Early Soviet Manned Space flight

Historical Background

A central element in the Soviet Union's exploration and exploitation of space has been its reliance on Salyut-class orbital stations occupied by cosmonauts. Seven of these stations have been officially announced by the U.S.S.R. as of December 1983. These facilities have begun to realize the possibilities envisioned by Konstantin Tsiolkovsky, the Russian scientist/engineer who is considered the founder of Soviet astronautics. Early in the century, he described how orbital stations might be built, noting that they represented the very heart of a program of space conquest.

Typical of his observations is this *1923* description of the construction of a system of Earth-orbiting stations:

> We take off in a space ship . . . and stay at a distance of 2000-3000 versts [each verst equaling 0.6629 mile] from Earth, as its Moon. Little by little appear colonies with implements, materials, machines, and structures brought from Earth. Gradually, independent production, though limited at first, will develop. *

Reinforcing the conviction of Tsiolkovsky, the late Leonid Brezhnev, then President of the Soviet Union, remarked in 1978:

> Mankind will not forever remain on Earth, but in the pursuit of light and space will first timidly emerge from the bounds of the atmosphere, and then advance until he has conquered the whole of circumsolar space. We believe that permanently manned space stations with interchangeable crews will be mankind's pathway into the universe.[2]

As the launch of Sputnik l—the Earth's first artificial satellite, on October 4, 1957—opened the path toward realization of Tsiolkovsky's visions, so the Soviet Union's increasing ability to transport people into space in the 1960's, 1970's, and 1980's has added substance to Brezhnev's declaration. At least since the early 1970's, the Soviet Union seems to have taken a slow, more-or-less steady approach toward fulfilling the aspirations of its engineers and political leaders. *

Vostok

Vostok (meaning "East"), a one-seater spacecraft, was the first Soviet vehicle to carry a cosmonaut into orbit. * * Six Vostoks were launched between April 1961 and June 1963; they remained in orbit for periods ranging from 108 minutes to nearly 5 days. Weighing 4.7 metric tons (tonnes) and simple in design, the vehicle consisted of two modules: an almost spherical capsule which carried the cosmonaut, and an equipment package containing fuel, life-support gear, batteries, attitude-control thrusters, and a retrorocket to slow the vehicle for reentry into the Earth's atmosphere.

Vostok's pilot was little more than a passenger. With no orbital maneuvering capability designed into the system, the pilot had few responsibilities for control of the spacecraft.

On two occasions, pairs of Vostoks flew concurrently. Two A-1 vehicles launched Vostoks 3 and 4 from the same cosmodrome within 24 hours; *** Vostoks 5 and 6 were similarly launched within 48 hours. In the second case, the Soviets showed they could launch at precise times. In 1962 and 1963, the U.S. manned spaceflight program could not match this achievement, the Mercury program being plagued by a series of "holds" and postponements.

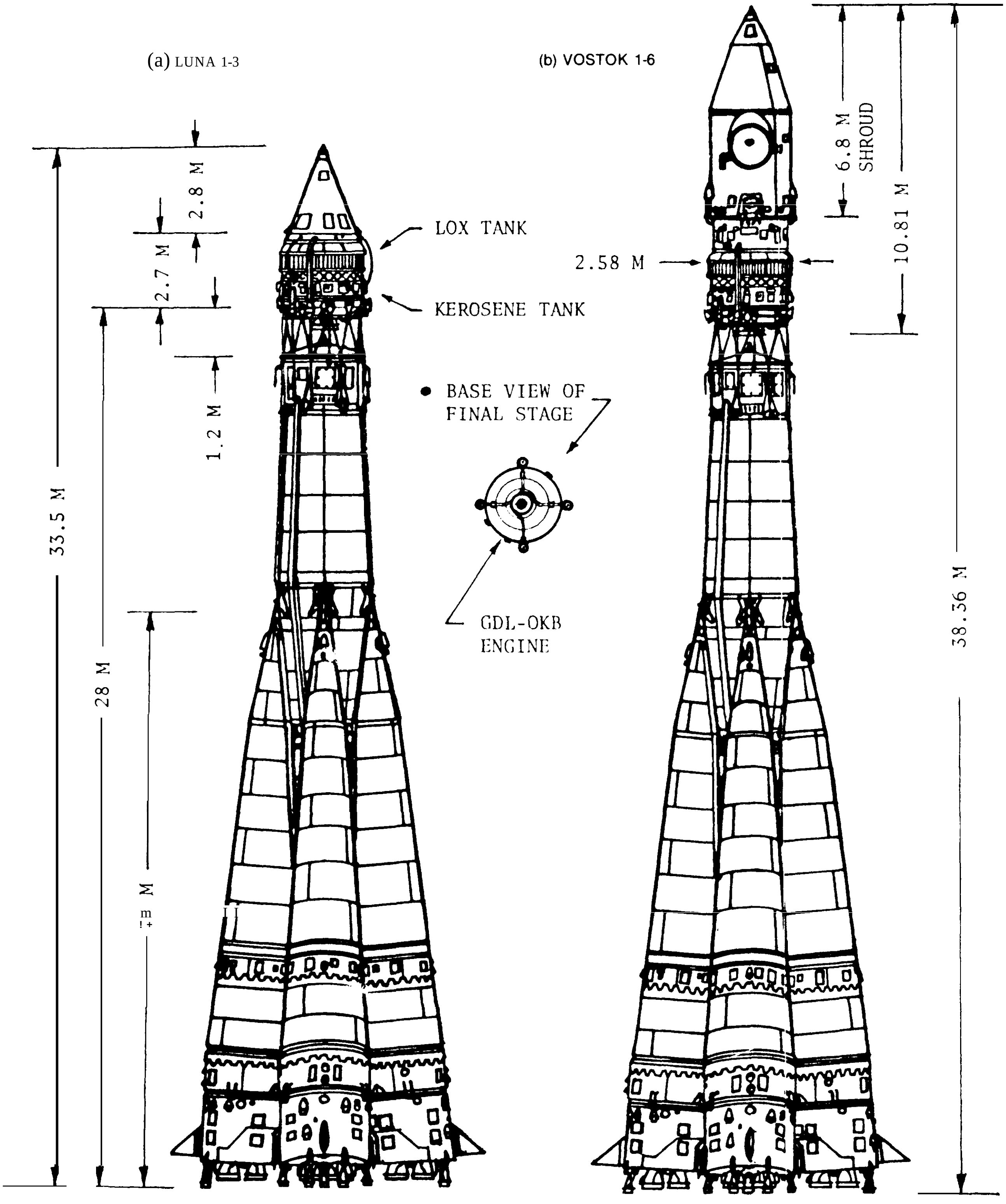
[1]K. E. Tsiolkovsky, *Collected Works, vol.* 2, Moscow, Izdatel'stvo AN U. S. S. R., 1954.

'Kenneth Gatland, chief author, *The Illustrated Encyclopedia of Space Technology* (London: Salamander Books, Ltd., 1981), p. 214,

*Many informed Western observers, as well as official Soviet historians and publicists, would extend this characterization to the early years of the Soviet program. Others, however, disagree, arguing that, especially in these early years, the appearance of an evolutionary course disguises a number of false starts, midcourse corrections, and radical changes of plan.

* 'In preparation for the first manned flight, the Soviets, in 1960 and 1961, launched at least four Sputniks with animals aboard in order to determine how they were affected by the operation of various spacecraft subsystems. These included the launch system, onboard life support and environmental control, and the reentry and recovery system.

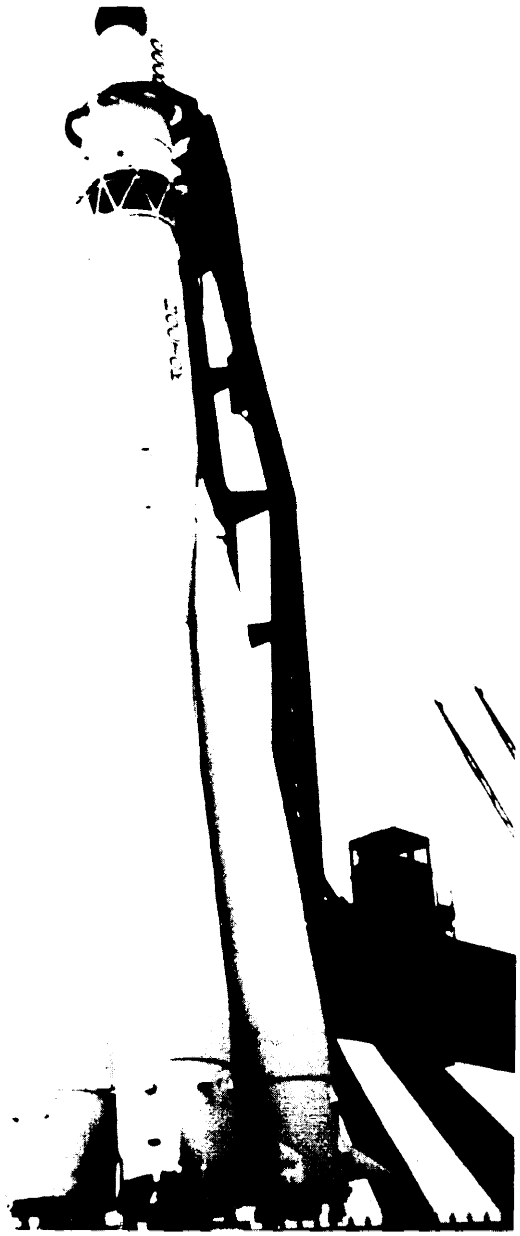
***The designations "A," "D," "G," etc., are based on an alphanumeric classification system devised by the late Charles Sheldon of the Library of Congress. Another system designates the launch vehicle with an "SL" and a number. Thus, the "A-2" vehicle is the same as the "SL-4"



Cred/t L C P *Vick,* 1982

Luna 1-3 (a); Vostok 1-6 (b) —standard launch vehicle with the first type of added upper stage A-1 (a) as used to launch the first three Luna spacecraft; (b) as used to launch the six Vostok manned spacecraft

Vostok **Booster**



These simultaneous flights not only served as tests of ground control and launch turnaround capability, but also, as precursors of future rendezvous and docking missions, allowed a determination of how closely spacecraft could be positioned in orbit without specific orbital maneuvers. The orbital injections were so accurate that the first pair coorbited and the second passed within 5 miles of each other in noncoplanar orbits. * With these Vostok missions, the Soviets also demonstrated the capability to handle communications with two spacecraft simultaneously.

Another highlight of the Vostok program took place in June 1963 when Valentina Tereshkova became the first woman in space. Flying in Vostok 6 for 48 orbits around the Earth, she tallied more flight time than all the male astronauts in the U.S. Mercury program. Although relatively untrained and rumored to have been ill throughout her flight, Tereshkova at least achieved substantial publicity.

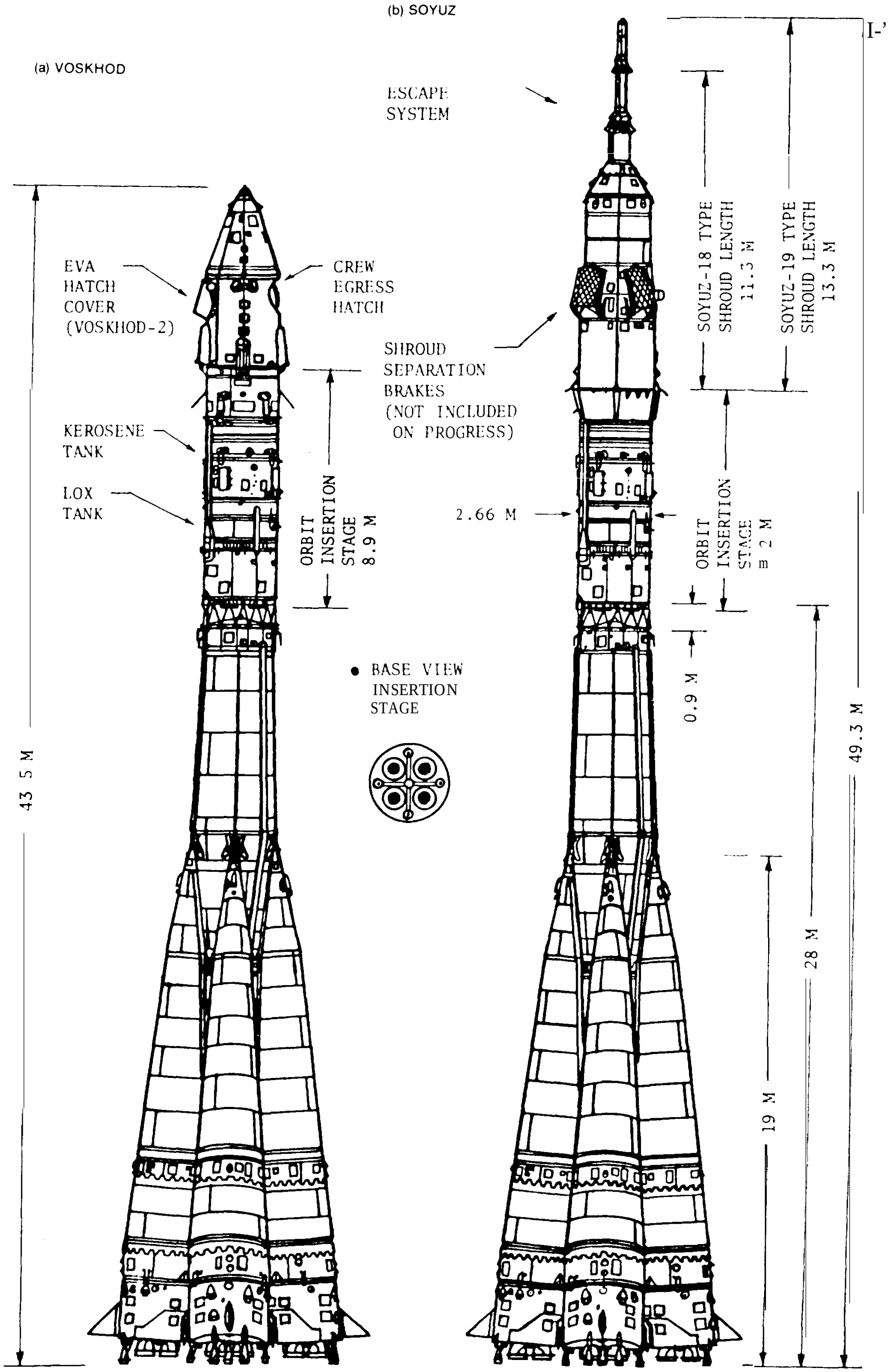
Voskhod

In October 1964 and March 1965, the Soviet Union launched the 6-tonne Voskhod (“Sunrise”), a modified Vostok capable of carrying two or three cosmonauts on daylong flights. Because the Voskhod was used only for these two flights, some Western experts believe it was intended primarily to preempt the U.S. Gemini program, which would put two astronauts in one vehicle, one of whom would “walk” in space. Voskhod had approximately the same pressurized volume as did Vostok, but more volume was made available for habitable crew space because the ejection seat and rails were removed and because the crew wore overalls instead of bulky pressurized space suits.

Voskhod 1, weighing 5.3 tonnes, had a three-person crew. In Voskhod 2, which weighed 5.7 tonnes, one of the crew couches was replaced with an inflatable airlock and associated hatches to allow for extravehicular activity (EVA), or “spacewalking. ” During the flight one of the crew accomplished the first spacewalk of some 10 minutes duration. ** The Voskhod program included the first flight of a physician to conduct in situ observations; it also tested new TV and audio communications equipment, evaluated techniques for spacecraft orientation, and employed a new solid-rocket, soft-landing system. It did not, however,

*The orbits of Vostok *5* and 6 were in fact separated by almost *29”* at their point of nearest approach, with the result that their relative velocity was approximately *12,000* feet per second. This hardly could be counted as a rendezvous.

* *The cosmonaut spent a total of some 22 minutes under space conditions—12 minutes outside the spacecraft, and the preceding 10 minutes in a depressurized, inflatable airlock.



Credit C P Vick, 1982

Voskhod-2 (a); Soyuz T (b) —standard launch vehicle with the improved upper stage A-2 (a) as used to launch the two Voskhod manned spacecraft; (b) as used to launch the Soyuz T manned spacecraft include a launch escape system. As the first of a series of individually small but cumulatively significant advances in Soviet space capabilities, the Voskhod program brought the Soviet Union's total person-hours in orbit to some 507; by contrast, U.S. astronauts had accumulated 53 hours through Project Mercury.

By the end of the Voskhod program, the Soviet Union was dedicating its engineering expertise to the creation of a more capable spacecraft—the Soyuz ("Union"). During the 2-year hiatus between the flight of Voskhod 2 and Soyuz 1, the U.S. Gemini program of 10 flights accomplished many outstanding first-time achievements; American crewmembers also overtook their Soviet counterparts in flight time, a lead they maintained, through the Apollo-Soyuz Test Project (ASTP) in 1975, until the flight of Soyuz 29 in June 1978. The Salyut 6 missions subsequently reestablished the Soviet lead, more than double the U.S. total.

Soyuz

Building on the technical foundation laid by Vostok and Voskhod, the Soviet Union developed the Soyuz space vehicle. First flown with a pilot aboard in 1967, * Soyuz, the first of the Soviets' truly operational spacecraft rated to carry crew, remains, with evolutionary modifications, the standard vehicle for transporting crewmembers to Salyut ("Salute") space stations. The current design, called Soyuz T, was introduced in 1979. Many Western observers believe that Soyuz was initially developed to serve as part of an ambitious program to send a cosmonaut to the Moon. However, it experienced a number of technical problems, including the inability of the A-2 booster to launch a fully fueled and instrumented spacecraft, launch failures of the medium-lift Proton type D-l-e and the heavy-lift G-class boosters, * * and troubles with control systems aboard automated lunar spacecraft. These problems made it impossible to use Soyuz for a manned lunar mission during the late 1960's, when beating the United States to the Moon was, presumably, of high priority. As a result, the Soviets appear to have postponed any such lunar missions indefinitely.

Why were such technical problems not overcome? The conventional explanation holds that the American lunar landings undermined the Soviets' incentive for, and interest in, putting a cosmonaut on the Moon. A fuller appraisal holds that, after Apollo 11, the planned Soviet program would have seemed second rate. The Soviets originally envisioned sending (only) one cosmonaut in a Zond spacecraft to loop once around the Moon (not to make multiple orbits) and probably required an Earth-orbit rendezvous. But the success of Apollo 8 at Christmas 1968 and subsequent near-perfect flights of Apollos 9, 10, and 11, apparently convinced the Soviets to concentrate on other activities. As alternatives that could be achieved, near-Earth, orbiting stations capable of human habitation, and automated probes for lunar sample return (via the Luna series spacecraft) and surface exploration (via Lunokhod 1 and 2) became the new foci of Soviet activities.

Carrying crews of one to three persons, Soyuz has been used to conduct a wide variety of military and scientific experiments. These vehicles are capable of orbital maneuvering, rendezvous and docking, and solo flights with crew aboard for up to 30 days. *

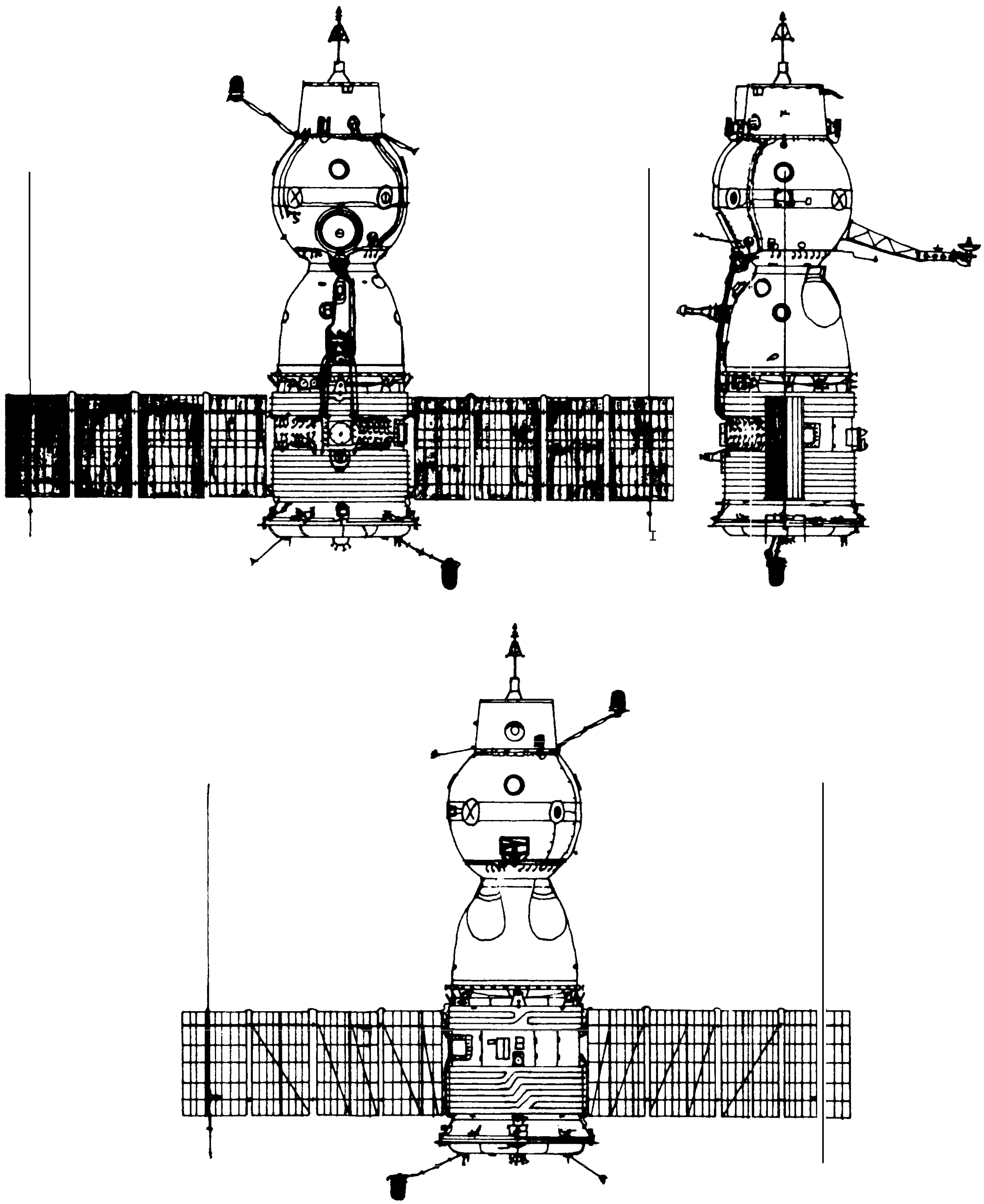
Soyuz is 7 meters in length, 2.7 meters in diameter, and up to 6,8 tonnes in weight, and contains three connected elements that are interdependent for power, thermal control, and propulsion:

- *Command Module.* —Serves as the ascent and descent compartment in which cosmonauts are ferried to and from orbit, as well as the module in which they are stationed during orbital maneuvers. It also contains system function indicators and control panels through which the cosmonauts interact with various automatic systems. The Command Module and the Orbital Work Module to-

● The first flight of the Soyuz in *1967,* ended with the death of the pilot in a crash landing; this kind of craft was not flown again until October 1968,

* *The G-series booster is comparable to the U.S. Saturn V vehicle,

*Although 18 days is the longest demonstrated flight of a Soyuz craft with crew aboard, the Soviets have repeatedly stated this time could be extended to 30 days. Without crew aboard, Soyuz vehicles are capable of much longer duration in orbit: Soyuz T-1 recorded a flight of 100 days while docked with Salyut 6, Cosmos 613, undocked remained in orbit for 60 days.



Credit C P Vick, 1983

Soyuz 4: The original Soyuz spacecraft. Average mass: 6,500 to 6,625 kg. Overall length from booster interface to the docking interface: 7.5 m. Body diameter: 2.2 m. Base diameter: 2,72 m. Descent module mass: 2,900 kg. The Soyuz 1-9 spacecraft were never launched fully fueled and fully instrumented. A full weight spacecraft would have weighed approximately 9,000 kg, exceeding the 7,500-kg payload capacity of the Soy Jz A-2 booster gether provide a total habitable volume of nearly 9 cubic meters (one cubic meter = 35 cubic feet), roughly twice that of Vostok; in Soyuz T the habitable volume has been increased to about 10 cubic meters. The slightly bell-shaped Command Module is a "lifting body;" its aerodynamic properties, similar to those of Apollo, are substantially better than those of Vostok, lessening reentry deceleration forces on its crew and enhancing landing zone targeting.

- Orbital Work *Module.* —Nearly spherical in shape, it allows cosmonauts to work, think, eat, relax, and sleep in surroundings that are spacious in comparison with those of the Command Module. The Orbital Work Module is also used as an airlock through which the crew may transfer to other spacecraft or embark on spacewalks; an airtight hatch is located at the interface that secures it to the Command Module.
- *Instrument and Systems Module.* —Contains a series of propulsion, maneuvering, and attitude control engines; associated fuel tanks; and a pressurized forward section holding major portions of the electronics for major operating systems (environmental, attitude control, communications, electrical, and propulsion). In some versions of Soyuz, solar cell arrays protrude, winglike, from opposite sides of this module, and provide charge and recharge of a set of internal chemical batteries. Use of solar panels ceased after Soyuz 11 but was resumed with the Soviet Union's component of the joint U.S.-Soviet Apollo-Soyuz Test Project, Soyuz ASTP,[3] and *re*-tained in the Soyuz T.

[3]For a detailed account of this mission, see, Edward and Linda Ezell, *The Partnership—A History of the Apollo-Soyuz Test Project*, in the NASA History Series, NASA SP-4209, Washington, D. C., 1978.