Space Studies 590 Colloquium

Soviet/Russian Human Space Flight Program

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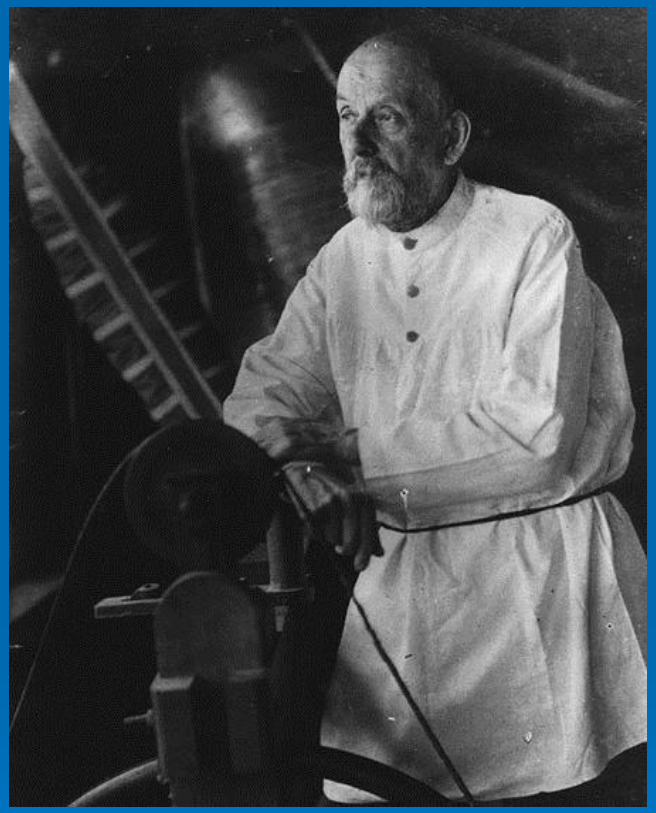
Manned Space Flight Program in Soviet Union & Russia

- Theoretical Developments for Space Research by Rocket Vehicles
- Rocketry: Science & Engineering
- Solar Planetary System Probes
- Manned Space Flight
- Health Care Programs
- Long-Term Life Support in Space

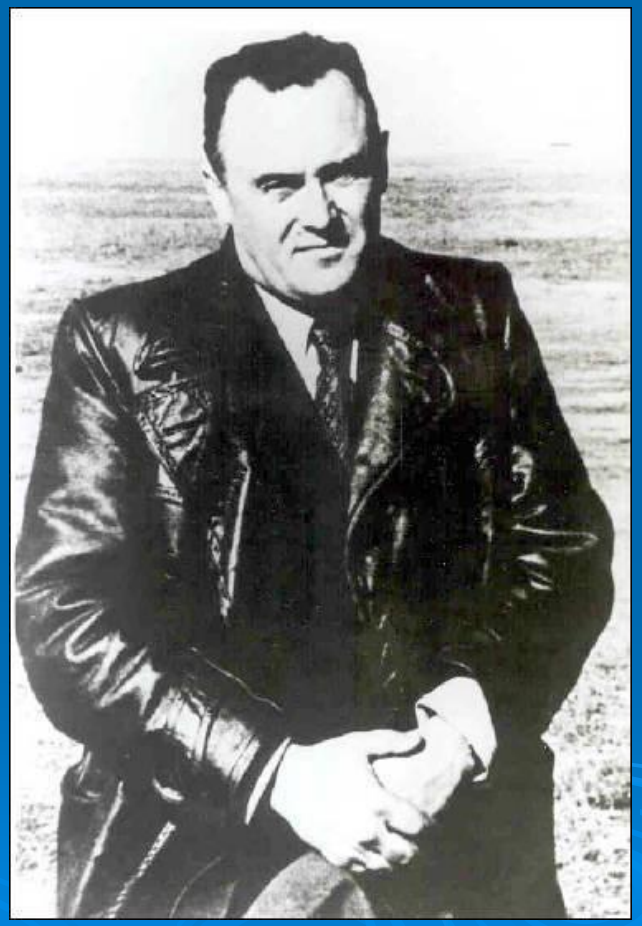
Origins of Manned Space Flights in Russia

1. Nikolai Kibalchich (1853–81), a Russian revolutionary and inventor. He was the first to propose a project of a manned flying machine with an engine powered by compressed-powder candles.

Origins of Manned Space Vehicles in Soviet Russia

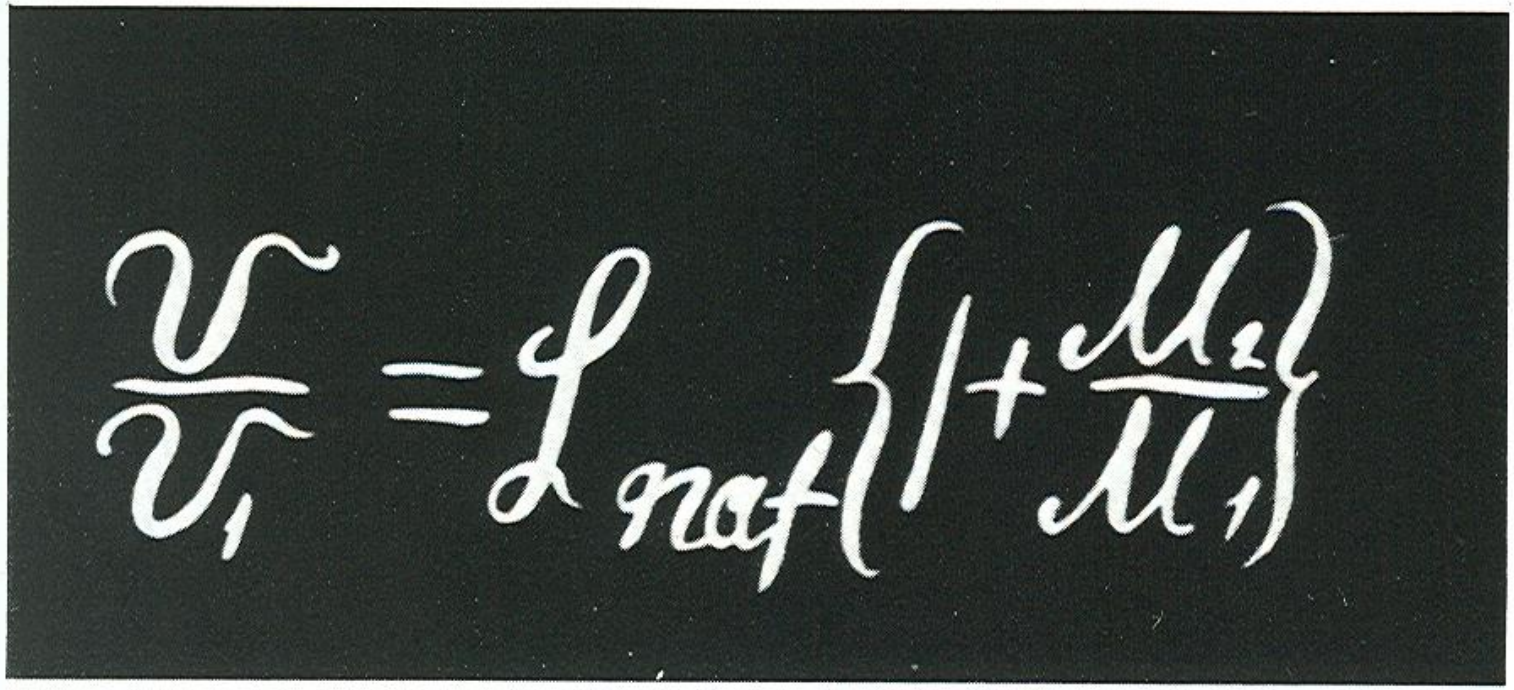


K.E. Tsiolkovski



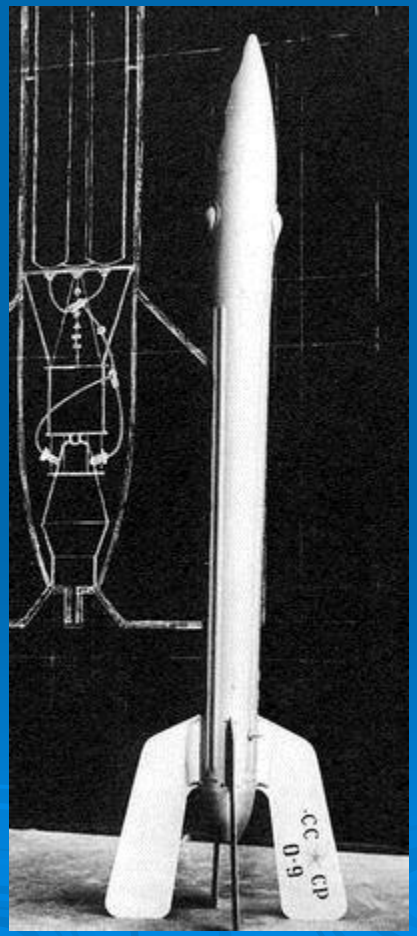
S. P. Korolev

The Rocket Equation

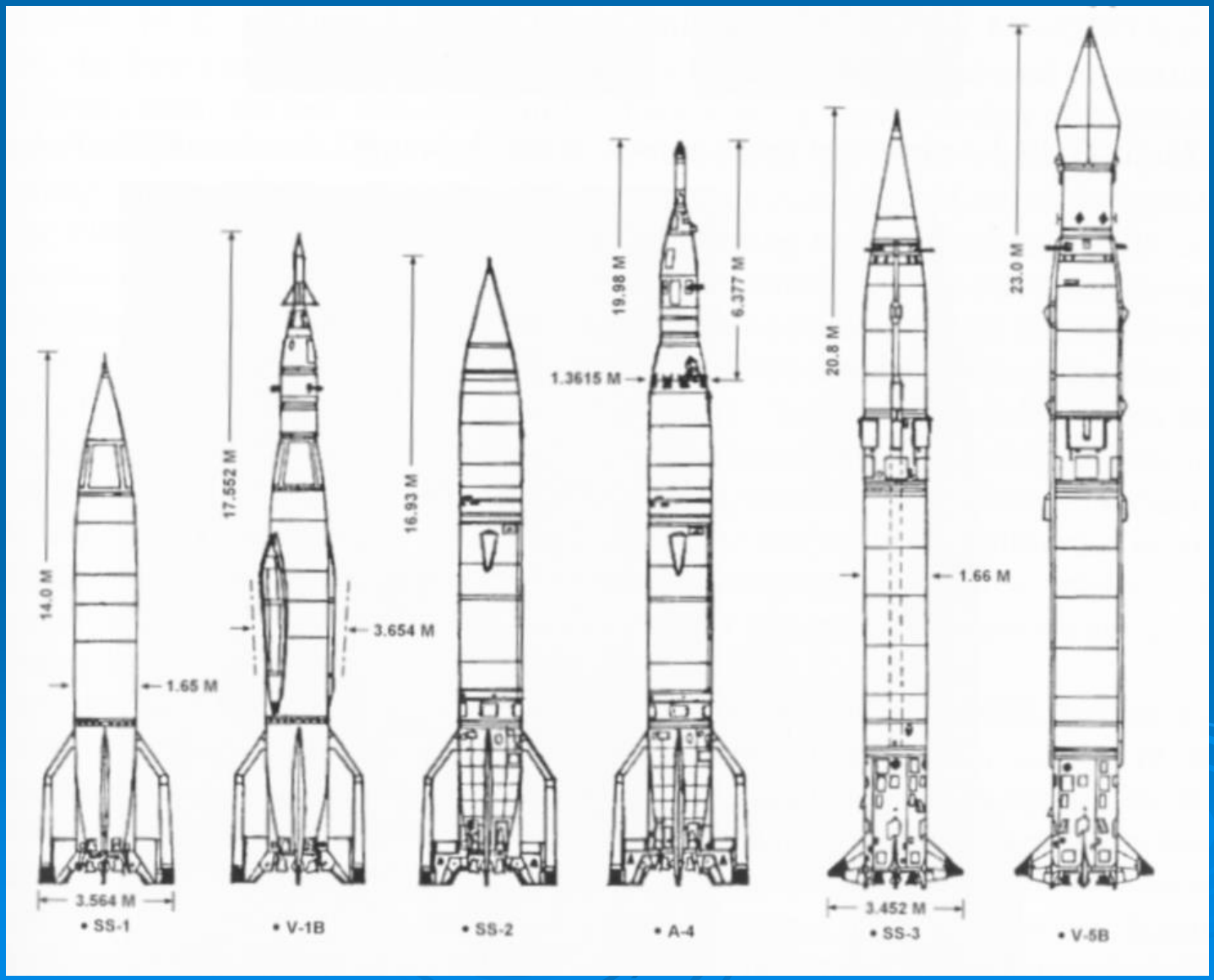


2. In 1903 Konstantin Tsiolkovsky expounded the theory of rocket flight and proposed the use of rockets for interplanetary travel. Advancing the hypothesis of the constant velocity of ejected reaction particles, he worked out and thoroughly investigated the equation for rocket propulsion. With it he established what we now call the Tsiolkovsky formula: the mathematical relationships between rocket mass and fuel mass. From this formula a highly important deduction was drawn: that rocket velocity depends on the relative weight of the rocket.

Origins of Manned Space Vehicles in Soviet Russia: GIRD



Soviet Sounding Rockets

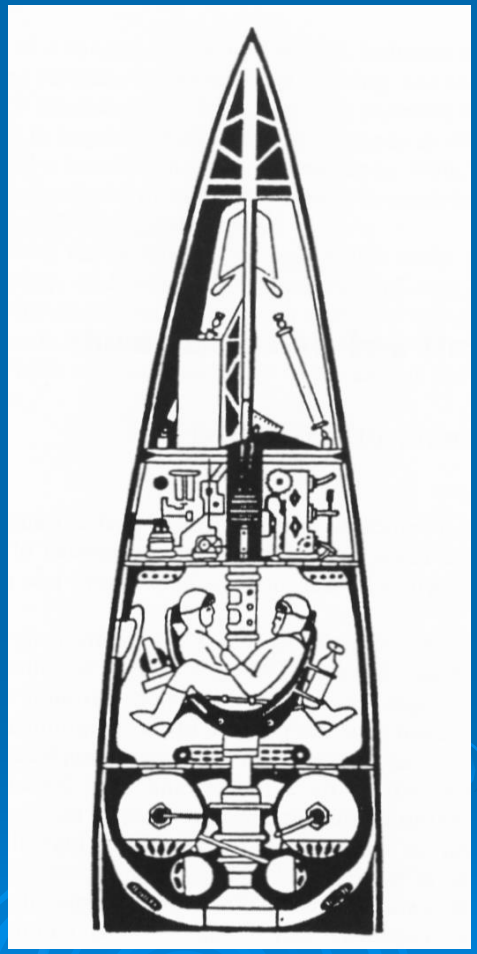


First Manned System

First Soviet plans to send a man to space started in 1948.

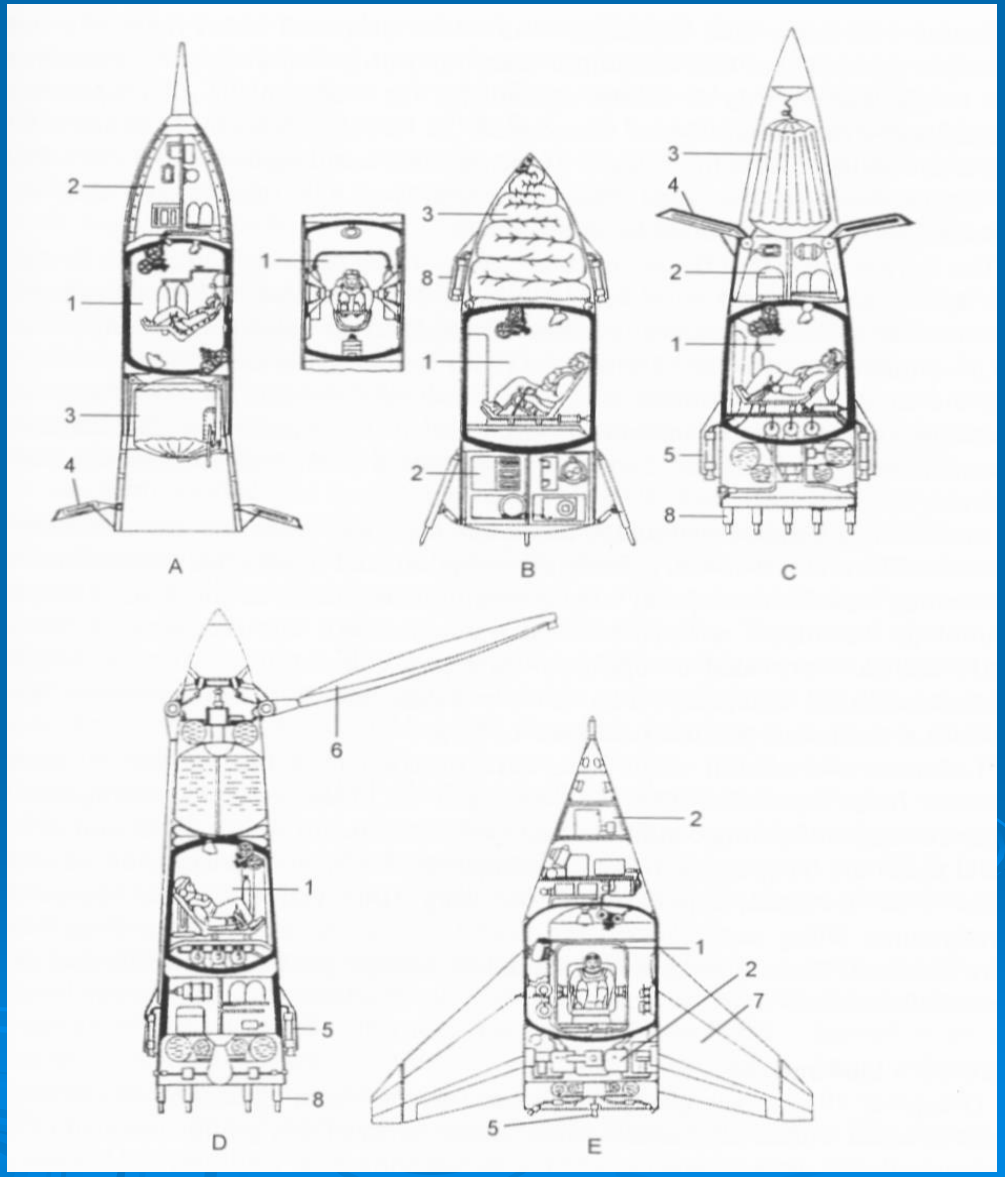
Plans were to launch a cosmonaut on board a modified R-5 (SS-3).

M.K. Tikhonravov was in charge of the design.



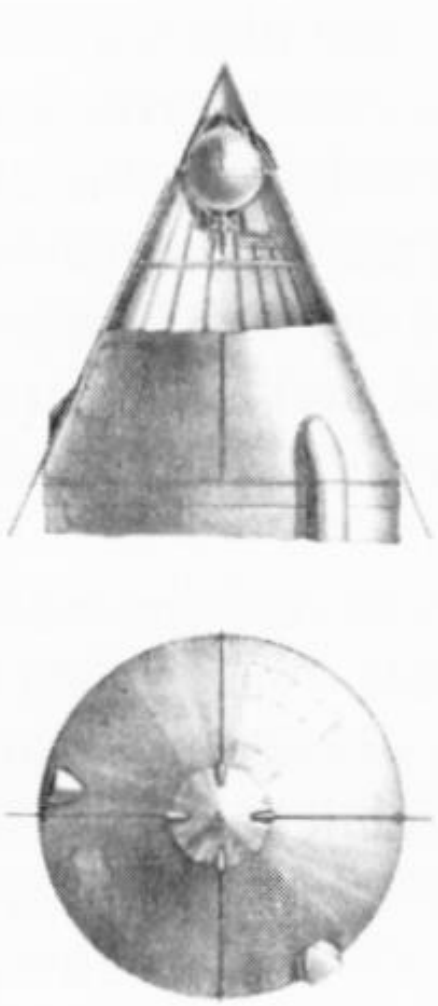
1955 Concepts

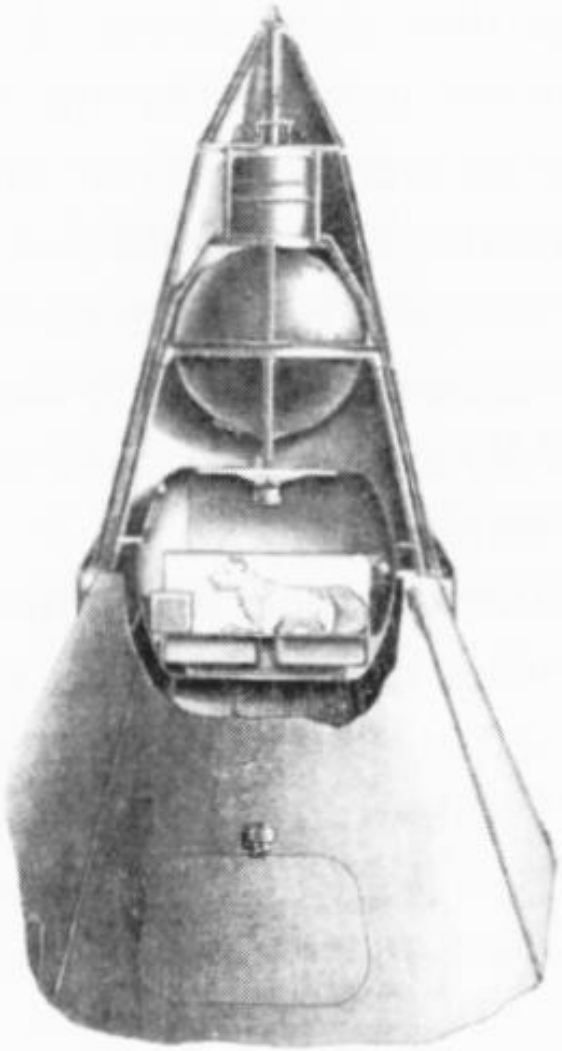
- Five concepts for suborbital flight designed in 1955.

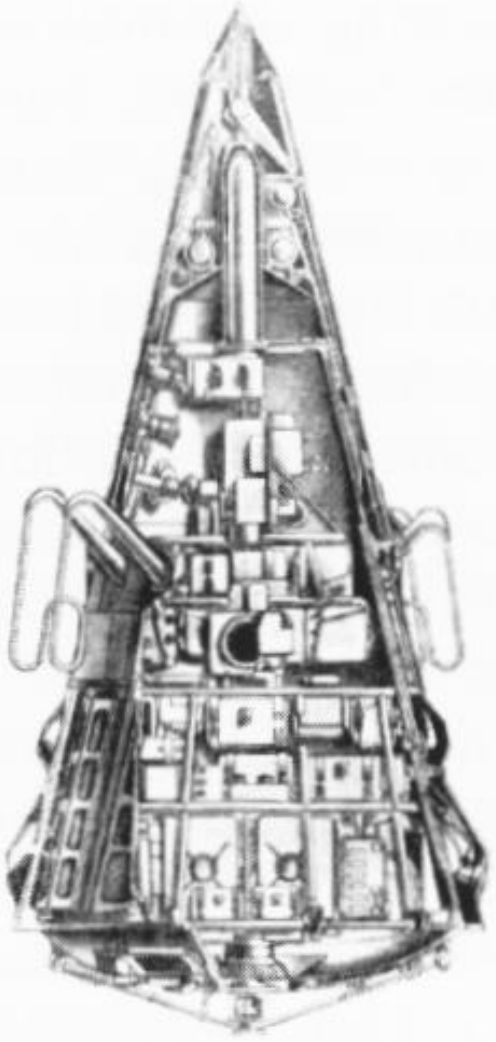


Sowjetischer Raketen by P. Stache

Sputnik I and II





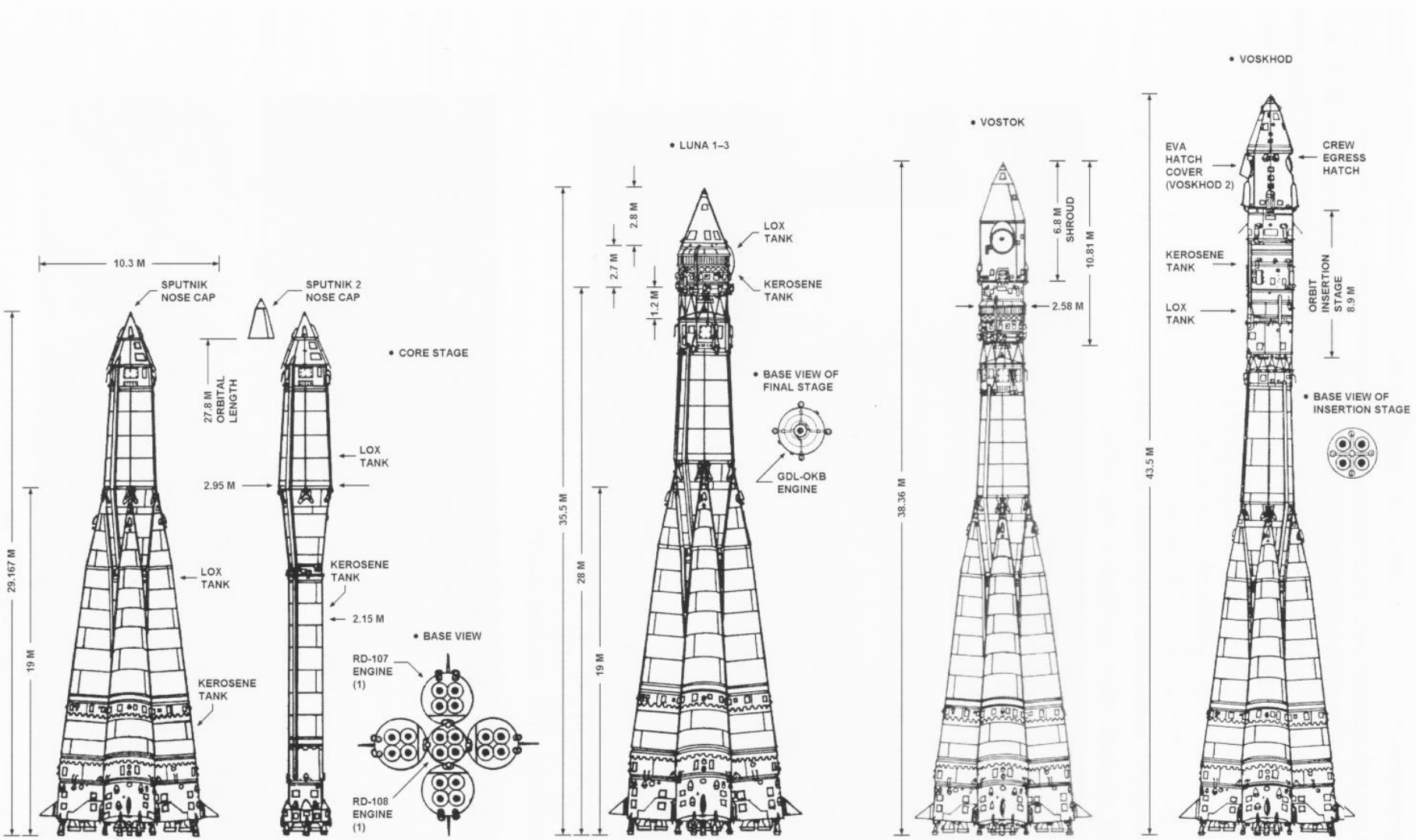


Animals in Space

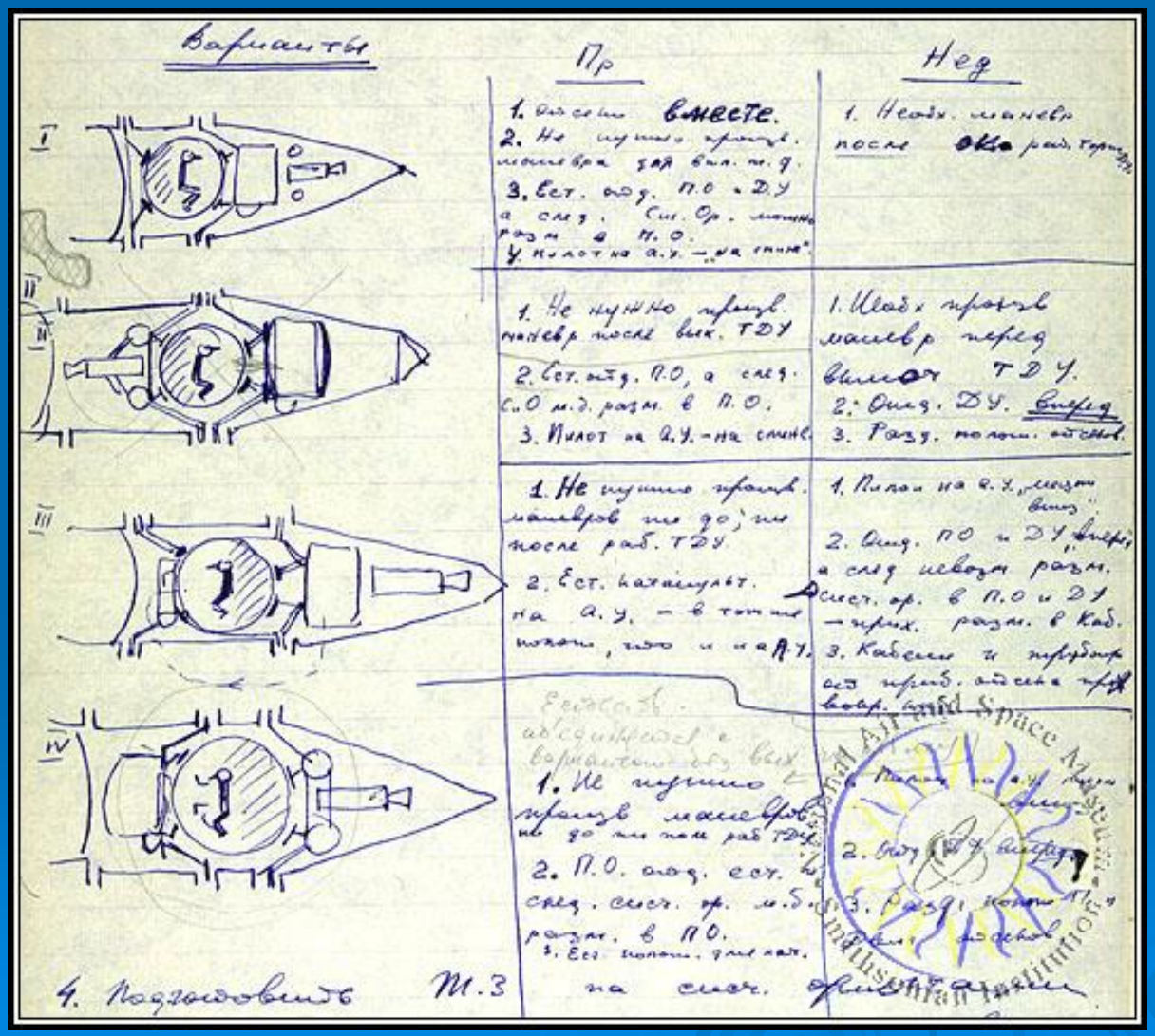
Laika in Sputnik II

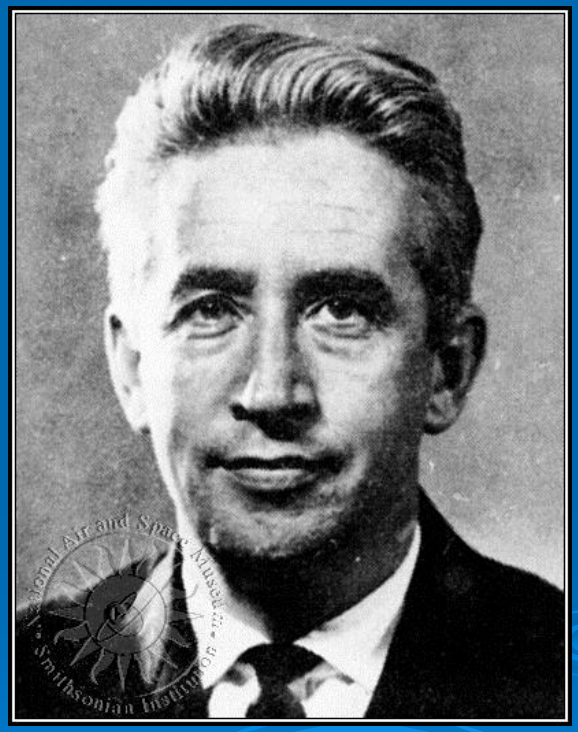
Belka and Strelka

7 – ‘Semyorka’ Rockets



Vostok and Konstantin Feoktistov

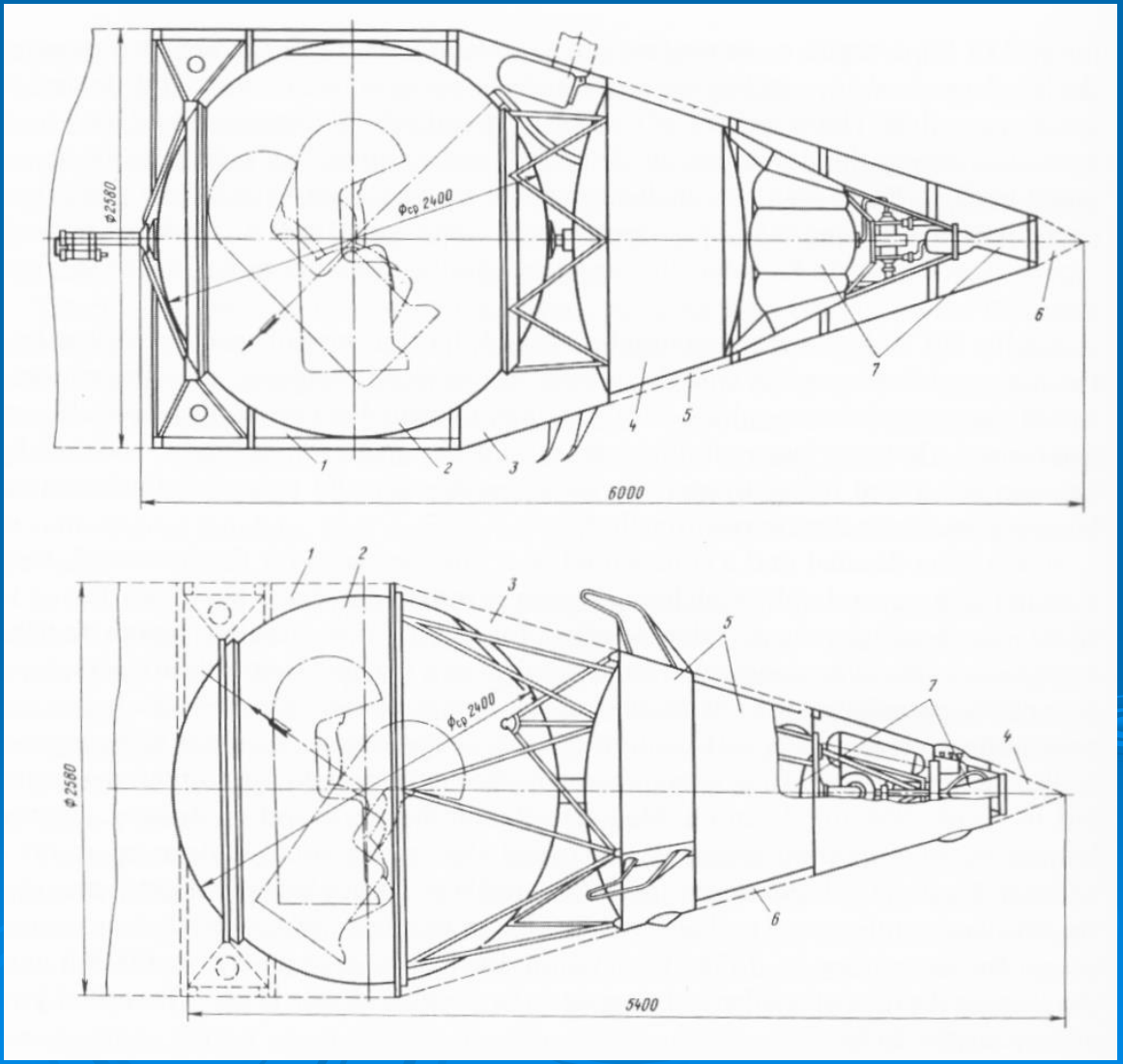




Courtesy: Smithsonian Air and Space Museum

Vostok First Design (1958)

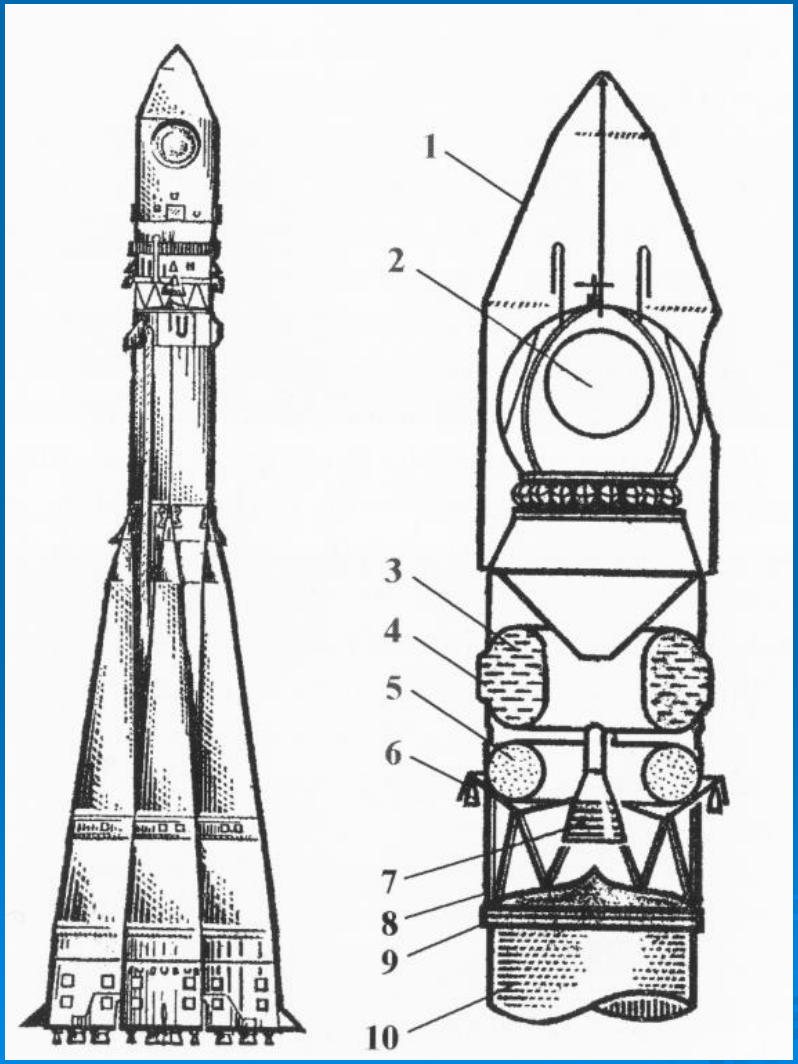
OD-2 Spacecraft

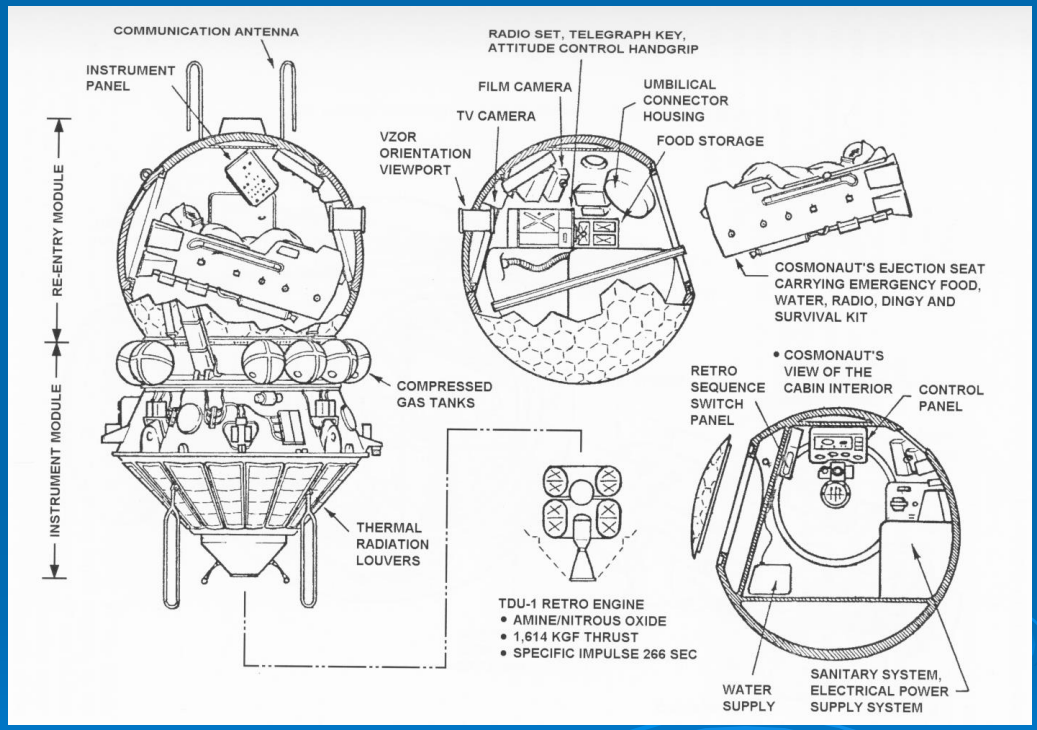


From: Materialy po istorii kosmischeskogo korablyam “Vostok”.

B. Raushenbaj, Moscow,1991.

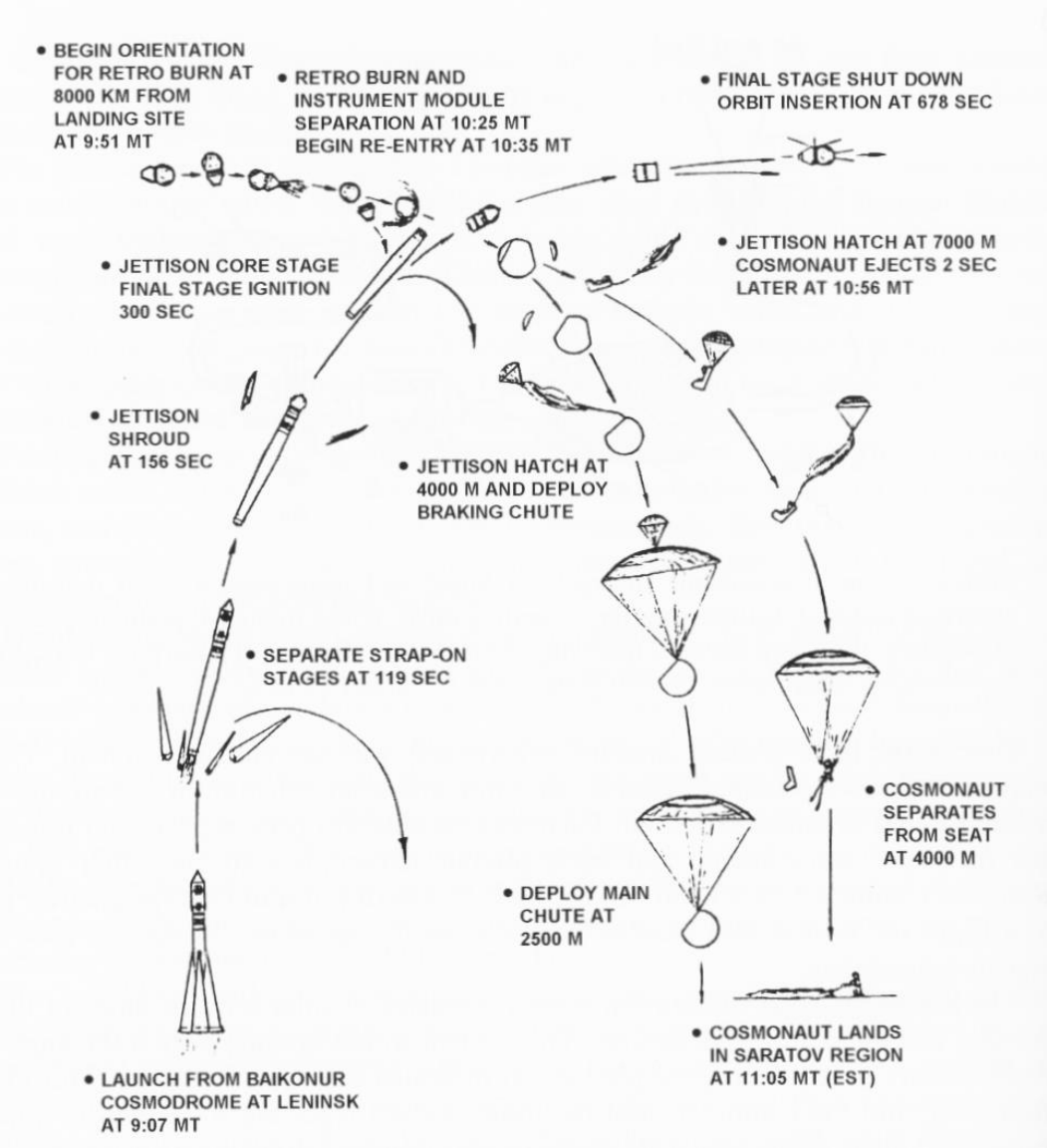
Vostok (East)





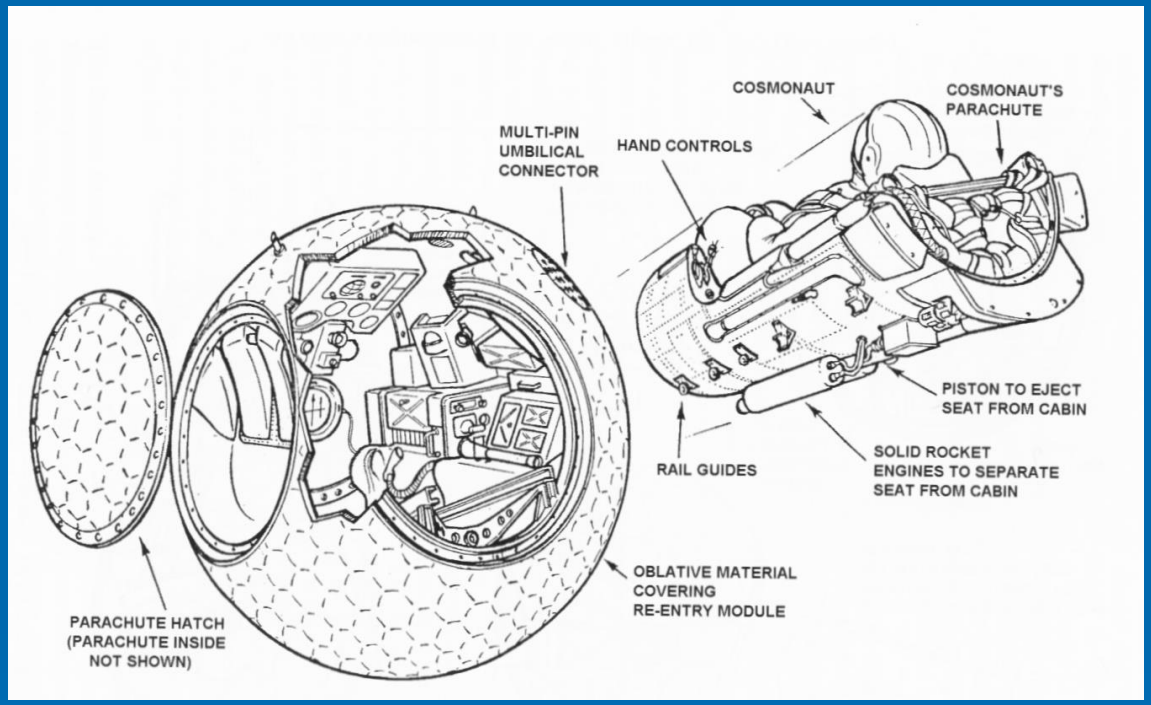
Drawing courtesy of Dave Woods

Vostok Flight Profile

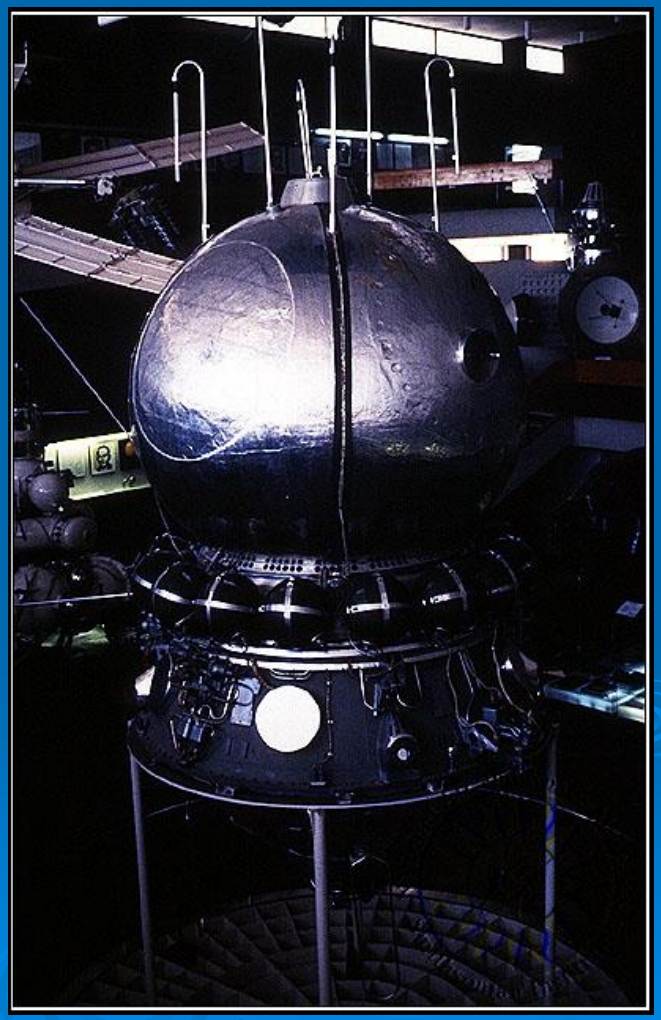


Drawing courtesy of Ralph Gibbons

Vostok Spacecraft



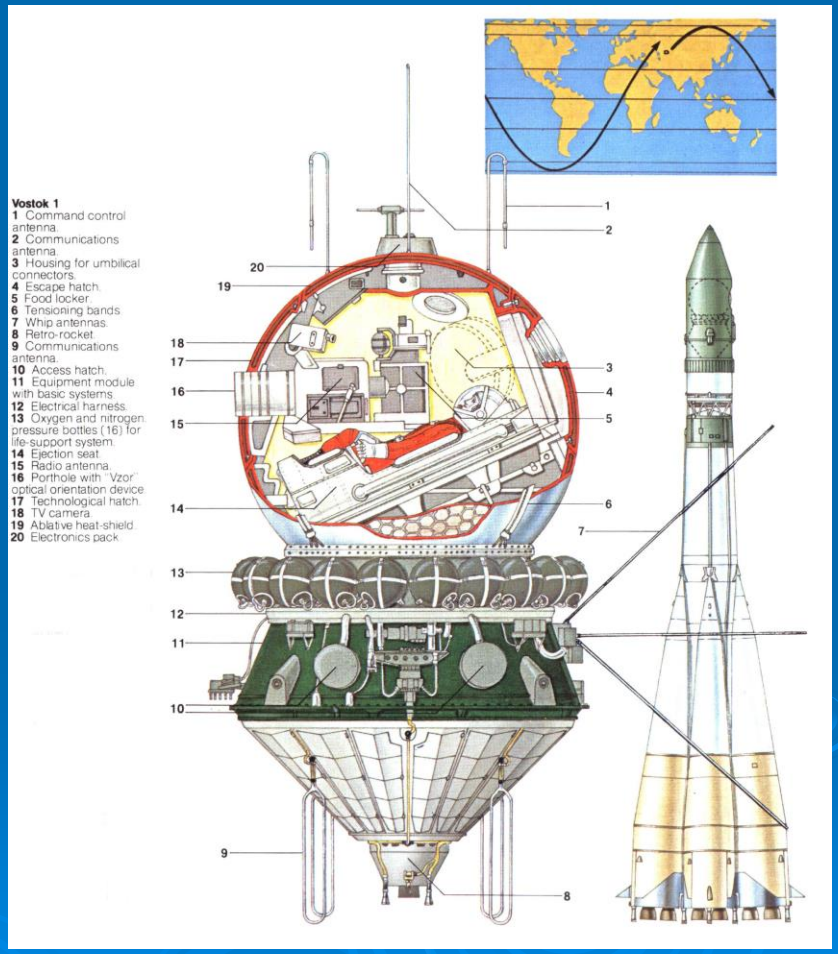
Drawing courtesy of Dave Woods



Courtesy of Tsiolkovski Museum in Kaluga

Vostok Ejection Seat

Museum of Economic Achievements of the USSR



www.astronautix.com

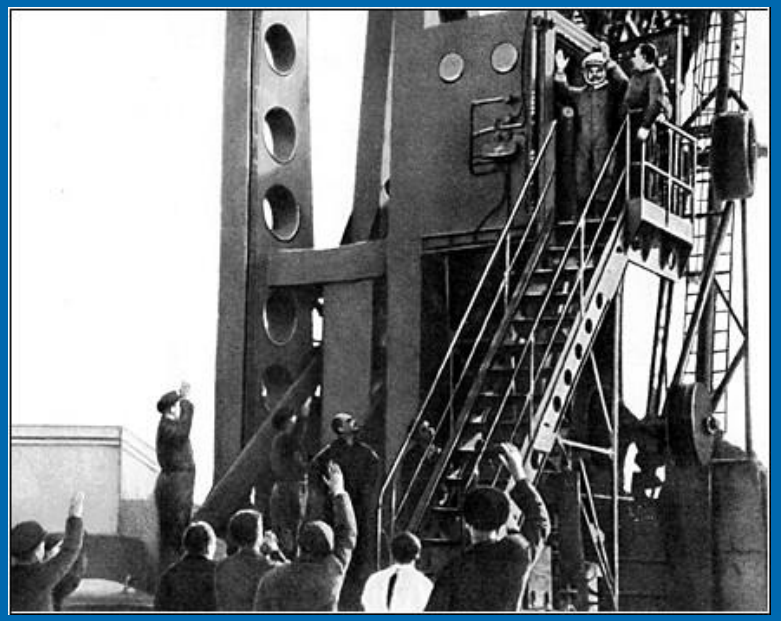
Ivan Ivanovich as a prelude to Gagarin

Korabl Sputnik 4 March 9, 1961

The Perot Foundation

Courtesy Videocosmos

1st Manned Flight April 12, 1961



Images courtesy Videocosmos

Life Support in Space

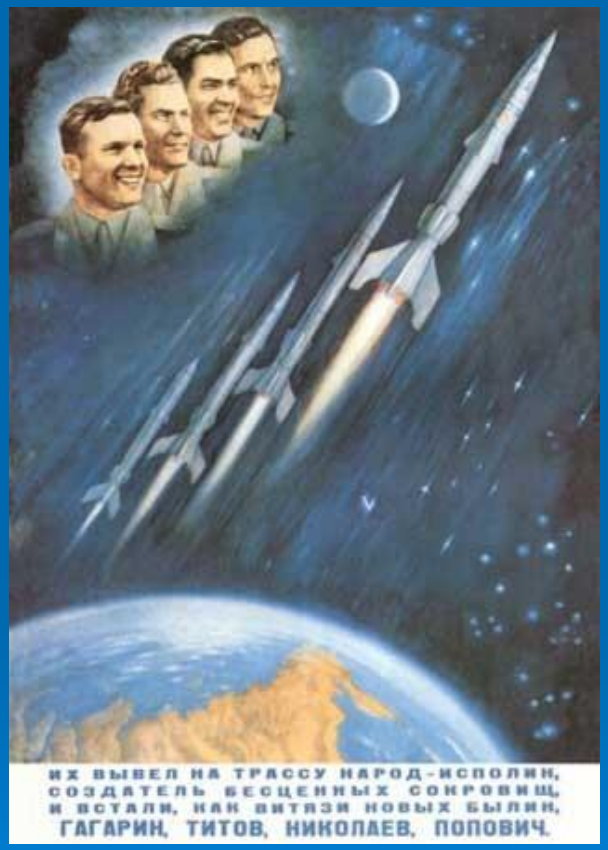
- Gagarin: Vostok-1,04/12/61, 1 h 48 min
  - Primary Life Support System (PLSS)
- Titov: Vostok-2, 08/06/61, 1 d 1h 18 min
  - First report of SMS…
- Tereshkova: Vostok-6, 06/16/63, 2 d 22 h 50 min
  - Severe SMS
- Humans are most vulnerable part of space flight…

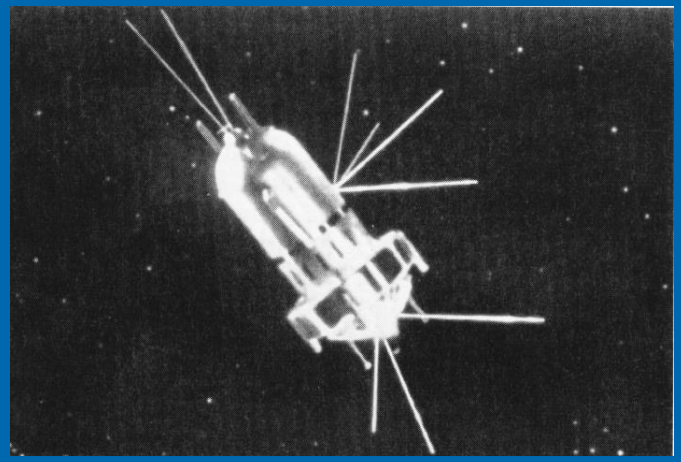
Physiological Side Effects in Space

- Medical Emergencies
  - SMS, toothaches, appendicitis
- Muscular Atrophy & OI
  - Strict exercise regime
- Bone Demineralization
  - Countermeasures are not found yet
- Radiation
  - Health deterioration & risk of cataract/cancer
- Socio-Psychological Stress
  - Loneliness… Personality conflicts…

Institute of Bio-Medical Problems: IBMP

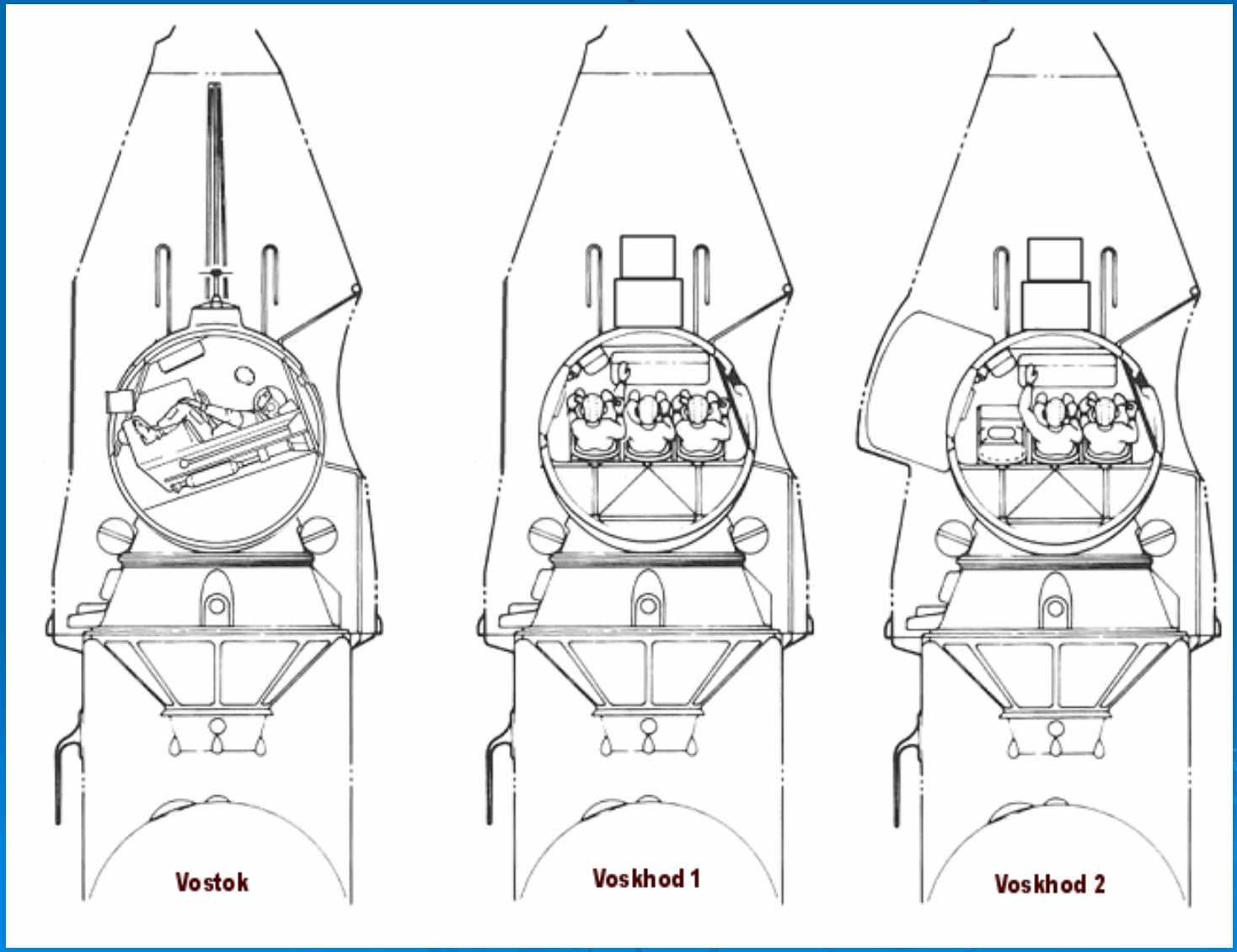
Vostok Disguised



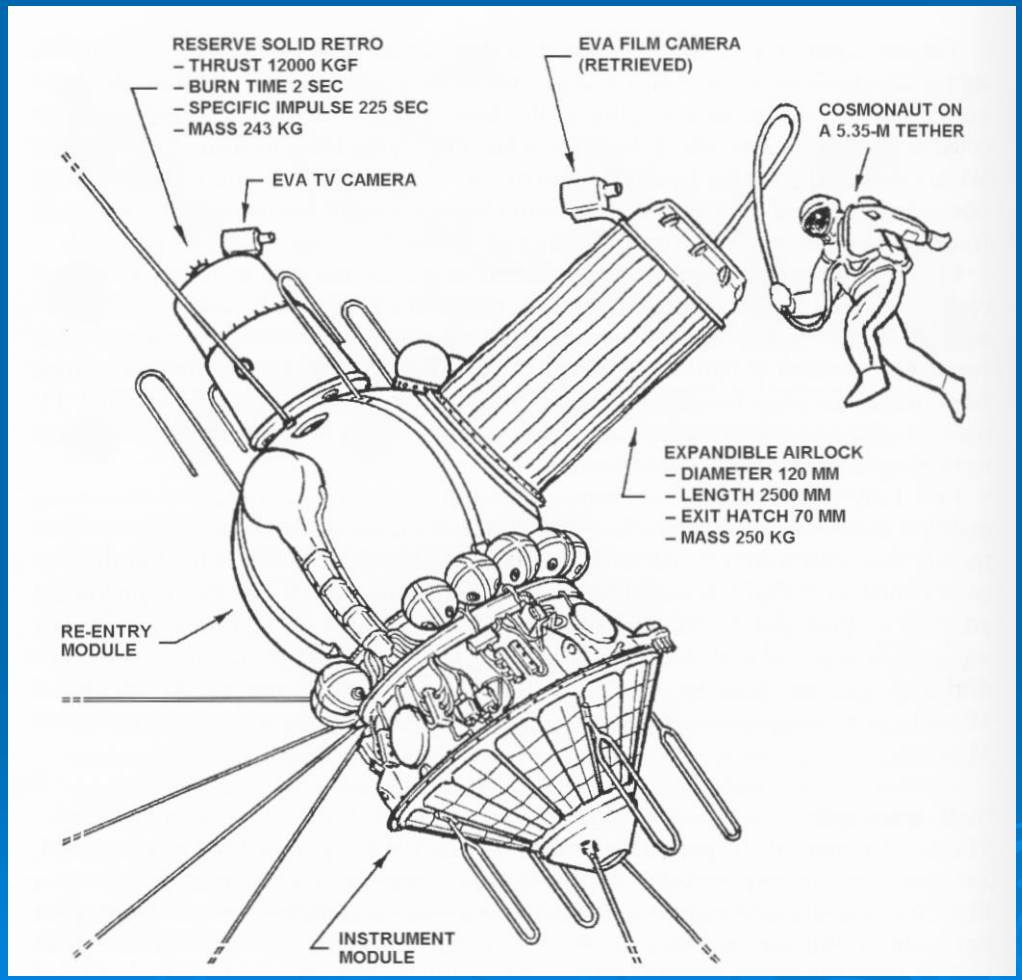


Images from Novosti Kosmonautika and Pravda

Voskhod (Sunrise)

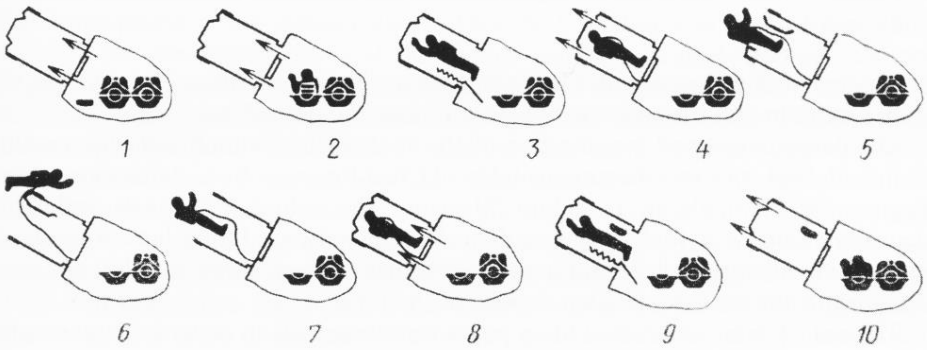


Voskhod II

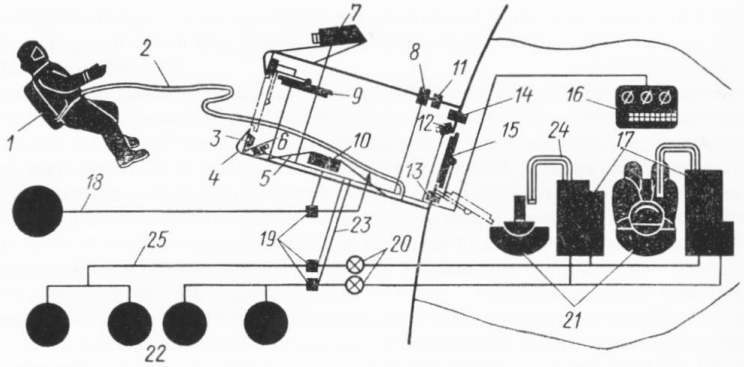


Courtesy David Woods

Voskhod II



The Voskhod 2 EVA sequence. 1) Airlock extension; 2) Leonov prepares to enter airlock, and dons the back-pack while Belyayev checks the integrity of the airlock pressurisation; 3) Leonov opens the inner hatch and floats into the airlock; 4) the main hatch is closed, and airlock pressure is released; 5) Leonov opens the outer hatch, and floats outside to begin EVA; 6) Leonov during the EVA; 7) Leonov re-enters the airlock; 8) the outer hatch is closed, and the airlock repressurised; 9) the main hatch is opened, and Leonov returns to the cabin; 10) the inner hatch is closed, and the airlock is depressurised and released.



The Voskhod 2 EVA systems. 1) The cosmonaut's self-contained life support system (suit and back-pack); 2) the safety tether, with communications and telemetry wires; 3) lights; 4) airlock structure; 5) handrails; 6) cine-camera; 7) cine-camera; 8) airlock pressure relief valve; 9) airlock exit hatch; 10) duplicate exit system back-up control panel; 11) airlock pressure valve; 12) cine-camera; 13) lamp; 14) mechanism for equalising pressure in the airlock chamber and cabin; 15) interior airlock hatch (main spacecraft hatch); 16) exit system primary control panel; 17) spacecraft life support units for cosmonauts in spacesuits; 18) independent airlock pressurisation system; 19) electronically controlled valves; 20) gas pressure reducers; 21) cosmonaut couches; 22) spacesuit and cabin pressurisation system; 23) electrical cable connections; 24) umbilical connects between spacecraft life support system and cosmonaut pressure garment; 25) gas transfer line.

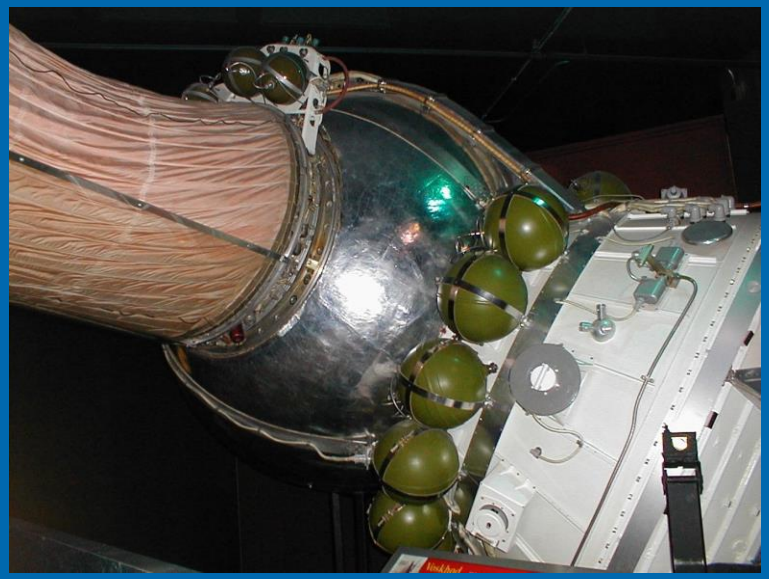
From: The Rocket Men from Rex Hall and David Shayler. Praxis Springer Publ.

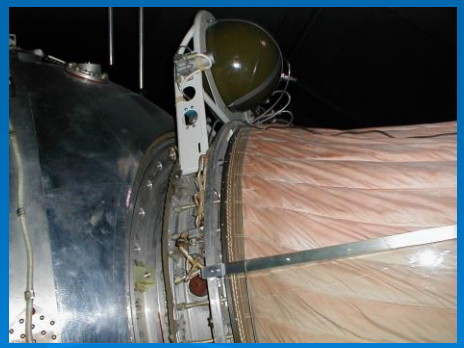
Voshod II: first EVA

- March 18, 1965: Voskhod-2
- Crew: Belyayev & Leonov
- Mission: 1 d 2 h 2 min
- Alexei Leonov – the first man to walk in space
- Suit was nominally pressurized at 5.87PSI = 40.45 kPa = ≈ 0.4 atm
- To get back to the vehicle:
  - Pressure had been decreased to ~ 0.2 atm
  - Leonov lost more than 10 Lbs of weight

From: David J. Shayler "Disasters and Accidents in Manned Space Flight", 2000

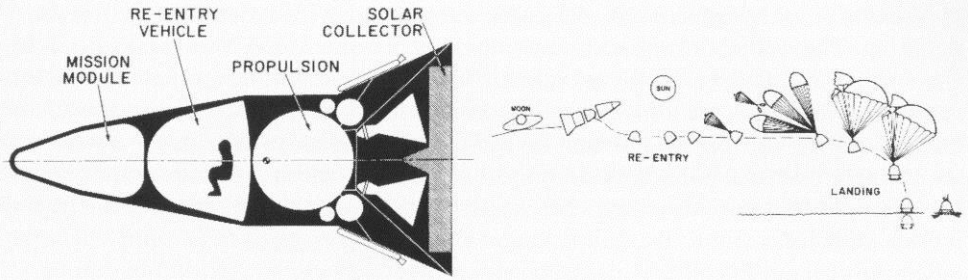
Voskhod II





Alexsei Leonov picture courtesy of RSC Energia.
Voskhod pictures from Pablo de Leon

Soyuz



The General Electric proposal for the US Apollo lunar spacecraft, *c*.1960–61 and landing sequence. This design featured a three-module spacecraft design – an option which was also adopted for Soyuz. (Courtesy NASA.)

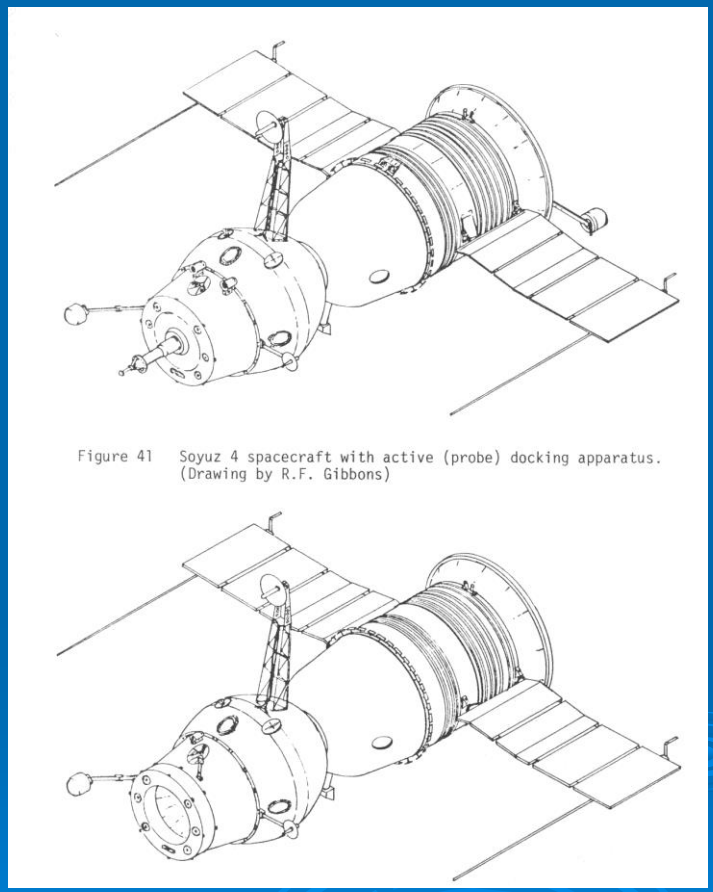
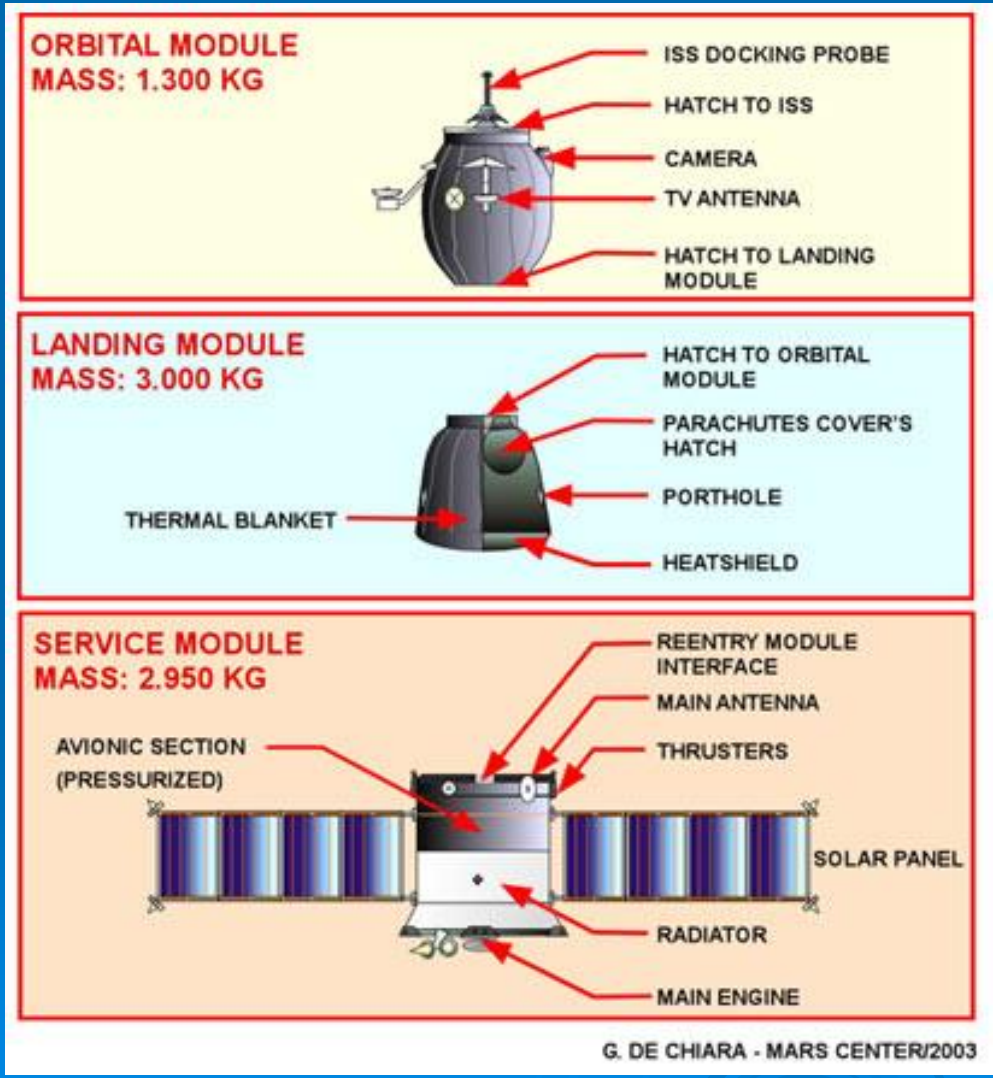
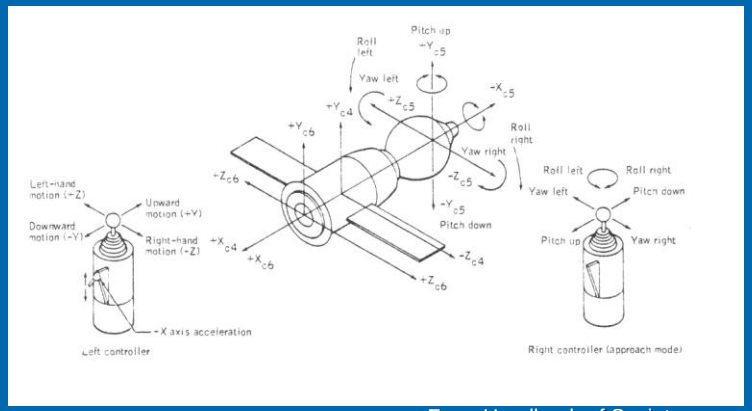


Figure 41 Soyuz 4 spacecraft with active (probe) docking apparatus. (Drawing by R.F. Gibbons)

- Uses same booster as Vostok
- Incorporates novel escape system
- Bell shaped return vehicle instead of sphere
- “Mission” or Orbital Module
- Propulsion Module

Soyuz Configuration

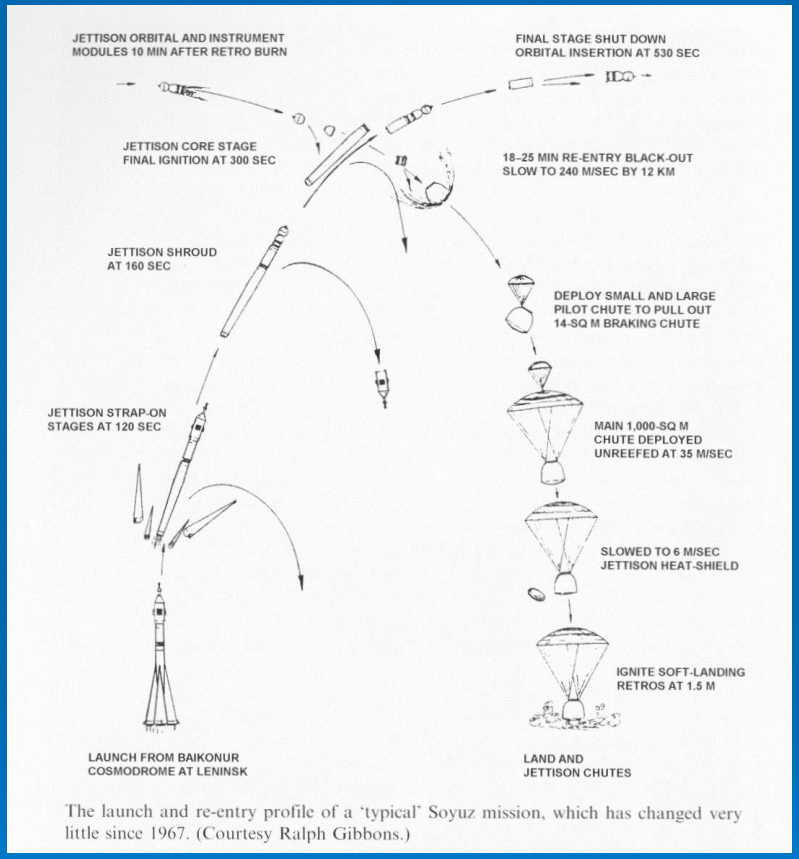




From Handbook of Soviet Manned Space Flight by Nicholas Johnson

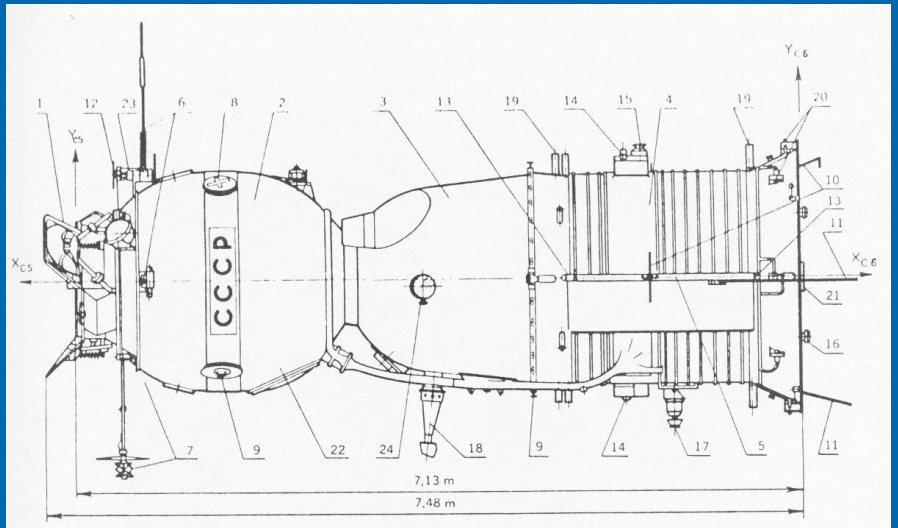
Courtesy NASA

Soyuz Spacecraft



The launch and re-entry profile of a 'typical' Soyuz mission, which has changed very little since 1967. (Courtesy Ralph Gibbons.)

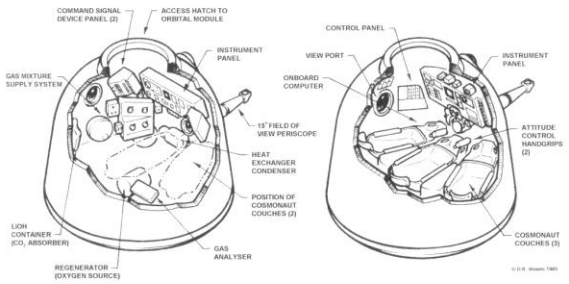
Mission Profile



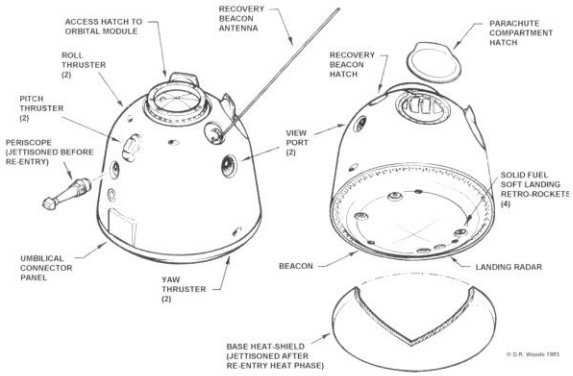
1. Docking mechanism
2. Orbital module
3. Command module
4. Propulsion module
5. Solar panels
6. VHF radio antennae (121.75 MHz)
7. VHG radio antennae (259.7 MHz and 296.8 MHz)
8. Radio/TV communications antennae
9. Command radio link antenna
10. Telemetry antennae
11. Communications antenna
12. Docking target
13. Orientation lights
14. Flashing light beacons
15. Sun sensor
16. Ion orientation sensor
17. Infrared orientation sensor
18. Periscope (optical orientation)
19. Approach and orientation engines
20. Orientation engines
21. Main propulsion engine
22. Orbital module side hatch
23. External television camera
24. Window

Courtesy Ralph Gibbons

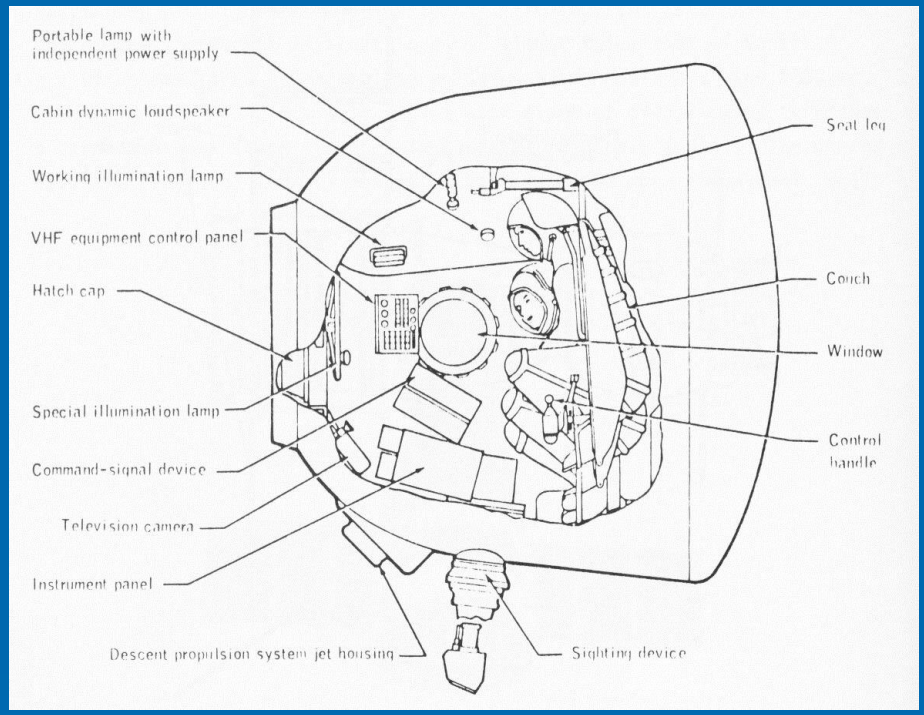
Soyuz Descent Module

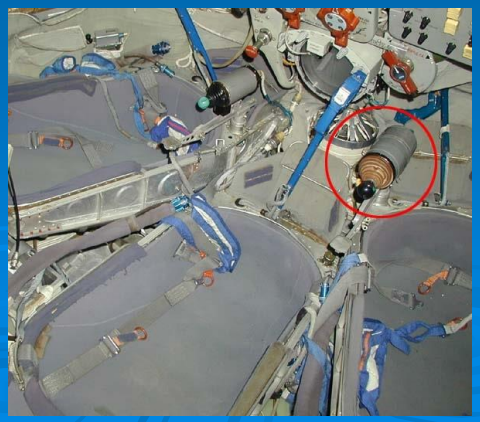


A cutaway of the Soyuz Descent Module. (Courtesy D.R. Woods.)



Details of the Soyuz Descent Module, showing the separated heat shield and soft-landing rocket system underneath. (Courtesy D.R. Woods.)



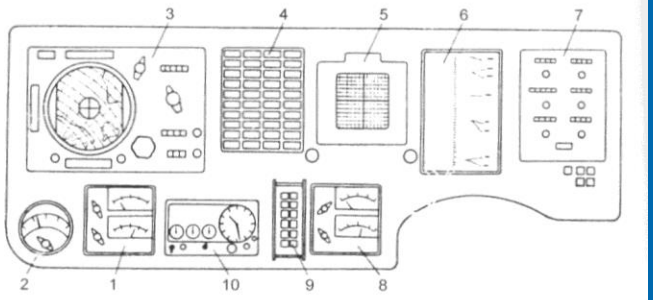


SRC Energia

Soyuz Descent Module

Photos NASA

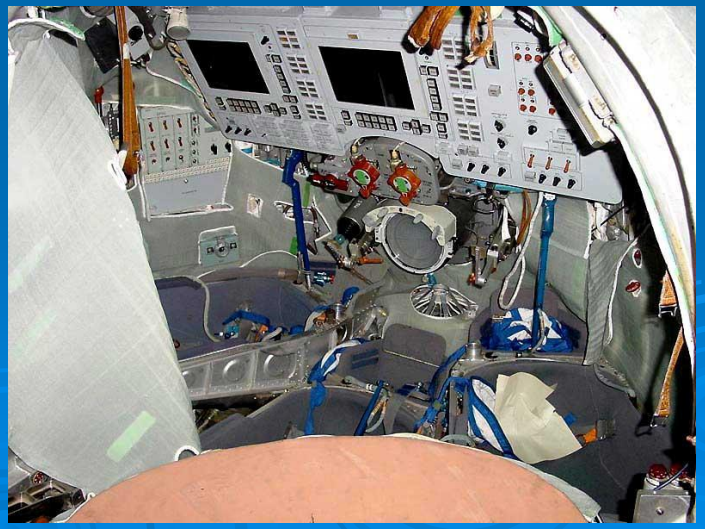
Soyuz Descent Module



The instrument panel: 1, pressure and temperature displays; 2, voltage and current display; 3, navigation display; 4, panel with electroluminescent indicators; 5, combined electron-ray display; 6, programme control display; 7, device to enter digital information; 8, range and approach speed displays; 9, keys for entering very important commands; 10, clock.

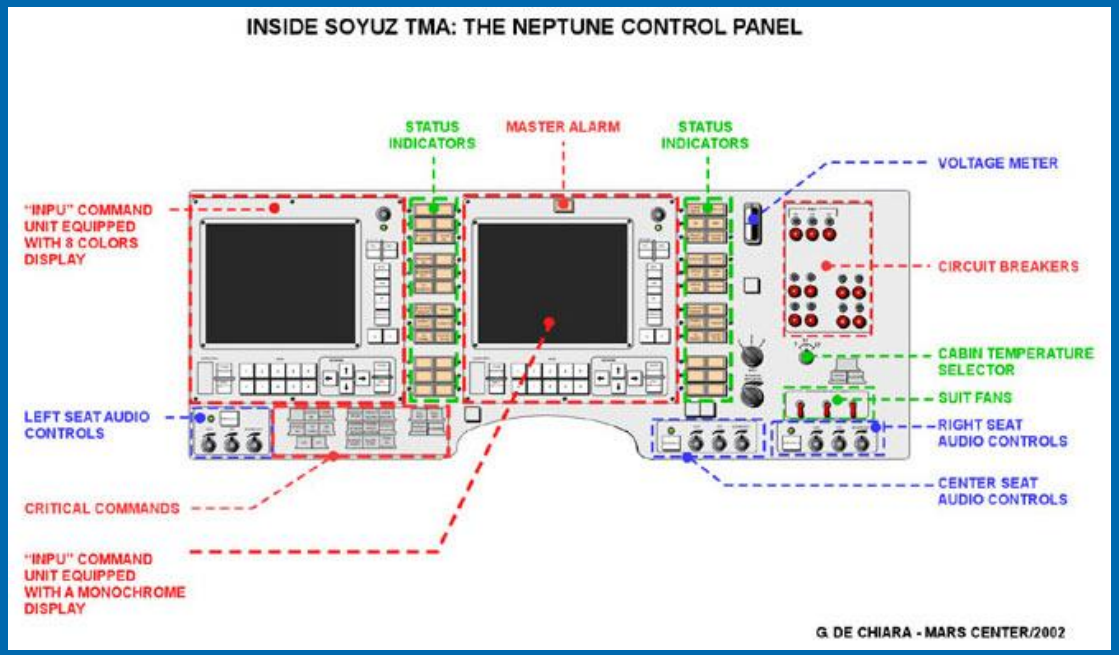
The crew display panels in the Descent Module.

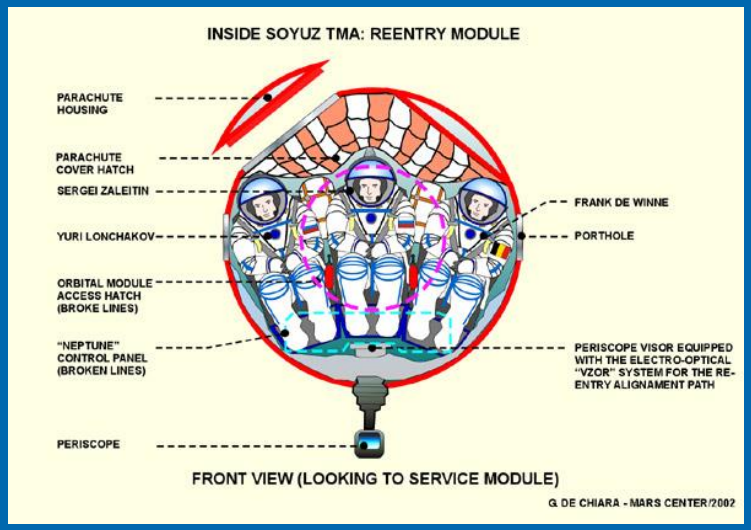
From: Soyuz, by Rex Hall and David Shayler

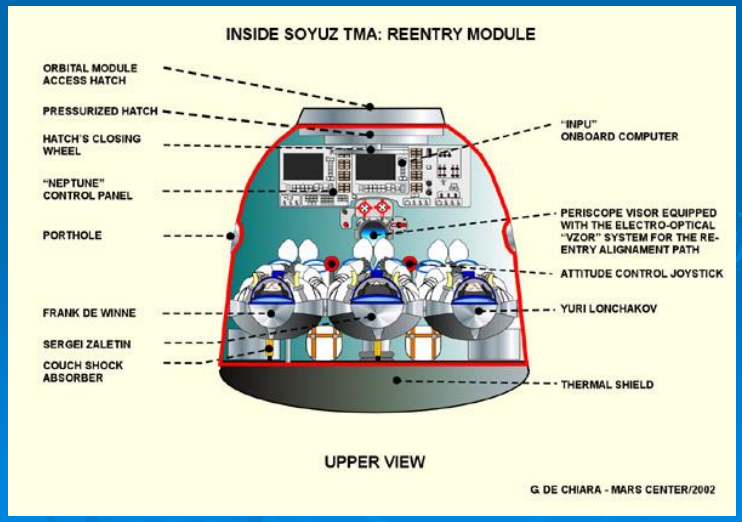


Photos SRC Energia

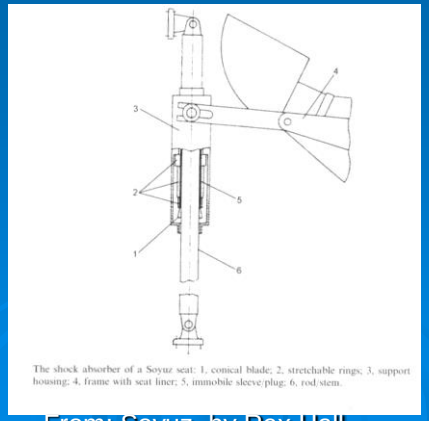
Soyuz Descent Module







SRC Energia



The shock absorber of a Soyuz seat: 1, conical blade; 2, stretchable rings; 3, support housing; 4, frame with seat liner; 5, immobile sleeve/plug; 6, rod/stem.

From: Soyuz, by Rex Hall and David Shayler

Courtesy Mars Center-Italy

Soyuz Landing and Recovery

Parachute deployment sequence: 1, deployment of pilot chutes; 2, deployment of drag chute; 3, deployment of main chute; 4, complete deployment of main chute; 5, repositioning of main chute; 6, landing, chute jettisoned.

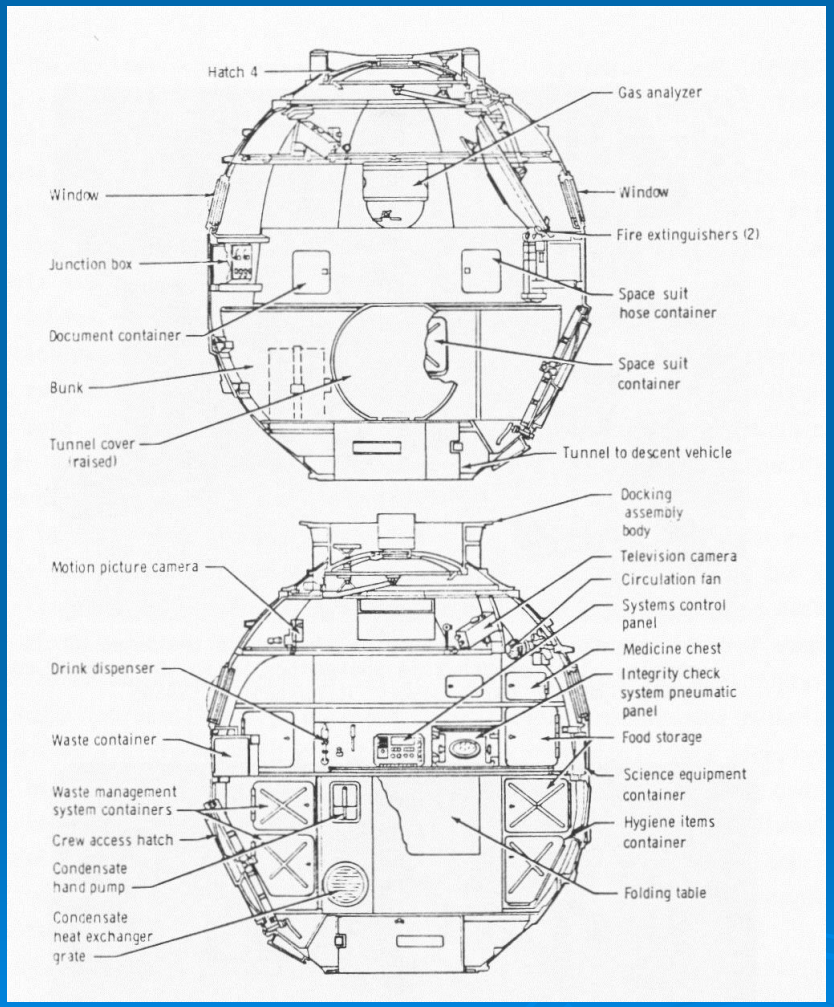
From: Soyuz, by Rex Hall and David Shayler

SRC Energia

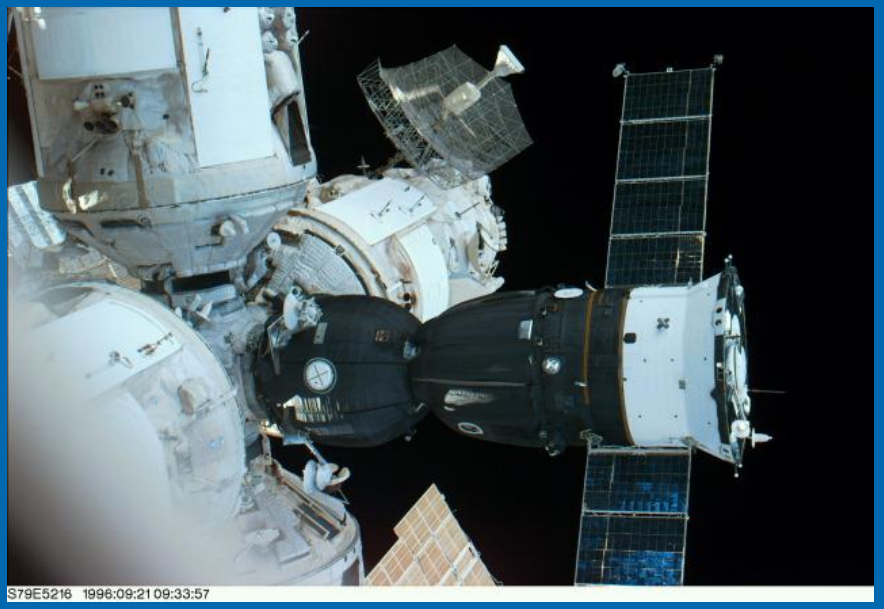
Soyuz Recovery

SRC Energia

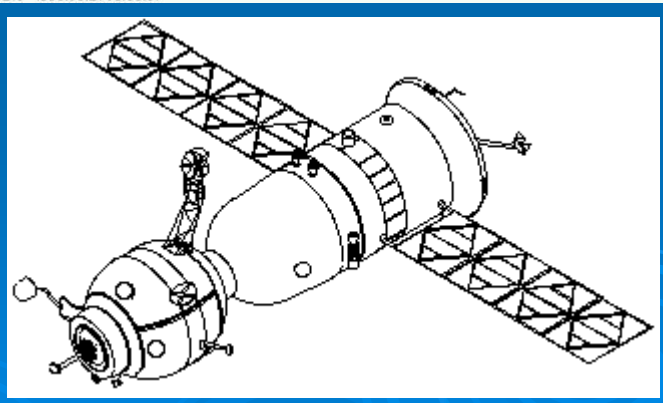
Soyuz Orbital Module



From Handbook of Soviet Manned Space Flight by Nicholas Johnson

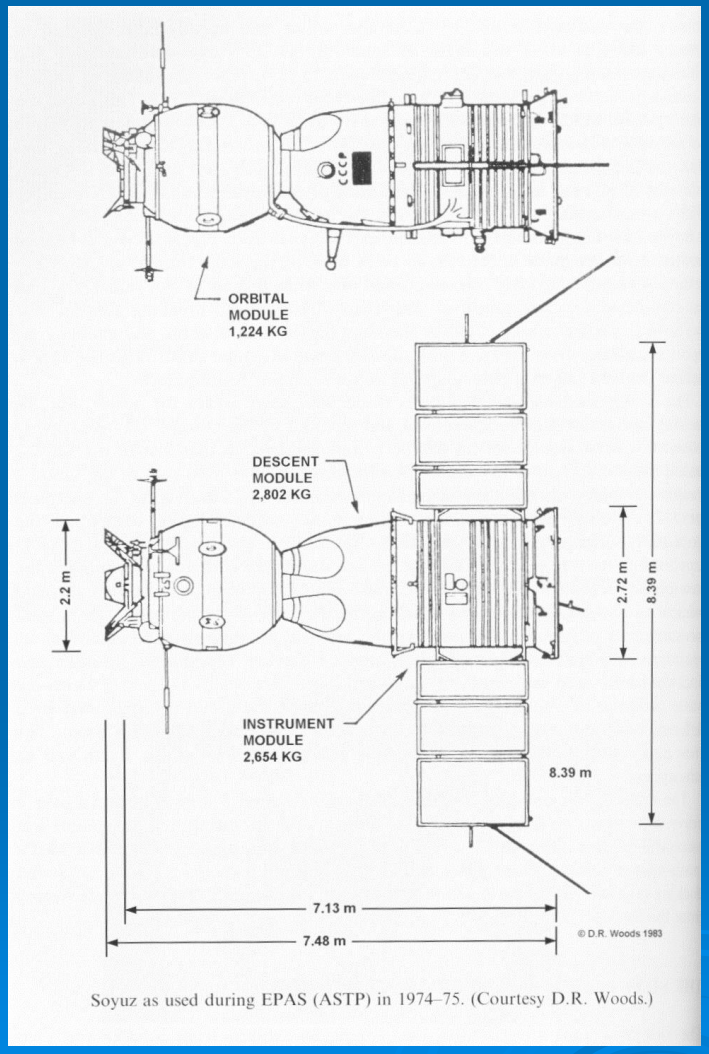


NASA

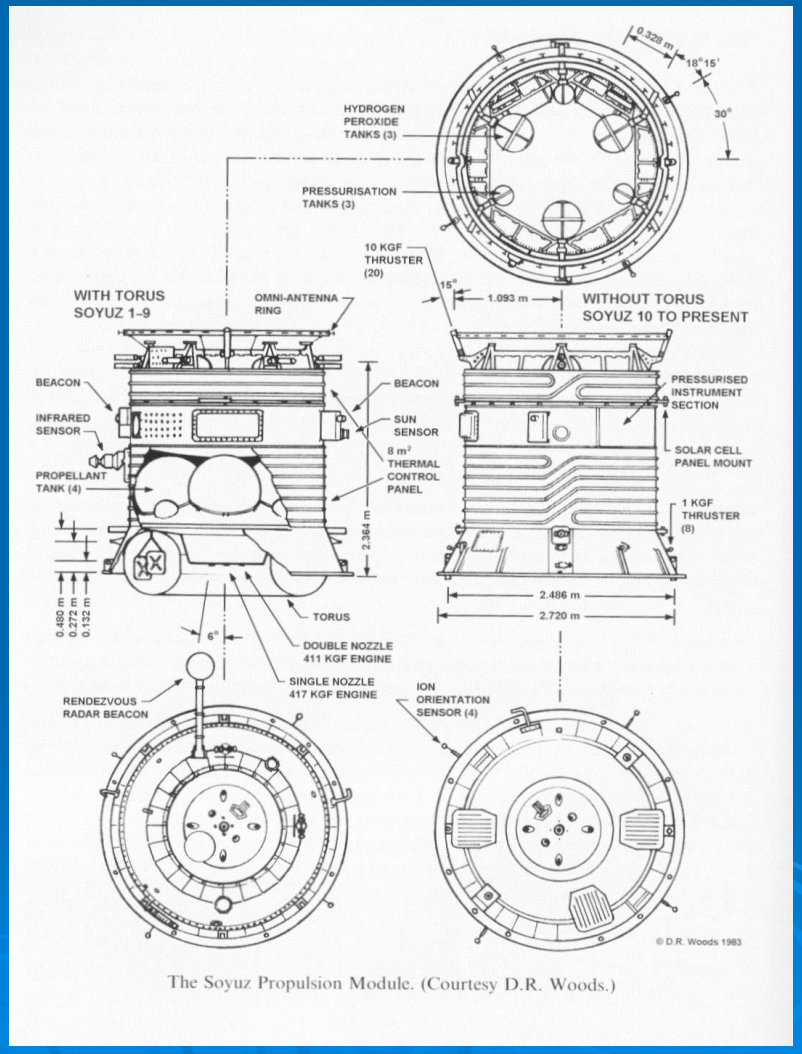


Astronautix.com

Soyuz Propulsion Module

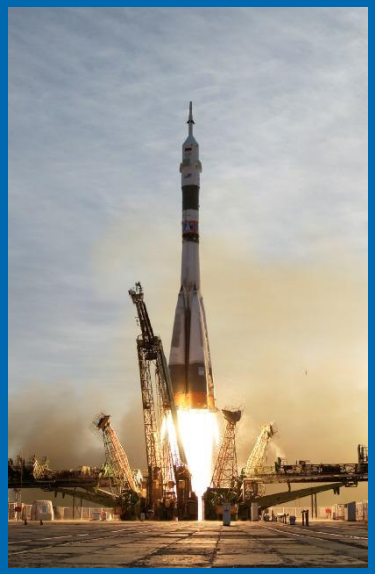


Soyuz as used during EPAS (ASTP) in 1974–75. (Courtesy D.R. Woods.)



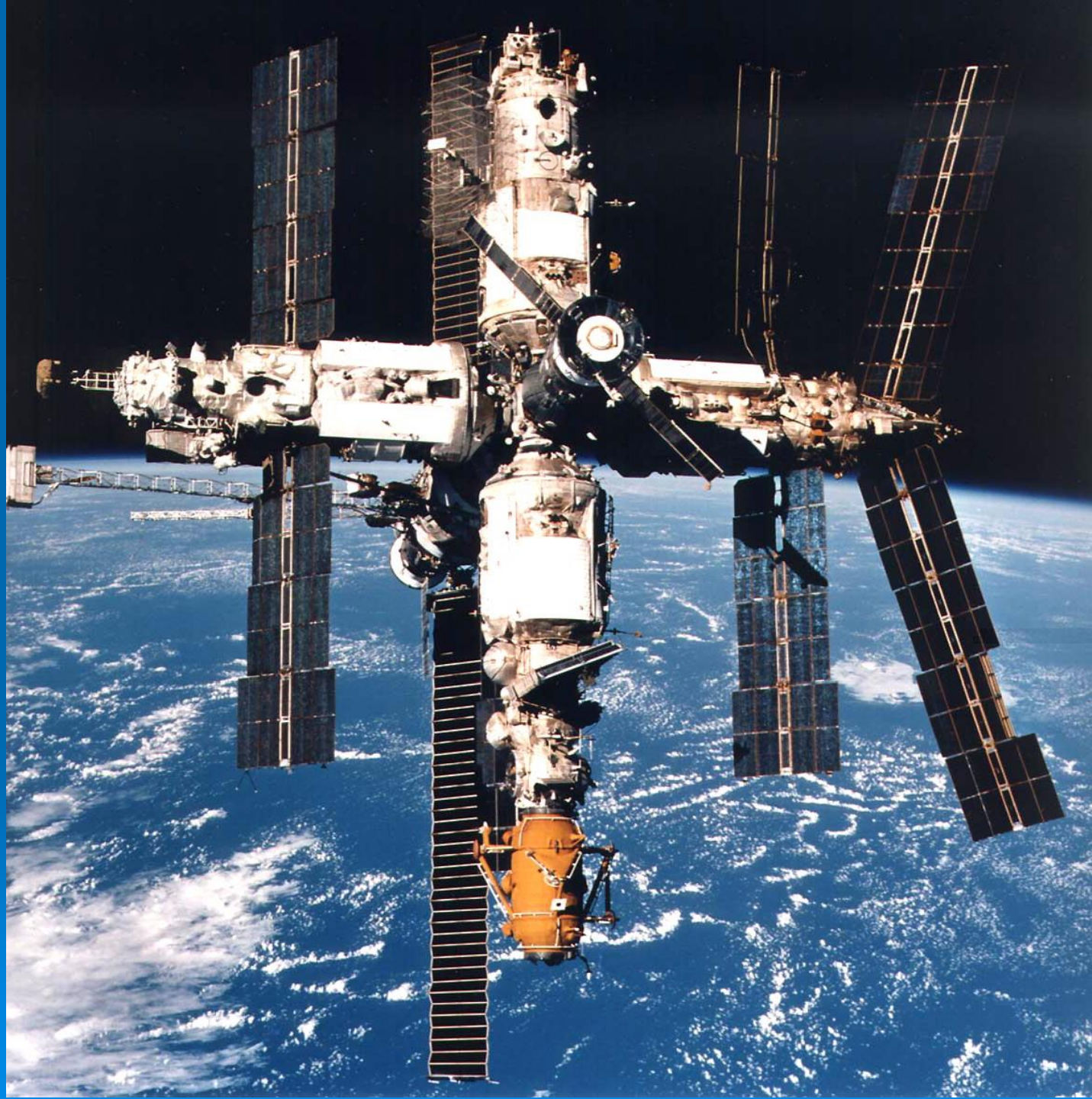
The Soyuz Propulsion Module. (Courtesy D.R. Woods.)

SOYUZ



SRC Energia

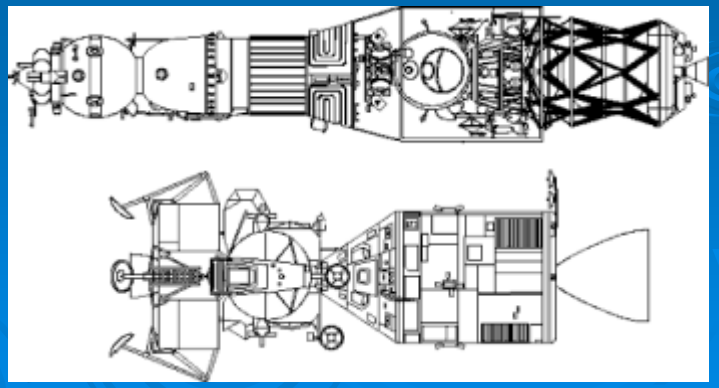
MIR



Long-Term Isolation: SFINCSS99

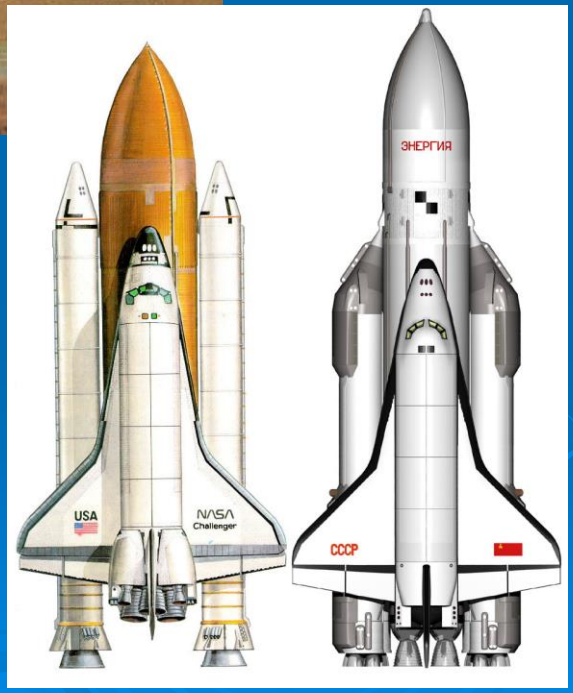
Long-Term Life Support: BIOS-3

Soviet Lunar-Program



Courtesy Mark Wade
Astronautix.com

Buran (Snow-Storm)

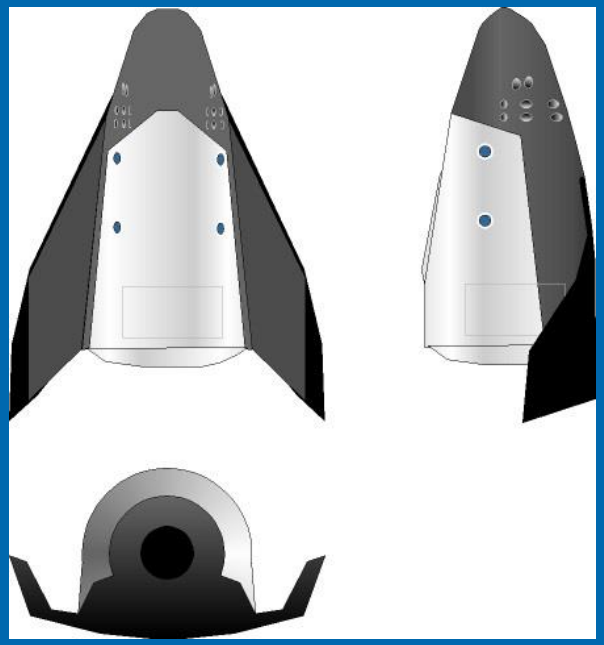


Courtesy Mark Wade
Astronautix.com

Buran

www.aerospaceweb.com

Kliper



Courtesy: Anatoly Zak

Commercialization of Space

- Space Tourism
- Rocket Boosters
- 500/700 Days Test to simulate International Expedition to Mars

Questions?