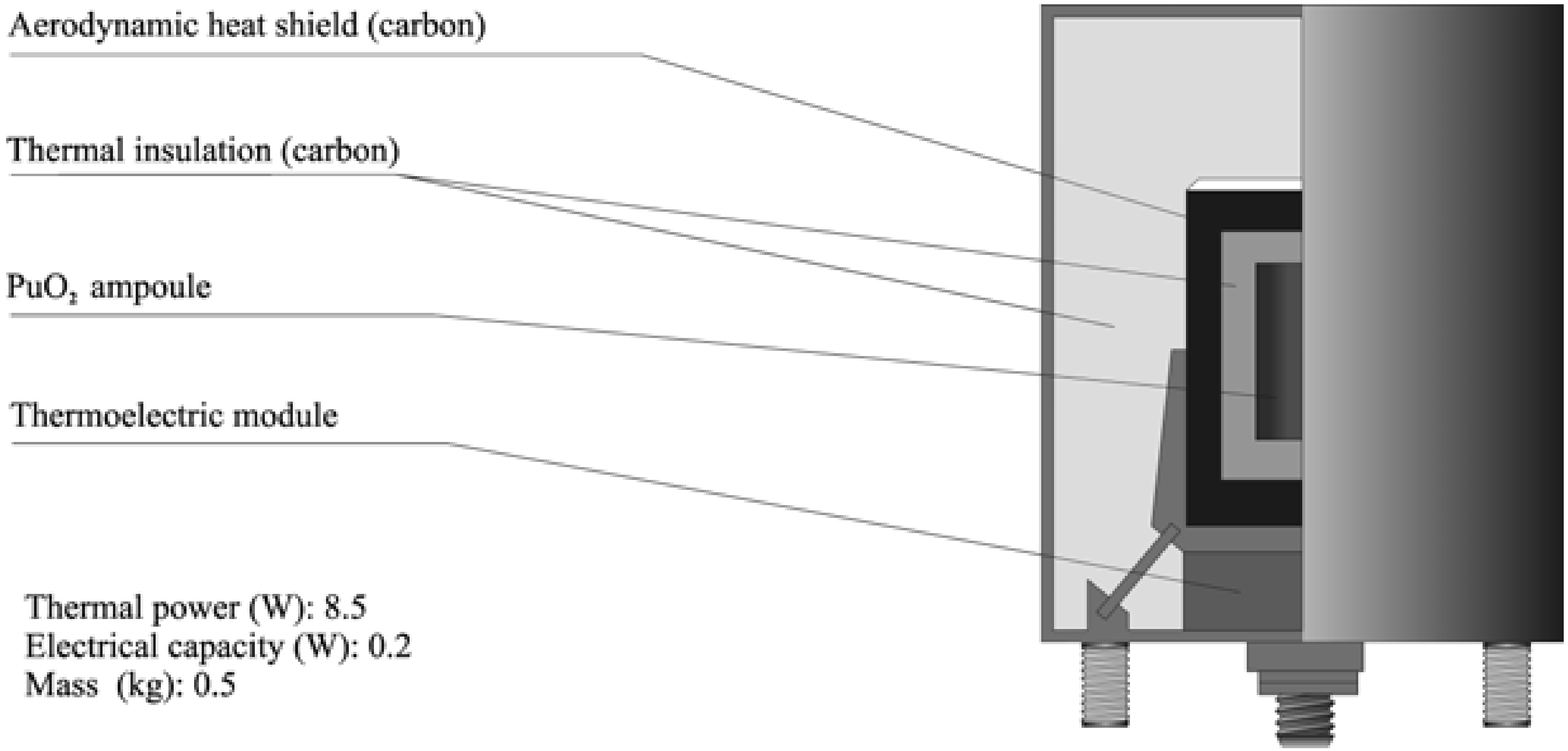

Figure 6 - Radioisotope thermoelectric generator of Mars-96 spacecraft