ISSN 0735-9314

THE COMMERCIAL SPACE REPORT™

A MONTHLY NEWSLETTER ON FREE ENTERPRISE IN SPACE

Volume 9, No. 12 December, 1985

New NASA Space Station Configuration Heeds Users' Requirements

The National Aeronautics and Space Administration (NASA) Space Station reference design has been changed from the original "power tower" structure to a new layout called the "dual keel" design (see illustration, page 2). With the new design, NASA is attempting to address a number of user criticisms of the old design.

A major reason for the change was to provide users with an improved microgravity environment. A large structure such as the Space Station orbiting the Earth is acted upon by tidal forces which tend to pull the top and bottom of the Station in an upward and downward direction respectively. This "gravity gradient stabilization" keeps the Station oriented vertically with respect to the surface of the Earth, and is useful in conserving station-keeping propellant. However, these tidal forces, although quite weak by normal standards, can still affect microgravity experiments and processes which are sensitive to even the slightest gravitational pull. To counter this, NASA has moved the laboratory and habitation modules from the bottom of the structure to a point near the Station's center of gravity where tidal forces are reduced to a minimum.

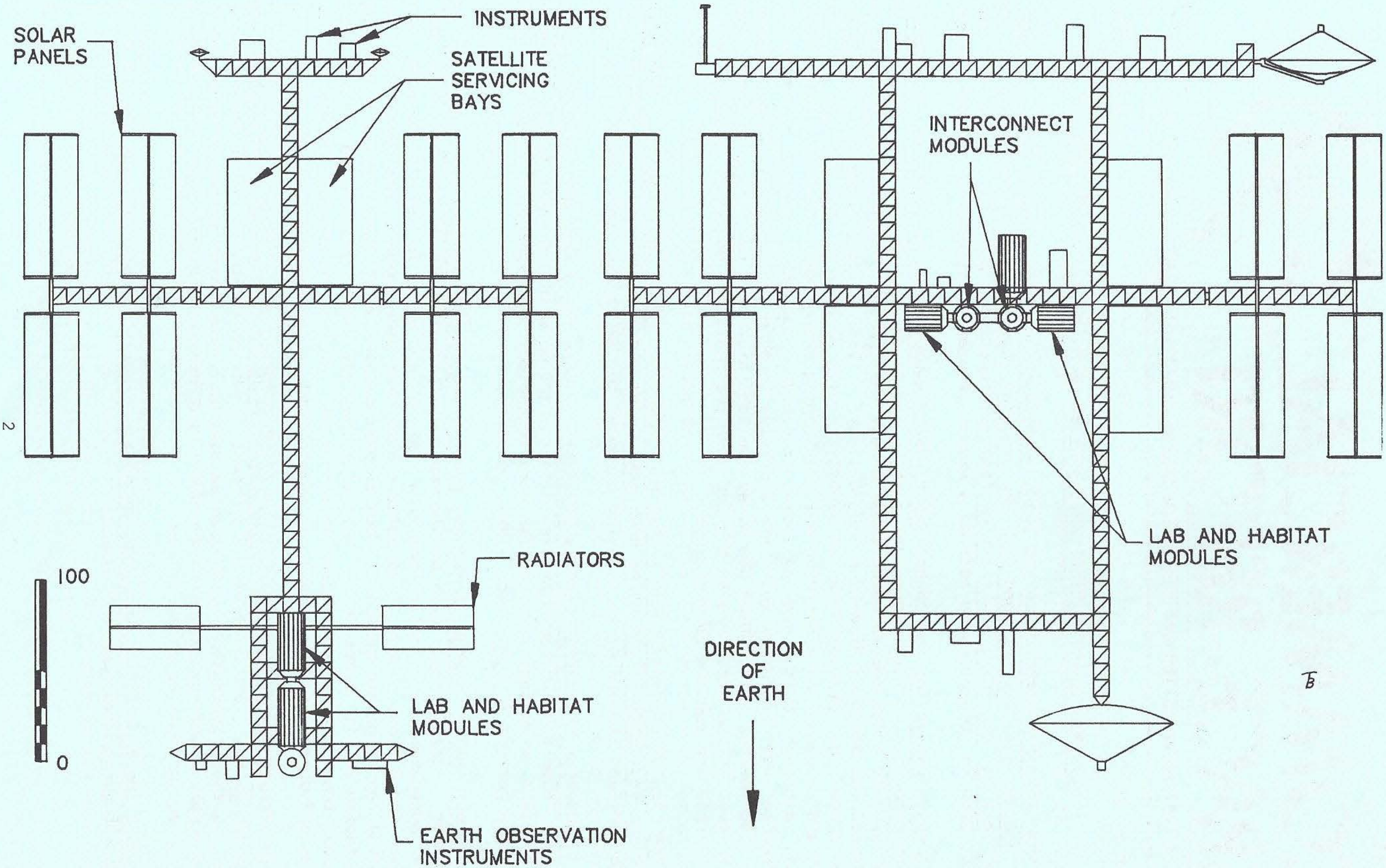
The dual keel design also allows more space to mount experiments, satellite servicing facilities, and other elements. The wide top and bottom crossbeams in particular lend themselves to mounting hardware for Earth and space observation.

In addition, the dual keel is structurally more rigid than the old power tower concept. Some sources had expressed dissatisfaction with the power tower, claiming its flexible structure required far more technology and expense to stabilize than more rigid designs (C.S.R., Sept. 1984, pp. 5-6).

Another major change is the way the lab and habitat modules are connected to each other. Originally, each module was connected directly to the next in an end-to-end approximately circular formation (this is not clear in the illustration due to the front view). Now, the modules have been made longer, and they will be connected by separate spherical interconnect modules which have multiple docking ports facing in all directions. This will increase usable pressurized volume and, by using the interconnect modules as air locks, will allow greater flexibility in docking and greater safety should one module need to be isolated.

The design is still not yet finalized, although this should occur within the next month or so. For example, replacement of the photoelectric solar power arrays (shown on the illustration) with a solar dynamic power system is being considered. Such a system would use parabolic mirrors to collect sunlight and heat a fluid which would drive turbines to produce power.

Costs are expected to increase beyond the original $8 billion estimate, but no official figures have been mentioned.



"POWER TOWER" CONFIGURATION

"DUAL KEEL" CONFIGURATION

Astronauts, Cosmonauts Continue to Verify Value of Manned Space Operations

Space Shuttle Construction Experiments Successful:

Astronauts aboard Mission 61-B of the NASA Space Shuttle exceeded expectations with experiments designed to investigate manual construction techniques in space. The techniques had been heavily rehearsed on Earth in large neutral buoyancy water tanks designed to simulate weightlessness.

The two experiments were ACCESS and EASE, which stand for "Assembly Concept for Construction of Erectable Space Structures" and "Experiment Assembly of Structures in Extravehicular activity" respectively (it wouldn't surprise me to find out that a considerable portion of NASA's budget goes to a department whose sole job it is to create acronyms.)

In the ACCESS experiment, two space-suited astronauts, Army Lt. Col. Sherwood C. Spring and Air Force Major Jerry L. Ross, used a series of components (an assembly jig, 93 1-inch-diameter tubular aluminum struts of two different lengths, and 33 nodal joints--all components designed to snap together without tools) to assemble a truss structure 45 feet in length. Such a truss is a basic design element in large space structures such as space stations or various types of space platform (note the truss structure that forms the backbone of the U.S. Space Station design on the opposite page).

In the EASE experiment, the astronauts assembled considerably larger elements (six aluminum beams, each 12 feet long and weighing 64 lbs.) into an inverted tetrahedron, or three-sided pyramid with its fourth side, or "base" upwards.

During the first extravehicular activity (EVA), the astronauts began with basic assembly exercises. Ross and Spring fixed themselves to foot restraints in the payload bay and used an assembly jig to snap together the ACCESS truss from the bottom up, sliding each assembled portion upward as it was completed. Reversing the process, they then disassembled it. This procedure took an average of 58 minutes during water tank rehearsals and a time period of two hours had been allotted to do the task in space. The astronauts completed the task in 55 minutes.

Ross and Spring then turned to the EASE experiment. Held in place only by safety lines, both astronauts climbed around on the structure, assembling and disassembling the tetrahedron eight times. Again, assembly times were shorter than those in the water tank (mission planners had estimated that there would be time for only about six assembly operations). The astronauts had no real problems except for a notable fatigue in their hands, possibly due to stiffness in the spacesuit gloves.

During the second EVA the next day, the astronauts experimented with more complex assembly techniques. The ACCESS truss was assembled using the previous method, except for a portion at the top. Ross then stood on a foot restraint mounted on the orbiter's manipulator arm, controlled from within the Shuttle by astronaut Mary L. Cleave. Using the arm, Cleave and Ross completed the truss assembly. Then, Ross was moved by Cleave slowly up the side of the truss, practicing stringing a simulated electrical cable along the structure. Additional exercises included both Ross and Spring taking turns on the arm removing the ACCESS truss from its attachment point on the Shuttle, single-handedly moving the 45-foot structure around to show handling capability, and then manually replacing the structure on its attach point. The astronauts later performed further experiments with the EASE structure, including detaching it from the Shuttle and moving the 400 lb. pyramid around by hand. Over the two EVAs, the astronauts spent a total of 12 hours on the space structures experiments.

The success of these experiments proves that manual construction of large space structures is workable, eliminating much of the necessity for the complex, expensive automatic deployment systems or "beam builders" that would otherwise be required. In addition, human construction workers are capable of a flexibility unmatched by other methods, as shown by the wide variety of techniques used in the Shuttle experiments. Even teleoperator systems, where a human operator remotely manipulates handling equipment to assemble structures, have been shown to take up to five times longer in water tank tests to perform similar tasks although this can probably be improved.

We may be able to look forward to a day when the term "high-steel worker" will take on a whole new meaning.

Cosmonauts Salvage Dead Space Station:

Soviet Cosmonauts also demonstrated the value of having human beings "on the spot" to take over when automatic equipment fails. In October of 1984, the last Salyut crew left the station to return to Earth, putting the Salyut into "mothballs." In early 1985, the Soviets announced that the Salyut 7 had "completed its mission," implying that the station was obsolete and would be replaced for that reason. The real story, which began to emerge from the Soviet Union only last August, was something completely different.

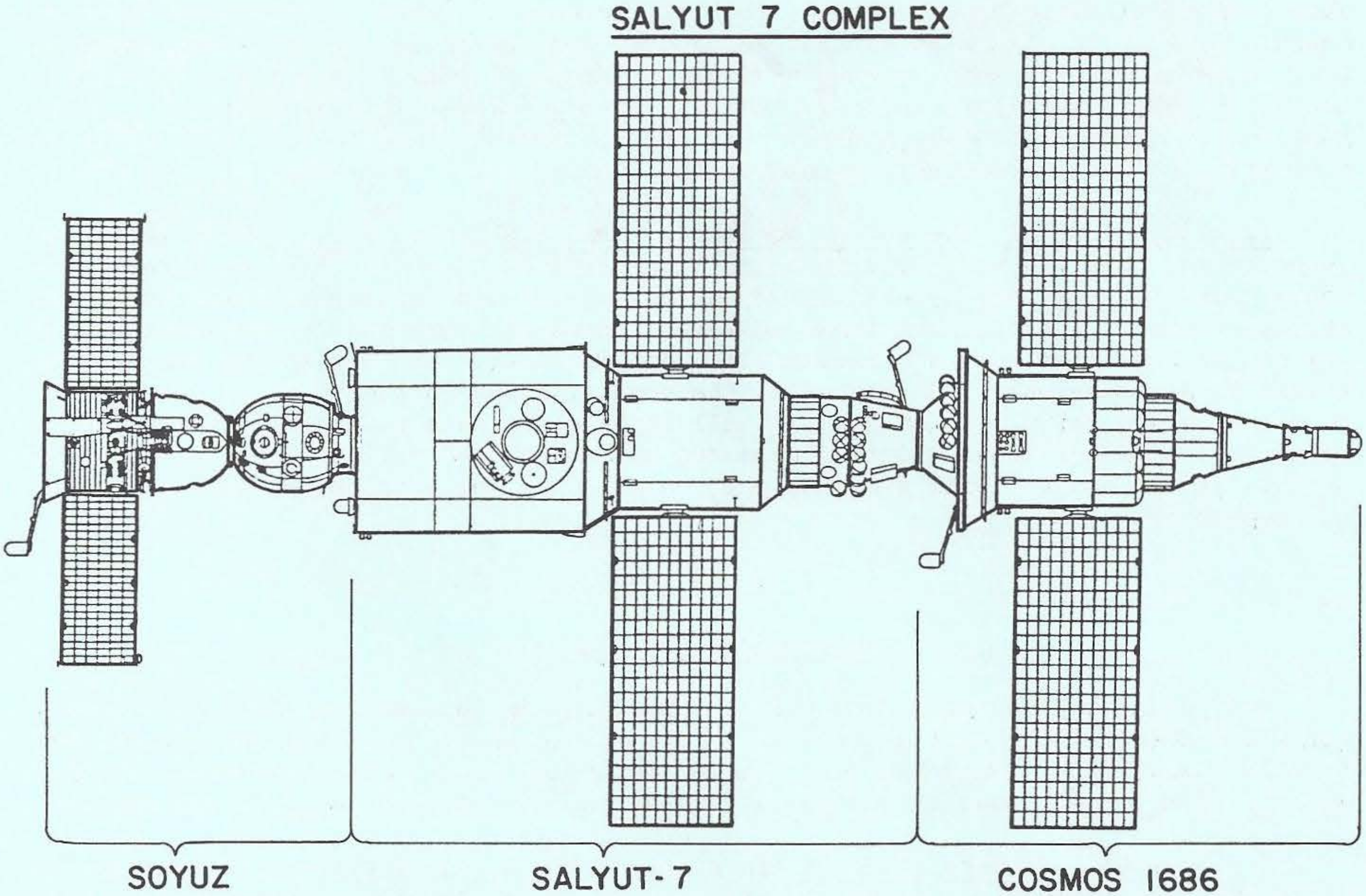
Sometime in the winter of 1984-85, the Salyut 7 electrical control system failed and its batteries died. As a result, water and equipment on board literally froze solid, and the station ceased transmission of signals and began to drift. It appeared that the station was lost.

In June of 1985, the Soviets launched cosmonauts Vladimir Dzhanibekov and Victor Savinykh aboard Soyuz T-13 to rescue the stricken Salyut. On June 8, the cosmonauts were forced by the station's inactivity to perform the first totally manual docking in the Soviet space program. Complicated by the slow rotation of the drifting Salyut, the docking took 50 hours to accomplish.

The two cosmonauts found the air breathable, but bitterly cold, well below freezing. A crust of ice had formed on the surfaces of the controls, and the station was without lights. For ten days, living out of their Soyuz spacecraft and wearing their spacesuits for warmth, Dzhanibekov and Savinykh worked to restore the station. They could not simply tap the Soyuz power supply, since the unknown electrical fault could drain the spacecraft's batteries as well, leaving the cosmonauts stranded. Bypassing the electrical control system, they connected some of the Salyut's batteries directly to the station's solar power arrays and began to charge them. Finally, all the batteries were either replaced or recharged, and the fault in the control system was located and repaired. The Salyut was brought up to normal temperatures and operating levels.

Once before, in April of 1984, cosmonauts made major external repairs to the Soviet Salyut 7 space station. I covered this event in the December, 1984 issue of the C.S.R. along with earlier feats of U.S. astronauts in an article very similar to this one. In light of the recent American and Soviet advances detailed above, I believe that the closing paragraph of that article bears repeating:

> "Regardless of the nations involved, or the financial and political merits of launch systems such as the Shuttle, the concept of manned spaceflight stands on its own. The future of humanity in space depends on having humanity itself out there. Not too many years ago, supporters of this position had to defend it largely on faith, and on historical precedents based on analogous earth explorations. With more and more examples of human beings putting space missions back on the scoreboard when the machines drop the ball, this is no longer true."



Salyut Mission Update

After its repairs, Salyut began performing its mission once more, and considerable activity has taken place over the past year. On June 24, an unmanned Progress resupply vehicle was docked to the Salyut. After its resupply mission was complete, the Progress was detached and commanded to a destructive reentry on July 15th.

In July, a spacecraft designated Cosmos 1,669 docked with the Salyut using the port vacated by the Progress vehicle (the Salyut has only two docking ports, and organizing docking of various vehicles often begins to look like a game of "Musical Chairs"). This spacecraft's purpose was unclear, although some observers speculated that is may have been a prototype unmanned free-flyer. If so, it didn't do much free-flying...following its separation from Salyut on August 29, it was commanded to a fiery burnup just like the Progress module.

On August 2, the cosmonauts left the station to attach a supplementary solar power array to one of the Salyut's three existing solar arrays (the other two arrays have had similar panels attached on earlier missions).

The vacant docking port was then filled on Sept. 18 by a new Soyuz capsule (T-14) containing three new cosmonauts, Lt. Col. Vladimir Vasyutin, Lt. Col. Alexander Volkov and Georgiy Grechko. After about a week, Grechko returned to Earth along with one of the first crew, Dzhanibekov, aboard the old T-13 Soyuz. Savinykh stayed on board with Vasyutin and Volkov (this was the first time that an actual crew rotation has taken place on Salyut 7, an important step in establishing a permanent manned presence in space).

The next guest at the docking port was a large unmanned module, Cosmos 1,686, which docked only a few days after the crew exchange. This 43-foot, 44,000 lb. unit nearly doubled the interior volume of the Salyut 7 complex (see above illustration).

This module's purpose was unknown, but it includes a large recoverable reentry capsule similar to one on an earlier version of such a module. Speculation was that this capsule was intended to return either products of materials processing experiments, or Soviet military intelligence data from instruments aboard Salyut. Given that the two new crewmembers aboard, Lt. Cols. Vasyutin and Volkov, were military officers, the latter conclusion seems likely.

Finally, towards the end of November, Vasyutin became ill. The illness was unspecified, but was suspected of being kidney stones, appendicitis, or viral pneumonia. Hints from the Soviets that other cosmonauts had earlier suffered from less serious forms of the disorder seem to favor the respiratory theory (ironically, it was one of the later crew who became ill, not Savinykh, who was aboard during the frigid repair mission). In any case, the condition was warranted to be too serious to treat aboard Salyut, so on Nov. 21, all three cosmonauts returned to Earth in the Soyuz T-14 capsule, leaving Salyut unmanned once more, and waiting for its next crew which, it is hoped, will find the empty station in somewhat better condition than the repair crew did.

* * *

Recommended Publication

The current issue of McGraw-Hill's *Commercial Space* magazine (Fall 1985) contains a number of interesting articles. Subjects covered in detail include Ariane/Shuttle competition, Spacehab Inc., some history on space entrepreneurs, further details on McDonnell Douglas and 3M (discussed in last month's *C.S.R.*), and more.

I recommend *Commercial Space* (in spite of the title) for those interested in following up commercial space activities in more detail. Subscriptions are $30.00/year (four quarterly issues). Unfortunately, as with their publication *Aviation Week and Space Technology* (which I also recommend), McGraw-Hill tries to restrict *Commercial Space* to subscribers associated in some way with the aerospace industry. On the other hand, the publishers are noted for some flexibility in this area. For information, find an *Aviation Week*. An ad for *Commercial Space* is usually inside, which includes a subscription form. If you're interested, copy it and fill it out, asking them to "bill you." All you stand to lose in that case is the postage required to mail it. If you want more information, contact Laster Maddox of McGraw-Hill at 404 Bayswater Ave., Burlingame, CA 94010. Phone number: (415) 579-4409.

Until next time,

Tom Brosz

The Commercial Space Report (C.S.R.) is published monthly, and endeavors to report and analyze developments in the field of private initiatives in space transportation and exploitation.

Subscription rates are: U.S., Mexico, Canada: 1 year–$15.00, 2 years–$28.00, 3 years–$39.00. Foreign Air Mail: 1 year–$20.00, 2 years–$38.00, 3 years–$54.00. Back issues are available at $1.50 each from September, 1977. Xerographic copies may be substituted as stocks are depleted.

Address all correspondence to: *Commercial Space Report, P.O. Box 60547, Sunnyvale, CA 94088.* Editor: Tom A. Brosz. Tel: (415) 965-8666. Comments, ideas, or requests for information are welcomed, as are any items which may be of interest to our readers.