1.0 SM FREE FLIGHT AND DOCKING OVERVIEW

The Service Module (SM) is the third module of the International Space Station (ISS). It is designated as Flight 1R because it will be the first exclusively Russian-built launch package. The SM will follow the Functional Cargo Block (FGB), launched in November 1998 and the Node 1/Pressurized Module Adapter (PMA), launched in December 1998. See Figure 1-1. Additional RS modules that will arrive later in the assembly sequence are also shown in Figure 1-1. They are the Science Power Platform (SPP), the Universal Docking Module (UDM), and the Docking and Stowage Module (DSM). An unmanned mission profile for the Service Module, starting from SM launch until ISS Flight 3A can be found at

http://iss-www.jsc.nasa.gov/ss/issapt/iop/products/bin/oos_0C1.doc

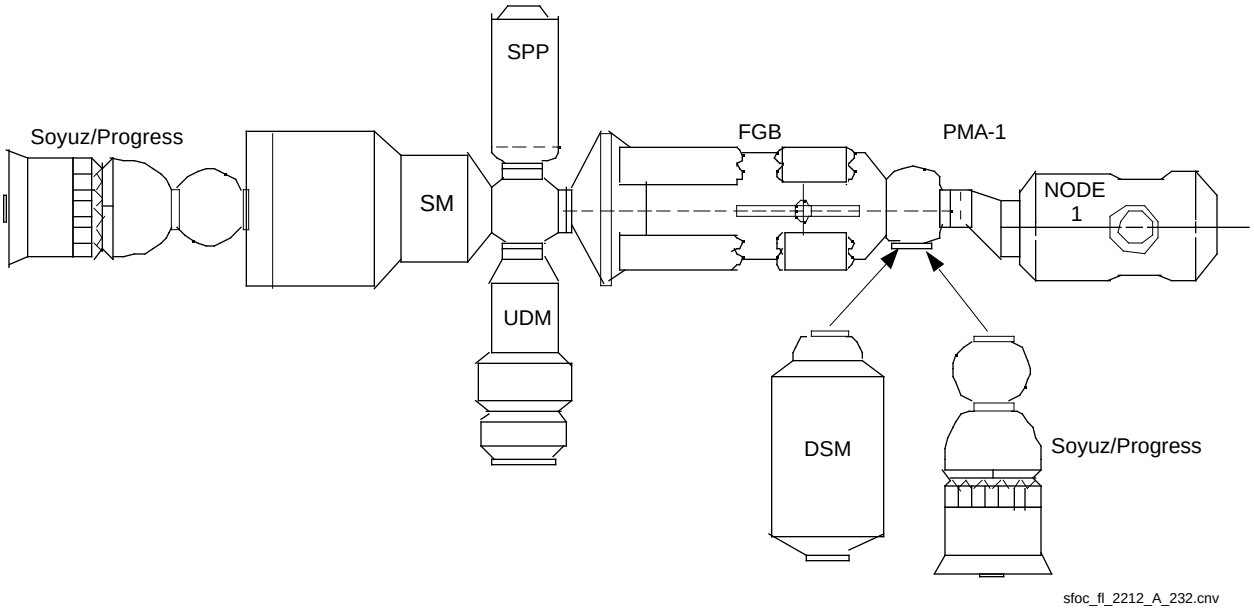

Figure 1-1. Assembly of the International Space Station

The SM is inserted into orbit at a 51.6° inclination by the Proton launch vehicle from Facility 548 at the Baikonour Cosmodrome in Kazakhstan. The Proton payload fairing accommodates the two solar arrays as well as numerous other externally mounted equipment. The payload faring is jettisoned at 190-195 seconds after liftoff at which time the SM is exposed to a maximum dynamic pressure of 40 Pa. The SM separates from the third stage of the Proton at 580-585 seconds after liftoff. After separation, braking engines pull the booster away from the SM flight path. The resulting parking orbit of the SM is 200-220 km by 320-340km.

Following separation from the third stage of the booster, the Motion Control and Navigation System [____] is activated, the SM is stabilized and the attitude control operations are performed. The SM is transferred into the circular assembly orbit by burns of the SM reboost engines (313 kg) [__] in the Integrated Propulsion System [___]. During the reboost operations, stabilization is achieved by gimbaling the SM main engines for pitch

and yaw control and by using the smaller SM Attitude Control Thrusters (13.3 kg) [__] for roll stabilization.

For the rendezvous operation, the SM is the passive vehicle and ISS, consisting of the FGB and Node, becomes the active vehicle. The FGB performs the long-range rendezvous maneuvers with MCC-M support. The FGB maintains the ISS stack in X-nadir spin until the MCC-M verifies that the SM has been successfully inserted into the rendezvous orbit. For the final rendezvous and docking, the FGB uses the Kurs system. The FGB/Node stack approaches the SM with Node 1 in the direction of flight. When braking is required, the FGB will rotate 180° for the braking burn, fire, and then maneuver back to the Node 1 'leading' attitude ($+X_{ISS}$VV). (See Figure 2-1.) Multiple sets of such maneuvers are expected prior to docking. The FGB will eventually dock to the SM forward axial port which contains the passive side of the hybrid probe and cone docking mechanism.

After docking is complete, the SM assumes responsibility for attitude control and reboost. Many of the FGB systems are deactivated. From this point the FGB serves primarily as a propellant storage facility and provider of pressurized volume.

Approximately 2 weeks after the FGB docking to the SM, the first ISS Progress vehicle will dock automatically to the aft SM port ($-X_{ISS}$ port), which contains a probe and drogue docking assembly. The Progress will then assume primary responsibility for reboost and propulsive maneuvers of the ISS. The Progress will transfer excess propellant to the FGB propellant tanks by lines routed through the SM. Several Progress flights per year will resupply the ISS with propellant, gases, and dry cargo. In addition to the aft SM port, the Progress will also be able to transfer propellant in contingencies through the FGB $+Z_{ISS}$ port or the UDM $+Z_{ISS}$ port.

The first ISS Soyuz will deliver three crewmembers to the ISS on Flight 2R and the ISS will become permanently manned. The Soyuz will dock to the SM aft port ($-X_{ISS}$ port) and will provide the capability for emergency crew return.

At the initial and advanced stages of the ISS assembly and operation, the SM will provide for routine docking of transport and cargo transport vehicles, ISS attitude control, and orbital correction, as well as control of other station vehicles. The SM, as a whole, is the structural and functional center of the Russian Segment (RS), providing accommodation and work stations for the crew, as well as supporting radio communications and research program equipment.

The basic requirements for the SM design are as follows:

- Total service life in orbit of up to 15 years
- Life support for a crew of up to six persons
- Accommodation of four docking ports, consisting of docking units, Kurs antennas, and docking targets

- Power supply for its own onboard systems and for docked spacecraft
- Intake and storage of propellant components pumped from the tanks of FGB and transport cargo vehicles
- Uplink and downlink of voice, television, telemetry, and command data over their respective radio channels in the Russian ground site zones, as well as via relay satellite
- Control of its own onboard systems and the systems of ISS Russian Segment
- ISS attitude control, stabilization, and orbital correction
- Support of United States Orbital Segment (USOS) GN&C attitude control by providing desaturation of U.S. Control Moment Gyroscopes (CMGs)
- Coordination of ISS-level modes and GN&C modes with the USOS, beginning with Flight 5A
- Air exchange between the atmospheres of the pressurized compartment and docked vehicles
- Accommodations for conducting experiments

Information on the ISS Assembly Sequence can be found at
http://iss-www.jsc.nasa.gov/ss/issapt/