

Ad Astra magazine, Nov 2007 -- **Making Room**  
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Russia's human spacecraft factory on the northern edge of Moscow has already begun ramping up production of its Soyuz and Progress spacecraft to support the planned six-person crew launch rate. With the first extra launch now scheduled for July 2009, that vehicle's keel reportedly was laid in January 2007. Despite earlier ambitions about a major spacecraft upgrade, only minor computer upgrades will be added to the improved Soyuz version to fly by the end of that year.

With the transportation system getting ready to support a six-person crew, managers of the International Space Station have been concentrating on getting the required hardware in place and certified to support the presence of such a crew. During crew handovers, routinely there are six people aboard the station, and after Columbia, NASA developed emergency plans to allow up to 10 people to survive there for several months if shuttle damage precluded safe return to Earth. But the hardware for sustained presence of a doubled crew under comfortable conditions has yet to be fully deployed.

Probably the most significant advance toward "six-ability" in 2007 was the inauguration of operations with NASA's own oxygen generation system (OGS). Using dry electrolyte in place of the troublesome liquids of Russia's Elektron system, the technology has been utilized in nuclear submarines for decades, and initial zero-G tests were promising once some control bugs were worked out. Additional plumbing to route condensate water directly into the unit (currently water has to be hauled to it in large plastic bags) and improved control software will bring the capability completely on line by early 2008.

At the September 2007 press briefing prior to the station handover to the Expedition-16 crew (Peggy Whitson, commanding), lead Flight Director Robert Dempsey elaborated on OGS plans: "We will push it longer and longer [over coming months]."

"We will also bring up additional equipment to reduce the CO<sub>2</sub> scrubbing load on the Russian hardware [the Vozdukh unit, which has generally functioned smoothly]," Dempsey continued. That unit will utilize waste hydrogen from the OGS that is now dumped overboard but will soon be piped to the CO<sub>2</sub> unit.

The hardware is the easy part. Johnson Space Center spokesman Rob Navias explained to me that the final critical load of gear—the extra bunkrooms, the final regenerative life support system hardware and the final supplies—will go up on the ULF-2 mission (STS-126), now slated for September 2008. After that, it's only a matter of personal luggage and mission-specific research materials, and the station will be ready for six permanent inhabitants.

In a detailed internal plan approved last August [2007], NASA has identified six distinct phases in its implementation of the six-person crew. Phase 1 involves delivering critical hardware, now in progress. Phase 2 verifies the hardware capability and performs

preliminary external reconfiguration to add a fourth Soyuz docking port (although that will not be available for the beginning of the six-person operations).

Probably the most significant operational challenge for crew expansion is the allocation of parking spaces. Currently there are three Russian standard docking ports, located at the back end of the Service Module, at the end of the Docking Compartment now attached to the nadir side of the Service Module, and on the nadir side of the FGB module. One spare modular attach point remains, on the zenith side of the Service Module. The docking ports must accommodate both Soyuz and Progress vehicles, along with long-term stays of Europe's Automated Transfer Vehicle supply drone (aft end only).

The latest plan is to relocate the Pirs Docking Compartment from its current position to the opposite attach point. This doesn't increase docking capability but clears the way for it to occur after the mid-2009 arrival of the fourth, fifth, and sixth long-term crewmembers.

Russia has announced plans to dock a laboratory unit (the rebuilt backup FGB), with at least one more docking port, after the installation at the nadir port of a second docking compartment brought up in one of the final shuttle missions. But the schedules for the so-called Docking and Cargo Compartment (DCM) and Proton-launched Multifunctional Laboratory Module, or MLM, remain in doubt because Russian government funds, not U.S. and European subsidies, are needed to pay for it.

When the MLM eventually arrives, Phase 4 begins, with each new crew overlapping the crew it is replacing to guarantee adequate handover familiarization. But until then, there may not be enough ports if even a single supply ship remains docked. The US Node 3 is also supposed to show up in this period, and there will then be a major reshuffling of equipment racks between it, the Destiny Lab and the two other nodes.

The best plan devised so far, in the absence of a fourth Russian docking port, is for the end-of-tour three-man crew to depart the station in their Soyuz prior to the arrival of the next Soyuz with their replacement crew. This would briefly leave the station with a three-person crew and would make face-to-face handovers impossible. Alternately, a Progress freighter could undock, hang out a few miles away for two weeks and return to a docking port just vacated—if it had enough maneuvering fuel left over.

This first approach would frustrate any Russian capability to fly paying space tourists once the station achieves the six-person crew size (but before the MLM arrives), eliminating a major income source. Currently the short-term tourist goes up with a new crew and comes down with the replaced crew, with the third permanent crewmember carried up and down on shuttle flights. Without shuttles, but with replacement crews overlapping their predecessors, this still might be feasible if some Russians stay aboard the station for longer than six months and come home on the next Soyuz, a practice that had been followed on Mir (U.S. officials are adamant they have no plans for American duty tours longer than six months). But with only three active docking ports, even that

option—and the money it would earn—vanishes, and that is a financial incentive to Moscow to get their fourth docking port operational ASAP.

Something will be worked out, say NASA officials. They will find some way to manage through Phase 5 (after the shuttle retires) and Phase 6 (after the new U.S. human spacecraft becomes operational). Meanwhile, this transition is already close enough that cosmonaut crews are beginning training. According to Moscow's NK magazine, Aleksandr Kaleri may command the first upgraded Soyuz mission in late 2009, since he has been assigned as lead development engineer for the improvements. The first extra Soyuz that establishes a six-person long-term capability will be commanded, according to preliminary schedules, by Yuri Lonchakov. Those assignments, and the precise schedules, are bound to shift in coming months, but the operational quantum leap to six station inhabitants remains the central goal of this dynamic and challenging phase of space station expansion.