

CBS News Space Place



[CBS NEWS](#) Coverage of Breaking Space News

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Editor's Note...

The CBS News space pages have been upgraded to improve compliance across different platforms. The revamped space pages are located here:

<http://www.cbsnews.com/network/news/space/home/index.html>.

Please bookmark the new site. CBS News space emails will continue as usual, but this page is being discontinued.

Changes and additions:

- 08/07/10 (07:25 AM): U.S. EVA-15 begins (ammonia pump R&R)
- 08/07/10 (06:35 PM): Marathon spacewalk derailed by ammonia leak, jammed fitting
- 08/09/10 (04:15 PM): Flight controllers revise plans for second coolant repair spacewalk
- 08/10/10 (05:45 PM): NASA managers approve plan for Wednesday spacewalk (UPDATED)
- 08/11/10 (06:15 AM): Spacewalk preparations slightly behind schedule
- 08/11/10 (08:30 AM): U.S. EVA-16 begins (ammonia pump R&R part 2)
- 08/11/10 (10:40 AM): M3 ammonia line successfully disconnected

10:45 AM, 8/11/10, Update: M3 ammonia line successfully disconnected

Astronaut Douglas Wheelock, applying brute force to shake a balky connector loose, successfully demated a final ammonia line from a failed coolant pump module today, setting the stage for the pump's removal and eventual replacement.

Because of a significant ammonia leak in the M3 connector during a spacewalk Saturday, Wheelock and Tracy Caldwell Dyson were unable to complete preparations for the pump's removal, leaving the line in place pending additional troubleshooting.

Today, the astronauts planned to first close a quick-disconnect fitting on the outboard end of the S1 truss to isolate the line leading to the M3 connector. But Caldwell Dyson was unable to depress a release button, preventing her from closing the outboard quick-disconnect.

Flight controllers then told Wheelock, anchored to the end of the space station's robot arm, to press ahead with an attempt to simply close the leaking M3 connector in hopes that lower pressure in the line, the result of earlier ground-commanded nitrogen venting, would reduce the leakage enough to disconnect the line from the pump.

To the relief of anxious flight controllers, the connector closed easily and no major leakage was observed.

"I don't see anything leaking," Wheelock reported.

"Excellent," replied Oscar Koehler from mission control in Houston. "And Wheels, if you see any leak, we're comparing this leak to what you saw when you first did the SPD on EVA-1.

"OK, I see a couple of little snowflakes," Wheelock reported a moment later. "But I don't see anything leaking around the white band like last time. ... OK, here they start to come out now by the white band, just little snowflakes."

The leakage quickly diminished and flight controllers told Caldwell Dyson there was no need to continue work to close the outboard quick-disconnect.

"That's great news," Wheelock said.

"It's awesome," Koehler agreed.

A few moments later, with no observable leakage, engineers decided there was no need to install a vent tool to release any residual ammonia that might be trapped in the line. Wheelock was then cleared to remove M3 from the pump module.

But in keeping with M3's now-familiar behavior, Wheelock was initially unable to pry the fitting apart using a lever tool.

"We believe there may be ice in there that's keeping it from releasing," Koehler advised. "So you've got a go to ... move the QD left to right to try to shake some of that ammonia ice out of there."

After working the fitting from side to side with no success, mission control told Wheelock "you've got a go to shake violently, that's the words I was given, in all directions."

Television views from Wheelock's helmet camera showed him energetically shaking the fitting from side to side. After multiple attempts, the connector finally released and Wheelock pulled the M3 line away from the pump at 10:23 a.m.

There were no obvious signs of problems with the connector and the astronauts were cleared to press ahead with their pump removal work. Five electrical cables will be demated by Caldwell Dyson before the astronauts loosen four bolts to free the pump from the S1 truss.

If all goes well, the pump will be mounted on an attachment fitting at the base of the station's robot arm transporter.

8:30 AM, 8/11/10, Update: Spacewalk begins

Astronauts Douglas Wheelock and Tracy Caldwell Dyson, floating in the Quest airlock module, switched their spacesuits to internal battery power at 8:27 a.m. to officially kick off a planned six-hour spacewalk. The primary goal of the excursion is to remove a shorted ammonia pump module so a replacement can be installed during a spacewalk Sunday.

This is the 149th EVA devoted to space station assembly and maintenance since construction began in 1998, the 13th so far this year, the fifth overall for Wheelock and the second for Caldwell Dyson. Going into today's outing, ISS spacewalk time stood at 929 hours and 38 minutes, or 38.7 days.

For identification, Wheelock, call sign EV-1, will be wearing a suit with red stripes around the legs and use helmet cam No. 19. Caldwell Dyson, EV-2, will wear an unmarked suit and use helmet cam No. 20.

The astronauts attempted to remove the faulty pump during a spacewalk Saturday, but one of four ammonia line quick-disconnect fittings leaked, presumably because of problems with an internal valve on the outboard side of the fitting.

Today, Wheelock will make another attempt to simply close the M3 quick-disconnect fitting. If the leak persists, the astronauts plan to close quick-disconnect valves at the inboard and outboard ends of the starboard one, or S1, truss where the pump module is located to isolate the ammonia line leading to the leaking connector.

Flight controllers earlier lowered pressure in the system and after the astronauts install a vent tool to get rid of any residual ammonia trapped in the line, the M3 quick disconnect will be closed and removed. That should clear the way for disconnection of five electrical umbilicals. After loosening four bolts, the failed pump module will be removed and temporarily mounted on a powered attach fitting at the base of the station's robot arm transporter.

If all goes well, a spare pump will be installed and reconnected during a third spacewalk Sunday.

Here is an updated timeline for today's spacewalk based on the official start time (in EDT and elapsed time; best viewed with fixed-width font):

```
EDT.....HH..MM..EVENT
08:27 AM...00...00...Suits to battery power
08:32 AM...00...05...Post depress/airlock egress
08:47 AM...00...20...Setup
09:12 AM...00...45...EV-2: Close S1 outboard QD
09:27 AM...01...00...EV-1: Vent line routing
09:57 AM...01...30...EV-1: S0/S1 inboard jumper QD closed
10:12 AM...01...45...EV-2: M1 ammonia line restrained
10:27 AM...02...00...EV-2: Start venting
10:37 AM...02...10...EV-1: Close M2 ammonia line
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11:07 AM...02...40...EV-1: Close vent tool
 11:12 AM...02...45...EV-2: Vent tool cleanup
 11:22 AM...02...55...EV-1: Close and demate M3 ammonia line
 11:32 AM...03...05...EV-2: Cover and restrain M3
 11:42 AM...03...15...EV-1: Break torque on failed pump module bolts
 12:02 PM...03...35...EV-1: Retrieve adjustable grapple bar
 12:02 PM...03...35...EV-2: Release failed PM electrical cables
 12:32 PM...04...05...EV-2: Release failed PM bolts
 12:47 PM...04...20...EV-1: Remove failed PM with AGB
 12:57 PM...04...30...EV-2: Remove failed PM
 01:32 PM...05...05...EV-1: Move failed PM to POA
 01:42 PM...05...15...EV-2: Break torque on new PM; cleanup
 02:02 PM...05...35...EV-1: Cleanup/airlock ingress
 02:27 PM...06...00...Airlock pre-pressurization

6:15 AM, 8/11/10, Update: Spacewalk preparations slightly behind schedule

Astronauts Douglas Wheelock and Tracy Caldwell Dyson are running about a half hour behind schedule in their preparations for a planned six-hour spacewalk to continue space station coolant system repairs. The spacewalk had been scheduled to begin at 7:55 a.m., but could slip to around 8:30 a.m. if the current pace holds up.

05:45 PM, 8/10/10, Update: NASA managers approve plan for Wednesday spacewalk (UPDATED at 6:25 p.m. with decision to delay start of spacewalk by one hour)

NASA managers Tuesday approved plans for a second spacewalk Wednesday to deal with an unexpected ammonia leak that blocked removal of a faulty coolant system pump aboard the International Space Station during a spacewalk Saturday. If the plan works, the old pump will be removed and a new pump installed and hooked up during a third spacewalk Sunday.

Astronauts Douglas Wheelock and Tracy Caldwell Dyson planned to spend the night in the station's Quest airlock module at a reduced pressure of 10.2 pounds per square inch to help purge nitrogen from their bloodstreams before the planned 6:55 a.m. EDT start of the six-hour spacewalk.

NASA managers decided late Tuesday, however, to delay the start of the EVA by one hour, letting the astronauts get a bit more sleep and giving engineers more time to fine-tune robotics procedures. Under the revised timeline, Wheelock and Caldwell Dyson will switch their spacesuits to battery power at 7:55 a.m. to officially kick off the excursion.

For identification, Wheelock, call sign EV-1, will be wearing a suit with red stripes around the legs. Caldwell Dyson, EV-2, will wear an unmarked suit. This will be the fifth spacewalk for Wheelock, the second for Caldwell Dyson, the 13th station EVA so far this year and the 149th since assembly began in 1998.

The ammonia pump in coolant loop A failed July 31, leaving the space station with just one coolant system to dissipate the heat generated by the lab's electronics. The loop A failure forced the astronauts to implement a widespread powerdown to prevent critical equipment from overheating.

Four spare pump modules are on board and NASA planners quickly developed plans for two spacewalks to remove the old pump and install a replacement. But those plans went awry Saturday when the spacewalkers ran into major problems disconnecting one of four ammonia lines.

After struggling to close a quick-release fitting on the M3 line, the astronauts reported a significant leak. The quick-disconnect was reopened and the spacewalkers headed back to the airlock for routine decontamination procedures. Engineers suspect a problem with one of two internal valves on the outboard side of the pump module.

For the second spacewalk, Wheelock and Caldwell Dyson first will close quick-disconnect valves on both ends of the starboard one, or S1, truss segment where the pump module is mounted. With those valves closed, the ammonia line leading to the leaking connector will be isolated.

Flight controllers planned to reduce pressure in the line before the spacewalk began, clearing the way for Wheelock and Caldwell Dyson to install a vent tool to release any residual ammonia trapped in the pump and its plumbing.

Then, if all goes well, the now-evacuated connector can be disconnected and moved out of the way. After unplugging five electrical cables, Wheelock and Caldwell Dyson will loosen four bolts and remove the old pump module, temporarily mounting it on a stowage fixture at the base of the station's robot arm transporter.

The replacement pump module would be installed and reconnected during a third spacewalk Sunday. The quick-disconnect valves that were closed to isolate the leaking connector would be reopened at that point and flight controllers would be free to re-activate coolant loop A.

Flight controllers are considering an alternative scenario for Wednesday's spacewalk that includes an initial attempt to simply close the M3 quick disconnect in hopes that whatever caused the leak Saturday is no longer present. If no leak is observed, Wheelock

could detach the M3 ammonia line straight away and press ahead with the pump's removal.

If the leak reappears, the astronaut would reopen the quick-disconnect and press ahead with work to isolate that section of the line. It is not yet clear whether flight controllers will, in fact, clear Wheelock to spend the time needed to reach the M3 valve as opposed to simply isolating the line right away as currently planned.

Here is an updated timeline of major events (in EDT and elapsed time; best viewed with fixed-width font):

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EDT.....HH...MM...EVENT
03:00 AM.....Crew wakeup
03:35 AM.....Crew hygiene break
04:45 AM.....EVA preps continue
06:15 AM.....Spacesuit purge begins
07:20 AM.....Airlock depressurization begins
07:55 AM...00...00...Suits to battery power
08:00 AM...00...05...Post depress/airlock egress
08:15 AM...00...20...Setup
08:40 AM...00...45...EV-2: Close S1 outboard quick-disconnect
08:55 AM...01...00...EV-1: Vent line routing
09:25 AM...01...30...EV-1: Inboard S0/S1 jumper QD closed
09:40 AM...01...45...EV-2: M1 ammonia line restrained
09:55 AM...02...00...EV-2: Start venting
10:05 AM...02...10...EV-1: Close M2 ammonia line
10:35 AM...02...40...EV-1: Close vent tool
10:40 AM...02...45...EV-2: Vent tool cleanup
10:50 AM...02...55...EV-1: Close and demate M3 ammonia line
11:00 AM...03...05...EV-2: Cover and restrain M3
11:10 AM...03...15...EV-1: Break torque on failed pump module bolts
11:30 AM...03...35...EV-1: Retrieve adjustable grapple bar
11:30 AM...03...35...EV-2: Release failed PM electrical cables
12:00 AM...04...05...EV-2: Release failed PM bolts
12:15 AM...04...20...EV-1: Remove failed PM with AGB
12:25 AM...04...30...EV-2: Remove failed PM
01:00 PM...05...05...EV-1: Move failed PM to stowage fixture
01:10 PM...05...15...EV-2: Break torque on new PM; cleanup
01:30 PM...05...35...EV-1: Cleanup/airlock ingress
01:55 PM...06...00...Airlock pre-pressurization
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04:15 PM, 8/9/10, Update: Flight controllers revise plans for second coolant repair spacewalk

Flight controllers are revising plans for a second spacewalk Wednesday to replace a coolant pump aboard the International Space Station, adding work to isolate an ammonia leak that should clear the way for installation of a new pump during a third spacewalk Sunday.

A formal decision on whether to proceed with the Wednesday spacewalk is expected after NASA's space station Mission Management Team reviews preparations during a meeting Tuesday at the Johnson Space Center in Houston.

The pump module, one of two in independent coolant loops, circulates ammonia through huge radiators to dissipate the heat generated by the lab's electronics. The loop A pump shorted out July 31, forcing the six-member crew to implement an extensive powerdown to prevent equipment from overheating.

The station can operate safely with just one coolant loop, but both are needed for normal operations. Adding a bit of urgency is the lack of redundancy in a critical system. If the loop B system should suffer a shutdown before loop A is repaired, the space station would face a much more serious problem with little time to resolve it.

Astronauts Douglas Wheelock and Tracy Caldwell Dyson conducted the first of what was expected to be a two-spacewalk repair job Saturday. They had hoped to disconnect the old pump, demating five electrical lines and four ammonia quick-disconnects, before installing a spare pump at the end of the excursion. Ammonia lines were to be reconnected during a second spacewalk Wednesday.

But Wheelock and Caldwell Dyson ran into major problems with a quick-disconnect fitting on one of the ammonia lines attached to the failed pump. After struggling to simply disconnect the M3 fitting, they ran into a significant leak that forced them to leave the line in place while troubleshooters considered what to do next.

Because of the leak, the spacewalk ran eight hours and three minutes and required a decontamination procedure at the end to make sure the astronauts did not bring any toxic ammonia back into the station's pressurize modules.

Engineers believe the leak is due to problems with one of two valves in the quick-disconnect fitting. The valve in question is outboard of the pump module and cannot easily be vented to stop the leak.

As a result, engineers have come up with a revised plan for the crew's second spacewalk Wednesday, one that would require them to first open a quick-disconnect between the central S0 truss segment and the starboard one, or S1, segment. Another QD near the outboard end of the S1 segment also must be opened.

To lower pressure in that segment of the line, flight controllers plan to activate a pressure relief valve before the spacewalk begins to make it easier for the astronauts to close the S0/S1 segment quick disconnect. Wheelock and Caldwell Dyson then can use a vent

tool to release any residual ammonia trapped in the line leading to the M3 quick-disconnect.

Assuming that works, the M3 line will be removed, clearing the way for Wheelock to disconnect the five electrical cables and loosen the four bolts holding the failed pump module in place. Caldwell Dyson, meanwhile, will prepare a spare pump module on external storage platform No. 2 for removal during the third spacewalk.

With that work done, Wheelock, assisted by Caldwell Dyson, will use an adjustable grapple bar to move the failed unit to a powered payload attachment fitting at the base of the robot arm's mobile transporter.

At that point, the spacewalkers will collect their tools and return to the Quest airlock for possible decontamination procedures.

In yet another complication for spacewalk planners, Wheelock and Caldwell Dyson will be using rechargeable carbon dioxide removal cartridges in their spacesuits, which cannot operate as long as the lithium hydroxide scrubbers used during the first spacewalk.

Because they must protect a block of time at the end of the spacewalk for decontamination, Wheelock and Caldwell Dyson will face a more compressed timeline with more limited objectives.

But if all goes well, the astronauts will be able to carry out a third spacewalk Sunday to install the spare pump module, disconnect a pressure-regulating jumper box and reconnect the electrical cables and ammonia lines. The failed pump module eventually will be moved to external storage platform No. 2, but it's not clear when that might happen.

Here is a preliminary timeline for the revised second spacewalk, assuming it is approved by the space station MMT (in EDT and elapsed time; best viewed with a fixed-width font):

```
EDT.....HH..MM...EVENT
06:55 AM...00...00...Suits to battery power
07:00 AM...00...05...Post depress/airlock egress
07:10 AM...00...15...Setup
07:40 AM...00...45...EV-2: CETA relocate; close DDCU QD; close M2
07:55 AM...01...00...EV-1: Close segment jumper QD; vent PM; close M2
10:00 AM...03...05...EV-2: Spare PM; open MLI; break torque
10:15 AM...03...20...EV-1: Failed PM electrical demate; break torque
11:00 AM...04...05...EV-1: retrieve adjustable grapple bar (AGB)
11:20 AM...04...25...EV-2: Attach AGB to failed PM
11:45 AM...04...50...EV-1: Remove failed PM from S1 truss
12:05 PM...05...10...EV-2: Cleanup
12:30 PM...05...35...EV-1: Failed PM to MBS POA
12:40 PM...05...45...EV-2: Airlock ingress; pre-press
01:00 PM...06...05...EV-1: Cleanup; airlock ingress
01:25 PM...06...30...Airlock pre-press
01:30 PM...06...35...Airlock repressurization (if no decontamination)
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6:35 PM, 8/7/10, Update: Marathon spacewalk derailed by ammonia leak, jammed fitting

An unexpected ammonia leak and a jammed quick-disconnect fitting disrupted an eight-hour three-minute spacewalk Saturday to replace a faulty coolant system pump on the International Space Station. Assuming engineers can come up with a fix for the leak, the pump replacement will be deferred to an already planned second spacewalk Wednesday.

But station Program Manager Mike Suffredini said he was not optimistic the work can be completed during a second excursion.

"It would take a lot of good luck and somebody coming up with a really short tweak to the EVA for us to get to the point where we could start that ammonia pump after the next EVA," he said. "I really think we're going to end up at three EVAs (spacewalks).

"So I think we're going to end up being in this condition, this risk posture, a few more days than we had originally planned. That, to me, is the risk. I fully expect us to get through this particular problem and move on. I just am not optimistic we'll get all the way to the point where we can hook up the ammonia (lines) to the new pump and start it after the second EVA."

Douglas Wheelock and Tracy Caldwell Dyson began the spacewalk at 7:19 a.m. when they switched their spacesuits to battery power before floating out of the station's Quest airlock module.

The astronauts already knew it would take two EVAs to replace the shorted ammonia pump module, which failed last Saturday and knocked out one of the station's two coolant loops.

During Saturday's excursion, Wheelock and Dyson hoped to disconnect three 1.5-inch-wide ammonia coolant lines, one .5-inch cooling line and five electrical cables before unbolting the pump and removing it from the starboard one, or S1, truss segment

They planned to install a replacement pump and, if time was available, reconnect the electrical cables. The ammonia lines were to be reconnected during the second spacewalk Wednesday.

The astronauts had no problem disconnecting the smaller M4 cooling line. But Wheelock ran into major problems with the quick

disconnect fitting on the second line he attempted. The fitting on the larger M3 line refused to unlatch initially, forcing Wheelock to use a lever to pry it open. That finally worked, but he reported seeing ammonia leaking out of the fitting.

"I see little sparklets of ammonia coming from the line," Wheelock reported.

"I copy. Are they continuous, or did you just see a few at first?" asked Oscar Koehler in mission control at the Johnson Space Center in Houston.

"It's just sort of random, like little tiny snowflakes," Wheelock said.

He was then asked to cycle the quick-disconnect latch, fully re-mating the connector. When he tried to reopen the QD fitting, the latch refused to budge.

After multiple attempts with the lever tool, he muttered "wow, that thing is not budging, Oscar." Astronaut Shannon Walker, operating the station's robot arm, moved Wheelock into a more favorable position and he tried again. But again, he was unable to reopen the latch.

Koehler told him to take a break at that point and to wait for orbital darkness in hopes that the temperature change would reduce internal pressure in the line and make the latch easier to throw. But again, the latch refused to budge.

While flight controllers considered various options, Wheelock and Caldwell Dyson pressed ahead with work to disconnect the other two 1.5-inch ammonia lines. Both unlatched without any trouble and there were no signs of additional ammonia leakage.

The M2 ammonia line was plugged into a so-called "jumper box," as was the .5-inch M4 cooling line. The jumper box will allow ammonia in the loop A cooling system to respond to temperature-induced pressure changes while the pump repair work continues.

With three of the lines successfully demated, Koehler asked Wheelock to give the M3 connector one more try. After applying more elbow grease - and lightly whacking the fitting with a tool - the latch released and engineers were hopeful the line could be disconnected as planned.

But once again, ammonia ice crystals spewed out of the connector and flight controllers, worried an internal valve might not be fully closed, told Wheelock to re-latch the M3 quick-disconnect fitting and leave it in place. Otherwise, the crew might run the risk of inadvertently draining a significant amount of coolant.

By that point, Wheelock and Caldwell Dyson were several hours behind schedule. And because of the ammonia leak, flight controllers had to protect a block of time at the end of the spacewalk for spacesuit decontamination. Anytime spacewalkers are exposed to ammonia, extra time is needed to make sure any ice crystals attached to the suits can evaporate before the astronauts re-enter the station.

With time running out, Wheelock and Dyson attached insulation to the ammonia line fittings and headed back to the Quest airlock. The spacewalk ended at 3:22 p.m. when airlock repressurization resumed after decontamination.

Suffredini said it appears one of two internal QD valves may be to blame for the leak, one that is on the outboard side of the coolant line. There are no nearby isolation valves upstream of that side of the connector and flight controllers cannot easily reduce the pressure in the system.

"There are a few options," Suffredini said. "One is try it again, does it work? Two is to see can we handle a leaky QD? If it's the female QD, can we just handle it and deal with the leak and put it somewhere else, perhaps on the jumper box, until we're ready to install it later?"

"Another possibility we're kicking around is the idea of just depressing that side of the system - and that's a much more drawn-out process where we'd have to disconnect jumpers between trusses and things of this nature. They'll go through all those cases. But I'm afraid there's nothing really we can do on the ground, command wise, that necessarily will clear these leaks."

And until the leak is cleared and the M3 coolant line demated, the failed pump module cannot be removed and replaced.

This was the longest station-based spacewalk by an expedition crew, although still shy of the U.S. EVA record of eight hours and 56 minutes.

Space station EVA time now stands at 929 hours and 38 minutes, or 38.7 days, over 148 spacewalks since assembly began in 1998. This was the first spacewalk for Caldwell Dyson and the fourth for Wheelock, who has now logged 28 hours and 44 minutes of EVA time.

7:25 AM, 8/7/10, Update: U.S. EVA-15 begins (ammonia pump R&R)

Floating in the Quest airlock module, astronauts Douglas Wheelock and Tracy Caldwell Dyson switched their spacesuits to battery power at 7:19 a.m. EDT to officially kick off a planned seven-hour spacewalk.

The primary goal of the excursion is to replace a 780-pound ammonia pump module that failed last Saturday, knocking one of the space station's two coolant loops out of action and forcing the crew to implement an extensive powerdown.

This is the fourth spacewalk for Wheelock and the first for Caldwell Dyson. For identification, Wheelock, call sign EV-1, is wearing a suit with red stripes on the legs. He will spend most of the spacewalk anchored to the end of the station's robot arm, operated by Shannon Walker in the Destiny lab module.

Caldwell Dyson, call sign EV-2, is wearing an unmarked suit and will position herself as required, using portable foot restraints.

The International Space Station is equipped with two independent coolant loops that circulate ammonia through giant radiators to dissipate the heat generated by the lab's electronics. Both loops are needed for normal operation.

Wheelock and Caldwell Dyson already were gearing up for a planned assembly spacewalk this past Thursday. But with the failure of the loop A coolant pump, NASA managers decided to mount two repair EVAs instead.

During today's outing, Wheelock and Caldwell Dyson plan to disconnect the faulty loop A coolant pump; install a jumper box to maintain the proper pressure in the coolant loop during the repair work; remove the old pump, temporarily stowing it on a mounting fixture; and install a replacement pump, one of four aboard the space station.

If time is available, the astronauts will reconnect five power and data cables. Four ammonia lines will be connected during a second spacewalk Wednesday.

The loop A pump module is located on the forward face of the starboard one, or S1, segment of the station's main solar power truss. The loop B pump module is located on the left side of the truss in the port 1 segment.

The replacement pump is mounted on external storage platform No. 2 just ahead of the Quest airlock.

Here is an updated timeline of today's activity (in EDT and elapsed time; best viewed with fixed-width font):

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EDT.....HH...MM...EVENT
07:19 AM...00...00...Spacesuits to battery power
07:24 AM...00...05...Post depress/egress
07:49 AM...00...30...Setup
08:09 AM...00...50...EV-1: Pump module (PM) removal preps
08:19 AM...01...00...EV-2: CETA cart preps
08:59 AM...01...40...EV-1: Robot arm (SSRMS) prep and ingress
09:09 AM...01...50...EV-2: PM jumper vent
09:24 AM...02...05...Initial PM quick-disconnect ops
10:29 AM...03...10...EV-1: Retrieve adjustable grapple bar (AGB)
10:29 AM...03...10...EV-2: Prep failed PM for removal
11:14 AM...03...55...Remove failed PM
11:34 AM...04...15...EV-1: Move failed PM to POA stowage location
11:34 AM...04...15...EV-2: Spare PM preps
11:54 AM...04...35...EV-1: Spare PM preps
12:14 PM...04...55...BINGO for spare PM removal
12:44 PM...05...25...Remove spare PM
01:14 PM...05...55...Install spare PM
01:49 PM...06...30...Cleanup and ingress
02:14 PM...06...55...Pre-airlock repress
02:19 PM...07...00...Airlock repress
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This is the 148th spacewalk devoted to space station assembly and maintenance since construction began in 1998 and the 12th so far this year. Total EVA time going into the spacewalk was 921 days and 35 minutes, or 38.4 days.

11:38 AM, 8/6/10, Update: Astronauts set for Saturday space station coolant system repair spacewalk

Astronauts Douglas Wheelock and Tracy Caldwell Dyson made final preparations Friday for a planned spacewalk Saturday to replace a shorted ammonia pump module in the International Space Station's external cooling system.

Wheelock and Caldwell Dyson planned to shut themselves in the Quest airlock module around 4 p.m., lowering the pressure to 10.2 pounds per square inch overnight to help purge nitrogen from their bloodstreams. Crew sleep was scheduled to begin at 5:30 p.m. with wakeup at 2 a.m. Saturday.

"I just want to let everyone know we have unanimous concurrence on a 'go' for EVA tomorrow," Kathy Bolt radioed the crew from mission control at the Johnson Space Center in Houston.

"And you've got a 'go' from the crew," Wheelock replied. "Thanks, we're very excited, Cathy, that's great news. We're ready to perform."

The space station features two ammonia coolant loops to dissipate the heat generated by the lab's electronics. A short circuit knocked the loop A pump module out of action Saturday, forcing the crew to implement an extensive powerdown.

Wheelock, making his fourth spacewalk, and Caldwell Dyson, making her first, trained for a pump replacement in September 2009. Engineers and astronauts at the Johnson Space Center have spent the past week refining procedures and fine-tuning the timeline.

For identification, Wheelock, call sign EV-1, will be wearing a spacesuit with red stripes while Caldwell Dyson, EV-2, will be wearing an unmarked suit. Wheelock will spend most of his time anchored to the end of the station's robot arm, operated by Shannon Walker inside the Destiny laboratory module. Caldwell Dyson will free float, positioning herself as required.

The station's other three crew members - Russian commander Alexander Skvortsov and cosmonauts Mikhail Kornienko and Fyodor Yurchikhin - are not directly involved in the repair work.

To replace the pump module, Wheelock and Caldwell Dyson will have to disconnect five power and data lines, three 1.5-inch ammonia lines and one half-inch coolant line. Two of those lines must be quickly connected to a "jumper box" to prevent pressure extremes in the ammonia supply as the station moves into and out of Earth's shadow.

An ammonia pump module, showing electrical and fluid line connections.

(Photo: NASA TV)

Once disconnected, the old pump will be unbolted, pulled out and moved to a powered payload attachment fitting at the base of the robot arm's mobile transporter. The astronauts then will move to external stowage platform No. 2, just in front of the Quest airlock module, to retrieve a replacement pump.

The primary goal of the spacewalk is to get the new pump module bolted in place. If time is available, Wheelock and Caldwell Dyson will reconnect the power and data lines. The ammonia lines will be connected during a spacewalk Wednesday.

Here is an updated timeline for Saturday's spacewalk (in EDT and elapsed time):

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EDT.....HH...MM...EVENT
02:00 AM.....Crew wakeup
02:35 AM.....Hygiene break
03:45 AM.....Spacewalk preparations resume
05:15 AM.....Spacesuit purge begins
06:00 AM.....NASA television coverage begins
06:20 AM.....Airlock depressurization begins
06:55 AM...00...00...Spacesuits to battery power (official start time)
07:00 AM...00...05...Post depress/airlock egress
07:30 AM...00...35...Tools/tether setup
07:50 AM...00...55...EV-1: Pump module (PM) removal preps
08:00 AM...01...05...EV-2: CETA cart preps
08:40 AM...01...45...EV-1: Robot arm (SSRMS) prep and ingress
08:50 AM...01...55...EV-2: PM jumper vent
09:05 AM...02...10...Initial PM quick-disconnect ops
10:10 AM...03...15...EV-1: Retrieve adjustable grapple bar (AGB)
10:10 AM...03...15...EV-2: Prep failed PM for removal
10:55 AM...04...00...Remove failed PM
11:15 AM...04...20...EV-1: Failed PM to temporary stowage fixture
11:15 AM...04...20...EV-2: Spare PM preps
11:35 AM...04...40...EV-1: Spare PM preps
11:50 AM...04...55...Deadline for beginning spare PM preps/removal
12:25 PM...05...30...Remove spare PM from external storage platform 2
12:55 PM...06...00...Install spare PM in S1 truss
01:30 PM...06...35...Cleanup and ingress
01:55 PM...07...00...Pre-airlock repress
02:00 PM...07...05...Airlock repress
03:30 PM.....Post-spacewalk news briefing on NTV (approximate)
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Engineers have developed a variety of contingency procedures to deal with any jammed or troublesome quick-disconnect fittings to minimize the threat of an ammonia leak during the replacement work.

The spacewalk's duration will be driven in part by a requirement to make sure the astronauts have enough power and air at the end of the excursion for a lengthy "bake out" procedure if their suits get contaminated by leaking ammonia. The idea is to make sure no ammonia inadvertently makes it into the station's pressurized crew modules.

Because of that, multiple "breakout" points have been built into the spacewalk timeline that will leave the coolant system in a safe configuration if the astronauts run into problems and end up deferring some tasks to the second EVA.

11:31 AM, 8/6/10, Update: Engineers investigate washer found in external tank oxygen line

NASA engineers are looking into how a metal washer ended up in the liquid oxygen feedline of an external tank scheduled for use by the shuttle Endeavour next February.

While mesh screens in the main propulsion system plumbing are in place to prevent "foreign object debris," or FOD, from entering

a shuttle main engine, such debris could, in theory, puncture a propellant line in the high-flow-rate operating environment. Engineers want to make sure no other debris is present in external tank No. 138.

*Engineers inspecting external tank 138 found a metal washer in a liquid oxygen feed line.
(Photo: NASA)*

External tanks feature a liquid oxygen tank at the top and a larger liquid hydrogen tank at the bottom. The propellants are fed into the shuttle's main propulsion system through 17-inch-wide feed lines before branching out to three main engines. During engine operation, nearly 2,800 pounds of liquid oxygen are consumed per second.

The washer in question was found during initial inspections of ET-138 after its arrival at the Kennedy Space Center. Endeavour and ET-138 are scheduled for launch Feb. 26 to deliver supplies to the International Space Station, along with a \$1.5 billion physics experiment.

Metallic foreign object debris is always a concern in the extreme operating environment of the space shuttle's main propulsion system. The washer in question does not pose a significant combustion threat, engineers say, but the high flow rates could cause a propellant line puncture in a worst-case scenario. The washer has been returned to the Michoud Assembly Facility in near New Orleans, where the external tanks are built, for analysis.

01:30 PM, 8/5/10, Update: NASA delays station repair spacewalks

NASA managers, assessing timelines for two planned spacewalks to replace a faulty ammonia coolant pump aboard the International Space Station, decided Thursday to delay the first of two repair spacewalks, from Friday to Saturday, to give planners more time to fine-tune the required procedures.

The second spacewalk, which had been tentatively targeted for Monday, will slip an additional two days to Wednesday. Both spacewalks will still begin around 6:55 a.m. EDT.

There are no major issues or "show stoppers," officials said, but spacewalk planners needed more time to work out the details, including what to do in a variety of contingency situations.

"The Team 4 group has decided we will move the EVA to Saturday," Mike Jensen radioed the astronauts from mission control at the Johnson Space Center. "Expect for the three of you working the EVA stuff, we'll have probably a half-duty day tomorrow focussed on EVA prep."

"Understand all, Mike, thank you for the words," astronaut Douglas Wheelock replied from the station. "And thanks for the hard work. We know people are still working in the evenings and through the night and we really appreciate it. Thanks."

Wheelock, call sign EV-1, and Tracy Caldwell Dyson, EV-2, will carry out both spacewalks, assisted by Shannon Walker, operating the station's robot arm from inside the Destiny laboratory module. The station's three Russian crew members - commander Alexander Skvortsov, Mikhail Kornienko and Fyodor Yurchikhin - will not be directly involved in the repair work.

The 780-pound ammonia pump module failed Saturday, knocking one of the space station's two coolant loops out of action and forcing flight controllers to implement a major powerdown to keep critical equipment from overheating.

The faulty loop A pump module is mounted in the starboard one - S1 - segment of the station's main power truss. An identical module is mounted on the port one, or P1, segment. Four spare pump modules are mounted on various external storage platforms.

The preliminary plan calls for Wheelock and Caldwell Dyson to remove the faulty S1 pump module during the initial spacewalk Saturday, disconnecting a half-dozen electrical cables and four ammonia lines. The first two ammonia lines to be disconnected - M3 and M4 - will be connected to a "jumper box" that will prevent the loop A coolant system from over pressurizing during temperature swings in orbit.

With the jumper box in place, the old pump will be removed and temporarily mounted on a nearby fixture. Caldwell Dyson and Wheelock, anchored to the end of the station's robot arm, then will retrieve the replacement pump from external storage platform No. 2 just in front of the Quest airlock and bolt it into place on the S1 truss. The astronauts plan to wrap up the excursion by reconnecting electrical and data lines.

During the second spacewalk Wednesday, Wheelock and Caldwell Dyson will reconnect the ammonia lines to finish the repair.

The ammonia lines must be disconnected and reinstalled in a specific order and the astronauts must guard against any leaks that might contaminate their spacesuits. Flight planners are fine tuning procedures to deal with any troublesome quick-disconnect

fittings that might crop up.

Delaying the spacewalks to Saturday and Wednesday "will allow for an additional day of time for the teams, who have been working twenty four hours around the clock, to prepare these procedures, make sure all of the safety blocks are checked in terms of the disconnect and reconnect of the cables and quick disconnects associated with these ammonia coolant lines," said NASA spokesman Kyle Herring.

"All of that is coming together, the teams just need a little more time to refine all of that," he said. "So the plan now is for the two crew members to begin their preparations ... tomorrow afternoon rather than today."

Here is the latest timeline for the first spacewalk (in EDT and elapsed time):

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EDT.....HH...MM...EVENT
08/07/10

06:55 AM...00...00...Spacesuits to battery power
07:00 AM...00...05...Post depress/airlock egress
07:25 AM...00...30...Tools/tether setup
07:45 AM...00...50...EV-1: Pump module (PM) removal preps
07:55 AM...01...00...EV-2: CETA cart preps
08:35 AM...01...40...EV-1: Robot arm (SSRMS) prep and ingress
08:45 AM...01...50...EV-2: PM jumper vent
09:00 AM...02...05...Initial PM quick-disconnect ops
10:05 AM...03...10...EV-1: Retrieve adjustable grapple bar (AGB)
10:05 AM...03...10...EV-2: Prep failed PM for removal
10:50 AM...03...55...Remove failed PM
11:10 AM...04...15...EV-1: Move failed PM to POA fixture
11:10 AM...04...15...EV-2: Spare PM preps
11:30 AM...04...35...EV-1: Spare PM preps
11:50 AM...04...55...BINGO for spare PM removal
12:20 PM...05...25...Remove spare PM from external storage platform No. 2
12:50 PM...05...55...Install spare PM in S1 truss
01:25 PM...06...30...Cleanup and ingress
01:50 PM...06...55...Pre-airlock repress
01:55 PM...07...00...Airlock repress
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12:30, 8/4/10, Update: Preliminary timeline for pump replacement spacewalk (EVA-1)

Flight planners at the Johnson Space Center are continuing to fine tune the timeline for a planned spacewalk Friday by Expedition 24 astronauts Tracy Caldwell Dyson and Douglas Wheelock to replace a faulty ammonia pump that failed Saturday, shutting down one of the space station's two primary coolant loops.

Under the current plan, Wheelock, call sign EV-1, and Caldwell Dyson, EV-2, will switch their spacesuits to battery power at 6:55 a.m. Friday, officially kicking off a planned seven-hour spacewalk. It will be the fourth EVA for Wheelock and the first for Caldwell Dyson.

The primary objectives of the spacewalk are to remove the faulty 780-pound pump module; temporarily stow it on a nearby payload attach fitting; and install the new pump module on the starboard one - S1 - truss segment on the right side of the International Space Station.

Viewed from just ahead of the International Space Station, the faulty loop A pump module -- PMI -- is located in the starboard one, or S1, truss segment. (Credit: NASA)

Along with unbolting the faulty pump, the astronauts also will have to demate electrical cables and four ammonia lines. The first two ammonia lines to be disconnected - M3 and M4 - will be connected to a "jumper box" that will prevent the loop A coolant system from over pressurizing during temperature swings in orbit. After installing the new pump module, the astronauts will reconnect the data and electrical lines.

During a second spacewalk Monday, Wheelock and Caldwell Dyson will reconnect the ammonia lines to finish the repair.

Four ammonia lines leading to the faulty pump module must be disconnected, along with bolts and electrical cables. (Credit: NASA)

The timeline for Friday's spacewalk may change pending additional analysis at the Johnson Space Center in Houston, but here is a preliminary version (in EDT and elapsed time):

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EDT.....HH...MM...EVENT
08/06/10

06:55 AM...00...00...Spacesuits to battery power
07:00 AM...00...05...Post depress/airlock egress
07:25 AM...00...30...Tool and tether setup
07:45 AM...00...50...EV-1: Pump module (PM) removal preps
07:55 AM...01...00...EV-2: CETA cart preps
08:35 AM...01...40...EV-1: Station arm (SSRMS) prep and ingress
08:45 AM...01...50...EV-2: PM jumper vent
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09:00 AM...02...05...Initial PM quick-disconnect (QD) operations
09:30 AM...02...35...QD demate
09:50 AM...02...55...Thermal shrouds on all QDs
10:05 AM...03...10...EV-1: Retrieve AGB (adjustable grapple bar)
10:10 AM...03...15...EV-2: Prep failed PM for removal from S1 truss
10:50 AM...03...55...Install AGB on failed PM
11:10 AM...04...15...EV-1: Failed PM moved to payload attachment fitting
11:10 AM...04...15...EV-2: Spare PM preps
11:30 AM...04...35...EV-1: Spare PM preps
11:50 AM...04...55...BINGO for spare PM removal
12:20 PM...05...25...Remove spare PM from external storage platform No. 2
12:50 PM...05...55...Install spare PM in S1 truss
01:25 PM...06...30...Cleanup and ingress
01:50 PM...06...55...Pre-airlock repress
01:55 PM...07...00...Airlock repress

Engineers at the Johnson Space Center are refining guidelines for the spacewalk, including what to do in the event of ammonia leaks or problems mating/demating any of the fluid lines. Even though the loop A coolant system is out of action until repairs are complete, the crew should have normal use of the station's robot arm -- Wheelock will ride on the end of the arm during the EVA while Caldwell Dyson will free float -- and near-normal television views are expected.

01:15 PM, 8/2/10, Update: NASA refines plans for coolant pump replacement (UPDATED at 6:15 PM with news conference; quotes and details; UPDATED at 7:45 PM with decision to retarget spacewalks for Friday/Monday; CORRECTED at 9:25 to fix number of truss segment housing failed pump module)

NASA astronauts and engineers are refining plans for two spacewalks by astronauts Douglas Wheelock and Tracy Caldwell Dyson to replace a large ammonia pump module that shut down Saturday, knocking out one of the International Space Station's two cooling loops.

The astronauts hope to carry out the first spacewalk Friday morning, starting at 6:55 a.m. EDT, and a second excursion Monday to finish the job, one of the so-called "big 14" on a list of critical components that require spacewalk repair if problems crop up.

NASA managers initially targeted Thursday for the first spacewalk and Sunday for the second, but decided late Monday they needed more time to review procedures.

"This is an anomaly we knew someday would happen," said space station Program Manager Mike Suffredini. "It's an anomaly we have trained for, it's an anomaly we have planned for."

With four spare pump modules on board the station, "we're in a good position to go solve this problem," he said. "It is a significant failure, though, in terms of systems on board ISS, so it's one we need to go after."

The shutdown of coolant loop A forced the station crew, working with flight controllers at the Johnson Space Center, to quickly power down a variety of critical systems to prevent overheating, including a communications channel, two of four stabilizing gyroscopes, a GPS navigation sensor and several computer control boxes and heaters.

Engineers attempted to restart the pump early Sunday and "the data suggests the motor and impeller are not frozen," Suffredini said. "In fact, the motor did start to pump some of the ammonia when we tried to start it the second time."

But in a repeat of the Saturday malfunction, a circuit breaker tripped within a few moments "so this tells us there's a short somewhere in the power feed to the motor between the controller and the motor."

The pump module was installed and electrically activated in 2002. The pump was not turned on for active cooling until late 2006. Based on ground testing, the "mean time between failures" was calculated to be around 100,000 hours. The pump in question failed earlier than that, after about 80,000 hours of combined electrical and mechanical operation.

Suffredini said engineers hope to get the faulty unit back for a detailed failure analysis, but there is no room on the next two shuttle flights, the final two missions on NASA's manifest. There is congressional support for an additional flight next June, however, and if that mission is approved, Suffredini said room would be available to bring the old pump home.

In any case, flight controllers analyzed heat loads after Sunday's restart attempt and were able to revive one of the shut-down gyros. Other components were switched to coolant loop B and officials said the six-member crew - three American astronauts and three Russian cosmonauts - was never in any danger.

But the coolant loops, which circulate ammonia through huge radiators to dissipate the heat generated by the station's electronics, are critical to lab operations. With one loop out of action, the station is one failure away from a major shutdown that would be much more difficult to resolve.

As a result, NASA managers decided Sunday to defer more routine tasks in an already planned spacewalk Thursday and to proceed instead with a pump module changeout, a job that will require two spacewalks to complete.

The loop A pump module is mounted on the forward face of the station's main power truss, just above and to the right of the Destiny laboratory module, in the starboard 1, or S1, truss segment. Its loop B counterpart is mounted to the left of Destiny in the port 1 truss segment.

The Boeing-built 780-pound pump modules measure 5-and-a-half feet long, 4 feet wide and 3 feet high. It is too large to fit aboard European or Russian unmanned cargo craft.

With only two, or possibly three, flights left on NASA's shuttle manifest, the agency been launching as much in the way of spare parts and components as possible on recent flights as a hedge against failures after the shuttle stops flying.

Four spare ammonia pump modules already are stored aboard the space station. One is mounted on External Storage Platform No. 2 by the Quest airlock on the right-side of the station, about 30 feet or so from the failed unit in the S1 truss segment. That is the pump that will replace the one that malfunctioned.

A second pump module is mounted on ESP No. 3, attached to the upper side of the port three power truss segment on the left side of the station. A third is attached to a logistics carrier on the lower side of the P3 truss segment and the fourth is attached to a carrier on the upper side of the starboard 3 truss.

Wheelock and Caldwell Dyson were preparing to carry out a spacewalk Thursday to mount a robot arm mounting fixture on the Russian Zarya module and to prepare NASA's central Unity module for attachment of a storage compartment during a shuttle flight in November.

They practiced an ammonia pump swap out during a September 2009 training run. Astronauts at the Johnson Space Center are now practicing the swap out in the huge swimming pool NASA uses to simulate weightlessness to refine those procedures and develop a reliable timeline.

That information will be radioed to Caldwell Dyson and Wheelock for review on the space station over the next two days.

"They're in great spirits, they're ready to do this EVA," Suffredini said. "This is one of the 'big 14' EVAs, which to date we haven't had to do yet. The big 14 refers to some of the major (components) an increment crew might have to do without the shuttle vehicle there.

"We don't train them all," he said. "The crews train generically for maintenance and then train for some of the big 14. This particular one, the crew did train for, so they have some familiarity with the task being asked of them."

Overall, he said, "we're actually in great shape. To have the EVA already planned (for this Thursday), that is significant because there's quite a bit of work to configure the airlock, get everything set up for the crew to use the suits."

Most of that work had already been done in preparation for the previously planned spacewalk and "that was really a blessing in terms of the time to get to this job." Even so, spacewalk planners needed more time to refine procedures for the pump replacement EVA, pushing the first excursion to no earlier than Friday.

The current plan calls for the astronauts to first remove the failed pump module and temporarily mount it on an external storage fixture. A "jumper box" will be attached to two of the ammonia lines, preventing possible pressure problems as coolant in the lines expands.

The pump module "is a difficult box to maneuver with, it's a big, unwieldy object," said space station Flight Director Courtenay McMillan. "So maneuvering it around and handing it off between crew members if that needs to be done, that could take some time. None of that part of it is technically difficult, but it's just very time consuming and takes a lot of focus."

The new pump then can be removed from ESP-2 and bolted into place on the S1 truss segment. During a second spacewalk, Wheelock and Caldwell Dyson will make the required electrical connections, disconnect the jumper box and attach the ammonia lines.

Engineers are still thrashing out the details. With a single working coolant loop, the electronics used to run and operate station's robot arm cannot be allowed to overheat. It's not yet clear whether the arm can be used to move a spacewalker, the spare pump module, both or neither.

Another complication is managing the station's solar arrays. The station and its huge arrays can generate a charge as the lab moves through the tenuous upper atmosphere at 5 miles per second and two devices, called plasma contactor units, operate during spacewalks to minimize the shock hazard to the spacewalkers.

With the failure of coolant loop A, one of those devices is out of action. Under current flight rules, that would require all but two of the station's solar arrays to be parked and locked in a favorable orientation, unable to track the sun, during the spacewalk. If that rule

remains in play, the astronauts could be faced with additional powerdowns during the spacewalk.

Finally, planners will have to make sure Wheelock and Caldwell Dyson have enough air and power for possible ammonia contamination "bake out" procedures at the end of the spacewalk. Engineers plan to vent the ammonia lines leading to the pump module on Tuesday, but even residual ammonia poses a risk if it is brought back into the station on a contaminated spacesuit.

As a result, the astronauts must have enough time available at the end of their planned work to let any trace amounts of ammonia bake out, or sublime, before re-entering the space station.

"Since the external loop uses ammonia as the cooling fluid, all the lines are pressurized with ammonia and have to be released by the crew during the EVA," McMillan said. "We've done this before with different parts of the thermal system. The crew is very well trained on how to do decontamination if they get ammonia on them during the procedures. But it presents a timeline challenge to make sure we have enough room in the timeline to account for that."

11:50 PM, 7/31/10, Update: Coolant problem triggers powerdowns aboard space station (UPDATED at 1:30 AM and 7:25 AM with additional details; pump restart attempt fails; UPDATED at 1:45 PM with plans for repair spacewalk; UPDATED at 3:15 PM with quotes, status)

Trouble with one of the International Space Station's external coolant loops, used to dissipate the heat generated by the lab's electronics systems, triggered an extensive powerdown late Saturday. NASA managers met Sunday and gave preliminary approval to a difficult two-spacewalk repair job, starting as early as Thursday, to restore the critical system to normal operation.

It is not yet clear what went wrong, but the ammonia pump module that is part of coolant loop A, mounted on the right side of the station's main power truss, failed around 8 p.m. EDT Saturday. A problem somewhere in the system caused a circuit breaker to trip, setting off multiple alarms and waking the crew.

With half the station's cooling gone, flight controllers were forced to shut down two of the station's four U.S. control moment gyroscopes, used to help maintain the lab's orientation in space, one communications channel, several solar power current converters and a variety of computer control boxes known as multiplexer-demultiplexers, or MDMs.

Tracy Caldwell Dyson and Douglas Wheelock assisted with the powerdowns and hooked up jumper cables between the Russian Zarya module and the U.S. segment of the station to prevent additional cooling problems.

"It seems like we're in a sim right now," Caldwell Dyson joked with ground controllers shortly after 1 a.m. Sunday.

The space station remained in a safe configuration throughout, officials said, with critical life support systems, computers and communications gear operating with coolant loop B.

"We're going to be working hard overnight to figure out what's going on," astronaut James M. Kelly radioed from mission control shortly before the astronauts went back to bed. "By tomorrow, a little bit later on, hopefully we'll be able to send you up a little bit better idea of where we stand on everything."

Shortly before 6 a.m., flight controllers attempted to restart the stalled pump, resetting the circuit breaker that opened late Saturday. Once again, the crew was awakened by alarms.

"Sorry about that. We thought we had (the alarms) taken care of," Jay Marschke called from Houston, apologizing for another unplanned wakeup call. "We were trying to turn on the loop alpha pump to see if there was any life in it. Unfortunately, we got a recurrence of the problem and it shut down. No other actions at this time for you guys, everything else is nominal, we're still in our jumper contingency configuration."

Later in the morning, engineers restarted one of the two powered-down control moment gyroscopes and while the main bus switching units that direct power to various subsystems ran hotter than normal, engineers said the lab was stable and the six-member crew was not in any immediate danger.

In an evening status update to the crew, Marschke reported "loop bravo is rejecting heat just fine."

The teams here are monitoring the temperatures on MBSUs 1 and 4, they're all currently within limits and seem to be holding steady," he said. "The biggest impact at this point is (loss of power to a component in the Unity module that) caused us to power off half the JEM (Japanese Experiment Module) and Columbus (laboratory module) loads. ... The team's done a great job of getting back full redundancy on tier 1 and tier 2 MDMs. Thanks again for installing that jumper."

"We know you're doing your job, but we know you're also thinking about us and our comfort and our awareness and we can't stress enough how much we appreciate the response we've gotten up here," Caldwell Dyson replied.

The space station features two independent coolant loops that use ammonia circulating through huge radiators to dissipate the heat

generated by the station's electronic systems. Each loop is fed by a large tank of ammonia that includes an internal bellows pressurized by nitrogen. That pressurization system allows the loops to handle the periodic expansion and contraction of the ammonia coolant due to temperature changes in orbit.

"Losing one of those loops is very significant," space station flight director Brian Smith said before a shuttle flight last year. "We'd lose cooling capability to half of the electronics on the U.S., European and Japanese part of the space station."

Spare coolant system components, including two pump modules, are mounted on external stowage platforms, one on the left side of the station and the other on the right, just ahead of the Quest airlock module.

Wheelock and Caldwell Dyson already were scheduled to perform a spacewalk Thursday to mount a robot arm attachment fixture to Zarya and to prepare the station for attachment of a new U.S. storage module in November.

Those tasks will now be deferred. Instead, NASA managers gave preliminary approval to a plan that calls for Wheelock and Caldwell Dyson to remove the faulty pump module during a spacewalk no earlier than Thursday. The old unit will be temporarily attached to a mounting fixture and the spare module will be moved from External Storage Platform No. 2 to the S1 truss segment for installation.

The 780-pound pump module, built by Boeing, will require numerous electrical and ammonia coolant line connections. Flight planners hope to get the new pump mechanically attached by the end of the first spacewalk. A second outing likely will be required two to three days later to make all the connections.

But mission managers caution that the preliminary plan may change, depending on the results of training runs and analysis at the Johnson Space Center. Caldwell Dyson and Wheelock have not rehearsed a pump module replacement, but they completed extensive spacewalk training together before launch.

The ammonia tank on the left side of the station's power truss, part of coolant loop B, was replaced in August 2009. During a flight by the shuttle Discovery last April, astronauts replaced the tank on the right side in coolant loop A. Other than alignment problems and trouble getting a few bolts to engage, the tank swap went well and there were no indications of any major issues. But flight controllers were unable to re-open the main nitrogen valve needed to re-pressurize coolant loop A.

After Discovery undocked, engineers resolved the problem, cooling the valve and using back pressure to get it open. There have been no other obvious signs of trouble with either coolant loop since then.

"In its place, we have an EVA prep session for all three U.S. crew members and study materials are on the way.

07/30/10, 2:25 PM, Update: NASA hopes for contact with silent Spirit rover

NASA's aging Spirit Mars rover, stuck in loose soil and forced to endure the harsh martian winter with reduced solar power, has not phoned home since March 22 and officials warned Friday "a miracle" may be needed to restore the rover to limited operation.

A file photo from Spirit's navigation camera showing wheels buried in the fine soil on Mars. (Photo: NASA TV)

No longer mobile, Spirit was unable to orient itself to maximize solar power levels before the onset of its fourth winter on Mars. Engineers expected the rover to put itself into electronic hibernation, suspending communications and conserving power to warm and recharge its batteries and to run an internal clock.

The rover is programmed to take itself out of hibernation and call home whenever the batteries are sufficiently charged. But if the batteries lose too much charge, and if the internal clock stops ticking, the rover's computer could re-awaken but not know what time it is.

In that case, known as a "mission-clock fault," the Rover's computer would start a new clock, waking up every four hours during daylight to listen for signals from Earth. In a best-case scenario, Spirit could have started listening as early as July 23.

Starting July 26, engineers began sending commands to Spirit, ordering it to phone home if possible. But analysis of available sunlight and the cold environment indicates the rover may not be able to respond until late September to mid October. That's assuming it's able to respond at all.

"It will be the miracle from Mars if our beloved rover phones home," Doug McCuiston, director of NASA's Mars Exploration Program, said in an agency statement. "It's never faced this type of severe condition before - this is unknown territory."

Winter on Mars runs from May through November. During past winters, heaters kept Spirit's internal temperatures above minus 40 degrees Fahrenheit. This time around, most of the heaters are not powered and temperatures could go as low as minus 67 degrees.

Whether Spirit can survive is an open question.

"This has been a long winter for Spirit, and a long wait for us," Steve Squyres, the principal investigator for the Mars Exploration Rovers at Cornell University, said in the NASA statement. "Even if we never heard from Spirit again, I think her scientific legacy would be secure. But we're hopeful we will hear from her, and we're eager to get back to doing science with two rovers again."

Spirit and a twin rover, Opportunity, landed on opposite sides of Mars in January 2004. Designed to operate for just three months, both rovers have now been in operation for six-and-half Earth years, studying the role of water in the martian environment.

Opportunity remains in relatively good health, still mobile and able to collect science data.

11:35 AM, 7/29/10, Update: Station controllers monitor possibly threatening space debris (UPDATED at 12:55 PM with additional tracking data; no crew action required)

Space station flight controllers tracked a piece of debris from a deliberately destroyed Chinese satellite that threatened to pass relatively close to the lab complex Thursday afternoon. But additional radar tracking passes showed the debris would not pass close enough to require any action by the six-member crew.

The debris, catalog number 29829, is from the Fengyun 1C satellite that was blown up in a Chinese anti-satellite test in 2007, producing a huge cloud of debris.

When radar tracking indicates a piece of debris from any source might enter a protective "box" around the space station, the lab's orbit can be changed slightly or, if not enough time is available, the crew can "shelter in place" aboard the station's Soyuz re-entry vehicles.

In this case, multiple radar tracking passes showed the debris would stay outside the box and around 12:45 p.m., flight controllers told the station astronauts and cosmonauts there was "no probability of a conjunction" and no need to shelter in place.

6:40 AM, 7/27/10, Update: Cosmonauts wrap up cable connections; jettison camera; end spacewalk

Cosmonauts Mikhail Kornienko and Fyodor Yurchikhin ran cables from the Zvezda command module to the new Rassvet docking compartment Tuesday to connect the new module to the station's Russian computer system. They also connected cables to a passive rendezvous system antenna to enable future automatic dockings at Rassvet.

The work went smoothly, but Russian flight controllers ran into problems during tests to make sure all the KURS-P rendezvous antenna system cables were properly seated.

"Are you positive that all the connectors have been mated?" a flight controller radioed.

"Well, I do have fairly good assurance," Yurchikhin replied through a translator. "Are there any issues?"

"You know, for some reason, when we did the first activation we received nothing," the controller said.

Yurchikhin then double checked the connections to make sure the cables were properly seated. He found no obvious problems and the cosmonauts were told to head back to the Pirs airlock module.

The KURS automated rendezvous system on Rassvet will not be needed until a Soyuz docking in December and if problems persist, additional troubleshooting can be carried out during upcoming Russian spacewalks.

Kornienko and Yurchikhin had one final task: jettisoning an aging television camera used to support dockings by the European Space Agency's ATV cargo ships. A new camera was installed earlier in the spacewalk and the old unit was temporarily stowed at Pirs.

Because of flaking insulation that posed a contamination threat to the station's air supply, mission managers decided to have the cosmonauts throw the old camera overboard after making sure its replacement was operating properly. It was, and Yurchikhin tossed the old camera away around 6:40 a.m. EDT, releasing it in the opposite direction of the station's travel.

Engineers expect the camera to fall into the atmosphere and burn up in about four months.

With the camera on its way, Yurchikhin and Kornienko headed back inside Pirs to wrap up the spacewalk. Tot

2:00 AM, 7/27/10, Update: European video camera replaced; handling fixture lost; cable connections begin

Cosmonauts Mikhail Kornienko and Fyodor Yurchikhin successfully replaced an aging European video camera on the end of the Zvezda command module. The cosmonauts then made their way back to the Pirs airlock module where they temporarily stowed the

old camera before beginning work to run data cables between Zvezda and the new Rassvet module.

Russian flight controllers, meanwhile, reported the new camera is working as expected. A few minutes later, the cosmonauts apparently allowed an untethered piece of equipment to float away, presumably a handling fixture for a reel of data cable. Engineers are assessing the track of the debris to make sure it will not pose a threat to the station later.

12:15 AM, 7/27/10, Update: Russian spacewalk begins

Cosmonauts Mikhail Kornienko and Fyodor Yurchikhin opened the outer hatch of the International Space Station's Pirs airlock module at 12:11 a.m. EDT Tuesday to officially kick off a planned six-hour spacewalk.

"Isn't it beautiful outside?" one of the cosmonauts said.

Yeah, kind of windy outside," the other joked.

The first item on the agenda is to replace an aging video camera on the aft end of the Zvezda command module that is used by approaching European Space Agency cargo vehicles.

After the new camera is installed, the cosmonauts will focus on running computer data lines from Zvezda to the new Rassvet docking compartment attached to the Zarya module's Earth-facing port. Once that work is complete, the cosmonauts will hook up another set of cables to connect passive KURS rendezvous antennas near Rassvet's docking port.

10:23 PM, 7/26/10, Update: Cosmonauts gear up for spacewalk

Cosmonauts Mikhail Kornienko and Fyodor Yurchikhin geared up for a planned six-hour spacewalk overnight Monday to replace a European docking camera on the back of the space station's Zvezda command module and to route cables to and from the new Rassvet docking compartment.

One set of cables will connect the KURS-P automated rendezvous system on the new module, allowing its use in future dockings. The other set will tie the module into the station's Russian command-and-control computer system.

This will be the 147th spacewalk devoted to station assembly and maintenance since construction began in 1998, the 11th so far this year, the fourth overall for Yurchikhin and the first for Kornienko. Both cosmonauts will be wearing Russian spacesuits.

The spacewalkers plan to open the hatch of the Pirs module around 11:45 p.m. EDT to officially kick off the excursion. The first item on the agenda is replacing a camera used by the European Space Agency's Automated Transfer Vehicle, or ATV, during final approach to the Zvezda module's aft port.

"The ATV is an unmanned spacecraft that brings supplies to the station, and the video camera is used to monitor the approach as it comes in and docks on the aft-end of the Zvezda module," said Chris Edelen, NASA's lead spacewalk flight controller. "The video camera currently on-orbit has numerous bad pixels, resulting in degraded picture quality. So the new camera is expected to restore the system to its full functionality in time for next the ATV mission (in December)."

While ground controllers test the new camera, the cosmonauts will move forward along the space station "stack," dropping the old camera off at Pirs before making their way to the front of the Zvezda module. Four electrical cables, part of the Russian command-and-control system, will be plugged in and routed to the forward Zarya module. From there, the cables will be connected to the new Rassvet module attached to Zarya's Earth-facing port.

"First, a cable bundle will be run from the Zvezda and Zarya modules to connect the Rassvet to the Russian command and data handling computers," Edelen said. "Then, a second set of cables will be run from Rassvet to Zarya to provide full functionality of the KURS docking system to allow automated vehicle dockings of Progress and Soyuz spacecraft to the docking port at the bottom of the Rassvet module."

At the end of the spacewalk, Kornienko and Yurchikhin will move back to Pirs and jettison the old camera, releasing it in the opposite direction of the station's travel. Edelen said the camera is expected to re-enter the atmosphere and burn up in about four months.

"It will not be brought back inside the station due to concerns the insulation around the camera has degraded in the space environment and could result in fiberglass particles being shed inside the station resulting in a breathing hazard for the crew," Edelen said. "So at the end of the EVA, we will jettison the old ATV video camera."

05:00 PM, 7/22/10, Update: House panel joins Senate in support for additional shuttle flight

The House Committee on Science and Technology, reviewing its version of NASA's \$19 billion 2011 funding package Thursday,

approved an amendment that would clear the agency to launch an additional shuttle flight next summer to deliver critical supplies and equipment to the International Space Station.

The Senate version of the appropriations legislation already included the additional flight. But major differences remain in other key areas, including how much money goes to support development of a new private-sector manned launch industry, the timetable for development of a NASA heavy-lift rocket for deep space exploration, and plans for a new government-designed manned spacecraft.

Even so, Science and Technology Committee Chairman Bart Gordon (D-TN) said in a statement that the House legislation "sets a clear, sustainable, and executable path for NASA, especially in the area of human space flight."

The Obama administration earlier this year proposed canceling NASA's Constellation moon program, including the Ares I and Ares V rockets the agency had planned to build to replace the shuttle. The Orion crew capsule that would have been launched atop the Ares I rocket would be converted into a space station crew lifeboat.

At the same time, the president called for a transition to private-sector rockets and capsules to ferry astronauts to and from the space station, allowing NASA to focus on development of new heavy-lift rockets and capsules for eventual flights to nearby asteroids and, eventually, to Mars.

But the president's plan would defer work on a heavy lifter until 2015, delaying deep space missions beyond low-Earth orbit until the middle of the 2020s in favor of near-term development of advanced technologies.

Supporters of the administration's space policy applauded the shift to private-sector launch services, arguing that increased efficiencies and innovation would open up the high frontier to more extensive - and routine - use. Under the administration's proposed budget, NASA would spend \$6 billion over the next five years to spur development of private-sector launch services.

But critics decried the proposed write-off of some \$9 billion already spent on the Constellation program, the long development cycle proposed for eventual deep space missions, and the reliance on as-yet-unproven commercial launchers and capsules.

The House and Senate versions of NASA's appropriations package both cut out the moon as NASA's next major goal and both extend space station operations through 2020 as requested by the president. But both reduce funding for commercial manned space initiatives. The Senate version provides \$1.3 billion over the next three years while the president's initial proposal called for \$3.3 billion. The House version would provide just \$450 million over the next three years.

The Senate version also would accelerate development of a heavy lift rocket, using components of the Constellation program where possible, for initial flights as early as 2016. The House version would stretch out development to around 2020. Both versions also call for development of a government-sponsored crew capsule, based on the Orion design, for deep space exploration and possible space station support.

"I have the sense that the rest of the policy community thinks the Senate bill is a reasonable compromise we can live with," said a space policy analyst who asked not to be named.

In 2004, the Bush administration directed NASA to finish the space station and retire the shuttle fleet by the end of fiscal 2010. An additional \$600 million later was promised to pay for shuttle operations through the end of calendar 2010 and shuttle program managers came up with additional savings to cover costs through early 2011.

NASA currently has just two flights on its shuttle manifest. First up is a mission by the shuttle Discovery, scheduled for launch Nov. 1, to deliver spare parts and equipment to the station in a logistics module that will be permanently attached to the lab complex.

In keeping with NASA's post-Columbia safety policies, the shuttle Endeavour will be available for possible rescue duty if any major problems develop that might prevent a safe re-entry for Discovery's crew.

Assuming a rescue flight isn't needed, Endeavour will be launched Feb. 26 to deliver the \$1.5 billion Alpha Magnetic Spectrometer physics experiment to the space station along with additional supplies and spare parts.

The shuttle Atlantis is being processed to serve as the rescue vehicle for Endeavour's crew. NASA managers have been lobbying for months to win approval to actually launch Atlantis on a final flight next June to deliver one last load of equipment.

By launching Atlantis with a reduced crew of four, a second shuttle would not be required for rescue duty. If a problem prevented a safe re-entry, the yet-to-be-named Atlantis astronauts could seek safe haven aboard the space station and rotate home aboard Russian Soyuz capsules.

It would not be easy and it would take months to cycle all four crew members back to Earth aboard already planned Soyuz flights. But supporters believe the benefits of a final resupply mission outweigh the risks and justify the \$1.6 billion needed to extend the

shuttle program through mid 2011.

"This mission will help minimize the spaceflight gap by stretching out the human spaceflight capabilities into mid 2011," Rep. Suzanne Kosmas, a Florida Democrat, said Thursday, introducing an amendment for "contingent authorization." "This additional launch provides the most risk-free logistical support in the next year. ... I urge you to support my amendment and to authorize this critical shuttle mission in order to preserve our workforce and maximize the investments we've made in the International Space Station."

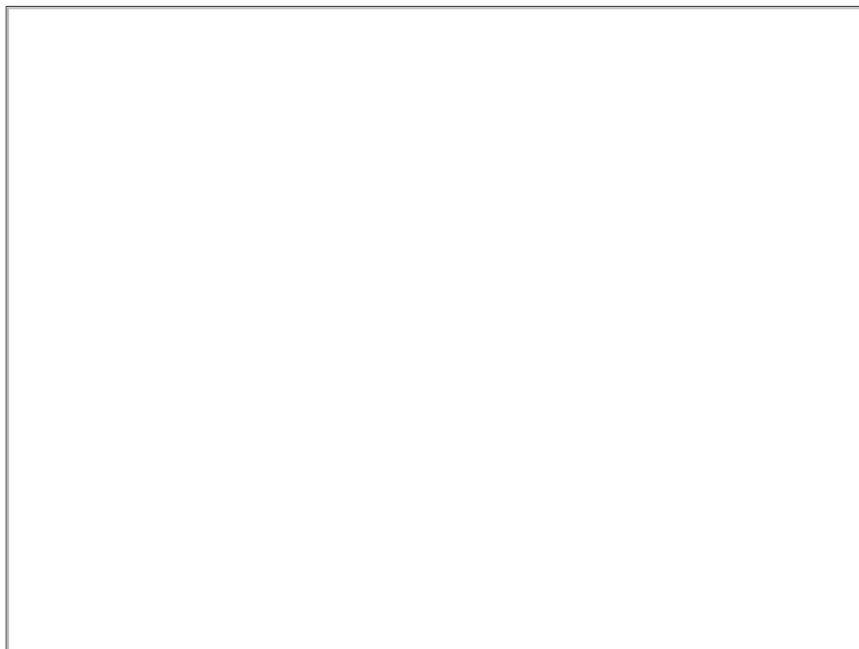
The amendment, which passed on a voice vote, would pay for the flight by transferring funds from NASA's space station and exploration budgets.

"I think the White House is on board with it," the policy analyst said.

2:20 PM, 7/8/10, Update: External tank for final planned shuttle mission heads to Florida

The external tank for the final planned shuttle mission was rolled out of Lockheed Martin's Michoud Assembly Facility Thursday to begin the 900-mile voyage to the Kennedy Space Center for launch next February.

Wrapping up 37 years of tank deliveries in support of the shuttle program, Lockheed Martin employees, joined by senior NASA managers, lawmakers and company officials, gathered for a departure ceremony to mark the completion of ET-138. Many of the workers were wearing black T-shirts with the words "Finish Strong" on the back.



**The external tank for the final planned shuttle mission leaves the Lockheed Martin factory near New Orleans.
(Photo: NASA TV)**

"Everyone of you should be proud, as I know you are," said Joanne Maguire, Lockheed Martin executive vice president for space systems. "The accomplishments of the external tank team are the stuff of legend. The challenges and hardships you've overcome have been monumental and our respect for, and gratitude to you, is immeasurable.

"We have two more missions to fly before we bring to a close one of America's most iconic human spaceflight programs. I have every confidence this team will rally together, as they have through thick and thin, to safely and successfully conclude the space shuttle program even as we prepare for what comes next. Whatever that might be. This team is a team we have counted on for decades to do the heavy lifting, figuratively and literally, and it is my firm commitment and hope that we can continue to rely on you going forward."

The tank will travel by barge across the Gulf of Mexico from New Orleans, around the tip of Florida and up the coast to the Kennedy Space Center where it will be prepared for launch Feb. 26 with the shuttle Endeavour.

Sen. David Vitter, a Louisiana Republican, attended the ET-138 rollout and took the opportunity to criticize the Obama administration's post-shuttle space policy, which includes a shift to commercial manned launch operations and a multi-year gap

between the shuttle's retirement and the debut of whatever spacecraft replaces it.

"I for one am extremely concerned about those proposals and plans for NASA," Vitter said. "Because quite frankly, if we stay on that radical new path - and it is a radical new plan for NASA - it will mean two things. Here at Michoud, it will turn that gap into a cliff, and I'm fighting to prevent that from happening. And for the nation, I truly think it will give up our leadership in manned spaceflight, probably for the rest of our lifetimes.

"Now, call me old fashioned, but I think NASA should be about space flight," Vitter said, prompting applause. "Call me old fashioned, but I don't want NASA just to be the fourth or the fifth or the sixth climate change research agency. And call me old fashioned, but I certainly don't want its primary purpose to be outreach to Muslim countries to make them feel good about their scientists."

The last comment, loudly cheered by the assembled workers, was a clear dig at NASA Administrator Charles Bolden, who told Al-Jazeera last week that President Obama had told him that one of NASA's primary objectives was to "reach out to the Muslim world and engage much more with dominantly Muslim nations to help them feel good about their historic contribution to science, math and engineering."

Vitter concluded his remarks by saying "the good news is there are many folks in Congress, Republicans and Democrats, who feel as I do. So this battle is not over by a long shot."

While Endeavour's flight is the last officially planned shuttle mission, NASA plans to prepare the shuttle Atlantis for launch on a possible rescue flight in case of any major problems with Endeavour that might prevent a safe re-entry.

The tank for the stand-by mission, ET-122, was damaged in Hurricane Katrina, but it has since been repaired and is in the final stages of assembly. Shipment to the Kennedy Space Center is expected in September.

NASA managers are studying the possibility of actually launching Atlantis on a final space station resupply mission if a rescue flight is not needed. By launching the shuttle with a reduced crew of four, Russian Soyuz spacecraft could be used for possible rescue duty, eliminating the need for a second shuttle stand-by mission.

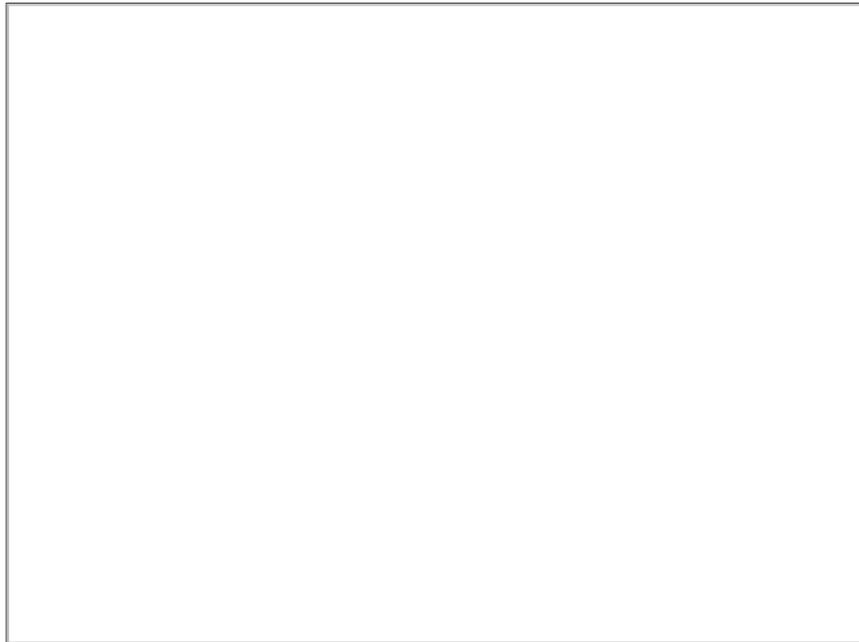
Shuttle program managers are studying cost projections and potential savings to see how far they can stretch current funding. The shuttle program normally costs about \$200 million a month to operate and even with projected savings, sources say additional money almost certainly will be required to cover a final mission with Atlantis.

A decision is expected by early August.

12:35 PM, 7/4/10, Update: Progress 38 successfully docks with space station

An unmanned Russian supply ship successfully docked with the International Space Station Sunday, two days after an interference issue with a television transmitter in a backup docking system triggered an unexpected abort Friday.

For today's approach, the backup TORU system was not activated, there was no interference and the KURS automated rendezvous system worked flawlessly, lining the Progress up for a docking at the Zvezda command module's aft port.



The International Space Station as seen from the approaching Progress 38 cargo ship Sunday. (Photo: NASA TV)

After a brief period of station keeping, the cargo ship resumed its approach, docking on time at 12:17 p.m. EDT as the two spacecraft sailed 220 miles above central Asia. A few moments later, hooks and latches retracted, pulling the Progress firmly into place.

"Congratulations on the successful Progress docking," a flight controller radioed from Moscow.

"Thank you very much," Expedition 24 commander Alexander Skvortsov replied from the station.

Launched Wednesday from the Baikonur Cosmodrome in Kazakhstan, the Progress 38 vehicle is loaded with 1,918 pounds of propellant, 110 pounds of oxygen, 220 pounds of water and 2,667 pounds of experiment equipment, spare parts and other supplies.

During an initial docking attempt Friday, the Progress 38 craft aborted its approach and flew past the station, rotating slowly to keep its solar arrays face on to the sun.

It was the second Progress docking problem in a row for the Russians. During an approach May 1, a problem with the automated KURS navigation system aboard an approaching cargo ship forced Expedition 23 commander Oleg Kotov to take over manual control using the TORU backup system.

Russian engineers concluded the abort Friday was triggered by interference between the KURS system and a television transmitter that is part of the backup TORU system that was activated around the time of the abort. The result of the interference was a "cancel dynamic operations" command that prompted the Progress flight computers to abort the automated approach.

After tests to make sure redundant KURS components were working properly, Russian managers approved plans for a second docking attempt using the KURS system alone, telling the crew not to activate the backup TORU system. There were no apparent problems.

11:35 AM, 7/4/10, Update: Second Progress docking attempt on tap

Russian flight controllers are pressing ahead with plans for a second attempt to dock an unmanned Progress supply ship at the International Space Station. The linkup, at the aft port of the Zvezda command module, is expected around 12:17 p.m. EDT.

Engineers believe an aborted approach Friday was caused by interference between the spacecraft's television transmitter and a backup manual docking system aboard the station. For today's docking attempt, the backup TORU system will not be turned on, which should prevent any similar interference.

Here is an updated docking timeline (in EDT and mission elapsed time):

EDT DD . . . HH . . . MM . . . SS . . . EVENT

7/4

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09:40:00 AM...03...22...04...46...U.S. to Russian attitude control handover
09:52:42 AM...03...22...17...28...Automated Rendezvous start
09:55:00 AM...03...22...19...46...ISS maneuvers to docking attitude
10:14:14 AM...03...22...39...00...AR&D DV9/Impulse 1 (23.6 mph)
10:34:33 AM...03...22...59...19...AR&D Impulse 2 (2.6 mph)
10:40:00 AM...03...23...04...46...Progress Kurs-A Activation (T1)
10:42:00 AM...03...23...06...46...SM Kurs-P Activation (T1)
10:57:56 AM...03...23...22...42...AR&D DV10/Impulse 3 (10.2 mph)
11:04:42 AM...03...23...29...28...Good Kurs-P data at 50 miles
11:20:04 AM...03...23...44...50...Sunrise
11:25:42 AM...03...23...50...28...Kurs-A/P Short Test at 9.3 miles
11:32:22 AM...03...23...57...08...Range = 5 miles - TV activation
11:39:44 AM...04...00...04...30...AR&D Impulse 4 (14.7 mph)
11:42:42 AM...04...00...07...28...AR&D Ballistic Targeting Point
11:44:14 AM...04...00...09...00...AR&D Impulse 5 (11.7 mph)
11:46:47 AM...04...00...11...33...AR&D Impulse 6 (5.3 mph)
11:49:57 AM...04...00...14...43...AR&D Flyaround mode start
11:56:45 AM...04...00...21...31...AR&D Stationkeeping start
12:04:59 PM...04...00...29...45...Daily Orbit 2 Russian ground station AOS
12:06:00 PM...04...00...30...46...AR&D Final Approach start

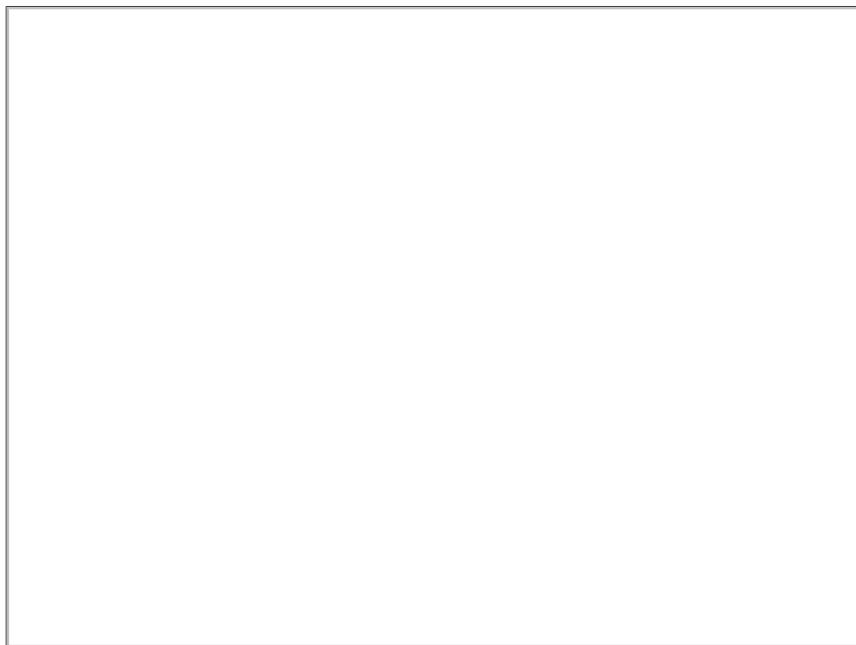
12:17:00 PM...04...00...41...46...Docking

12:19:14 PM...04...00...44...00...Sunset
12:28:08 PM...04...00...52...54...Daily Orbit 2 Russian ground station LOW
12:37:00 PM...04...01...01...46...Progress hooks closed
01:45:00 PM...04...02...09...46...Russian to U.S. attitude control handover
    
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12:20 PM, 7/3/10, Update: Russians trace docking problem to interference; second attempt on tap Sunday

Russian engineers believe electrical interference caused an approaching unmanned Progress supply ship to abort its approach to the International Space Station Friday, officials said Saturday. Subsequent tests showed the cargo craft is in good health and that its automated rendezvous system is working normally, clearing the way for a second docking attempt around 12:10 p.m. EDT Sunday.

The aborted approach Friday occurred about 20 minutes before the Progress 38 craft was scheduled to dock at the Zvezda command module's aft port. Instead of proceeding, the craft aborted and flew safely past the station, rotating slowly to keep its solar arrays face on to the sun.



An unmanned Progress supply ship during approach to the space station May 1. The spacecraft was docked using a manual system after its KURS automated system malfunctioned. (Photo: NASA TV)

It was the second Progress docking problem in a row for the Russians. During an approach May 1, a problem with the automated KURS navigation system aboard an approaching cargo ship forced the space station commander to take over manual control using a backup system.

Russian engineers have concluded the abort Friday was triggered by interference between the KURS automated rendezvous system and a television transmitter that is part of the backup manual system, known as TORU, that was activated around the time of the abort. The result of the interference was a "cancel dynamic operations" command that prompted the Progress flight computers to abort the automated approach.

It is not yet clear why the interference issue cropped up during this approach, but Russian engineers told their NASA counterparts

that the Progress spacecraft performed normally in the face of conflicting commands, executing a safe abort and standing by for additional instructions.

The KURS system features redundant components, or "strings," and subsequent tests in the absence of any interference showed both were working normally. As a result, a second attempt to dock the Progress 38 spacecraft will be made Sunday, but the TORU system will not be activated.

The Progress 38 spacecraft, loaded with 1,918 pounds of propellant, 110 pounds of oxygen, 220 pounds of water and 2,667 pounds of experiment equipment, spare parts and other supplies, was launched Wednesday from the Baikonur Cosmodrome in Kazakhstan.

01:55 PM, 7/2/10, Update: Russian Progress supply ship aborts automated rendezvous with space station; Russian flight controllers troubleshooting (UPDATED at 5:20 PM with tentative plans for Sunday docking try)

The automated approach of an unmanned Russian Progress supply ship to the International Space Station was aborted today when telemetry between the spacecraft and the Russian command module was lost during final approach.

The Progress 38 cargo ship flew safely past the lab complex and the station's six-member crew was not in any apparent danger. But Russian flight controllers were unable to immediately resolve the problem.

Amid ongoing troubleshooting, the Russians plan to carry out two Progress rocket firings overnight Friday and one on Saturday, setting up a second docking attempt around 12:17 p.m. EDT Sunday. But that assumes engineers identify and resolve the problem that derailed Friday's docking or mission managers get comfortable with making a second try in the absence of a firm fix.

The preferred option, a NASA official said, is to attempt another automated approach using the Russian KURS navigation system that malfunctioned Friday. If that doesn't work, engineers could attempt to maneuver the Progress close enough to the space station for commander Alexander Skvortsov to take over manual control using a different system.

For the manual TORU system to work properly, however, the Progress must be within about six-tenths of a mile of the station. It never got that close during Friday's approach.

Progress 38, loaded with 1,918 pounds of propellant, 110 pounds of oxygen, 220 pounds of water and 2,667 pounds of experiment equipment, spare parts and other supplies, was launched Wednesday from the Baikonur Cosmodrome in Kazakhstan.

The spacecraft was in the final stages of an automated approach to the Zvezda command module's aft port Friday when the KURS communications gear in the station lost lock on the approaching Progress. Docking had been targeted for 12:58 p.m., but instead the Progress flew past the International Space Station and pulled ahead.

"It's rotating slowly," Skvortsov radioed at one point. "We see the vehicle and it keeps sliding behind and moving toward the front part of the station."

"OK, copy," a Russian flight controller replied.

"It's moving slowly and I think the range is increasing," Skvortsov said.

A few moments later, he reported: "It's drifting away from us, it's rotating and also it's moving away from us. We are moving with service module forward and it's moving in the same direction but it's going farther and farther away from us."

"Ok, copy."

About an hour after the problem cropped up, Russian managers told the crew to stand down for the day.

"We are not going to do the docking today," Russian flight controllers called up shortly after 1:30 p.m. "All activities for the Progress have been deleted for right now. When you are going to have your lunch, please be available for communication if we need to call you."

NASA mission control commentator Rob Navias said engineers did not immediately understand what might have gone wrong.

"They're in the process of evaluating what may have caused a loss of telemetry between the Progress 38 cargo ship and the Zvezda service module about 30 minutes or so before its expected docking," he said.

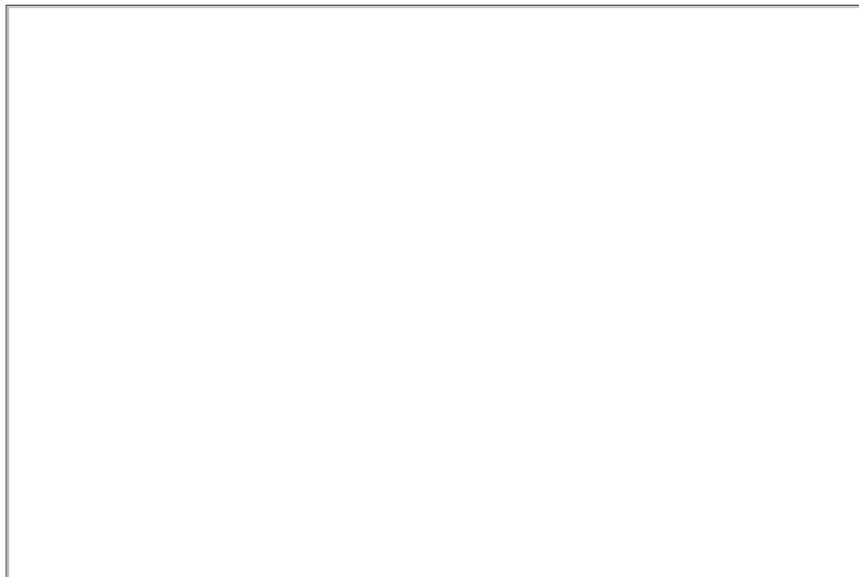
"That exchange of data between the radio beacons on the active side of the system, which is the Progress, and the passive side of the system, which is the Zvezda in this case, provides the distance between the two vehicles and the rate of closure between the approaching vehicle and the docking target so the computers can be updated on the Progress itself for its final approach for a linkup at a rate of about one tenth of a meter per second.

"In this case, that telemetry link was lost for unexplained reasons," Navias said. "The Progress aborted its automated rendezvous and flew a safe distance past the International Space Station and now is maintaining an opening rate."

The last confirmed distance call indicated the Progress was nearly four miles ahead of the station and Navias said "the crew was never in any danger."

2:15 PM, 6/30/10, Update: Progress supply ship launched to space station

An unmanned Russian Progress supply ship was successfully launched Wednesday from the Baikonur Cosmodrome in Kazakhstan, the first step in a two-day voyage to the International Space Station.



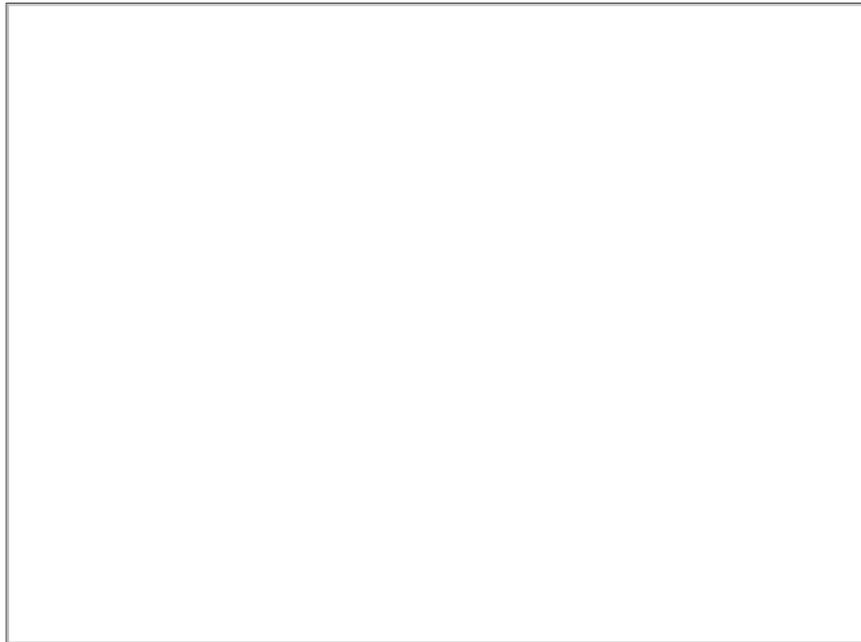
The Progress spacecraft being prepped for launch at the Baikonur Cosmodrome. (Photo: Roscosmos and Energia)

Liftoff occurred on time at 11:35 a.m. EDT and if all goes well, the craft will complete an automated rendezvous and docking at the aft port of the Zvezda command module around 12:58 p.m. Friday.

The cargo craft is loaded with 1,918 pounds of propellant, 110 pounds of oxygen, 220 pounds of water and 2,667 pounds of experiment equipment, spare parts and other supplies.

4:30 PM, 6/28/10, Update: Soyuz TMA-19 spacecraft moved to new Russian docking port

Cosmonaut Fyodor Yurchikhin, flight engineer Shannon Walker and Douglas Wheelock strapped into the Soyuz TMA-19 spacecraft that carried them into orbit earlier this month, undocked from the Zvezda command module's aft port and redocked at the new Russian Rassvet module.

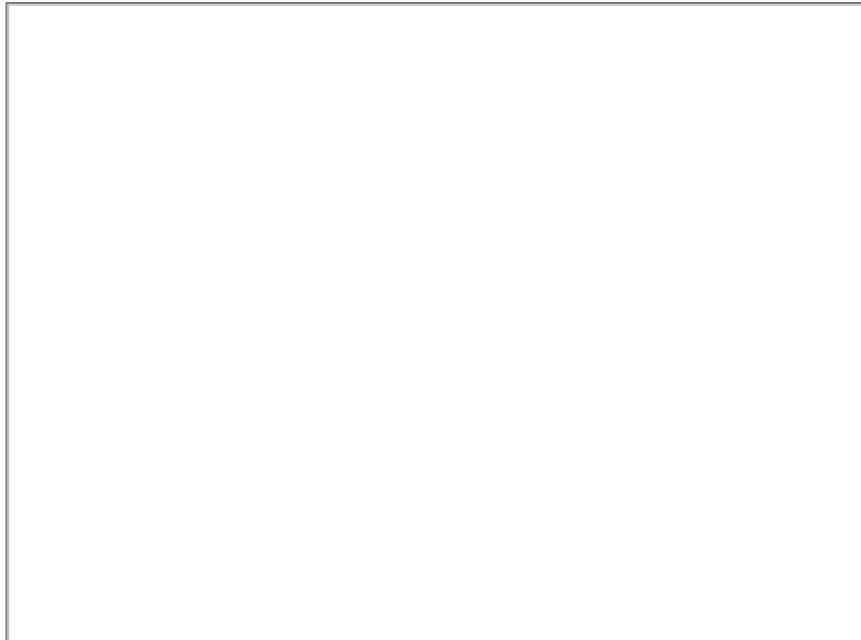


The Soyuz TMA-19 spacecraft in transit to the new MRM-1 - Rassvet - docking port. (Photo: NASA TV)

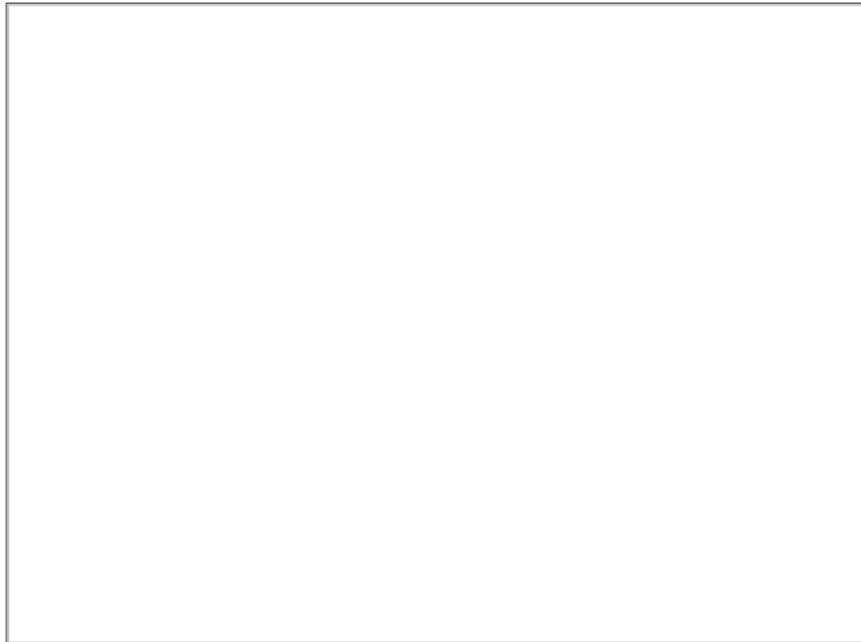
The relocation was delayed about 75 minutes because of a circuit breaker trip that prevented NASA flight controllers from latching down one of the International Space Station's solar arrays. After the problem was resolved and the array was locked in place, Yurchikhin undocked from the Zvezda module's aft port at 3:13 p.m. EDT. The move to the new mini research module, or Rassvet, was completed at 3:38 p.m.

Rassvet was carried up to the space station aboard the shuttle Atlantis and attached to the Russian Zarya module on May 18. Yurchikhin, Walker and Wheelock took off aboard the Soyuz on June 15 and docked at Zvezda's aft port two days later because Rassvet has not yet been configured for auto rendezvous procedures.

Today's relocation was carried out in manual mode. Rassvet will be rigged for auto rendezvous during a Russian spacewalk July 26.



The MRM-1 docking port as seen by the crew of the Soyuz TMA-19 spacecraft. (Photo: NASA TV)



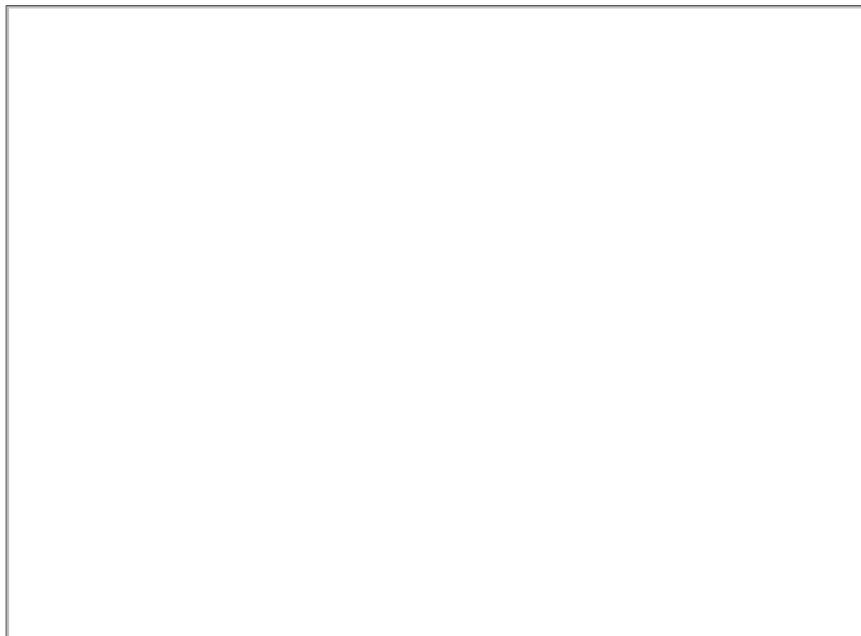
The Soyuz TMA-19 against the limb of the Earth. (Photo: NASA TV)

06:30 PM, 6/17/10, Update: Soyuz TMA-19 docks with space station (UPDATED at 6:50 PM with post-docking news conference; UPDATED at 11:15 PM with hatch opening, crew quotes)

Completing a two-day orbital rendezvous, a Russian Soyuz spacecraft carrying a veteran cosmonaut and two NASA astronauts docked with the International Space Station's aft port Thursday, boosting the lab's crew back to six.

Soyuz commander Fyodor Yurchikhin, assisted by NASA flight engineer Shannon Walker, monitored an automated approach to the Zvezda command module's aft port, docking at 6:21 p.m. EDT as the station complex sailed 220 miles above the south Atlantic Ocean just east of Argentina.

"We are in alignment, right in the center," Yurchikhin radioed as the spacecraft closed in. "We are in alignment ... contact, mechanical capture."



The view from the Soyuz TMA-19 spacecraft during final approach to the International Space Station. (Photo: NASA TV)

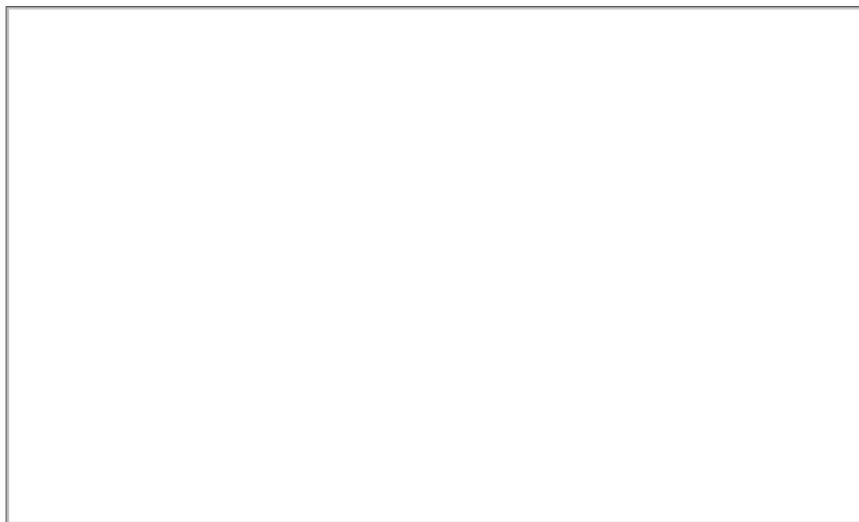
Hooks and latches then engaged, pulling the Soyuz TMA-19 spacecraft snugly into place. Hatches were opened at 8:52 p.m. and after waiting for a solid satellite link, Yurchikhin, Walker and Douglas Wheelock were welcomed aboard by Expedition 24

commander Alexander Skvortsov, Mikhail Kornienko and Tracy Caldwell Dyson, who were launched to the station April 2. This is the first time a long-duration station crew has included two women.

"I want to congratulate you for a picture-perfect rendezvous and docking," former shuttle commander Michael Coats, director of the Johnson Space Center, radioed from Moscow. "It's delightful to see the space station fully manned again, with a six-person crew. I want you to enjoy your time up there. ... But don't waste a whole lot of time, we need you to get to work in the world's finest laboratory!"

"I'm sitting next to Shannon's mother, Sherry," he continued. "And I promised her, Shannon, that you would get plenty of exercise, eat right and get to bed at a reasonable time."

Sherry Walker then took the phone and told her daughter "I hope you had a great flight up there and it was everything you thought it was going to be. I can see the big grin on your face, so I know you're having a good time."



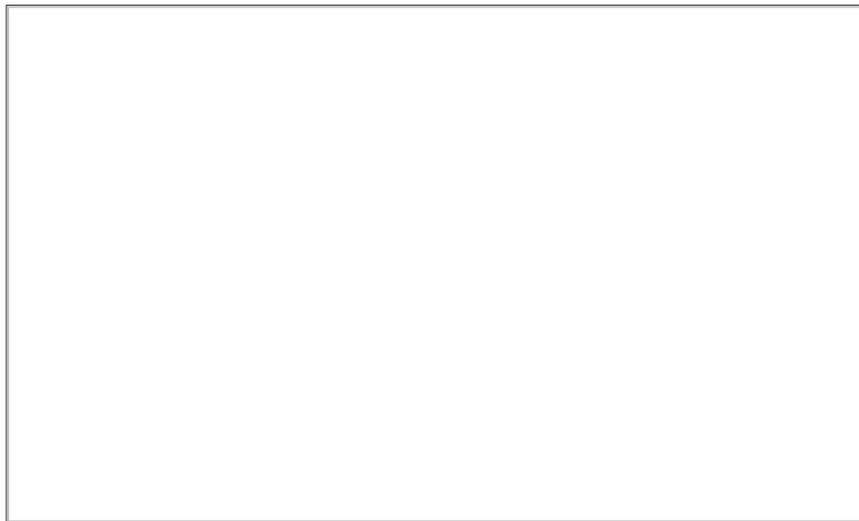
Astronauts Tracy Caldwell Dyson and Shannon Walker embrace in the Zvezda command module behind Fyodor Yurchikhin. (Photo: NASA TV)

Shuttle veteran Catherine Coleman, scheduled for launch to the station later this year, asked Walker and Wheelock to describe takeoff aboard the Soyuz TMA-19 spacecraft.

"I don't think there's any way to easily describe what ascent is like," replied Walker, who is making her first space flight. "It is totally amazing. This giant beast comes to life and shoves you skyward and it's noisy and shaky but wonderful at the same time."

Wheelock, a shuttle veteran, said in the moments before liftoff, "you can feel things happening underneath you and hear mechanical things going on and so the last few minutes leading up to launch (are) quite exciting and quite dynamic. You know something's happening."

"And then when it lights off, of course, it's sort of centerline thrust and you're sitting right on the center you just feel that kick in the pants," he said. "The second to third stage is pretty dramatic."



The Expedition 24 crew fields questions from Moscow after the Soyuz TMA-19 docking. (Photo: NASA TV)

Earlier, Bill Gerstenmaier, director of space operations at NASA headquarters said "it is great to see all you guys together in space, all six of you."

"You'll have an awesome expedition, plenty of good work in front of you, enjoy your time, enjoy your friendship, the time will go by fast," he said. "But make sure you enjoy yourself. Good work, and have a good time."

Flight controllers, meanwhile, are monitoring no less than four pieces of orbital debris that have a chance to pass relatively close to the space station over the next few days. One piece from a Russian rocket body was expected to make its closest approach, known as a conjunction, around 2:19 a.m. Friday, but it was not considered a threat to the station.

Three other pieces of debris are expected to pass by the station early Sunday.

"All conjunctions will be re-evaluated ... as soon as perturbations to the ISS orbit from the 23S docking activities have been tracked out," according to a NASA space station status report. "If a DAM (Debris Avoidance Maneuver) is necessary for any of these objects, it would be performed using Progress 37P mid-ring thrusters (docked at DC-1 nadir). The effects of such a maneuver on the other conjunctions will be analyzed as necessary, with appropriate action taken."

Yurchikhin, Walker and Wheelock, who plan to spend 164 days in space, are replacing Expedition 23 commander Oleg Kotov, Timothy Creamer and Soichi Noguchi, who returned to Earth two weeks ago aboard the Soyuz TMA-17 spacecraft after five-and-a-half months in space.

The new additions, in turn, will form the core of the Expedition 25 crew when Skvortsov, Kornienko and Caldwell Dyson depart in late September.

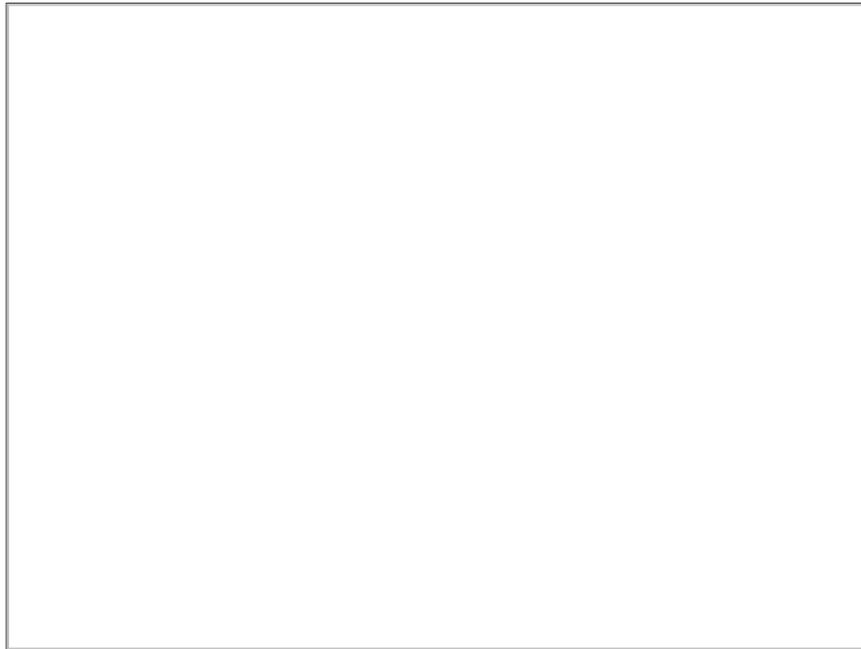
Following standard procedures, the Soyuz TMA-19 spacecraft docked at the Zvezda module's aft port Thursday using an automated rendezvous and navigation system. On June 28, Yurchikhin, Walker and Wheelock will strap in and move the spacecraft to the newly installed MRM-1 docking module attached to the Earth-facing side of the central Zarya propulsion and storage module.

The MRM-1, known as Rassvet, is not yet equipped with auto-rendezvous equipment and the fly-over at the end of the month will be carried out in manual mode. The rendezvous equipment will be configured during a spacewalk July 26 by Yurchikhin and Kornienko.

10:00 AM, 6/15/10, Update: Soyuz TMA-19 spacecraft prepped for launch to space station (UPDATED at 6:00 PM with successful launch)

Lighting up the pre-dawn Kazakhstan sky, a Russian Soyuz rocket carrying a veteran Russian cosmonaut and two NASA astronauts roared to life and vaulted into orbit Tuesday, kicking off a two-day flight to the International Space Station.

Station veteran Fyodor Yurchikhin and NASA astronauts Douglas Wheelock, a shuttle veteran, and rookie flight engineer Shannon Walker lifted off aboard the Soyuz TMA-19 spacecraft at 5:35:19 p.m. EDT Tuesday (3:35:19 a.m. Wednesday local time) from Yuri Gagarin's launch pad at the Baikonur Cosmodrome in Kazakhstan.



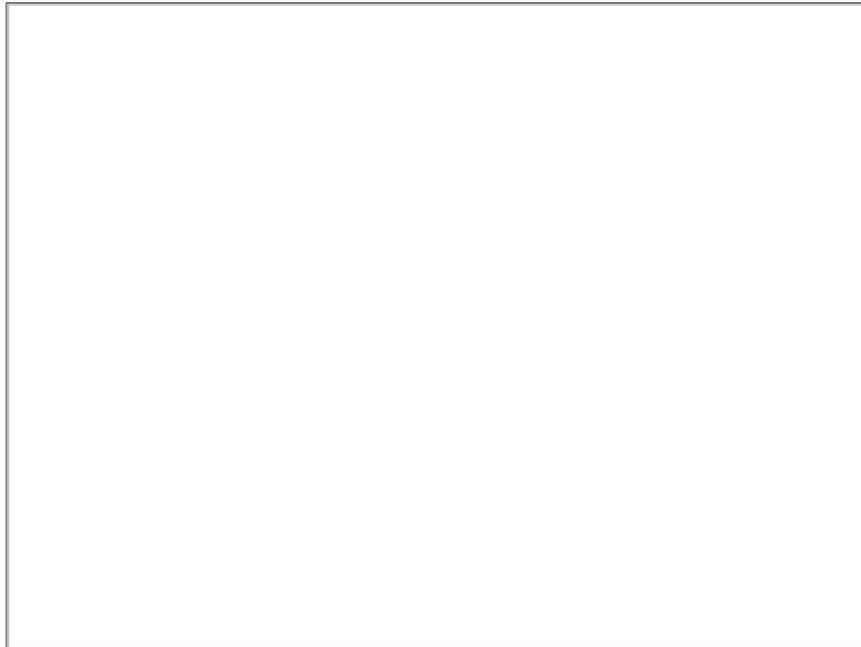
**The Soyuz TMA-19 spacecraft blasts off from the Baikonur
Cosmodrome in Kazakhstan. (Photo: NASA TV)**

Riding atop a torrent of fiery exhaust from its multiple first stage rocket engines, the Soyuz quickly climbed away from the launch pad and arced away to the east through a clear, dark sky.

There were no apparent problems during the climb to space. Shutdown and separation of the first-stage strap-on boosters was clearly visible on NASA television and all three crew members appeared relaxed and in good spirits as the rocket accelerated.

Eight-and-a-half minutes after launch, the spacecraft slipped into its planned preliminary orbit with a high point of 161 miles and a low point of 134 miles. A few moments later, its solar arrays and antennas deployed as planned to complete the ascent.

"OK, guys, all the best to you," a Russian flight controller radioed in an interpreted feed. "That's it."



**Soyuz commander Fyodor Yurchikhin, left, and flight engineer
Shannon Walker, moments after reaching orbit. (Photo: NASA TV)**

Including manned space shuttles and Soyuz capsules, along with unmanned Russian, European and Japanese cargo ships, this was the 100th launch supporting space station operations since assembly began in 1998.

Walker, a private pilot and wife of shuttle astronaut Andrew Thomas, was trained to serve as Soyuz flight engineer, assisting Yurchikhin in critical phases of flight.

"Only a handful of us have been trained as the co-pilots on the Soyuz, and it's quite an extensive training process," Walker said in a NASA interview. "I've spent the better part of the last three years over in Russia working with my Russian colleagues and my Russian instructors to learn how to be the co-pilot, so it's quite an endeavor."

A member of the Ninety-Nines International Organization of Women Pilots, Walker is taking a watch into space that was worn by Amelia Earhart during a solo flight across the Atlantic Ocean. In a NASA news release, Walker said she hoped that by honoring the legendary flier "people will become interested in the continuing story of women in aviation, and perhaps draw some new pilots to the field."

If all goes well, Yurchikhin and Walker will oversee an automated approach to the International Space Station, docking at the Zvezda command module's aft port around 6:25 p.m. Thursday.

After leak checks, hatches will be opened and Yurchikhin, Walker and Wheelock will be welcomed aboard by Expedition 24 commander Alexander Skvortsov, Mikhail Kornienko and Tracy Caldwell Dyson, who were launched to the station April 2. This will be the first time a long-duration station crew has included two women.

Yurchikhin, Walker and Wheelock, who plan to spend 164 days in space, are replacing Expedition 23 commander Oleg Kotov, Timothy Creamer and Soichi Noguchi, who returned to Earth two weeks ago aboard the Soyuz TMA-17 spacecraft after five-and-a-half months in space.

The new additions, in turn, will form the core of the Expedition 25 crew when Skvortsov, Kornienko and Caldwell Dyson depart in late September.

"Our increment is going to be pretty busy," said Wheelock, who will command Expedition 25. "We'll see a fairly long gap for the next shuttle flight to arrive, and so we have a fair amount of EVAs, or spacewalks, we'll be doing as well. We have three Russian EVAs. Fyodor and our Russian colleagues will go outside and be doing some configuration on the outside of the Russian segment and we'll also have two U.S. EVAs in August to do the very same thing, to outfit the station to be a little more independent of the heavy lift capability that the shuttle was bringing to the station."

Only two more shuttle flights currently are planned, one with Discovery and one with Endeavour. Discovery is officially targeted for launch Sept. 16, but the flight is expected to slip to around Oct. 29 because of payload issues. Endeavour currently is targeted for launch in late November, but that flight is expected to slip to February because of payload and launch conflict issues.

NASA managers are lobbying the Obama administration for permission to fly one additional mission with Atlantis next June to deliver critical equipment and supplies. A decision is expected around the end of the month.

"It's actually bitter sweet to see the shuttle go," Wheelock said. "But it's really an exciting time as well, because we're also going to be the first increment to really go to full utilization of the space station as an orbiting laboratory.

"All of our international partners, we've pulled together and done things in the engineering world that only 10 years ago seemed to be impossible. Did we think we'd get to this point sooner? Yes. Did we think we'd get to this point cheaper? Yes. ... We had big dreams and visions. I think that now we're just getting to that point where we're going to begin to really see the return on investment for us."

Looking beyond space station, Bill Gerstenmaier, director of space operations for NASA, told the crew to give some thought to how the station might be used to help pave the way for future missions into deep space.

"I'd like to congratulate the crew on being ready and completing their training," Gerstenmaier told the astronauts in a pre-flight meeting. "That's a tremendous accomplishment. The teams in Houston, Canada and Japan are all ready to support your efforts. Have a good time on station, we look forward to your activities and work.

"And I have a special request for you, to think about how station can be used for exploration activities, can be a stepping stone to things beyond. So in addition to your normal tasks and things to which you were trained, think about how station can be used for the future and as a stepping stone to new and bigger things."

Here is an updated timeline of critical events through docking with the International Space Station (in EDT; best viewed with fixed-width font):

DATE/EDTEVENT

06/15/10

05:35:19 PM...Launch
05:44:04 PM...Orbital Insertion
09:32:31 PM...DV1 orbit adjust burn (33.1 mph)
10:04:32 PM...DV2 orbit adjust burn (18 mph)

06/16/10
06:06:51 PM...DV3 orbit adjust burn (4.5 mph)

06/17/10
03:00:00 PM...US to Russian attitude control handover
03:17:00 PM...ISS maneuvers to docking attitude
04:06:09 PM...AR&D Automated Rendezvous start
04:28:13 PM...AR&D DV4/Impulse 1 (49.7 mph)
04:51:17 PM...AR&D Impulse 2 (3.2 mph)
04:52:30 PM...Soyuz Kurs-A activation
04:54:30 PM...SM Kurs-P activation
05:12:09 PM...Range = 62 miles: Soyuz VHF-2 link
05:12:37 PM...AR&D DV5/Impulse 3 (57.3 mph)
05:16:39 PM...Daily Orbit 1 Russian ground station acquisition of signal
05:16:49 PM...Range = 49.7 miles: Valid Kurs-P range data
05:20:50 PM...Sunrise
05:37:49 PM...Range = 9.3 miles: Kurs-A & Kurs-P short test
05:39:31 PM...Daily Orbit 1 Russian ground station loss of signal
05:45:09 PM...Range = 5 miles: Soyuz TV activation
05:53:13 PM...AR&D Impulse 4 (14.6 mph)
05:56:09 PM...AR&D Ballistic Targeting Point
05:58:10 PM...AR&D Impulse 5 (15.2 mph)
06:00:54 PM...AR&D Impulse 6 (3.8 mph)
06:02:52 PM...AR&D Flyaround mode start
06:08:19 PM...AR&D Stationkeeping start
06:16:00 PM...AR&D Final Approach start
06:18:00 PM...ISS inertial snap-and-hold window open
06:20:40 PM...Sunset

06:25:00 PM...Docking

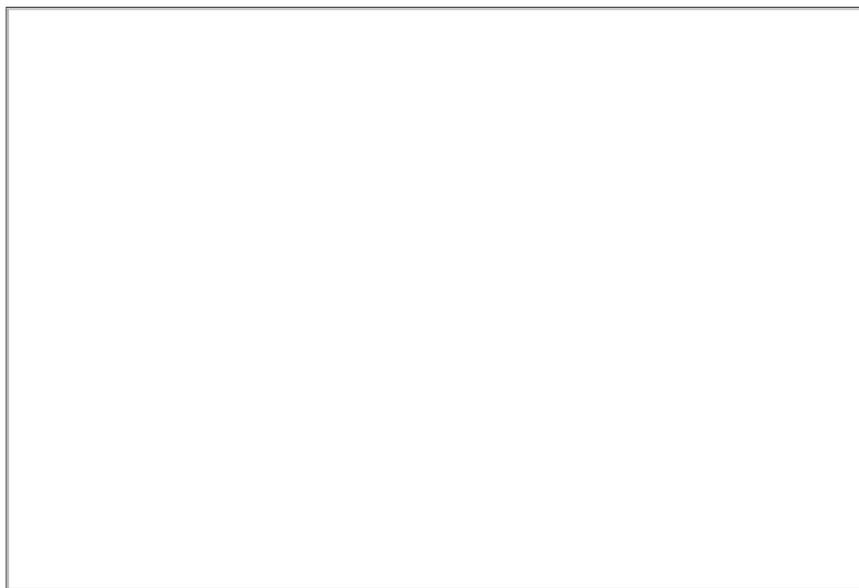
06:25:00 PM...ISS inertial snap-and-hold window close
06:45:00 PM...Soyuz hooks closed: ISS maneuvers to LVLH
06:49:43 PM...Daily Orbit 2 RGS AOS
06:52:25 PM...Sunrise
07:13:00 PM...Daily Orbit 2 RGS LOS
07:45:00 PM...Russian to US attitude control handover

3:15 PM, 6/4/10, Update: Falcon 9 rockets into space on maiden flight (UPDATED at 4:20 p.m. with confirmation of orbit; UPDATED at 6:35 p.m. with Musk telecon; quotes and details)

Powered by 10 engines and the vision of an internet entrepreneur, an untried Falcon 9 rocket blasted off Friday and successfully boosted a dummy payload into orbit on a maiden voyage intended to help pave the way for commercial missions to the International Space Station.

In a major milestone for the commercial launch industry, the two-stage Falcon 9's nine first-stage Merlin engines, fueled by liquid oxygen and RP-1 kerosene rocket fuel, roared to life at 2:45 p.m. EDT.

After computer checks to verify engine performance, four hydraulic hold-down clamps pulled away and the 157-foot-tall Falcon 9, riding atop a torrent of orange flame, climbed away from launch complex 40 at the Cape Canaveral Air Force Station.



The Falcon 9 rocket roars to life and climbs away from its launch pad. (Photo: Ben Cooper/Spaceflight Now)

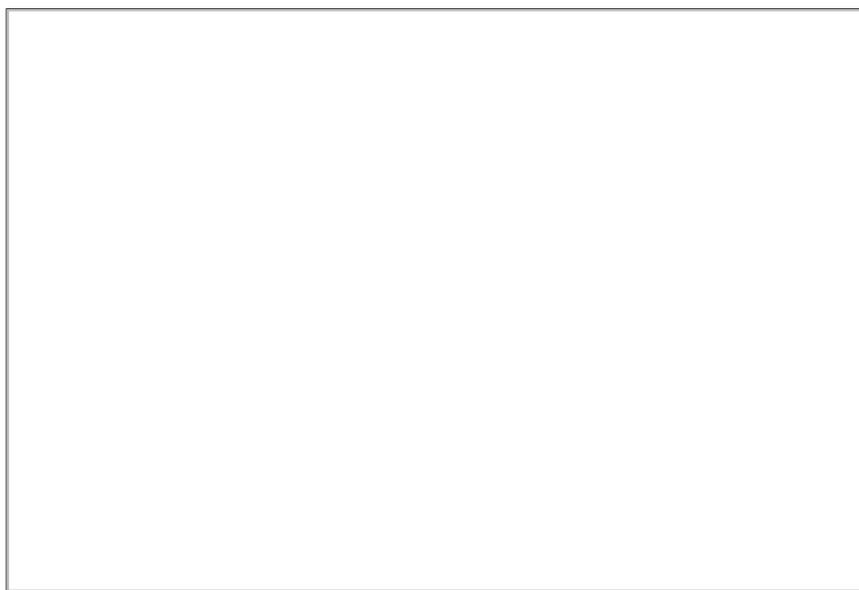
Liftoff came three hours and 45 minutes into a four-hour launch window because of tests of the rocket's self-destruct system, a

sailboat in the off-shore danger zone and a last-second abort because of a higher-than-expected pressure reading with engine No. 3 that blocked a 1:30 p.m. launch try.

Engineers with the Space Exploration Technologies Corp., or SpaceX, recycled the countdown to the T-minus 15-minute mark and decided to try again after concluding the engine was in good shape. This time, the countdown proceeded to zero without incident.

The initial stages of the ascent appeared normal as the rocket climbed straight up and then arced away to the northeast on a trajectory tilted 34.5 degrees to the equator.

Cameras mounted on the rocket provided spectacular views looking back toward Earth, showing shutdown and separation of the spent first stage and ignition of the second stage's single Merlin engine, its nozzle glowing bright orange from the heat of the exhaust. The second stage began an initially slow roll midway through the burn that became more and more pronounced as the rocket climbed.



A long-range view of the Falcon 9 toward the end of the first stage burn. (Photo: Ben Cooper/Spaceflight Now)

By the time the second stage engine shut down, the roll was more rapid than is typically seen with large rockets. But in an evening teleconference with reporters, SpaceX founder Elon Musk said the second stage engine shut down on time, putting the rocket's dummy payload, a structural test article representing the company's planned Dragon space station cargo module, into its intended 155-mile-high orbit.

"When the rocket achieved orbit, there was tremendous relief and elation at SpaceX," Musk said. "People have really put so much blood, sweat and tears into Falcon 9 and bringing that to launch. Upon liftoff, there was relief that it cleared the pad. Things were extremely tense here, everybody was glued to the monitors looking at the data streams and the video as I was. And then just a huge elation and relief that it reached orbit and we achieved 100 percent of the objectives on the mission."

Musk said the second stage rolled more than expected and that engineers would look into the issue to make sure it was not an indicator of a more serious problem. But he said the roll did not affect the rocket's overall performance.

"This has really been a fantastic day," he said. "It's been one of the best days of my life and certainly one of the greatest days for the people of SpaceX. We put our Falcon 9 rocket to orbit, it achieved a near bullseye on the target. We would have been excited even to have the first stage work or get some of the way through the second stage burn. As I said before, it would be a great day if we got to orbit. And thankfully, it has been a great day."

He said the successful launching "bodes very well" for President Obama's proposed shift in national space priorities, turning launches to low-Earth orbit over to the private sector while NASA focuses on deep space exploration.

"It really helps vindicate the approach that he's taking and it shows that a small, new company like SpaceX can make a real difference," Musk said. "We look forward to the (next Falcon 9) launch that's going to come up soon when we will be carrying an active version of our Dragon spacecraft, getting to the space station next year and hopefully launching astronauts as well as soon as possible."

NASA Administrator Charles Bolden congratulated Musk on the flight, saying the accomplishment "is an important milestone in the commercial transportation effort and puts the company a step closer to providing cargo services to the International Space Station."

"This launch of the Falcon 9 gives us even more confidence that a resupply vehicle will be available after the space shuttle fleet is retired," Bolden said.

SpaceX is building the Falcon 9 rocket and Dragon cargo modules to deliver supplies to the International Space Station and to bring equipment and experiment samples back to Earth. The initial test flight Friday was funded by SpaceX, but the company plans three subsequent test flights under a Commercial Orbital Transportation Services, or COTS, contract with NASA.

Following the demonstration flights, SpaceX hopes to begin space station resupply missions under a \$1.6 billion Commercial Resupply Service contract covering 12 flights.

Orbital Sciences Corp. also is developing an unmanned cargo craft under NASA's COTS/CRS program that is expected to fly next year. But SpaceX has generated most of the commercial space publicity in the wake of the Obama administration's proposed shift to commercial rockets for station resupply and, eventually, crew transport to low-Earth orbit.

Musk said the success of the first Falcon 9 launch gave the company a "huge boost of confidence, really, and it bodes very well for the future of commercial spaceflight."

"We're really at the dawn of a new era," he said. "You had the sort of Apollo era, the space shuttle era and those were government eras. And the government will continue to play a significant role in the future. But I think what you're really seeing is the rise of commercial as well, in many ways a partnership with government.

"I don't think we could have gotten this far without NASA," he said. "But this heralds a point at which space becomes a combined commercial and government endeavor with commercial playing an increasingly significant role."

1:45 PM, 6/4/10, Update: SpaceX Falcon 9 countdown halted seconds before liftoff

Running two-and-a-half hours late because of technical problems and a sailboat in the launch danger zone, SpaceX attempted to launch its new Falcon 9 rocket on its maiden flight Friday, but the countdown was interrupted with less than five seconds to go by an unspecified problem.

There was no immediate word from SpaceX on what caused the 1:30 p.m. EDT abort or whether another launch try might be possible before the four-hour launch window closes at 3 p.m.

The company is attempting to provide live coverage with a webcast anchored from SpaceX headquarters in Hawthorne, Calif., but presumably overloaded servers have caused lengthy interruptions and intermittent service throughout the day. No other source of information was provided.

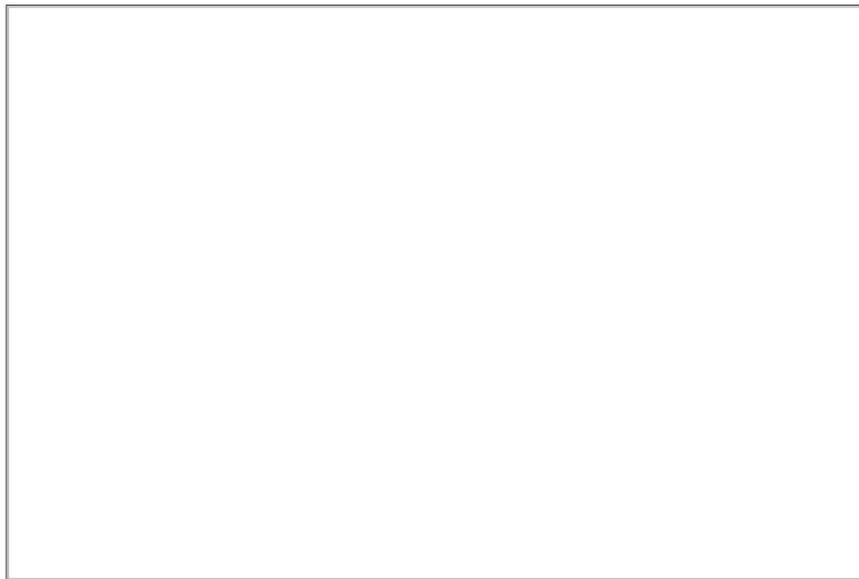
This status report will be updated after launch or as conditions warrant.

3:30 PM, 6/3/10, Update: SpaceX set for long-awaited Falcon 9 test flight

Downplaying expectations, the founder of SpaceX, one of the companies NASA is counting on to help resupply the International Space Station after the shuttle's retirement, said Thursday he believes the maiden flight of the new Falcon 9 rocket Friday has a 70 percent to 80 percent chance of succeeding.

"However, I should point out that is less than the probability of success in Russian roulette," Elon Musk, the co-founder of Paypal, told reporters. "Remember that scene from 'The Deer Hunter'? That's tomorrow. But not quite as likely."

The two-stage Falcon 9 rocket, carrying a dummy Dragon cargo module, is scheduled for its maiden launch from complex 40 at the Cape Canaveral Air Force Station during a four-hour launch window opening at 11 a.m. EDT. Forecasters are calling for 60 percent chance of good weather, improving to 70 percent favorable on Saturday.



The Falcon 9 rocket at launch complex 40 during initial pad checks late last year. (Photo: SpaceX)

"There is a lot of anticipation by all the people here at SpaceX," said Ken Bowersox, a former shuttle commander who now works for Musk as vice president for astronaut safety and mission assurance. "It's a really big launch for the company. We're trying not to let that excitement and anticipation bias our judgment."

Said Musk: "Everyone at this point feels pretty confident. There's very little we can do to improve the rocket as far as reliability is concerned. We've done everything we could possibly think of."

SpaceX, short for Space Exploration Technologies Corp., has not released any details about the countdown, ascent milestones or performance objectives, other than to say the dummy Dragon simulator is bound for a 155.3-mile-high circular orbit tilted 34.5 degrees to the equator.

The launch will be carried live in a company webcast anchored from SpaceX headquarters in Hawthorne, Calif., but television coverage is not being provided. NASA is honoring a request by the company not to release any video from its own cameras and tracking systems at the nearby Kennedy Space Center.

"We will report events as they happen, but are not providing a score sheet that our numerous enemies can use against us to nitpick what will hopefully be a great flight," Musk told Spaceflight Now earlier. "This is the first flight of a new vehicle, so there will necessarily be differences between predictions and reality."

The heavily instrumented 12-foot-wide Falcon 9 rocket stands 154 feet tall and weighs about 735,000 pounds. Its nine first-stage Merlin engines, burning RP-1 kerosene rocket fuel with liquid oxygen, will generate more than 1 million pounds of thrust at liftoff, firing for about three minutes. The second stage is powered by a single Merlin engine that will fire about six minutes.

As with all rockets launched from the Air Force Eastern Range, the Falcon 9 is equipped with a self-destruct system in case things go wrong. Getting the flight termination system certified took longer than planned, but Musk said he expected final approval Thursday.

"This is very much a test flight of the Falcon 9," he told reporters Thursday. "It's analogous to sort of the beta testing of some new technology. The payload in this case is the structural test article of our Dragon spacecraft. It'll give us good aero data, environments data, vibration, shock, G loading, that kind of thing. But really, it's about testing the launch vehicle. Does the first stage work? And you can break that down into first stage propulsion, structures, thermal, avionics, the guidance.

"Then you move to the upper stage. Do the two stages separate correctly, does the upper stage start, does it acquire its target vector, does the guidance, navigation software and electronics work? How does it perform in vacuum, how does it perform in the radiative environment of space, in that initial zero G period between stage separation and second stage start? And then just in terms of the specific impulse, what's the performance of the engines, propellant depletion, just the core functions of the vehicle?"

He said 100 percent success would mean reaching the planned orbit.

"But I think, given this is a test flight, whatever percentage of getting to orbit we achieve would still be considered a good day,"

Musk added. "I think even if we prove out just that the first stage functions correctly, that's a good day for a test. That's a great day if both stages work correctly."

Asked what he worried about the most, Musk said "stage separation may be sort of the scariest moment."

"Stage separation and second stage start, that's probably what I worry about the most," he said. "We spent a lot of time testing that and trying to design something that was redundant and certain to separate and restart. But generally speaking, whenever you've got a change of state in flight, that's where things get riskiest."

SpaceX is building the Falcon 9 rocket and Dragon cargo modules to deliver supplies to the International Space Station and to bring equipment and experiment samples back to Earth. The initial test flight Friday was funded by SpaceX, but the company plans three subsequent test flights under a Commercial Orbital Transportation Services, or COTS, contract with NASA.

Musk said Thursday a second Falcon 9 rocket carrying an operational Dragon spacecraft will be launched later this summer on the first NASA-sponsored flight, known as COTS-1. A second flight, originally planned for later this year, will be delayed until the second quarter of 2011, Musk said.

But in a major change, SpaceX has proposed launching the COTS-2 spacecraft on an actual resupply mission to the space station. The company originally planned to make the first rendezvous on the third COTS mission but Musk said it made more sense to move ahead with an actual rendezvous and to use the third flight as an operational backup.

NASA has not yet formally approved the change of plans.

"This launch (Friday) is about testing the rocket," Musk said. "Flight two is about testing the Dragon spacecraft that we've developed, and that flight is probably sometime this summer. The Dragon will not go to the space station on flight two, it'll go to the space station ... on flight three. This is something we haven't sort of been all that clear about, but I think it's probably worth mentioning.

"There was some press about a delay in our second Dragon flight, which will be our third Falcon 9 flight. Actually, an important point was missed, perhaps, by the press. We are actually intending to go to the space station on the second flight of Dragon. So that would be sometime next year, most likely in the second quarter of next year."

After the three demonstration flights, SpaceX hopes to begin space station resupply missions under a \$1.6 billion Commercial Resupply Service contract covering 12 flights.

Orbital Sciences Corp. also is developing an unmanned cargo craft under NASA's COTS/CRS program that is expected to fly next year. But SpaceX has generated most of the commercial space publicity in the wake of the Obama administration's proposed shift to commercial rockets for station resupply and, eventually, crew transport to low-Earth orbit.

During the teleconference Thursday, Musk repeated his belief that SpaceX could deliver a manned version of the Dragon spacecraft within three years of receiving a contract from NASA.

"We have designed Falcon 9/Dragon to meet the published NASA human rating standards," he said. "There's only one major development item we need to complete, which is the launch escape system. Our internal timeline is about a two-year development for that launch escape system. We add an additional year of schedule margin on top of that to account for the unknowns.

"So we believe, we're very confident in being able to say that three years from when we are handed a contract to deliver astronauts to the space station, that is when we'll be able to do it. If that were to occur at the end of this year, then at the end of 2013 is when we could begin delivering astronauts."

Many space agency insiders have been critical of Musk's optimism, arguing that development problems almost certainly will cause delays and drive up costs. Musk dismisses such criticism, saying "I feel sort of like a political punching bag or whipping boy, I suppose. It's been unfortunate in that regard."

"The opponents of the commercial approach have taken a very calculated strategy of attacking SpaceX while ignoring the Atlas and Delta rockets that are also commercial and have had now, I think, 31 or 32 consecutive successes," he said. "Because obviously, if they compare themselves to that, it's a much harder argument to make.

"I think this is a very good point really worth emphasizing, that tomorrow's launch should not be a verdict on the viability of commercial space. Commercial space is the only way forward. If we go with super-expensive government developments, in the absence of some massive increase in the space budget, we will never do anything interesting in space. ... It's not 'a' path forward, it's the 'only' path forward.

"I hope people don't put too much emphasis on our success, because it's simply not correct to have the fate of commercial launch

depend on what happens in the next few days. But it certainly does add to the pressure. There's more weight on our shoulders because of that. I wish there weren't."

Bretton Alexander, president of Commercial Spaceflight Federation, agreed, telling Spaceflight Now that because of the ongoing debate over the Obama administration's new space policy, the Falcon 9 launch has taken on "added significance."

That said, they are trying to lower expectations," Alexander said. "It's quite possible they won't be 100 percent successful, and people have to understand that. We are not going to be overly gushing if it's successful, and we're not going to be overly critical if it's not. It's just a step, and you have to treat it as that."

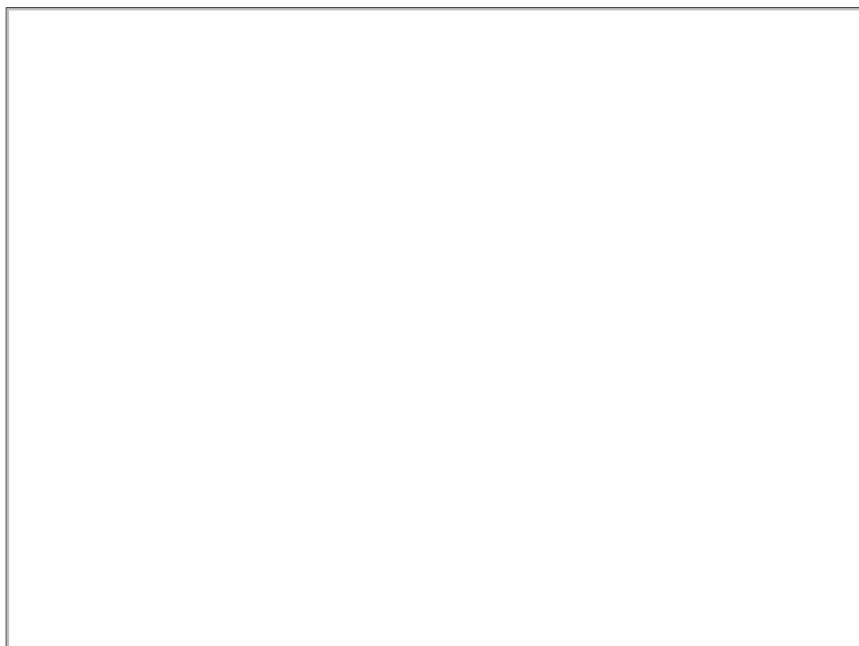
Asked a final time about his optimism and confidence level going into Friday's launch attempt, Musk said "I feel like that scene in 'The Deer Hunter.' I think we're probably three quarters likely to succeed. I hope that space favors us tomorrow and we're in the right three quarters of that probability."

"But either way, we're going to learn something," Bowersox said. "When the vehicle lifts off the pad, no matter what the outcome is, we're going to learn something that's going to make the second flight more likely, and the third flight and the fourth flight."

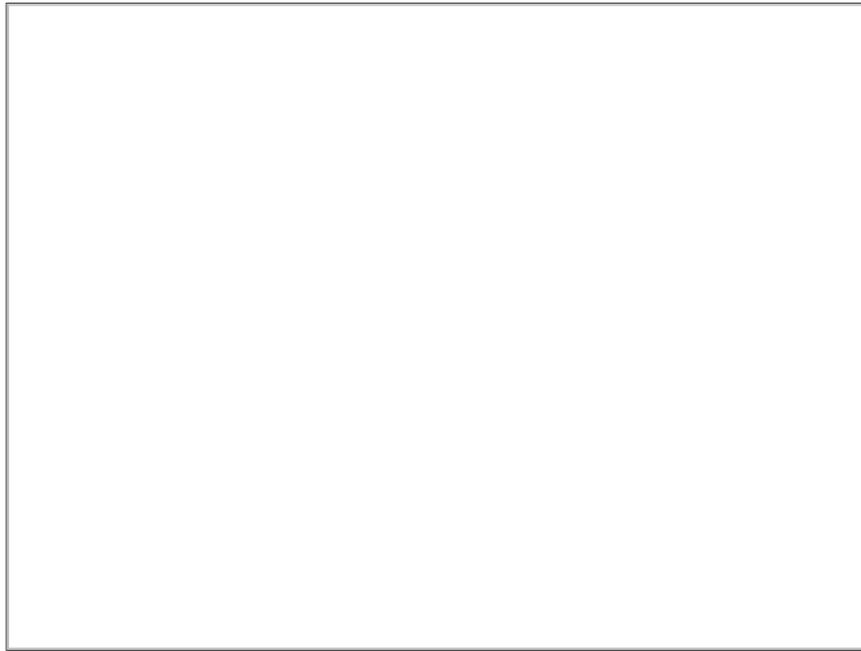
11:55 PM, 6/1/10, Update: Soyuz TMA-17 lands in Kazakhstan

The Soyuz TMA-17 crew capsule, carrying outgoing space station commander Oleg Kotov, Timothy Creamer and Soichi Noguchi, settled to a safe parachute-and-rocket-assisted landing in Kazakhstan Tuesday after a descent from the International Space Station.

Closing out a 163-day space mission, the Expedition 23 crew members fell through a clear blue sky and touched down on target near Dzhezkazgan in central Kazakhstan at 11:25 p.m. EDT. Recovery crews, including Russian, U.S. and Japanese personnel, quickly reached the capsule to provide assistance.



The Soyuz TMA-17 spacecraft as its braking rockets fire an instant before touchdown. (Photo: NASA)



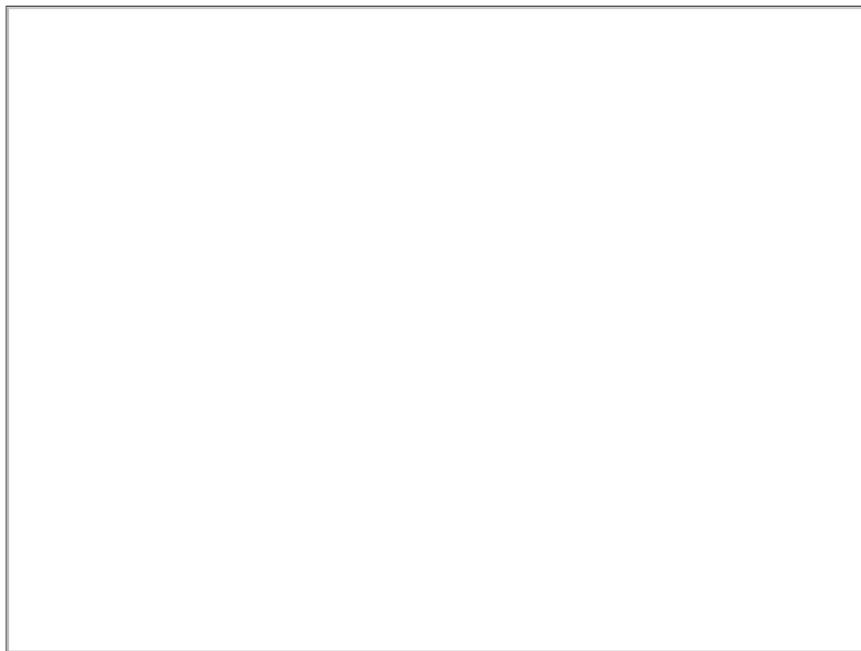
Soichi Noguchi, left, Oleg Kotov and Timothy Creamer relax after landing. (Photo: NASA TV)

Television views from the landing site showed all three crew members, still wearing their pressure suits, seated in reclining chairs under blankets, smiling and appearing relaxed as medical officers checked their vital signs. All three enjoyed fresh apples, smiling and waving to supporters.

"It was an on-target landing," NASA spokesman Rob Navias said from the landing site. "This is a beautiful spring day. ... This crew, after 163 days in space, is doing just great."

The return to Earth appeared to go smoothly, starting with the Soyuz TMA-17 spacecraft's undocking from the aft port of the Zvezda command module at 8:04 p.m. Kotov then monitored a four-minute 21-second deorbit rocket firing starting at 10:34 a.m. that slowed the craft by about 258 mph to drop it out of orbit.

Just before falling into the discernible atmosphere at an altitude of about 62 miles, the three modules making up the Soyuz TMA-17 separated as planned. The crew, strapped into the central descent module, fell into the atmosphere around 11:02 p.m. and followed the planned trajectory to the landing site, tipping over on its side after touchdown.



The Soyuz TMA-17 descent module after landing. (Photo: NASA TV)

After medical checks, Kotov, Creamer and Noguchi were to be flown to Karaganda where they planned to split up. Kotov was expected to head for Moscow and the cosmonaut training center at Star City while Creamer and Noguchi planned to board a NASA jet for a direct flight back to the United States. They are expected to arrive in Houston late Wednesday.

Kotov, Creamer and Noguchi blasted off from the Baikonur Cosmodrome in Kazakhstan on Dec. 20, 2009, docking two days later and joining Expedition 22 commander Jeffrey Williams and Maxim Suraev.

Kotov took over as commander of Expedition 23 with the departure of Williams and Suraev on March 18 and the crew expanded to six with the arrival of Alexander Skvortsov, Mikhail Kornienko and Tracy Caldwell Dyson on April 4.

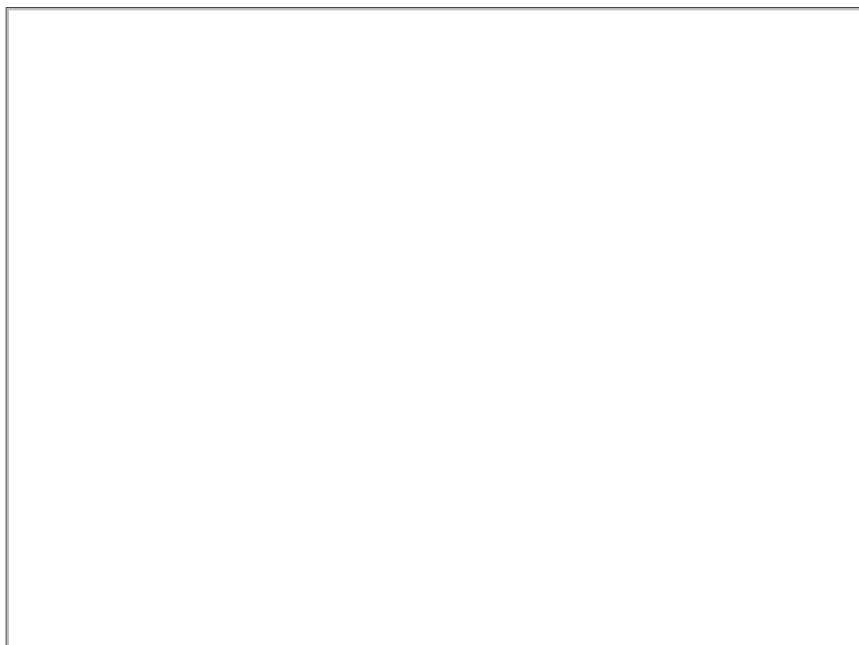
With the departure Kotov and his two crewmates, Kornienko, Caldwell Dyson and Skvortsov, the new commander of the space station, became the core members of the Expedition 24 crew. They will be joined June 17 by Douglas Wheelock, Shannon Walker and Fyodor Yurchikhin, who are scheduled for launch aboard the Soyuz TMA-19 spacecraft on June 15.

8:20 PM, 6/1/10, Update: Soyuz TMA-17 undocks from space station

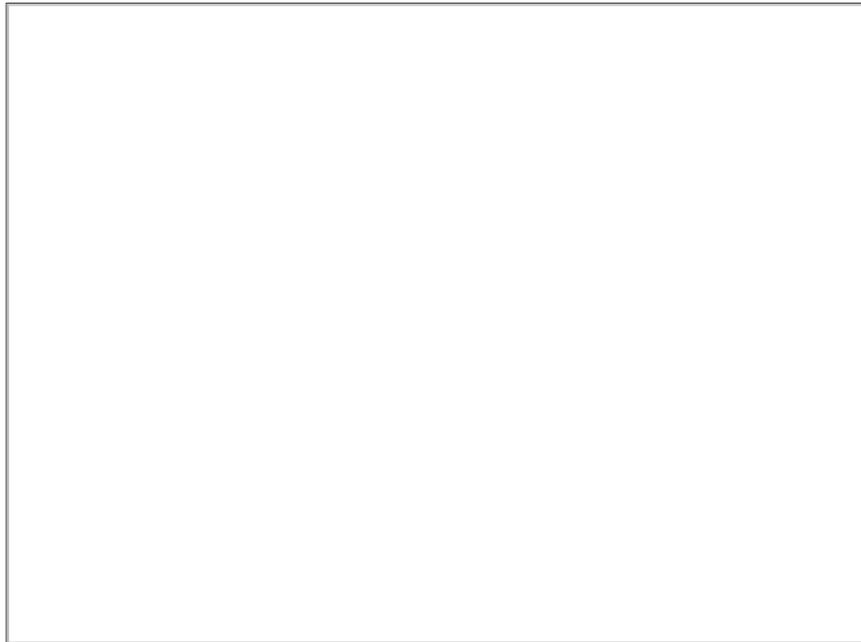
The Russian Soyuz TMA-17 spacecraft, carrying outgoing Expedition 23 commander Oleg Kotov, Timothy Creamer and Soichi Noguchi, undocked from the International Space Station Tuesday evening, setting the stage for landing in Kazakhstan to close out a five-and-a-half-month mission.

Undocking from the Zvezda command module's aft port occurred on time at 8:04 p.m. EDT as the two spacecraft were sailing 215 miles above eastern Mongolia.

"No issues, a smooth departure," someone radioed as the Soyuz backed away from the space station. A few moments later, a translator passed along someone saying "Bye bye, station. ... A beautiful view."



**The view from the Soyuz TMA-17 spacecraft moments after undocking.
(Photo: NASA TV)**



The Soyuz TMA-17 and the moon as seen from a space station camera. (Photo: NASA TV)



The Soyuz TMA-17, the moon and Earth's limb. (Photo: NASA TV)

If all goes well, Kotov will oversee a computer-orchestrated de-orbit rocket firing at 10:34:40 p.m., a four-minute 21-second burn designed to slow the spacecraft by about 258 mph and drop it out of orbit.

Just before falling into the discernible atmosphere at an altitude of about 62 miles, the three modules making up the Soyuz TMA-17 spacecraft were expected to separate. The crew, strapped into the central descent module, will fall into the atmosphere at 11:02 p.m., protected from the heat of re-entry by an ablative heat shield.

Commands to deploy the spacecraft's braking parachute system are expected at 11:10 p.m., setting up a landing near Dzhezkazgan, Kazakhstan, around 11:24 p.m. This status report will be updated after landing or as conditions warrant.

5:20 PM, 6/1/10, Update: Kotov, Creamer and Noguchi board Soyuz, prepare for re-entry and landing

Outgoing space station commander Oleg Kotov, NASA flight engineer Timothy Creamer and Japanese astronaut Soichi Noguchi floated into their Soyuz TMA-17 spacecraft Tuesday afternoon, closed the hatch and readied the ship for for undocking and landing

in Kazakhstan to close out a 163-day stay in space.

With Kotov acting as Soyuz commander, undocking from the aft port of the International Space Station's Zvezda command module was scheduled for 8:04 p.m. EDT. If all goes well, a four-minute 21-second rocket firing, starting at 10:34:40 p.m., will slow the spacecraft by about 258 mph, setting up a landing near Dzhezkazgan, Kazakhstan, at 11:24 p.m. (5:24 a.m. June 2 local time).



Outgoing Expedition 23 commander Oleg Kotov, right, shakes hands with Expedition 24 commander Alexander Skvortsov in a change-of-command ceremony Monday. (Photo: NASA TV)

Russian recovery forces were deployed near the targeted landing site, along with NASA and Japanese flight surgeons and support personnel, to assist the returning crew members.

Here is an updated timeline of major re-entry events (in EDT and mission elapsed time; best viewed with fixed-width font):

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EDT.....DDD...HH...MM...SS...EVENT
6/1
04:54:00 PM...162...23...02...00...Soyuz hatch closure
06:35:00 PM...163...00...43...00...US-to-Russian attitude control handover
07:28:00 PM...163...01...36...00...Sunrise at landing Site
07:50:12 PM...163...01...58...12...Sunrise
07:59:42 PM...163...02...07...42...Daily Orbit 14 Russian ground station AOS
08:00:00 PM...163...02...08...00...ISS to free drift
08:01:00 PM...163...02...09...00...Undocking Command
08:04:00 PM...163...02...12...00...UNDOCKING
08:07:00 PM...163...02...15...00...Soyuz sep burn #1 (15 sec, 1.5 mph)
08:09:00 PM...163...02...17...00...ISS maneuver to duty attitude
08:17:04 PM...163...02...25...04...Daily Orbit 14 Russian ground station LOS
08:46:17 PM...163...02...54...17...Sunset
10:15:00 PM...163...04...23...00...ISS maneuver to relaxation attitude
10:34:40 PM...163...04...42...40...DEORBIT BURN START (dT: 4:21; dV: 257.7 mph)
10:39:01 PM...163...04...47...01...Deorbit burn complete
10:41:00 PM...163...04...49...00...ISS maneuver to duty attitude
10:58:36 PM...163...05...06...36...Soyuz module separation (86.9 sm)
11:01:43 PM...163...05...09...43...Atmospheric entry (62.1 sm)
11:03:17 PM...163...05...11...17...Entry guidance start (50.2 sm)
11:07:43 PM...163...05...15...43...Maximum Gs (22.5 sm)
11:09:45 PM...163...05...17...45...Parachute deploy command (6.7 sm)
11:24:04 PM...163...05...32...04...LANDING (47°21' N, 69°35' E)
11:30:00 PM...163...05...38...00...Russian-to-US attitude control handover
11:11:00 AM...163...17...19...00...Sunset at Landing Site
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Kotov, Creamer and Noguchi were launched to the International Space Station on Dec. 20, 2009, becoming the core members of the 23rd expedition to the lab complex. During a change-of-command ceremony Monday, Kotov turned over the station to Expedition 24 commander Alexander Skvortsov, Mikhail Kornienko and NASA flight engineer Tracy Caldwell Dyson.

Kotov, speaking in English, offered his thanks "to everyone who support us in our work, who provide us with our success, who trained us."

"It's time. It's time to give up commanding of the station," he said. "It was really a success mission for us, and I really appreciate all my crew members who help me. ... I would like to wish all the best (to the) crew that stay here for their mission. It's time. Alexander, I give up command of this station."

"I am proud to accept command of International Space Station from you," Skvortsov said in English. "I was glad to work with crew members on space station in this time and I hope that we will continue with good tradition ... and I think everything will be OK. We'll see in future good work. Tomorrow, our space veterans will depart to Earth, very successful, and they will have good landing."

Creamer told reporters last month that he was looking forward to seeing his family again and enjoying the benefits of gravity.

"We've been up here five-ish months and right now, you kind of go, "I'm finally getting the hang of this," he said. "It's sad to be departing that operational world that I so enjoy and love, as well as just the camaraderie we share with our crewmates."

"What I'm looking forward to, of course, is getting back together with family and friends," he said. "Specifically, though, I'd really like to drink something not through a straw and have the food stay on the plate for a change."

Noguchi, Japan's second long-duration space station astronaut, took advantage of the lab's Ku-band internet access to post a stream of pictures on the web during his stay in space, showing targets of interest around the world. Asked about the oil spill in the Gulf of Mexico, Noguchi said "it's kind of sad to see the beautiful sea kind of tinted."

"These days, the stain kind of spreads around to the south," he said. "We're just hoping for a quick recovery."

As for his frequent Twitter use, Noguchi passed along "kudos to the engineers who made it possible. And also my personal thanks to me crewmate, T.J. Creamer, who worked very hard to make it happen. I was just a user, he's actually the background engineer to make it possible."

"My message to you guys is look, the Earth is beautiful and I just want to share the pictures," he said. "I'm not the best photographer, there are a lot of people who take a better picture, but I like to just share how a regular person comes up to the space station and sees this beautiful view and just want to share the view. So I'm very happy to have a chance to share the photographs with you guys."

Skvortsov, Kornienko and Caldwell Dyson will have the space station to themselves until June 17 when Fyodor Yurchikhin, Douglas Wheelock and Shannon Walker arrive aboard the Soyuz TMA-19 spacecraft, which is scheduled for launch from the Baikonur Cosmodrome in Kazakhstan at 5:28 p.m. EDT on June 15.

7:30 PM, 5/12/10, Update: Armstrong, Cernan question shift to commercial manned spaceflight

Apollo 17 commander Eugene Cernan, the last man on the moon, told lawmakers Wednesday the Obama administration's plan to shift near-term manned spaceflight from NASA to private industry could result in a 10-year gap between the end of the shuttle program and the debut of reliable commercial rockets.

He also said NASA Administrator Charles Bolden, in a recent conference call, told him and Apollo 11 commander Neil Armstrong, the first man on the moon, that he was concerned NASA might have to subsidize commercial rocket companies if they run into major problems.

"This may be a sensitive point because I'm going to mention something about a dear friend who I have the ultimate respect for, Charlie Bolden," Cernan told the Senate Commerce, Science and Transportation Committee.

"Because we did have a briefing last week and it was in that briefing that Charlie expressed some concern over the potential of the commercial sector to be successful in any reasonable length of time. He indicated we might have to subsidize them until they are successful."

"And I can say with authority, because I wrote this down and I put the word 'wow' right next to it, because Charlie did say it may be a bailout like GM and Chrysler. As a matter of fact, it may be the largest bailout in history."

Earlier in the hearing, Bolden was asked if he used the word "bailout" during the briefing for Cernan and Armstrong.

"I'm not sure I said that," Bolden said. "I'm not sure who was in the room. I have always said I will do everything in my power to facilitate the success of the commercial entities in access to low-Earth orbit. ... I am a contingency planner. I have to look at the possibility that the commercial sector may have difficulties and we will do everything in my power to facilitate their success. So that's what I meant."

The president's new space policy was unveiled in the fiscal 2011 budget proposal, a sweeping change of course for NASA as the

agency struggles to complete the International Space Station and retire the space shuttle by the end of the year.

Because of earlier funding shortfalls under the Bush administration, NASA already was facing a five- to six-year gap between the end of shuttle and the debut of the Ares I rocket and Orion capsule being designed as part of the Constellation moon program. NASA currently is buying seats on Russian Soyuz rockets to carry U.S. astronauts to and from the International Space Station.

The Obama administration plans to cancel the Constellation program and the Ares rockets NASA was designing to replace the space shuttle. Instead, the space agency will fund development of new commercial rockets and capsules to end the near-term reliance on Russia. No such "man-rated" rockets or spacecraft currently exist, but Bolden said Wednesday he believes the private sector can be ready to launch astronauts to the station by around 2015.

Cernan questioned that timetable, saying the gap may be much longer.

"In this proposed budget we find several billions of dollars allotted to developing commercial human access to low-Earth orbit, based upon the assumptions and claims by those competing for this exclusive contract who say that they can achieve this goal in little more than three years, and that it can be done for something less than \$5 billion.

"Based upon my personal experience and what I believe is possible, I believe it might take as much as a decade, a full decade, and the cost may be two to three times as much as they predict."

While Cernan and Armstrong both said they supported development of commercial space operations, "there are a myriad of technical challenges in their future yet to be overcome," Cernan said, "safety considerations which cannot be overlooked or compromised as well as a business plan and investors that they will have to satisfy."

"All this will lead to unplanned delays which will cost the American taxpayer billions of unallocated dollars and lengthen the gap from shuttle retirement to the day we can once again access LEO (low-Earth orbit) leaving us hostage as a nation to foreign powers for some indeterminate time in the future."

Armstrong agreed, saying "I am very concerned that the new plan, as I understand it, will prohibit us from having human access to low-Earth orbit on our own rockets and spacecraft until the private aerospace industry is able to qualify their hardware under development as rated for human occupancy."

"I support the encouragement of the newcomers toward their goal of lower-cost access to space," he said. "But having cut my teeth in rockets more than 50 years ago, I am not confident. The most experienced rocket engineers with whom I have spoken believe that will require many years and substantial investment to reach the necessary level of safety and reliability."

If so, Armstrong continued, "the United States will be limited to buying passage to the International Space Station from Russia, and will be prohibited from traveling to other destinations in LEO, such as the Hubble Space Telescope, or any of the frequently mentioned destinations out on the space frontier."

"As I examine the plan as stated during the announcement and subsequent explanations, I find a number of assertions which at best, demand careful analysis, and at worst, do not deserve any analysis."

It has been asserted, Armstrong told the committee, that by "buying taxi service to low-Earth orbit rather than owning the taxis 'we can continue to ensure rigorous safety standards are met.' The logic of that statement is mystifying."

"Does it mean that safety standards will be achieved by regulation, or contract, or by government involvement?" he asked. "Does it mean that the safety considerations in the taxi design, construction and test will be assured by government oversight? ... The cost of that government involvement will be substantial and that cost must be acknowledged in the total cost of the service."

In the Obama administration's initial budget rollout, there were no concrete plans to build a new heavy-lift rocket to replace the Constellation program's huge Ares V and no firm timetables for manned flights beyond low-Earth orbit.

During a visit to the Kennedy Space Center last month, the president announced plans to proceed with development of a new heavy lift rocket in 2015 to boost future manned spacecraft out of Earth orbit to any one of a variety of deep space targets.

Both Armstrong and Cernan said they favored sticking with the Constellation program. But Committee Chairman John D. Rockefeller, a West Virginia Democrat, said the status quo was not an option.

"The President has challenged the United States government to seek greater international collaboration, enable commercial services and develop new exploration technologies leading to human expansion beyond low-Earth orbit," he said.

"These are good priorities and should help ensure that in tough fiscal times, we build our space future in a measured, relevant, innovative, and sustainable way. This is not easy to do but we can do it - and we must. NASA cannot continue down the same path."

11:50 AM, 5/6/10, Update: NASA tests launch abort system

In a spectacular \$220 million test, NASA fired a new astronaut escape system rocket in New Mexico Thursday, boosting a dummy crew module more than a mile up in just 20 seconds to demonstrate how a future manned spacecraft could be pulled to safety in the event of a catastrophic on-pad rocket failure.

Using a solid-fuel motor generating some 500,000 pounds of thrust, the launch abort system ignited with a torrent of orange fire and smoke at 9 a.m. EDT, pulling the dummy crew module to nearly 450 mph in just 2.5 seconds with an acceleration of 16 times the force of gravity.

The motor burned for just six seconds or so, boosting the system to an altitude of nearly 4,000 feet and putting it on a ballistic trajectory with a predicted high point of roughly 6,000 feet.

An attitude control motor with eight computer-controlled exhaust ports helped maintain the craft's stability during the initial climb away from the White Sands Missile Range launch pad.

Ten seconds after takeoff, the attitude control motor began re-positioning the vehicle to a capsule-first orientation and as the craft passed through the apex of its trajectory, the burned-out escape rocket was jettisoned. Drogue parachutes then deployed to slow and stabilize the capsule before three 116-foot-wide parachutes unfurled for the final descent.

The heavily instrumented capsule, which will not be used again, hit the ground two minutes and 14 seconds or so after launch, 6,919 feet from its takeoff point. Touchdown velocity was 16 mph, about 6 mph slower than predicted.

"It's a great day for the country, for NASA and for industry," said NASA Test Conductor Don Reed. "It was absolutely successful. We didn't see anything anomalous. Everything worked as it was expected. In fact, we actually touched down at significantly less velocity than we predicted. The performance was absolutely astounding."

Developed as part of NASA's embattled Constellation moon program, the launch abort system is a critical element in the agency's drive to improve launch safety. The system was designed to be capable of pulling a crew to safety at any point from launch through an altitude of more than 55 miles.

The space shuttle does not have escape rockets, relying instead on high-reliability components and the ability to reach a runway or a lower-than-planned orbit with a single main engine failure at any point during the climb to space.

For multiple engine failures that might preclude a safe landing, the shuttle is equipped with a post-Challenger crew bailout system. But that system can only be used if the orbiter is in controlled, level flight and safely away from its external tank and boosters. There are no survivable booster failures.

Based on actual flight experience and safety upgrades over the years, the odds of a catastrophic failure during a shuttle launch are believed to be roughly 1-in-207. NASA managers hoped to improve those odds to 1-in-1,000 or better for the Orion capsules and Ares I rockets being developed as part of the Constellation program.

The Obama administration, citing high costs and tight budgets, has proposed canceling Constellation in favor of commercially developed rockets and capsules. NASA managers say the launch abort system technology tested Thursday could be incorporated in any such rocket.

"There are two parts of launch abort," Mark Geyer, NASA's Orion project manager, told reporters Thursday. "One, you need to get out of the way quick. Two, you need to make sure you can steer it so you can safely get out of the way and three, you need to make sure you have a chance to get the parachutes out. So no matter what the size is, you've got to integrate that system."

"I think the key part about this, regardless of the thrust level, is we've shown you can put those disparate pieces together in an integrated system with computers and everything else and make it work. So I think it's obviously very much applicable to any other system."

While similar in concept to the escape rockets used in the Apollo program, the new system relies on an active guidance system and state-of-the-art technology to reduce weight and improve reliability. Unlike the Apollo escape rockets, the motor designed for Orion points upward, using four exhaust ports that turn the plume 155 degrees to provide forward thrust.

The result is a more powerful, lighter and shorter escape system.

"The beauty of (Thursday's test) is it puts all the key elements together and launches them in this extreme environment," Geyer said before launch. "That's going to apply to anybody. All those elements on going to be needed, no matter who does this job."

1:40 PM, 4/30/10, Update: ISS nitrogen valve opens after extended troubleshooting; ammonia coolant loop A pressurized

After extended troubleshooting, space station flight controllers successfully coaxed open a stuck nitrogen tank valve, Friday, finally re-pressurizing an ammonia coolant loop serviced during the shuttle Discovery's recently completed mission.

One of the primary objectives of Discovery's flight was to replace a 1,700-pound ammonia tank in coolant loop A, one of two that circulate ammonia through huge radiators to dissipate the heat generated by the station's electronics.

The ammonia tank was installed in coolant loop A over the course of three spacewalks, but commands to open an electrically driven valve to repressurize the system with nitrogen were unsuccessful.

The system uses nitrogen to pressurize a bellows-like accumulator in the ammonia tank that allows the system to compensate for changes in volume as the station's orbit periodically result in higher temperatures. Without pressurization, a high beta angle - the angle between the sun and the plane of the station's orbit - could force controllers to shut down the loop to prevent damage. And shutting down a coolant loop would force the crew to power down critical systems.

Flight controllers carried out extensive troubleshooting to get the stuck nitrogen valve to open and finally succeeded Friday, cooling the valve and applying increased back pressure. A senior manager said the valve opened and was positioned as required, restoring coolant loop A to normal operation.

"Our leading theory was reduced friction on a force fitting," Kirk Shireman, deputy manager of the station program, said in an email. "We cooled the NTA (nitrogen tank assembly) down and tried yesterday with no luck. Today, at the same cold condition, we put some back pressure on the valve and it worked. We've positioned the valve to regulate the correct pressure. This allowed us to reincorporate the ATA (ammonia tank assembly). We are in great shape. There was cheering in the MCC (mission control center)."

The successful valve operation came as station managers were in the process of refining plans for Expedition 23 flight engineers Timothy Creamer and Tracy Caldwell Dyson to install a spare nitrogen tank assembly during one or more upcoming spacewalks. Those plans now can be shelved.

02:20 PM, 4/26/10, Update: Summer shuttle flight slips to mid November

Work to replace a powerful magnet in a \$1.5 billion physics experiment bound for the International Space Station has forced NASA to move a summer flight by the shuttle Endeavour to mid November, agency officials said Monday, delaying the planned end of the shuttle program.

NASA will press ahead with plans to launch the shuttle Atlantis May 14 on a space station assembly mission, but Endeavour's planned July 29 flight will slip to mid November, leap frogging a Sept. 16 launch by the shuttle Discovery that was to have been the shuttle program's final flight.

NASA did not specify a firm target launch date for Endeavour and mission STS-134 pending completion of work to modify its primary payload, the Alpha Magnetic Spectrometer.

The AMS payload is now expected to be delivered to the Kennedy Space Center in late August, but as of this writing it is not clear whether November is a realistic target for Endeavour's launch on the final planned shuttle mission.

As it now stands, temperature constraints related to the station's orbit would preclude a shuttle launch between Nov. 8 and 25. Complicating the picture, three of the station's six crew members are scheduled to return to Earth Nov. 26. Their replacements are scheduled for launch Dec. 10.

To avoid a conflict with the December Soyuz flight, Endeavour would need to take off between Nov. 26 and the end of the month, it would appear, to complete its mission and undock before the new crew members arrive.

Other options appear limited. Looking further downstream, shuttle software issues would preclude launching Endeavour after Dec. 15 to avoid having the shuttle in orbit during an end-of-year rollover. Another so-called beta-angle cutout - the period when the angle between the sun and the station's orbit precludes a shuttle visit - begins Jan. 4 and extends through Jan. 20.

A NASA spokesman said the schedule will be re-evaluated later this summer, depending on how the AMS magnet swap-out proceeds.

The Alpha Magnetic Spectrometer is designed to study high-energy cosmic rays, helping determine the balance of normal matter to antimatter. AMS also may be capable of detecting evidence for the so-called dark matter that is believed to exist throughout the universe. Dark matter has not yet been directly detected, but it is believed to make up about a quarter of the mass-energy density of the universe. Normal matter accounts for about 5 percent and repulsive dark energy, believed to be accelerating the expansion of the cosmos, makes up the balance.

The AMS experiment was designed to use a liquid helium-cooled superconducting magnet to bend the paths of electrically charged subatomic particles, allowing scientists to study their properties. Payload managers, however, recently decided to use a less powerful, non-superconducting magnet that will enable AMS to operate through the planned life of the space station instead of a relatively short three years. While it will not be as sensitive, the longer run time is expected to make up for the shortfall.

"Given that the ISS lifetime has been extended (to at least 2020), the permanent magnet gives them a much longer science mission than the cryo magnet," Mike Moses, director of shuttle integration at the Kennedy Space Center, said last week. "From a thermal challenge standpoint, I think they'll get a lot better science out of this other magnet."

The AMS experiment was removed from NASA's shuttle manifest in the wake of a 2004 directive by the Bush administration to complete the space station and retire the space shuttle by the end of fiscal 2010. Completing the station was the priority, NASA officials said at the time, and AMS could not be accommodated.

Congress later provided funding for an additional shuttle flight to get the international experiment to the space station. The payload was assigned to Endeavour and launch was targeted for July 29.

The delay to mid November, or later, means NASA will miss the Sept. 30 deadline for completing the shuttle program. But the agency earlier secured an additional \$600 million in funding to pay for flights through the end of the calendar year if necessary.

Under the revised manifest, Discovery will serve as the emergency rescue vehicle for the Atlantis astronauts. If all goes well, Atlantis would serve as the rescue shuttle for Endeavour.

Late last year, NASA managers privately discussed the possibility of adding a fourth and final shuttle flight to the remaining manifest using the boosters and tank set aside for the final emergency mission. By launching the shuttle with a crew of four, a rescue flight would not be needed; the astronauts could rely on the space station and downstream Soyuz flights to make it back to Earth if a major problem crippled the shuttle.

Talk about an extra flight has lingered, but given the end-of-year launch constraints and the delay for Endeavour, an additional flight does not appear to be possible before the end of the year and there is no funding currently available for a flight in 2011.

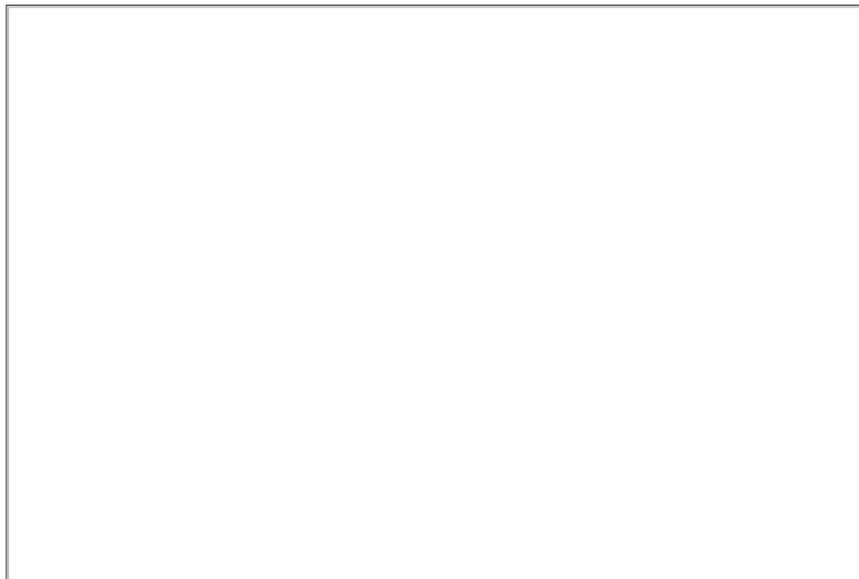
04:40 PM, 4/15/10, Update: President Obama touts new space policy in KSC speech

President Barack Obama flew to the Kennedy Space Center Thursday to sell his new space policy, a radical change of course for NASA that would cancel the Constellation moon program and shift manned launches to private industry while NASA studies options for future deep space exploration.

For the first time, the president laid out a rough timeline for expeditions beyond low-Earth orbit and even the moon, calling for manned missions to nearby asteroids by the mid 2020s, flights to orbit Mars by the mid 2030s and manned landings shortly after.

"What I hope is that everybody will take a look at what we're planning," the president told a crowd of NASA officials and dignitaries. "Consider the details of what we've laid out and see the merits as I've described them.

"The bottom line is, nobody is more committed to manned spaceflight, to human exploration of space than I am," he said. "But we've got to do it in a smart way and we can't just keep on doing the same old things we've been doing and thinking that somehow that's going to get us where we want to go."



President Obama outlines his new space policy during a speech at the Kennedy Space Center. (Photo: Ben Cooper/Spaceflightnow)

In a perfect storm of politics, a struggling economy and changing priorities, the president's new plan comes as NASA is struggling to complete the International Space Station and retire the space shuttle, resulting in more than 7,000 lost jobs this year at the Kennedy Space Center alone.

Because of earlier funding shortfalls, NASA already was facing a five- to six-year gap between the end of shuttle and the debut of the Ares I rocket being designed as part of the Constellation program. During that interim, the agency will be forced to buy seats on Russian Soyuz rockets to carry U.S. astronauts to and from the space station.

With the proposed cancellation of Constellation and the Ares family of rockets, NASA will rely on private industry to build new rockets and capsules to fill the breach. No such "man-rated" rockets or spacecraft currently exist, but the administration believes the private sector can deliver new hardware in three to five years, first launching cargo capsules to the station and eventually astronauts.

As for deep space exploration, the administration plans to proceed with development of a new heavy lift rocket in 2015 that would take the place of the Constellation program's Ares V to boost future manned spacecraft out of Earth orbit to any one of a variety of deep space targets. Possible destinations include the moon, near-Earth asteroids, the moons of Mars and, eventually, Mars itself.

Obama also has approved a plan to modify the Constellation program's Orion crew capsule for use as an emergency escape vehicle for the International Space Station. He also promised to use the spacecraft as a test bed for future deep space missions.

"We will invest more than \$3 billion to conduct research on an advanced heavy lift rocket, a vehicle to efficiently send into orbit the crew capsules, propulsion systems and large quantities of supplies needed to reach deep space," he said.

"In developing this new vehicle, we will not only look at revising or modifying older models. We want to look at new designs, new materials, and new technologies that will transform not just where we can go but what we can do when we get there. And we will finalize a rocket design no later than 2015 and then begin to build it. That's at least two years earlier than previously planned, and that's conservative, given that the previous program was behind schedule and over-budget."

"At the same time, after decades of neglect, we will increase investment in other groundbreaking technologies that will allow astronauts to reach space sooner and more often, to travel farther and faster for less cost, and to live and work in space for longer periods of time more safely."

The lack of firm targets and timetables was a major source of criticism from opponents to the president's plan, concerns he at least partially addressed Thursday. He insisted his approach will bear fruit in the years ahead by making the space program more affordable and sustainable over the long haul.

"By investing in groundbreaking research and innovative companies, we have the potential to rapidly transform our capabilities ... for future missions," Obama said. "And unlike the previous program, we are setting a course with specific and achievable milestones."

"Early in the next decade, a set of crewed flights will test and prove the systems required for exploration beyond low-Earth orbit."

And by 2025, we expect new spacecraft designed for long journeys to allow us to begin the first-ever crewed missions beyond the moon into deep space. We'll start by sending astronauts to an asteroid for the first time in history. By the mid-2030s, I believe we can send humans to orbit Mars and return them safely to Earth. And a landing on Mars will follow. And I expect to be around to see it!

"But I want to repeat, critical to deep space exploration will be the development of breakthrough propulsion systems and other advanced technologies," he said. "So I'm challenging NASA to break through these barriers. We'll give you the resources to break through these barriers, and I know you will, with ingenuity and intensity as you've always done."

Air Force One landed at the Kennedy Space Center's shuttle runway at 1:25 p.m. EDT, marking the first spaceport visit by a sitting president since Bill Clinton attended a shuttle launch in 1998. Joining Obama for the flight from Washington were Sen. Bill Nelson and Rep. Suzanne Kosmas, both Florida Democrats whose districts include the space center, NASA Administrator Charles Bolden and Buzz Aldrin, the second man on the moon.

Obama began his visit by touring the Space Exploration Technologies Corp. - SpaceX - rocket processing facility at the nearby Cape Canaveral Air Force Station. SpaceX, a relatively small company founded by internet entrepreneur Elon Musk, is building a new family of rockets as a commercial venture to deliver cargo to the International Space Station. SpaceX hopes to become a player in the manned launch marketplace under the administration's new policy.

"Handing over Earth orbit transport to American commercial companies, overseen of course by NASA and the FAA, will free up the NASA resources necessary to develop interplanetary transport technologies," Musk said in a statement. "This is critically important if we are to reach Mars, the next giant leap in human exploration of the Universe."

While the new space policy will not replace lost shuttle jobs, the president said up to 2,500 new jobs will be created at the Kennedy Space Center above and beyond the 2,000 jobs that had been earmarked for Constellation.

The administration's proposed policy shift has generated widespread opposition in Congress and among current and former NASA contractors and civil servants.

"We are very concerned about America ceding its hard earned global leadership in space technology to other nations," read a letter signed by more than two dozen former astronauts and NASA managers, including legendary flight directors Gene Kranz, Chris Kraft and Glynn Lynney.

"We are stunned that, in a time of economic crisis, this move will force as many as 30,000 irreplaceable engineers and managers out of the space industry. We see our human exploration program, one of the most inspirational tools to promote science, technology, engineering and math to our young people, being reduced to mediocrity.

"NASA's human space program has inspired awe and wonder in all ages by pursuing the American tradition of exploring the unknown. We strongly urge you to drop this misguided proposal that forces NASA out of human space operations for the foreseeable future."

Former NASA Administrator Mike Griffin, the chief architect of the Constellation program, said he did not understand "how this plan, if that is the word, is an improvement."

"We had an integrated architecture," he said in an email. "They have hope. We had a 'public option' along with commercial alternatives, when and as they matured. They have a commercial option only, they are leaving the International Space Station a hostage to fortune, and they are spending money on technology in what might be termed a faith based initiative. We knew how to replace shuttle, get to the moon and go on to Mars. They don't."

An open letter signed by Apollo 11 commander Neil Armstrong, Apollo 13 commander Jim Lovell and the last man on the moon, Gene Cernan, was equally blunt.

"For The United States, the leading space faring nation for nearly half a century, to be without carriage to low Earth orbit and with no human exploration capability to go beyond Earth orbit for an indeterminate time into the future, destines our nation to become one of second or even third rate stature," they wrote in a letter first posted by NBC News.

"While the President's plan envisages humans traveling away from Earth and perhaps toward Mars at some time in the future, the lack of developed rockets and spacecraft will assure that ability will not be available for many years."

But White House officials released two statements of their own this week, one from Aldrin and the other by Sally Ride, the first American woman in space and a member of a panel of experts that proposed the plan approved by Obama.

"As an Apollo astronaut, I know the importance of always pushing new frontiers as we explore space," Aldrin wrote. "The truth is,

that we have already been to the moon - some 40 years ago. A near-term focus on lowering the cost of access to space and on developing key, cutting-edge technologies to take us further, faster, is just what our nation needs to maintain its position as the leader in space exploration for the rest of this century."

Ride said the president's plan "will enable NASA to return to its roots: developing innovative technologies aimed at enabling human exploration and tackling the truly challenging aspects of human spaceflight, enduring beyond Earth orbit, beyond the Earth-moon system and into the solar system."

Along with extending the life of the International Space Station, the new policy "articulates a strategy for human exploration that will excite and energize the next generation," Ride said. "It shifts our focus from the moon and frees us to chart a path for human exploration into the solar system. ... Because this strategy systematically develops the necessary technologies and experience, the path will lead to a human mission to Mars."

Nelson, who flew with Bolden on the shuttle Columbia in January 1986, said the commitment to building a heavy-lift rocket would help the plan in Congress.

"As with most presidential proposals, Congress will not just rubber stamp it," he said in a statement. "So we'll take what he's saying to our committee, and then we'll change some things."

In the wake of the 2003 Columbia disaster, President Bush decided to complete the space station and retire the shuttle by 2010. At the same time, he directed NASA to begin development of new rockets, capsules and landers to carry astronauts back to the moon by the early 2020s. NASA came up with the Constellation program to implement those directives, spending some \$9 billion over the past five years.

But funding shortfalls resulted in a projected five-year gap between the end of shuttle operations and the debut of the Ares I rocket and Orion crew capsule. To bridge the gap, NASA is paying the Russians some \$50 million a seat to launch U.S. and partner astronauts to the space station aboard Soyuz rockets.

During the presidential campaign, Obama expressed support for Constellation but after the election, he set up a panel of outside experts to review NASA's plans and how much they might ultimately cost.

The panel concluded NASA could not afford to implement Constellation, or any other reasonable exploration program, without an additional \$3 billion or so per year, primarily to make up for earlier budget reductions. And that did not take into account the cost of operating the International Space Station beyond 2015.

The group favored a shift to commercial launch services to carry astronauts to and from low-Earth orbit while NASA focused on development of a new heavy-lift rocket system that would enable eventual flights to the moon, nearby asteroids or even the moons of Mars.

The Obama administration agreed with the idea of commercial launch services, but it did not explicitly embrace the "flexible path" approach to deep space exploration suggested by the panel, focusing instead on development of enabling technologies and somewhat vague long-range goals.

The new commitment to development of a heavy lifter with specific deep space objectives may defuse at least some of the outside criticism.

02:00 AM, 4/14/10, Update: Obama plan to include heavy lift rocket; scaled-down Orion capsule

As part of a sweeping post-shuttle change of direction for NASA, the Obama administration's shift to private-sector rockets and spacecraft will include government development of a new heavy-lift rocket for eventual manned flights to a variety of deep space targets including, ultimately, Mars, an administration official said Tuesday.

While committed to terminating the Bush administration's Constellation moon program, the president supports development of a scaled-down version of Constellation's Orion crew capsule for use as a space station emergency escape vehicle and possible technology test bed.

Speaking on background, a senior administration official said Tuesday the Orion capsule could be launched unmanned to the International Space Station using commercial rockets as part of a broad effort to reduce reliance on Russian Soyuz spacecraft.

The official said the use of a scaled-down version of Orion, along with the development of new private-sector rockets and capsules to replace the shuttle, would end NASA's reliance on Russia for space transportation services sooner than would have been possible with the Constellation program's Ares rockets.



An Orion capsule approaches the International Space Station in this Constellation program graphic. (Credit: NASA)

The president will discuss his new strategy for NASA during a conference at the Kennedy Space Center on Thursday, outlining a series of robotic and eventual manned deep-space missions that will build in an evolutionary, step-by-step approach to eventual flights to Mars, the official said.

While no timetable for such flights will be specified, a decision on what sort of heavy lift rocket architecture to pursue will be made in 2015, based in part on advanced technologies research that will be funded at more than \$3 billion over the next five years.

As previously announced, the administration's plan for NASA includes an additional \$6 billion over the next five years to fund a variety of technology and infrastructure development efforts that by 2012 will result, the administration official said, in 2,500 more jobs at the Kennedy Space Center than would have been expected under Constellation.

Looming job losses across NASA's contractor workforce have cast a pall over the space program in recent months. With the shuttle program's retirement late this year or early next - only three more missions are planned beyond Discovery's current flight - some 7,000 jobs will be lost at the Kennedy Space Center alone, with thousands more at other NASA field centers.

The Obama administration's change of course for NASA will not restore the lost shuttle jobs, but the additional spending will more than make up for the expected Constellation losses, the official said. Along with a shift to commercial launch services, the administration plans a \$2 billion upgrade to the Kennedy Space Center's launch infrastructure.

And in the near term, the administration will spend \$40 million to fund an "economic development action plan" to help the local workforce make the transition.

Taken together, the new initiatives mark a "more ambitious space strategy" than Constellation offered, the official said, adding that critics who have charged the president's approach represents an end to government-sponsored manned spaceflight "are just flat wrong."

Development of a new heavy lift super rocket will "unlock the solar system," the official said, and do it sooner than would have otherwise been possible.

Whether these new elements - commitment to a heavy lift rocket and use of Orion technology - will satisfy the administration's critics in Congress and elsewhere remains to be seen.

In a recent open letter to the president signed by legendary Apollo flight directors Chris Kraft, Gene Kranz, Glynn Lunney and more than 20 former astronauts, including Apollo 13 commander Jim Lovell and Apollo 17 commander Gene Cernan, the administration's plan was criticized for ceding America's "hard earned global leadership in space technology to other nations."

"We are stunned that, in a time of economic crisis, this move will force as many as 30,000 irreplaceable engineers and managers out of the space industry," they wrote. "We see our human exploration program, one of the most inspirational tools to promote science, technology, engineering and math to our young people, being reduced to mediocrity."

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The Obama administration agreed with the idea of commercial launch services, but it did not explicitly embrace the "flexible path" approach to deep space exploration suggested by the panel, focusing instead on development of enabling technologies and somewhat vague long-range goals.

The result, administration officials said, was an affordable, more sustainable space program.

The new commitment to development of a heavy lifter may defuse at least some of the outside criticism. But the benefits of using a scaled-down version of Orion for space station crew escape are not as clear. Seats purchased on Russian Soyuz rockets include launch and landing and the capsules remain docked at the station throughout a crew's stay, available as emergency lifeboats if needed.

Former NASA Administrator Mike Griffin, chief architect of the Constellation program and a signer of the open letter to the president, said in an email "the people who are offering this plan are flailing."

Launching the capsules atop unmanned rockets would eliminate the need for complex abort systems, he said, but even unmanned rockets are expensive, the capsules would need an autonomous rendezvous and docking capability and they would have to be periodically replaced.

"The proposed 'Orion Lite' vehicles will not carry crew to the ISS," Griffin said. "Indeed, the first time they carry crew will be in an emergency. So we will need to replace them periodically to ensure that a fresh vehicle is available. ... Through all this we will have to continue to pay the Russians for crew transfer services until and unless commercial capability emerges.

"In the end, this seems like an expensive proposition that makes simply continuing to use the Russians for crew rescue look like a bargain."

06:05 PM, 4/8/10, Update: 'Space Summit' to discuss Obama plan for NASA

A presidential "space summit" in Florida next week will give NASA and the administration a chance to discuss, and explain to the public, the space agency's post-shuttle shift to commercial rockets and technology development, the administrator said Thursday.

Few details about the president's April 15 visit to Florida's Space Coast have been revealed, including where the meetings will be held. But NASA Administrator Charles Bolden said Thursday he hopes the summit will clear the air and give the president "the opportunity to continue the conversation that he has been having with members of Congress."

"As the plan is laid out right now, I think I can share that he actually plans to have some private moments with members who will be there for the conference, he then plans to deliver a major space policy speech and, hopefully, convince everybody ... that he's dedicated to exploration and human space flight.

"And then, as it's planned right now, there will be several round table or panel discussions, breakouts on a number of topics that have to do with the programs in the proposed budget so that we can get some feedback from people who attend the conference and we have an opportunity for learned people to share their insights."

The public portions of the invitation-only meetings will be carried live on NASA's satellite television channel and open to media coverage.

"I'm not the writer of the guest list, but there will be members of Congress invited because ... none of this happens unless Congress approves the budget," Bolden said. "So it's very important that they be involved in the discussion and the deliberation. Members of

the press will be there, because it's only through you that we can tell our story."

Other invited guests will include "people involved in future concepts, whether they're commercial spaceflight developers, scientists, engineers, representatives from academia," Bolden said. "We're attempting to get a broad cross section of people who can participate and the breakout of the four, I think, different groups will represent distinctly different areas so we don't get a lot of overlap. We try to cover a lot of ground in a short period of time."

5:45 PM, 4/8/10, Update: Bolden unveils sweeping programs to implement Obama space plan

One week before President Obama attends a major "space summit" in Florida, NASA unveiled sweeping new programs Thursday designed to implement the administration's proposed shift to commercial manned rockets and development of new technologies to enable eventual deep space exploration.

The president's fiscal 2011 budget request, which would cancel the Bush administration's Constellation moon program, does not specify a long-range target for manned exploration or a timetable for moving beyond low-Earth orbit, factors that have generated widespread criticism.

But NASA Administrator Charles Bolden, a former shuttle commander, defended the agency's new direction Thursday, saying the president's controversial "vision" is, unlike past programs, affordable and sustainable.

"This budget provides an increase to NASA at a time when funding is scarce," he said. "It will enable us to accomplish inspiring exploration, science and R and D, the kinds of things the agency has been known for throughout its history."

While deep space targets are not specified, the budget "enables NASA to set its sights on destinations beyond Earth orbit and develop the technologies that will be required to get us there, both with humans and robots," Bolden said.

"We're talking about technologies that the field has long wished we had but for which we did not have the resources," he said. "These are things that don't exist today but we'll make real in the coming years. This budget enables us to plan for a real future in exploration with capabilities that will make amazing things not only possible, but affordable and sustainable."

But even with increased funding, the looming retirement of the space shuttle and the proposed cancellation of Constellation will mean nearly 10,000 lost jobs at the Kennedy Space Center alone and thousands more at other NASA centers and communities.

"A very serious and real concern for everyone is the jobs," Bolden agreed. "But this is what we call progress. Unfortunately, if you look at every area of technology in this country, as you advance there are fewer and fewer manual-type jobs. That's what happens when you advance technology."

"We're doing everything within our power ... to help everybody understand we're expanding the amount of programs we have so that we can try to put people to work who are interested in being a part of the space program. Are we going to be able to employ everybody that used to work in shuttle? No, we're not. But that was never a vision."

"Even with the Constellation program, we were going to lose several thousand jobs because Constellation was a step further than shuttle. And the program we envision now is a step further than Constellation. But that is a significant issue for people."

In the wake of the 2003 Columbia disaster, President Bush decided to complete the space station and retire the shuttle by 2010. At the same time, he directed NASA to begin development of new rockets, capsules and landers to carry astronauts back to the moon by the early 2020s. NASA came up with the Constellation program to implement those directives, spending some \$9 billion over the past five years.

During the presidential campaign, Obama expressed support for Constellation but after the election, he set up a panel of outside experts to review NASA's plans and how much they might ultimately cost.

The panel concluded NASA could not afford to implement Constellation, or any other reasonable exploration program, without an additional \$3 billion or so per year, primarily to make up for earlier budget reductions.

The group favored a shift to commercial launch services to carry astronauts to and from low-Earth orbit while NASA focused on development of a new heavy-lift rocket system that would enable eventual flights to the moon, nearby asteroids or even the moons of Mars.

The Obama administration agreed with the idea of commercial launch services, but it did not specify any long-range destinations or timetables, focusing instead on development of enabling technologies.

The administration's \$19 billion fiscal 2011 budget request for NASA would pump an additional \$6 billion into the agency's budget over the next five years to kick start development of a new commercial manned spaceflight capability.

During a teleconference Thursday, Bolden and Deputy Administrator Lori Garver unveiled how some of that money will be spent, assuming Congressional approval, and which NASA centers will be responsible for implementing the new programs.

At the Johnson Space Center in Houston, where the International Space Station program is managed and where astronauts are trained, a flagship technology demonstration program office will be established, receiving \$424 million in fiscal 2011 and \$6 billion over the next five years.

The program will be responsible for flight tests of new technologies such as autonomous rendezvous and docking, in-orbit refueling and inflatable habitat modules. JSC also will continue to manage the space station program and work with the Kennedy Space Center on development of commercial manned spacecraft.

Asked if Johnson will give up its role in astronaut training and mission design as the agency shifts its focus to private-sector launch services, Bolden said he envisions a multi-faceted approach.

"At NASA, we provided astronauts for exploration," he said. "A lot of that exploration and experimentation today and in the future will be done on the International Space Station. So what we are doing is relying on commercial capability to get us access to low Earth orbit, to get us to the International Space Station.

"But to get to places like the moon and Mars and other beyond LEO places, that, we feel, is the responsibility of your government. Because that's risky, that's an investment that we can't really count on a commercial entity taking until we've demonstrated the ability to do that and do it safely."

Bolden said he did not envision "a significant change in the way we train, fly and operate a standard NASA mission, whether it's on the International Space Station or anywhere else."

"That activity will remain in Houston," he said. "The bulk of the work for the commercial crew actually deals with vehicle processing, vehicle purchasing or acquisition and the work with the commercial contractors themselves, since we expect they will all launch humans out of the Kennedy Space Center complex."

At Kennedy, the commercial crew development program office will manage \$500 million in fiscal 2011 and \$5.8 billion over the next five years to encourage development of a new private-sector launch industry. The deputy manager of the flagship technology demonstrations program will be based at Kennedy and a new program office will manage \$1.9 billion over five years to upgrade and modernize the launch infrastructure.

"The goal is to augment NASA's current and future operations to achieve safe, increased operational efficiency and reduced launch costs for all customers," Garver said. "We also want to facilitate multiple launches of different types of vehicles from different companies carrying both humans and cargo in a timely fashion."

At the Marshall Space Flight Center in Huntsville, Ala., \$3.1 billion would be spent over the next five years for heavy lift propulsion research and technology development to come up with designs for new rockets that can lift the large payloads needed for deep space exploration.

While the new plan for NASA does not specify a long-range target for exploration, Bolden said Mars is the ultimate objective. But getting there, he said, will require the new technologies that NASA's new approach is designed to develop.

"Sending humans to Mars is perhaps one of the most challenging endeavors technologically that I can imagine," said Bobby Braun, NASA's chief technologist. "We obviously need new launch systems that can lift much larger payloads, we need to have learned from our on-orbit assembly of the International Space Station on how to assemble large, complex spacecraft, we need new advanced propulsion technology to shorten the transit time, to limit the risk to humans during the duration of the in-space travel.

"We need to learn how to shield and protect our human astronauts during that transfer. We don't know how to land a significantly large amount of payload on the surface of Mars today. We know how to land perhaps golf-cart size or even small car size payloads. But we certainly don't know how to land a two-story house on the surface of Mars, particularly a two-story house right next to another two-story house that was sent ahead to prepare the way.

"So there are a wide range of technologies that need to be advanced to enable humans to go to that particular destinations," Braun said. "As you back off and consider other destinations, for instance, the moon, asteroids, the martian moons, we don't need all of those technological advances. But for our ultimate vision, we certainly need an investment in technology."

2:20 AM, 4/4/10, Update: Soyuz TMA-18 docks with space station (UPDATED at 4:15 AM with hatch opening; quotes)

On the eve of the shuttle Discovery's launch on a space station resupply mission, a Russian Soyuz spacecraft completed a smooth docking with the international lab complex early Sunday, boosting the station's crew from three to six.

With commander Alexander Skvortsov monitoring a problem-free, automated approach, the Soyuz TMA-18 docked to the International Space Station's new Poisk module at 1:25 a.m. EDT as the two spacecraft sailed 222 miles above Kazakhstan.



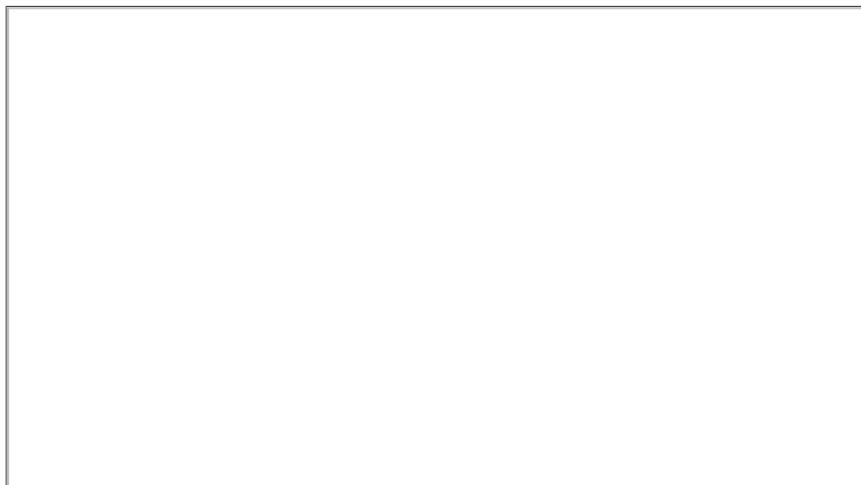
The International Space Station as seen from the Soyuz TMA-18 spacecraft during final approach. (Photo: NASA TV)

"Target is in the middle," said someone, presumably Skvortsov, as the Soyuz closed in. "Contact. Contact. OK, contact, hard mate."

"Everybody's clapping here," a Russian flight controller radioed. "Everybody's applauding you guys."

After extensive leak checks, hatches were opened at 3:19 a.m. and Skvortsov, flight engineer Mikhail Kornienko and NASA astronaut Tracy Caldwell Dyson were welcomed aboard by Expedition 23 commander Oleg Kotov, Soichi Noguchi and Timothy "T.J." Creamer.

All six then gathered in the Zvezda command module for a traditional call from dignitaries and family members gathered in the Russian mission control center near Moscow.



**The Expedition 23 crew aboard the International Space Station.
Back row, left to right: Soichi Noguchi, Oleg Kotov, Timothy Creamer.
Front row, left to right: Mikhail Kornienko, Alexander Skvortsov, Tracy
Caldwell Dyson. (Photo: NASA TV)**

"Congratulations on your successful launch and docking," said Kirk Shireman, deputy manager of the space station program at the Johnson Space Center. "It's great to see you on board the ISS. I wanted to wish you all a happy Easter. And for Soichi, T.J. and

Oleg, it's great to see all of you as a crew of six on board ISS and wish you all the best on this holiday."

"Thank you very much," Dyson replied.

Dyson's mother, Mary Ellen Caldwell, took the phone a few minutes after that, saying "Hi, Tracy, it's Mom. Hi guys, you all look wonderful and you look like you had a good flight. Congratulations on your big success and happy Easter."

"Thanks a lot, Mom," the astronaut replied. "Love you."

"Hello Tracy, it's your husband," George Dyson called. "I wanted to let you know that you look beautiful and with your grin from ear to ear, it looks like you're happy to be back in your home. Enjoy your time up there and I'll be talking to you soon. I love you."

"Love you, too."

The Soyuz docking came on the eve of the shuttle Discovery's launch Monday from the Kennedy Space Center on a flight to deliver some 10 tons of supplies and equipment. Assuming an on-time liftoff, Discovery will dock with the space station's forward port around 3:44 a.m. Wednesday, boosting the combined crew to 13.

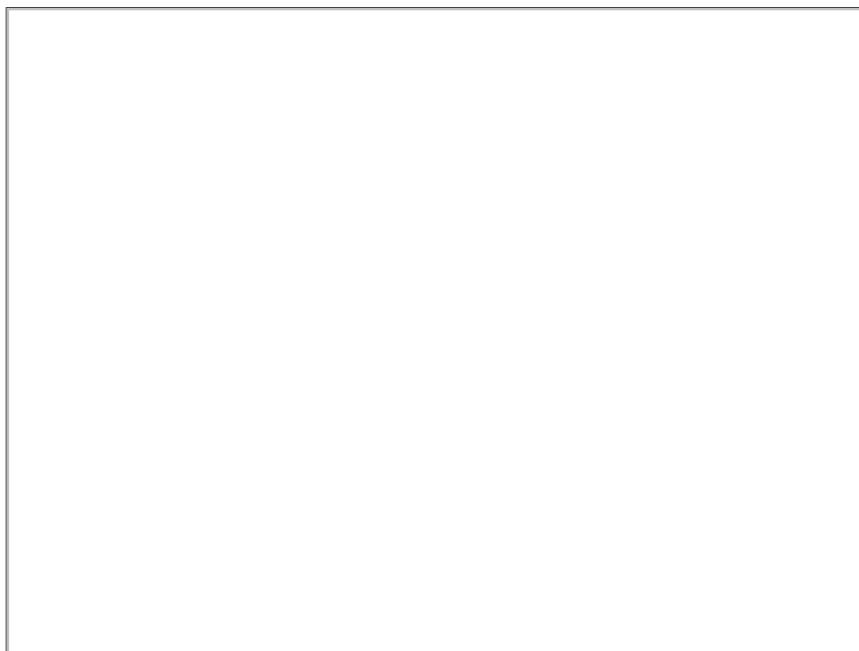
"Today was a beautiful beginning to Expedition 23," Shireman said at a post-docking news conference. "We're very pleased to have a successful docking and a successful launch a couple of days ago. It's great to have six people on board the International Space Station once again and we look forward to a lot of successful and difficult work this crew will perform.

"Early tomorrow in Florida, their colleagues will be launching from the Kennedy Space Center and docking two days later. So Alexander, Mikhail and Tracy won't have much time to rest before their new friends will arrive and it will be a busy time."

4:45 PM, 4/1/10, Update: Soyuz TMA-18 prepped for midnight ride to orbit UPDATED at 12:30 AM, 4/2/10, with launch

A Russian Soyuz spacecraft roared to life and rocketed away from its launching pad in Kazakhstan early Friday, carrying two cosmonauts and a NASA astronaut on a two-day flight to the International Space Station.

Soyuz TMA-18 commander Alexander Skvortsov, flight engineer Mikhail Kornienko and Tracy Caldwell Dyson, a shuttle veteran with a doctorate in chemistry, lifted off from the Baikonur Cosmodrome at 12:04 a.m. EDT Friday.



The Soyuz TMA-18 spacecraft lifts off from the Baikonur Cosmodrome. (Photo: NASA TV)

During the climb to space through a cloudless blue sky, television views from inside the capsule showed Skvortsov, seated in the center, flanked by Kornienko on his left and Dyson on the right. All three crew members appeared relaxed and in good spirits.

"Everything is fine, we're feeling fine," someone, presumably Skvortsov, radioed.

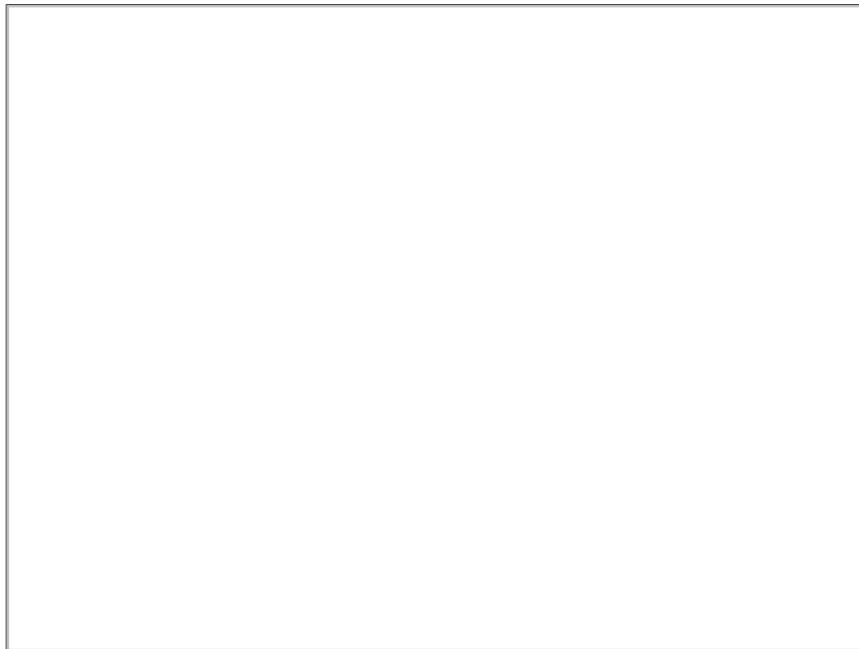
"Watch that rabbit," a flight controller said.

"It's a ducky!" Skvortsov replied, referring to a bright yellow doll hanging above the commander's head.

"Your mascot?"

"That's a zero-G indicator."

Hampered by poor communications, the crew reassured mission control at one point, radioing "everything is on schedule. We are fine."

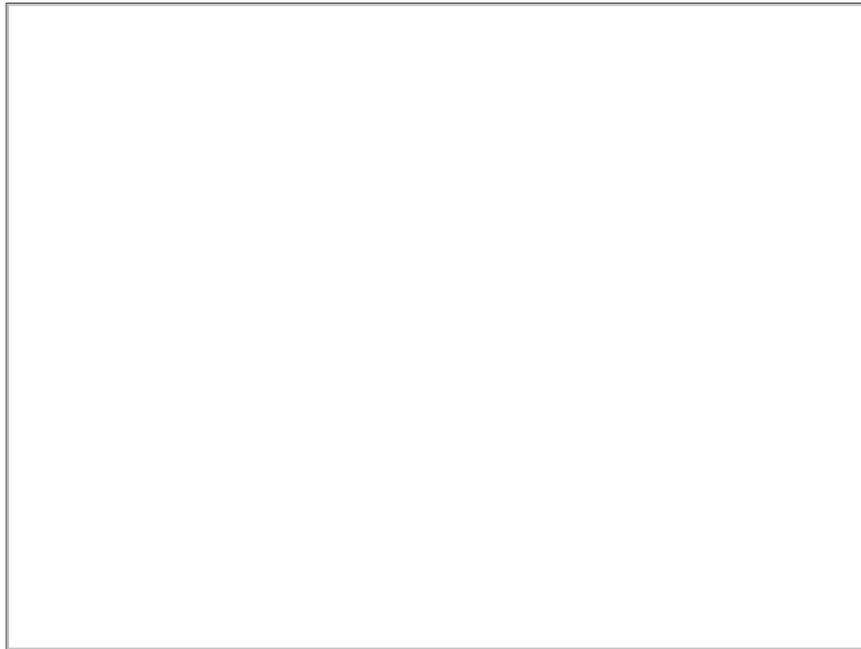


The Soyuz TMA-18 spacecraft climbs away through a clear sky.
(Photo: NASA TV)

Nine minutes after liftoff, the Soyuz spacecraft slipped into its planned preliminary orbit, with a planned high point of 143 miles and a low point of about 118 miles.

If all goes well, the trio will dock with the space station's upper Poisk module around 1:26 a.m. Sunday. Waiting to welcome them to the Expedition 23 crew will be commander Oleg Kotov, NASA astronaut Timothy Creamer and Japanese astronaut Soichi Noguchi.

The Soyuz launch came just a few hours before the 3 a.m. Friday start of the shuttle Discovery's countdown to blastoff Monday from the Kennedy Space Center. Assuming an on-time liftoff at 6:21 a.m., Discovery will dock with the space station's forward port around 3:44 a.m. Wednesday, boosting the combined crew to 13.



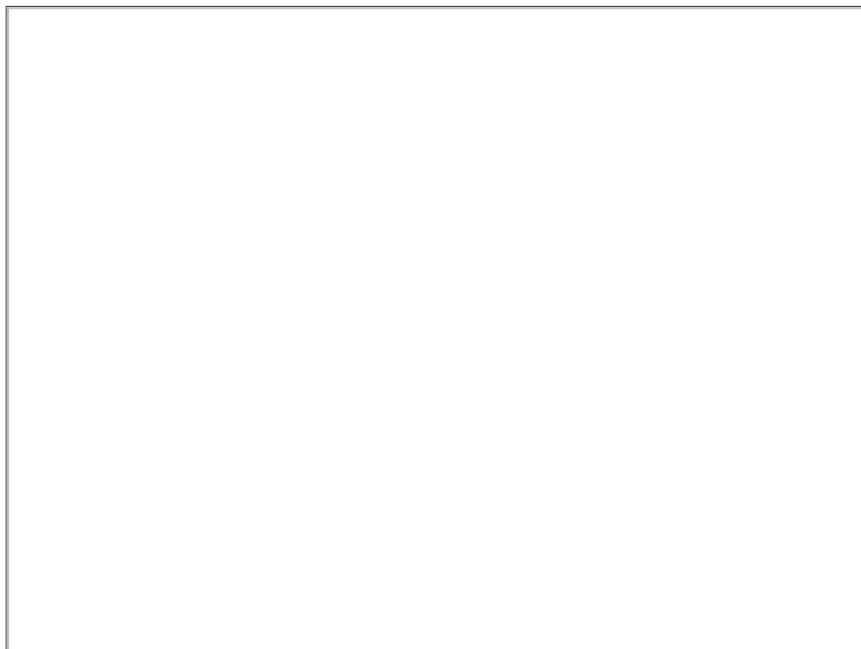
Astronaut Tracy Caldwell Dyson sings a Garth Brooks song to her husband before launch. (Photo: NASA TV)

The goal of the shuttle flight is to deliver some 10 tons of supplies and equipment, including a 1,700-pound ammonia tank for the lab's cooling system, science racks, an experiment sample freezer, a crew sleep station and other gear.

Asked about the tight scheduling between the shuttle and Soyuz, Dyson, veteran of a 2007 flight aboard the shuttle Endeavour, said "I think it rocks, I'm really excited."

"These are some great friends of mine on the shuttle and I've flown with some of them, I've trained with some of them and I've shared a lot of dinners and good times with these folks," she said at a pre-flight news conference in Baikonur. "And I'm delighted for them and just ecstatic that the timing worked out for us to be in space together.

"But what this means on a larger scale is it really brings out the essence of our International Space Station and our program that we could have a shuttle and a Soyuz launching within days of each other and how we can integrate and add to the already complex nature of what we do and the business we're in."



In-cabin television view showing Soyuz commander Alexander Skvortsov, left, and flight engineer Mikhail Kornienko.

(Photo: NASA TV)

In an interview, Dyson said she was looking forward to comparing the shuttle and Soyuz launch experiences.

"It's going to be cozy," she said of the three-seat Soyuz. "What I'm really looking forward to is the 180-degree difference between riding in a shuttle and living in a shuttle and doing the same in a Soyuz. They're both tremendous vehicles for totally different reasons.

"The shuttle's incredibly complex and it mesmerizes me still, just how all those systems work together at the appropriate time to get us through a mission. And likewise, the Soyuz is just incredibly robust. It's simple and where we're redundant, it's robust. I'm also impressed with the ingenuity and the cleverness of the Russian engineering that went into that vehicle. And that vehicle has withstood the test of time. So I have a deep respect for both vehicles."

As for sharing the cramped confines of a Soyuz for two days with two cosmonauts, Dyson said "they're great guys, really intelligent guys, they have diverse backgrounds, they are personally really good people to surround yourself with."

"This is their first spaceflight, so it's going to be interesting to see the transformation that I know I went through when I got to orbit for the first time," she said. "They're going to have plenty of time to get over that learning curve, operating in zero gravity."

Here is a post-launch Soyuz timeline of major events (in EDT):

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EDT.....EVENT
04/02/10
12:04:34 AM...Launch
12:13:19 AM...Orbital Insertion
03:39:44 AM...DV1 (36.4 mph)
04:38:38 AM...DV2 (8.8 mph)

04/03/10
01:05:50 AM...DV3 (4.5 mph)
11:06:50 PM...AR&D Automated Rendezvous start (T0)
11:10:00 PM...U.S. to Russian attitude control handover, LVLH
11:20:00 PM...ISS maneuver to dock attitude, LVLH (124.5, 85.7, 305.1)
11:28:56 PM...AR&D DV4/Impulse 1 (50.2 mph)
11:50:34 PM...AR&D Impulse 2 (3.1 mph)
11:53:00 PM...Soyuz Kurs-A Activation (T1)
11:55:00 PM...Service module Kurs-P Activation (T1)

04/04/10
12:13:37 AM...AR&D DV5 / Impulse 3 (55.3 mph)
12:13:50 AM...Range = 62.1 miles: Soyuz VHF-2 link
12:18:10 AM...Range = 49.7 miles: Valid Kurs-P range data
12:31:45 AM...Sunset
12:39:10 AM...Range = 9.3 miles: Kurs-A & Kurs-P short test
12:46:10 AM...Range = 4.9 miles: Soyuz TV activation
12:54:11 AM...AR&D Impulse 4 (14.4 mph)
12:56:50 AM...AR&D Ballistic Targeting Point
12:59:03 AM...AR&D Impulse 5 (14.7 mph)
01:01:42 AM...AR&D Impulse 6 (4.1 mph)
01:03:44 AM...AR&D Flyaround mode start
01:05:25 AM...Sunrise
01:10:10 AM...AR&D Stationkeeping start
01:14:51 AM...Daily Orbit 2 RGS AOS
01:17:00 AM...AR&D Final Approach start

01:26:00 AM...Docking

01:37:58 AM...Daily Orbit 2 RGS LOS
01:46:00 AM...Soyuz & MRM2 hooks closed: ISS maneuver to LVLH
02:03:14 AM...Sunset
02:50:00 AM...Russian to U.S. attitude control handover
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"I imagine when we first get there Oleg, T.J., Soichi, they'll be showing me and the guys around, making sure that we are really comfortable with the environment, able to find things, no problem, and start to work as a crew, a six-person crew which here in training we have limited opportunity to do," Dyson said in a NASA interview.

"So I imagine first off it'll be get used to your new home, and then it will be let's get ready for the (next) crew that's coming up and all of the details that we're going to need to provide and work with them to help make their mission a success."

07:50 AM, 3/18/10, Update: Soyuz TMA-16 lands in Kazakhstan (UPDATED with landing site photos)

Outgoing space station commander Jeffrey Williams and Soyuz commander Maxim Suraev settled to a jarring touchdown in "blizzard-like" conditions in Kazakhstan Thursday after an apparently trouble-free descent from the International Space Station.



**The Soyuz TMA-16 spacecraft lands in Kazakhstan.
(Photo: NASA/Bill Ingalls)**

Suraev, strapped into the descent module's center seat, monitored a computer-controlled four-minute and 16-second rocket firing at 6:33 a.m. EDT, slowing the ship by about 257 mph to drop it out of orbit.

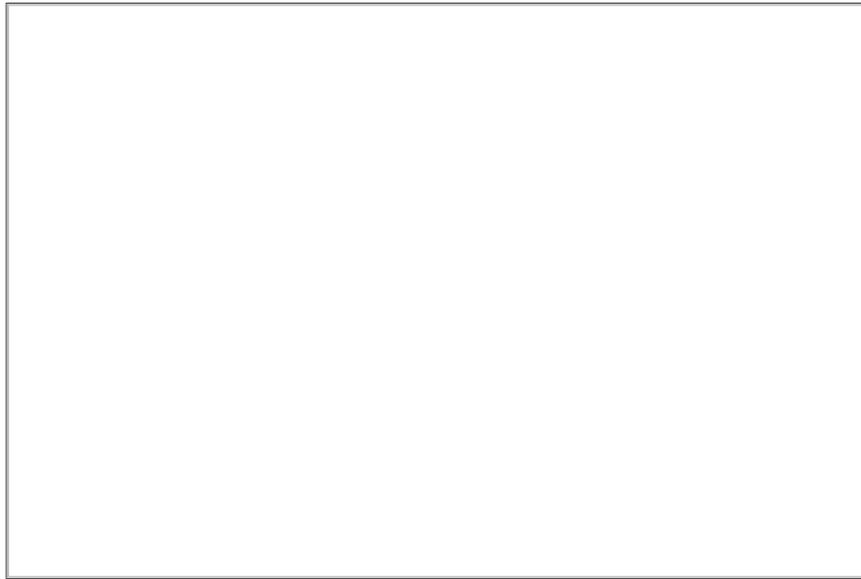
Just before falling into the discernible atmosphere around 7 a.m., the Soyuz TMA-16 spacecraft's three modules separated at an altitude of 87 miles and the central descent module carrying the crew oriented itself heat shield forward for the final stages of the entry.

There were no apparent problems and a large braking parachute deployed as planned. An instant before touchdown, a final burst of rocket power slowed the descent and the module touched down near Arkalyk, Kazakhstan, at 7:24 a.m. EDT, tipping over on its side in gusty winds.

Russian recovery forces, NASA flight surgeons and engineers were stationed nearby to help the crew members from the cramped descent module after 169 days in weightlessness.

"We're standing out here in blizzard-like conditions," NASA spokesman Josh Byerly said from the landing site at 7:50 a.m. "The Russian ground teams are moving fairly quickly through the procedures. They've already moved Jeff and Max to the medical tent."

He said the wind dragged the Soyuz descent module 20 to 30 feet after touchdown in three to four feet of snow. Both crew members, he said, flashed a thumbs up after being helped from the capsule.



Jeffrey Williams (left) and Maxim Suraev after landing Thursday.
(Photo: NASA/Bill Ingalls)

The space station's three remaining crew members - Expedition 23 commander Oleg Kotov, Soichi Noguchi and Timothy Creamer - monitored the Soyuz entry via updates from mission control in Houston.

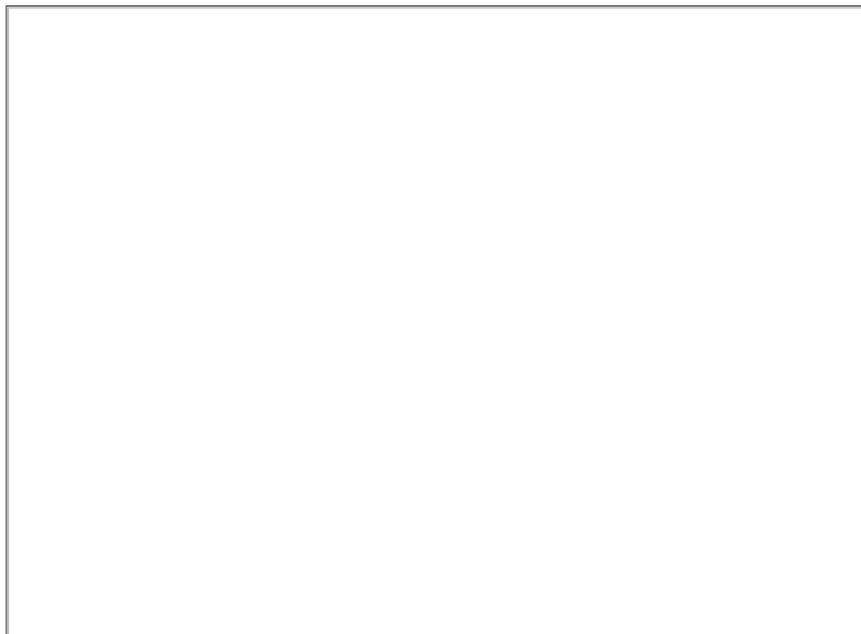
If all goes well, three fresh crew members - Alexander Skvortsov, Mikhail Kornienko and Tracy Caldwell Dyson - will blast off from the Baikonur Cosmodrome aboard the Soyuz TMA-18 spacecraft on April 2. Docking is expected two days later.

6:50 AM, 3/18/10, Update: Soyuz TMA-16 deorbit rocket firing

The two-man crew of the Soyuz TMA-16 spacecraft carried out a successful four-minute 16-second rocket firing Thursday, starting at 6:33 a.m. EDT, to slow the ship by about 257 mph, dropping the far side of the orbit into Earth's atmosphere. Soyuz commander Maxim Suraev and outgoing space station commander Jeffrey Williams are scheduled to land near Arkalyk, Kazakhstan, around 7:23 a.m.

4:25 AM, 3/18/10, Update: Soyuz TMA-16 undocks from space station

A Russian Soyuz spacecraft carrying outgoing flight engineer Maxim Suraev and Expedition 22 commander Jeffrey Williams undocked from the International Space Station at 4:03 a.m. EDT Thursday, setting up a planned landing in Kazakhstan to close out a 169-day stay in space.



Cosmonaut Maxim Suraev (left) and Jeffrey Williams bid farewell to their space station crewmates before closing the hatch to the Soyuz TMA-16 spacecraft prior to undocking early Thursday.

(Photo: NASA TV)

"Bye bye, station, bye bye," Suraev called as the spacecraft slowly backed away from the Poisk docking module.

"OK, all the best to you guys," someone called.

A few moments later, Expedition 23 flight engineer Timothy Creamer rang the ship's bell in the space station, saying "Soyuz 20S, departing."



The Soyuz TMA-16 spacecraft, shortly after undocking from the International Space Station. (Photo: NASA TV)

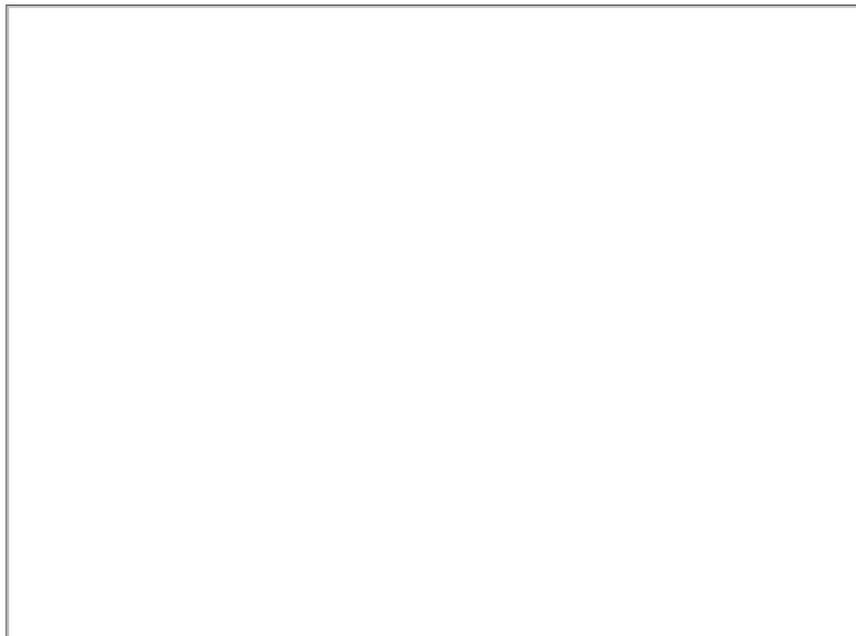
Strapped into the center seat of the cramped crew module, Soyuz commander Suraev planned to oversee a four-minute 16-second deorbit rocket firing starting at 6:33 a.m. to drop the craft out of orbit.

Just before atmospheric entry at 7:01 a.m., the flight plan called for the propulsion and orbit modules to separate from the central crew capsule, which will carry Suraev and Williams to a landing near Arkalyk, Kazakhstan, at 7:23 a.m.

01:35 PM, 3/17/10, Update: Two station astronauts prepare for landing Thursday

Astronaut Jeff Williams turned over command of the International Space Station to cosmonaut Oleg Kotov early Wednesday, setting the stage for Williams and flight engineer Maxim Suraev to undock and return to Earth on Thursday.

Williams and Suraev, who will command the Soyuz TMA-16 spacecraft for the trip home, plan to undock from the lab complex at 4:03 a.m. EDT Thursday, leaving the space station in the hands of Expedition 23 commander Kotov, Japanese astronaut Soichi Noguchi and NASA flight engineer Timothy Creamer.



Outgoing station commander Jeffrey Williams (right) turns over command to cosmonaut Oleg Kotov. T.J. Creamer (center), Soichi Noguchi and Max Suraev (hidden from view behind Kotov) look on (Photo: NASA TV)

A four-minute 18-second deorbit rocket firing at 6:34 a.m. will slow the Russian ferry craft enough to drop it back into the atmosphere for a landing in Kazakhstan at 7:24 a.m., 169 days, four hours and 10 minutes after launch from the Baikonur Cosmodrome on Sept. 30. Forecasters predicted temperatures in the low 20s, snow on the ground and gusty winds at the landing site near Arkalyk.

Here is a timeline of major re-entry events (in EDT and mission elapsed time):

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EDT.....DDD...HH...MM...SS...EVENT
3/18
03:00:00 AM...168...23...45...18...Station orientation under Russian control
03:22:02 AM...169...00...07...20...Sunrise
03:30:00 AM...169...00...15...18...Station maneuvers to undocking orientation
03:59:00 AM...169...00...44...18...Station is in free drift
04:00:00 AM...169...00...45...18...Undocking command
04:03:00 AM...169...00...48...18...UNDOCKING
04:06:00 AM...169...00...51...18...Soyuz separation burn No. 1
04:08:00 AM...169...00...53...18...ISS maneuvers to duty attitude
04:17:55 AM...169...01...03...13...Sunset
05:10:00 AM...169...01...55...18...Station orientation returns to U.S. control
06:25:01 AM...169...03...10...19...Sunrise
06:34:05 AM...169...03...19...23...Soyuz deorbit burn begins (dV: 258 mph)
06:38:23 AM...169...03...23...41...Soyuz burn complete
07:01:19 AM...169...03...46...37...Atmospheric entry
07:09:42 AM...169...03...55...00...Parachute deploy command
07:24:42 AM...169...04...10...00...LANDING
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With Williams and Suraev back on the ground, Kotov, Creamer and Noguchi will await the arrival of three fresh crew members - Soyuz commander Alexander Skvortsov, Mikhail Kornienko and Tracy Caldwell Dyson - boosting the station's crew size to six. Their launch aboard the Soyuz TMA-18 spacecraft is scheduled for 12:04 a.m. EDT on April 2.

If all goes well, the Soyuz will dock at the new Poisk module at 1:28 a.m. on April 4. The next day, NASA hopes to launch the shuttle Discovery on a three-spacewalk assembly and resupply mission, with docking at the forward Harmony module on tap around 3:50 a.m. on April 7.

Early Wednesday, Williams turned over command of the space station to Kotov, bringing an end to Expedition 22.

"I would like to thank the crew here for supporting me and for actually being really autonomous," Williams said. "I mean, I didn't have to do anything, everyone is a self starter here, everyone did a good job in everything that came before us, well beyond things that were asked."

Williams thanked Kotov, veteran of a previous long-duration stay aboard the station, saying "you came with a lot of experience, you made great contributions from end to end of the space station ... and even through today, I continue to take your advice on things

and (learn) new things from you. Thank you for that.

"T.J. and Soichi, you guys have done great," Williams said. "Soichi, it's your second flight, your first long-duration flight, and I would like to congratulate you. You're off to a great start, you really took charge of the (Japanese) Kibo facility and really across the U.S. segment. You've been a pleasure to work with and you have represented Japan very well. So congratulations to you and thank you for your great work."

Williams gave Creamer, a fellow Army aviator, a gold astronaut pin marking his status as a veteran space flier, along with an Army aviation award.

"T.J., I know you waited a long time for this flight and you are a natural up here," Williams said. "I congratulate you, that's especially important to me being a fellow Army aviator. ... You've also been a great pleasure to work with and Max and I leave the station in good hands with you."

He then thanked Suraev, saying the cosmonaut's performance during his first flight had prepared him for a future mission.

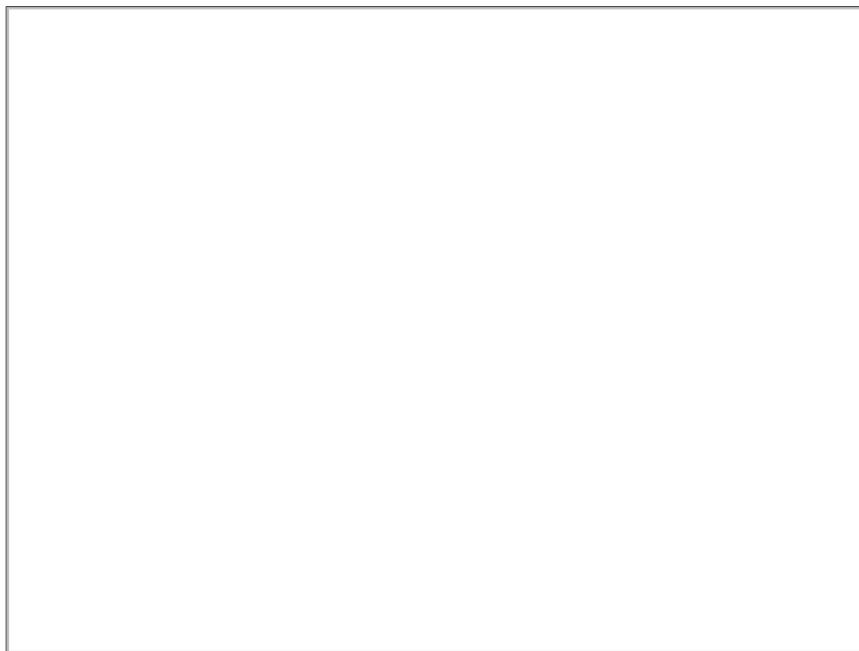
"But first, don't think about that, we'll go home and join our families and take a break that is deserving of our families," Williams said. "Speaking of our families, they are the ones that are sometimes not thought of by everybody, but they're also the ones that probably make the greatest sacrifices. And all of us here have a family behind us that's especially important to us. So I would like, on behalf of the entire crew, to thank the families and the support and the sacrifices that they have made."

Kotov spoke briefly, praising Williams for demonstrating "excellent leadership and a good example, being an excellent commander. Thank you for leaving station in such excellent condition. We'll try (to) keep it in good shape. Thank you, Jeff, thank you, Max, and Godspeed."

Williams then formally turned over command of the station to Kotov, saying "I stand relieved. Congratulations."

2:10 PM, 3/13/10, Update: SpaceX test fires Falcon 9 rocket engines (UPDATED at 5:10 p.m. with SpaceX statement)

SpaceX briefly test fired the nine Merlin engines in the first stage of its new Falcon 9 rocket today in a critical milestone before the booster's maiden flight next month.



The Falcon 9's first stage rocket engines ignite for a short test run.

"Today, SpaceX successfully completed a test firing of the inaugural Falcon 9 launch vehicle at Space Launch Complex 40 located at Cape Canaveral," SpaceX said in a statement. "Following a nominal terminal countdown, the launch sequencer commanded ignition of all nine Merlin first stage engines for a period of 3.5 seconds."

"Just prior to engine ignition, the pad water deluge system was activated providing acoustic suppression to keep vibration levels within acceptable limits. The test validated the launch pad propellant and pneumatic systems as well as the ground and flight control software that controls pad and launch vehicle configurations."

The statement said the test firing was "the latest milestone on the path to first flight of the Falcon 9, which will carry a Dragon spacecraft qualification unit to orbit."

The Falcon 9 rocket is being developed as a commercial venture to carry cargo, and eventually astronauts, to the International Space Station. The program's maiden launch from the Cape Canaveral Air Force Station is tentatively planned for April 12, a flight designed to collect engineering data and demonstrate the booster's ability to reach orbit.

Two subsequent flights are planned to demonstrate orbital operations and space station rendezvous procedures before a Dragon cargo capsule attempts an actual docking.

1:10 PM, 3/10/10, Update: Shannon says shuttle extension possible, but high cost poses major hurdle

Clarifying what he described as "a big misconception," the shuttle program manager said Tuesday that NASA's vendors could restart production and deliver the parts and hardware needed to extend shuttle flights beyond the current September retirement target.

But lawmakers lobbying to keep the orbiters flying until new commercial rockets are available to replace them would need to come up with about \$2.4 billion a year to pay for it. And there would still be a two-year gap between a decision to proceed and production of new flight hardware beyond the handful of external tanks and boosters left in the shuttle inventory.

"The real issue the agency and the nation has to address is the expense," said John Shannon, the shuttle program manager at the Johnson Space Center in Houston.

"The shuttle program is fairly expensive, we burn at about a \$200 million a month rate. So that gives you a base of about \$2.4 billion a year that it would require to continue flying the shuttle, almost irregardless of how many flights you flew during the year. ... There's just a base cost there you have to pay to keep the program in business. Where that money comes from is the big question."

NASA currently plans to fly just four more shuttle missions between now and the end of September. Discovery is up next, scheduled for launch April 5, followed by Atlantis on May 14, Endeavour on July 29 and Discovery for a final time on Sept. 16.

Launch dates for the final three flights may change depending on payload processing issues and other factors, but the orbiters and mission assignments are expected to be flown as currently planned.

The shuttle retirement date was set by the Bush administration, which announced plans in 2004 to complete the International Space Station by the end of fiscal 2010, to then shut down the shuttle program and to develop a new family of rockets to carry astronauts to and from the space station and eventually back to the moon.

But the Obama administration's 2011 budget request would cancel NASA's Constellation moon program and turn over flights to and from low-Earth orbit to private industry. With some 9,000 shuttle- and Constellation-related job losses expected in Florida alone, congressional criticism has been widespread, with some lawmakers calling for an extension of the shuttle program until new rockets become available.

President Obama plans to visit Florida's Space Coast in April for a conference to discuss his administration's new approach to manned spaceflight.

"A foundational element of this new strategy is to invest in the development of a targeted set of inter-related technologies and capabilities that can help us travel from the Earth's cradle to our nearby solar system neighborhood in a more effective and affordable way, thus laying the foundation to support journeys to the Moon, asteroids, and eventually to Mars," the White House said in a statement.

Extending the shuttle program would not appear to be an option, but looming job losses have prompted widespread discussion. Asked about extension possibilities Tuesday, Shannon said the real issue was money, not restarting the shuttle's complex supply chain.

"There's a big misconception out there (regarding) the shuttle supply chain, (people believe) they're all out of business because we're ending the program and to get them back would be this enormous effort," Shannon said.

"It's not like there are small companies or small businesses out there that made shuttle widget number five and now that we're not flying the shuttle anymore, they're out of business. For the most part, our suppliers and vendors are major companies."

As an example, Shannon cited North Carolina Foam Industries, which supplies the foam insulation that covers the shuttle's external tank. The company is a major player in the commercial insulation business, Shannon said, and "shuttle is a small part of their business."

"Because the shuttle is going out of business does not mean that those companies are gone," he said.

Last week, in the wake of congressional discussion of a possible shuttle extension, "we kicked off ... a study for each of the program elements to go out and physically touch base with each of the vendors and the sub vendors and the entire supply chain and understand where we might have some issues if we were to restart the program.

"I get those results on Thursday and we'll formally write that up and submit it to headquarters," Shannon said. "But there's this misconception that there's all this big supply chain that was shuttle specific only. Shuttle is for the most part a sideline business for these major companies that support the actual program."

Another issue for shuttle extension is recertification. In the wake of the 2003 Columbia disaster, the accident review board concluded that if NASA wanted to fly the shuttle past 2010, the vehicle should be recertified, a costly and complex procedure intended to make sure the aging spaceplanes can be safely maintained and operated.

While not required given the decision to retire the fleet this year, recertification-class reviews have been underway since 2005.

"We've pretty much, over the last five years, gone through the entire orbiter vehicle to make sure we're operating within the environment that the different orbiter pieces were originally certified for," Shannon said. "We feel like we've addressed recertification.

"We did not stop there. We continued and had meetings with aging vehicle experts to understand from an aviation standpoint what types of things do they typically find, what types of things do they typically look at, we benchmarked things like the B-52 bomber, things that have been flying for greater than 50 years. And as a result of those meetings, we added 23 additional inspection points into each of the orbiters that we hit every time we turn the vehicle around."

While he does not see any insurmountable problems with the shuttle's supply line or flight certification, Shannon said it would take about two years to build new external tanks and other hardware.

"We've addressed the orbiter recertification issues, we are addressing the supply line issues," he said. "I don't expect to find any problems there. The real issue we would have is just in manufacturing. While you have a supply chain, while you can get a workforce back to go and build things like external tanks, there would be some type of a gap. Right now we estimate that gap would be about two years from when we're told (to start) to when we'd have the first external tank rolling off the assembly line.

"You could address that in many different ways, by slowing down the shuttle program until that two years was up or you'd just accept that gap and do other things."

That leaves the issue of money to pay the thousands of workers required to maintain and process space shuttles for launch. Even with a reduced flight rate, Shannon said, the cost would be roughly what it is today, or about \$2.4 billion a year.

Shannon did not say whether he personally favored an extension, telling reporters "we just provide the data, and we'll let the nation go off and decide what they would like this team to go do." Even so, he added, "from a personal standpoint, I just think it's amazing that we're headed down a path where we're not going to have any vehicles at all to launch from the Kennedy Space Center for an extended period of time. To give up all the lessons learned, the blood, sweat and tears we've extended to get the space shuttle to the point where it is right now, where it's performing so magnificently.

"But it's a money discussion," he said. "If we don't have the resources to do that and to continue to logistically supply the space station, then I understand that, it's the path we've been on and we'll take this team and try our hardest to seed them out to either the commercial sector or into whatever NASA is going to do next to bring those lessons learned ... to try and make the next program as successful as possible."

02:00 PM, 3/4/10, Update: GOES weather satellite prepped for launch (UPDATED at 7:15 p.m. with rocket launch)

A United Launch Alliance Delta 4 rocket blasted off and thundered into space Thursday on a mission to deploy the third in a series of powerful new storm-tracking weather satellites.

Running 40 minutes late because of troubleshooting to resolve a software alarm, the \$500 million mission began with a ground-shaking roar at 6:57 p.m. as the Delta 4 climbed away from launch complex 37B at the Cape Canaveral Air Force Station.

The early stages of the flight went smoothly and if all goes well, the 7,100-pound solar-powered GOES-15 satellite will be released into its planned preliminary orbit around 11:18 p.m.

It will take two weeks to maneuver the satellite into the required circular orbit 22,300 miles above the equator and another five months to complete instrument testing and calibration. After that, GOES-15 will be held in reserve as an on-orbit spare, ready to

take over on short notice if another satellite fails.

The National Oceanic and Atmospheric Administration - NOAA - is spending about \$1.5 billion to develop, launch and operate the three N-series Geostationary Operational Environmental Satellites - GOES-13, 14 and 15 - that will replace aging predecessors over the next two years.

Two GOES satellites, one monitoring weather in the eastern half of the western hemisphere and the other focused on the western side, provide the continuous hemispheric views so familiar to viewers of nightly newscasts, helping forecasters predict the development of weather systems ranging from local storms to cyclones and hurricanes.

"The current on-orbit satellites are GOES-11 and 12," said Steve Kirkner, NOAA's GOES program manager. "Those two satellites were launched in 2000 and 2001. Both of those satellites have lived well beyond their design life and are rapidly approaching the end of their fuel life. In fact, GOES-12, which is the current GOES East satellite, will deplete its fuel and be replaced approximately one month from now with GOES-13.

"GOES-11, at the end of 2011, will also be replaced ... by GOES-14. So approximately one year after GOES-15 is launched and completes its checkout, it'll fill a very critical role for NOAA, which is the on-orbit spare. The reason that satellite is important is an on-orbit spare allows NOAA, within about 72 hours, to recover from a critical failure of either its GOES East or GOES West satellite."

Launch of GOES-15 "will maintain that continuity and provide an infrastructure that allows NOAA to continue to provide a very critical set of data products and warnings to the public," Kirkner said. "It's a set of data that not only do all the citizens of the continental United States but all the western hemisphere now demands on a daily basis. GOES-15 will continue to provide that data and will be our on-orbit spare by the end of 2011."

Built by Boeing Space and Intelligence Systems, the Boeing 601 satellite is equipped with two primary instruments: a multi-spectral imager for visible light and infrared views of Earth and a sounder to measure atmospheric temperature and moisture content. The satellite also features a solar X-ray imager for early detection of solar flares and a suite of instruments to monitor the space environment.

7:15 PM, 2/24/10, Update: Senators grill Bolden on proposed NASA budget; criticize lack of long-range goal for exploration

The Obama administration's plan to kill NASA's Constellation moon program without replacing it with a specific long-range goal for human space exploration came under sharp criticism in a Senate subcommittee Wednesday in one of the opening skirmishes of a looming battle over the space agency's future course.

In a hearing before the Science and Space subcommittee of the Senate Commerce Committee, NASA Administrator Charles Bolden defended the new approach as the best course possible given the harsh budget realities of the day, saying the agency simply did not have the money to make Constellation work.

The president's 2011 NASA budget, he said, will boost spending for development of new technologies that ultimately will lead to new heavy lift rockets and eventual flights back to the moon and on to Mars.

But committee members were sharply critical of the lack of specific, near-term support for development of a new heavy lift rocket to replace the Constellation program's Ares 5 and the lack of any specific long-range goal for human exploration.

"We should develop the technology in pursuit of a goal, not the other way around," said Sen. Bill Nelson, D-Fla. "As the saying goes, no wind is a good wind unless you know where the harbor is."

Sen. David Vitter, R-La., said he believes "this budget and the vision it represents would end our human spaceflight program as we know it and would surrender, at least in our lifetime, perhaps forever, our world leadership in the area. And in so doing i believe we would lose all the enormous benefits of the technological advances that go along with all of that.

"I believe it does this because it cancels all major existing human spaceflight programs, not only ending shuttle but completely canceling its replacement, the Constellation program, and replaces all that with little more than a hope and prayer that commercial providers will eventually pick up the slack.

"I don't think there's any realistic hope that that can be done in reasonable timeline," he said. "I'd also point out that this radical vision, this radical departure from all previous NASA plans under any administration bears no relation to anything laid out clearly in the Augustine commission report. So I'm not really sure why we went through that whole exercise."

NASA's 2011 budget follows many of the general recommendations of a blue-ribbon panel led by aerospace executive Norm Augustine that was formed by the Obama administration last year to review NASA's manned space program.

The panel discussed five broad options, including Constellation, saying NASA would need an additional \$3 billion or so per year to make any of them happen in a reasonable amount of time.

The panel did not make any recommendations per se, but members clearly favored a so-called "flexible path" approach in which NASA would shift manned launches to and from low-Earth orbit to the private sector. The agency would focus on developing a heavy lift rocket that could boost astronauts on a variety of deep space missions to the moon, nearby asteroids or even the moons of Mars.

The Obama administration's budget gave NASA a significant boost, although it was much less than what the Augustine committee suggested: an additional \$6 billion over the next five years to facilitate the shift to private sector launch services and to begin long-range technology development.

Funding for a heavy lift rocket, which was not in NASA's previous budget until later in the decade, was not included as a specific goal.

"I believe this budget is a budget without a mission," Vitter said. "Our greatest accomplishments in human spaceflight were gained because President Kennedy said we will land a man on the moon and return him safely to Earth by the end of this decade. President Kennedy didn't say we'll spend several billion and do some neat R & D (research and development). ... The mission this budget lays out is more like my second statement, which is no vision at all. You don't accomplish great things with no clearly defined mission and this budget has no clearly defined mission."

Bolden disagreed. In a question-and-answer session, the former shuttle commander said "Senator, with all due respect, I don't really think this is a radical departure from the (Bush administration's) Vision for Space Exploration and it's not a radical departure from any other visions or dreams people have had about going to space."

"What is different is, it funds what is necessary to realize that vision," Bolden said. "Somebody once told me a vision without resources is a hallucination. If you look at where we were prior to the 2011 budget, we were living a hallucination. We had a vision for getting back to the moon, getting to Mars and other places in our solar system but we didn't have the funding to do it, we didn't have the assets to do it. We now have the assets to make an orderly progression to getting humans to a place like Mars. And I'm confident we can do that"

Vitter was not swayed.

"I believe the consensus opinion reaction to this budget is that it is a radical departure," he said. "If vision without resources is a hallucination, resources without vision is a waste of time and money. That's what I think this budget represents."

He then asked Bolden about the impact of the one-two punch of shuttle retirement and the cancellation of Constellation. Some 7,000 jobs at the Kennedy Space Center are expected to be lost due to the shuttle's retirement alone.

"As I have told them in the last two weeks or so since the budget came out, I tell them i don't know how they feel," Bolden said, choking back tears. "My kids are 38 and 33, they're out of school. so I don't know what a young engineer with a 15-year-old kid feels like right now. I know they're hurting."

He vowed to do "everything in my power to try to make sure that we develop some programs that are going to help us get to where we all want to go as soon as possible."

"I don't think we would have ever gotten there with the Constellation program set up and funded the way it was," he said. "I don't think anyone said Constellation was a bad program. ... But I think we can develop capabilities (to) get back to the moon and enable us to get to Mars more quicker than the program of record."

Bolden said even with "an infinite pot of money, I could not get a human to Mars in the next 10 years. Because there are just some things we don't know. We don't understand the radiation environment, we don't understand fully what happens to the human body in transiting (the distance to Mars) for eight months."

He said technology development is "not a radical departure from anything, it's just a departure from the way we were trying to get there. And the way we were trying o get there, I'm just not confident was going to get us there anytime soon, if ever, in today's fiscal environment."

Vitter agreed that prior funding was inadequate, but he repeated his belief that "this new budget is a big step backwards."

Nelson flew aboard the space shuttle Columbia in 1986 for a mission piloted by Bolden. A strong supporter of Bolden's nomination to lead NASA, Nelson also was critical of the new budget's lack of a long-range goal for manned space exploration.

Citing Yogi Berra, Nelson said "you've got to be careful if you don't know where you're going because you might not get there."

"The hope is we could provide more efficient access to low-Earth orbit while freeing NASA to explore the heavens, the moon, the asteroids, Mars," he said. "But this budget doesn't hold up the second half of that bargain. By eliminating plans for a heavy lift vehicle and a spacecraft capable of excursions (beyond) low-Earth orbit, the U.S., this senator fears, is going to be on the sidelines while other countries continue to make incremental progress toward destinations like the moon."

Robert "Hoot" Gibson, NASA's former chief astronaut and a veteran of five shuttle flights including Nelson's, echoed the senator's concern, telling the subcommittee that "with the retirement of the space shuttle later this year, and if the administration's proposal is followed, the United States will no longer be a space-faring nation."

"We will have placed the future of our space program in the hands of the Russians and the unproven commercial sector, and with no program on the drawing boards, we will have ceased exploration beyond low-Earth orbit and will be many years away from any hope of regaining what we once had."

Veteran space journalist Mile O'Brien was the only one of four witnesses who generally supported the Obama administration's plan. He told the panel that much of the uproar over the new budget request was misplaced, the result of a "perfect storm" of poor communications by the White House and NASA and a lack of understanding by the main stream media.

"I see a lot of optimism here," he said. "This is a grown-up approach to space exploration. It synchs the goals with national needs and the budgetary realities right now."

He described Constellation as a "90-pound weakling" and questioned whether a program with the moon as its target would ever propel NASA into the deeper solar system.

"The space agency is getting a bit of a slap in the face," he said. "They should be saying 'thanks, I needed that,' I suppose. But what we're hearing is not that. Change is never easy. But let's think about this for a minute. NASA is supposed to be all about change. In fact, if NASA cannot embrace change, actually invent change, we should close the place down."

But Thomas Young, former director of NASA's Goddard Space Flight Center and CEO of Martin Marietta, returned to the lack of a specific long-range goal. He summed up his testimony by saying citing the subtitle of the Augustine panel's report: "A Human Space Program Worthy of a Great Nation."

"I believe the human spaceflight program contained in the proposed fiscal year '11 budget fails this test," he said. "One, I believe the reliance upon commercial human spaceflight for access to low-Earth orbit is a risk too high and is therefore not a responsible course. I do hope the commercial endeavors are successful.

"Two, the absence of a clearly defined human exploration program with no expectation of any human exploration for decades is not consistent with my views of a great nation. We can only hope that, by this time next year, we will recognize that our current course is not tenable, address those areas that need the most attention and re-establish a human spaceflight program once again deserving of a great nation."

3:20 PM, 2/21/10, Update: Station computer glitches possibly triggered by software in European Columbus module (UPDATED at 3:50 p.m. with success restoring high-speed station communications)

Engineers troubleshooting a series of glitches in the operation of the space station's three command and control computers Sunday may have traced the root cause to a problem with communications software in the European Space Agency's Columbus laboratory module.

"There's a memory address that's implicated every time one of the C&Cs has failed," Stan Love radioed the station from mission control. "It's part of the S-band telemetry software that packetizes Columbus data. So without enabling that particular piece of code, we are going to resume careful commanding ... to get your systems back to a nominal config. That commanding will include recovering the KU-band comm."

Love told station commander Jeffrey Williams "the silver lining of today's data system cloud, since we took up so much of your (off-duty) time today, we are clearing off Wednesday for you, so Wednesday will be an off-duty day for the crew."

"Well that's very generous. Thank you," Williams replied. "Once again, you think you've isolated it to some set of Columbus commanding. Is that true?"

"Yeah, Jeff, in the S-band software that takes Columbus data and puts it into packets to send to the ground."

Williams complimented the mission control team for its "detective work."

"Everyone's been working very hard on this," Love replied.

A few minutes later, Love called back to tell the crew that engineers had successfully restored the station's high-speed KU-band communications system to normal operation and along with it, email and the lab's internet phone.

"OK, good news, we got KU back," Love said. "We were in the middle of a mail synch when the C&C troubles occurred. As you've probably noticed, you've been locked out of email all day. We're going to get you a mail synch and then you'll get a go for Outlook shortly.

"Also, with the C&C config, we have a lot of nuisance messages that are normally suppressed, or inhibited, and right now they are all enabled. We estimate it'll take about 24 hours of ground commanding to get them all back to their normal config. What that means is that there's a greater than normal chance of waking you guys up tonight with alarm tones. Again, we're fixing that as quick as we can, but it's going to be a while.

A few minutes later, the crew was told they could resume using their internet protocol telephone.

"Yoo hoo! Thanks," Timothy Creamer replied from the station.

"And mail synch is complete and you're go for Outlook," Love said.

"Double yoo hoo. Thank you so much for that."

12:40 PM, 2/21/10, Update: Engineers troubleshoot space station computer glitches

Multiple computer glitches aboard the International Space Station triggered intermittent communications blackouts early Sunday, officials said, and while the three command and control computers seem to be working, engineers do not yet understand what has caused the machines to repeatedly transition from one to the other.

The station's command and control software was updated before the shuttle Endeavour's flight to account for the new Tranquility module and it's possible the computer failures, or transitions, are software related. Issues with computers in Tranquility also have been noted, but it's not yet clear whether they are related to the command and control issues.

During normal operations, one of the three C&C computers, known as a multiplexer/demultiplexer, operates as the "prime" machine, allowing station astronauts and ground controllers to send commands to various systems and providing critical telemetry.

A second C&C computer operates in backup mode, ready to take over if the prime computer suffers a problem, and the third machine operates in standby in a domino-like software architecture. The computer system is critical to all aspects of space station operation.

Early Sunday, the prime C&C computer ran into a problem, forcing a transition to the backup. A NASA source familiar with the troubleshooting said the backup "came on and was prime for about a second and then it failed a diagnostic, the equivalent of the blue screen of death on a Windows machine. The third one, which was in standby, it came up and was prime for about an hour and just a little while ago it also transitioned and stopped work. The first one that went down, the original prime, it's back up right now."

"But now that this has cycled through all three machines it is very clear there is some generic, probably software related problem," he said.

NASA mission control commentator Pat Ryan outlined a slightly different sequence of events, saying when the prime computer malfunctioned "the backup computer moved assume its responsibilities and then the standby computer moved to backup. In the process, Houston lost S-band communications with the crew on board."

Commander Jeff Williams called down at 9:55 a.m. EST "and confirmed there had been a primary and backup failure of the C&Cs," Ryan said. "However, two of the three computers were healthy. Later this morning, just before (11 a.m.), there was data here in mission control that indicated there had been another C&C transition, this time still with just two computers healthy.

"But after a third transition this morning, all three computers were indicating they were healthy, although they were now operating in different slots among the primary, backup and standby computers. About 20 minutes ago (just after noon EST), space station commander Jeff Williams indicated there had been another transition, this one only impacting the backup and standby computers.

"But we are still in a situation currently where all three computers are healthy but the team here in mission control is still scratching its head and trying to determine what's been causing the repeated transitions," Ryan said. "There has been no impact to station life support systems while this was going on and the crew is in good shape."

As of 12:30 p.m., command and control computer No. 3 was prime, with C&C No. 2 in backup and No. 1 in standby.

"We're thinking we might need another day off," Williams joked with mission control as the troubleshooting continued.

"Copy and concur, Jeff," replied Stan Love in Houston. "We are talking in the room, we still do not know what has been causing these transitions. We are toying with the idea there might be something related to commanding. But we are not sure, it's just speculation at this point."

Love later said engineers had detected a fault in a computer system in the Tranquility module, but it was not immediately known if that was related to the C&C issue.

2:24 PM, 2/11/10, Update: Solar Dynamics Observatory launched on sun-study mission

An Atlas 5 rocket boosted NASA's Solar Dynamics Observatory into orbit Thursday, kicking off an \$850 million mission to study the physics of the sun and the titanic magnetic storms, flares and explosions that drive space weather across the solar system.

Using three sophisticated instruments that will collect enormous amounts of data over short time scales, scientists hope to improve their ability to predict the onset of major flares and other phenomena that can disrupt communications, satellite navigation and power grids.

"SDO will observe the sun almost continuously for more than five years, sending back data at an astounding rate of one-and-a-half terabytes per day," said Project Manager Elizabeth Citrin at NASA's Goddard Space Flight Center. "That's almost 500,000 music downloads per day."

"With this wealth of data, we will learn how solar activity is created and how it will affect space weather. And space weather is what affects us humans here on Earth, our satellites, communications, power grids."

Madhulika Guhathakurta, lead scientist with NASA's Living with a Star program, said modern society's increasing dependence on satellite communications means "that any variability caused by the sun has an impact."

"Solar variability can affect human spaceflight, satellite operations, smart power grids, GPS navigation, emergency radio communications, air travel, financial services," she said.

SDO "will observe the sun faster, deeper and in greater detail than any previous observatories," she said, "breaking barriers of space, time and clarity that have long blocked progress in solar physics."

Running one day late because of high winds at the Cape Canaveral Air Force Station in Florida, the United Launch Alliance Atlas 5 rocket blasted off at 10:23 a.m. EST.

After a smooth climb out of the atmosphere, the rocket's Centaur second stage propelled the 8,800-pound solar-powered satellite toward geosynchronous orbit 22,300 miles up.

It will take the spacecraft about three weeks to reach its final parking slot above a ground station in New Mexico where two 60-foot dish antennas were built to take in the torrent of data from SDO's instruments - the equivalent of 300 movie downloads per day.

SDO builds on the successes of the Solar and Heliospheric Observatory, a joint project between NASA and the European Space Agency, and a fleet of more modest satellites that have revolutionized solar physics in recent years.

But the difference between SDO's output and previous sun-study satellites is a bit like the difference between a movie and a cartoon flip book.

"SDO is the crown jewel of a fleet of NASA satellites that are designed to study the sun," said Michael Luther, deputy associate administrator for programs, science mission directorate. "SDO is the most advanced spacecraft of its type ever designed and flown. It will give higher quality, more comprehensive and faster data rate than any spacecraft of its kind before."

One of its instruments, the Atmospheric Imaging Assembly, will snap multi-wavelength full-disk images of the sun every three quarters of a second. It will study on the sun's corona - the origin of the solar wind, flares and coronal mass ejections - taking 4096-by-4096 pixel pictures spanning 1.3 solar diameters.

"On the Earth, we have these things called earthquakes," said Principal Investigator Alan Title. "Earthquakes occur on tectonic plates. That's where big masses of the Earth move across each other and create shears, and these plates break and release a lot of energy. On the sun, the magnetic fields are the logical equivalent of tectonic plates. And as they move and create shear, they have the potential of releasing huge amounts of energy."

The Atmospheric Imaging Assembly was built to "develop real physical understanding of what goes on so we can make more sophisticated predictions of what's happening."

The Extreme Ultraviolet Variability Experiment will monitor changes in the sun's ultraviolet output, a critical factor in how the sun heats and energizes Earth's upper atmosphere. Changes in ultraviolet radiation can cause Earth's atmosphere to swell slightly, increasing drag on satellites in low-Earth orbit and triggering changes that reduce the accuracy of satellite navigation signals.

SDO's third instrument, the Helioseismic and Magnetic Imager, will measure magnetic fields at the sun's surface. It also will look into the star's interior by monitoring low-frequency sound waves, generated by convection, that cause the surface to pulsate, moving up and down several hundred yards every few hours.

By analyzing the vibrations at the surface, researchers can infer details about the sun's interior.

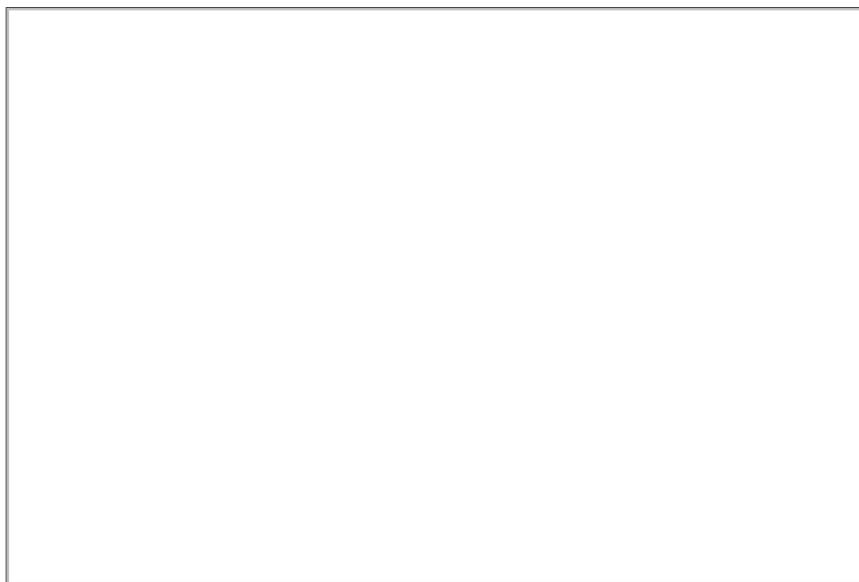
"The variability of the sun is predominantly caused by magnetic fields," said Principal Investigator Phil Scherrer. "So if we want to be able to predict that variability, we have to start with predicting the magnetic fields."

If all goes well, full-time science operations will begin in about two months, after the satellite is maneuvered into its final orbit and its instruments are checked out and calibrated.

12:40 PM, 2/6/10, Update: Bolden insists NASA not abandoning heavy lift rocket

NASA is not abandoning efforts to develop a new heavy lift booster to replace the Ares 5 moon rocket canceled by the Obama administration, NASA Administrator Charles Bolden said Saturday. But he added that any such rocket, even one using subsystems planned for the canceled Ares 5, is unlikely to fly before the 2020s at best, implying U.S. manned missions beyond low-Earth orbit are one to two decades away.

But even that long-range, somewhat nebulous goal is uncertain as NASA and congressional lawmakers struggle to understand the implications of the Obama administration's new direction for the civilian space agency.



NASA Administrator Charles Bolden, fielding question from reporters at the Kennedy Space Center. (Photo: NASA TV)

That new direction, laid out in the administration's fiscal 2011 budget, calls for NASA to operate the International Space Station through at least 2020 and to buy commercial rockets and capsules to ferry astronauts to and from the lab complex in low-Earth orbit.

The Constellation moon program, developed by NASA during the Bush administration, was canceled and while the space agency will get an additional \$6 billion over the next five years to spur development of a commercial manned launch capability, a long-range goal for exploration beyond low-Earth orbit was not specified.

Many critics of the president's plan have complained about the lack of emphasis on a heavy lift rocket to boost spacecraft into deep space. But Bolden insisted Saturday that NASA has not abandoned heavy lift development. He argued some form of a powerful new rocket likely would fly before the Ares 5 could have launched given Constellation budget shortfalls.

He said he hopes he can convince Congress in the weeks and months ahead "that we can put ourselves on a path to obtain a heavy lift launch capability within the next couple of decades."

"Ideally, I would like to be flying a heavy lift launch capability between 2020 and 2030," he said. "Whether or not we've matured to the point by then that the next NASA administrator will feel comfortable that it's OK to put humans on that heavy lift launch vehicle, I can't say right now."

In the near term, the most critical step is defining what destinations make the most sense and Bolden said he believes Mars should be the ultimate goal. But any target beyond low-Earth orbit will require a powerful new rocket.

"I haven't talked to anybody, whether it's in OMB (Office of Management and Budget), the White House or anywhere that doesn't believe the nation needs a heavy lift launch vehicle capability," he said. "We need it for science, we need it for intelligence, we need it for DOD and NASA definitely needs it if we're going to talk about sending humans beyond low-Earth orbit.

"So the need for a heavy lift launch vehicle, I don't think there's any disagreement on the part of anybody," he said. "How do we evolve there? We take the lessons learned from Constellation. If I'm able to negotiate with Congress appropriately, we may actually end up carving out some subsystems that are in the current Constellation program because they are advanced technology and they are things we will need to develop any heavy lift launch system.

"So while we will phase out the Constellation program per se, I don't want to throw away the baby with the bathwater, if you will. We want to try to capture technologies and capabilities that are resident in the present Constellation system and use them as we migrate toward a new heavy lift launch vehicle."

Bolden defended the controversial push to develop a private sector manned launch capability and said different levels of oversight would be applied to companies with different levels of operational experience.

He also said he expects a debate about the future role of astronauts in the new program, saying it was not yet clear whether the government would, in effect, hire a commercial crew to carry out a specific task or use government astronauts on a commercial rocket.

He said while many Americans "idolize" astronauts, "there is a small contingent of people on the outside who really have a great disdain for astronauts. They feel because there is this elite astronaut corps, that we have stopped others from being able to go into space. So if they can just get rid of the elite astronaut corps, then everybody else can go fly.

"That's a discussion we need to have," he said. "When we start using commercial capabilities to get people to low-Earth orbit, does that mean the astronaut office goes and says 'I want to rent a spacecraft to take a crew of six to the international space station?' Or 'I want to rent a crew to go to ISS to do six months of work?' There's a distinct difference between that operational mode. And that's the discussion we need to have."

Even so, Bolden, citing the experience of chief astronaut Peggy Whitson as an example, said space station astronauts require a high degree of training and "I contend that I can't go out here and pick Joe Schmuck up off the street and send them to Johnson Space Center or here to the Kennedy Space Center for six weeks and they're going to be a Peggy Whitson. Ain't going to happen."

"So we need to have the discussion of what the future, the next generation of astronauts will be like. And our international partners have a lot to say about that, because they happen to like the elite astronaut corps. So we need to have the discussion of how important is it to have a career astronaut contingent as opposed to none. But we'll do whatever the American public wants."

2:40 PM, 2/1/10, Update: 2011 NASA budget cancels moon program, endorses commercial manned space initiative (UPDATED at 4:10 p.m. with Griffin comments; UPDATED at 5:30 p.m. with ATK, Posey comments)

On the seventh anniversary of the 2003 Columbia disaster, the Obama administration unveiled a sweeping change of course for the nation's civilian space program Monday, killing NASA's post-Columbia moon program and shifting development and operation of new rockets and capsules from the government to private industry.

Requesting some \$19 billion for NASA in fiscal 2011, the administration announced plans to pump an additional \$6 billion into NASA's budget over the next five years to kick start development of a new commercial manned spaceflight capability, including some \$500 million in 2011.

Over that same five years, some \$7.8 billion will be earmarked for new technology development, including autonomous rendezvous, orbital fuel transfer systems and closed-loop life support systems. Another \$3.1 billion will support development of new propulsion technologies needed by future heavy-lift rockets. And another \$3 billion will go to pay for a series of robotic missions to the moon and beyond to test systems needed for eventual manned flights.

"Imagine trips to Mars that take weeks instead of nearly a year, people fanning out across the inner solar system, exploring the Moon, asteroids and Mars nearly simultaneously in a steady stream of 'firsts,'" NASA Administrator Charles Bolden told reporters. "And imagine all of this being done collaboratively with nations around the world. That is what the president's plan for NASA will

enable, once we develop the new capabilities to make it a reality."

No timetables were established for human flights beyond low-Earth orbit, with deputies saying the focus instead will be on enabling technology development and innovation.

As for commercial flights to and from the International Space Station, NASA Deputy Administrator Lori Garver said she hoped a new private-sector launch system, possibly including modified versions of technology developed for the canceled moon program, could be available by around 2016 if not earlier.

"We will try to accelerate and use the great minds of industry to get a competition going and I'm sure they'll want to beat that," she said.

Former NASA Administrator Mike Griffin, an architect of the now-canceled moon program, told CBS News the shift to commercial space operations was a profound mistake.

"I'm one of the biggest proponents of commercial spaceflight that there is, but it doesn't yet exist," he said. "I would like an enlightened government policy to help bring it about, but I don't believe you get there by destroying all your government capability so there's no option but for the government to do whatever necessary to get the - quote - commercial operators - unquote - to succeed. That's not the way to do it.

"Basically, you're burning the bridge behind you. Even if it's successful, now what you've done is you've created not a space program for the United States, you've created a capability to get to low-Earth orbit but there's nothing to do there because there's no government program. Where's the market?"

Griffin added that "for the U.S. government to deliberately give up its lead in something which is fundamentally an enterprise of governments ... for the United States to give up something that's an important part of our national identity in favor of outsourcing it to commercial enterprises when and as they come into being is bizarre."

The Bush administration's post-Columbia initiative to finish the International Space Station and retire the shuttle by the end of 2010 remains intact, with just five more missions planned for NASA's iconic winged spaceships. Funding is available to support operations through the end of the year or early 2011 if necessary.

The new budget also extends operation of the space station through at least 2020 and increases funding for science and utilization.

But as expected, it halts development of the Ares family of rockets and the Orion crew capsules NASA was designing to carry astronauts to the station and back to the moon by the early 2020s as part of the Bush administration's Constellation program.

The cancellation of Constellation and the near-term shift to commercial launch operations is a "more radical (plan) than I expected," John Logsdon, a space policy analyst at George Washington University, told CBS News.

"It represents really a fundamental shift in the way NASA goes about doing business, from being the direct designer of our space capabilities and then having industry build NASA designs to being the customer of what industry builds," he said. "Even NASA people use the analogy to the air mail contracts the government signed in the '30s. It's going to be a very different way of doing business."

The Obama administration concluded the Constellation program, which has cost taxpayers more than \$9 billion so far, "was over budget, behind schedule, and lacking in innovation due to a failure to invest in critical new technologies," according to a budget summary.

"Using a broad range of criteria, an independent review panel determined that even if fully funded, NASA's program to repeat many of the achievements of the Apollo era, 50 years later, was the least attractive approach to space exploration as compared to potential alternatives."

The independent review, chaired by aerospace executive Norman Augustine, concluded last fall that the Constellation program, hobbled by previous budget reductions under the Bush and Obama administrations, was not workable without an additional \$3 billion a year in restored funding.

The panel outlined a variety of alternatives and favored a so-called "flexible path" approach that called for relying on private industry for manned flights to and from low-Earth orbit while NASA focused on development of a new heavy lift rocket and eventual flights to a variety of possible deep space targets, including the moon, asteroids and even the moons of Mars.

The budget unveiled Monday said the Constellation program took money away from other NASA programs, "including robotic space exploration, science, and Earth observations."

"The President's Budget cancels Constellation and replaces it with a bold new approach that invests in the building blocks of a more capable approach to space exploration that includes:

- "Research and development to support future heavy-lift rocket systems that will increase the capability of future exploration architectures with significantly lower operations costs than current systems - potentially taking us farther and faster into space.
- "A vigorous new technology development and test program that aims to increase the capabilities and reduce the cost of future exploration activities. NASA, working with industry, will build, fly, and test in orbit key technologies such as automated, autonomous rendezvous and docking, closed-loop life support systems, in-orbit propellant transfer, and advanced in-space propulsion so that our future human and robotic exploration missions are both highly capable and affordable.
- "A steady stream of precursor robotic exploration missions to scout locations and demonstrate technologies to increase the safety and capability of future human missions and provide scientific dividends."

In a statement, Augustine said "by allocating the technology resources highlighted in our report as being necessary, it will be possible to lay the foundation for travel beyond low-Earth-orbit. ... NASA will be able to focus on this true frontier and to regain its position as a cutting-edge research and development organization.

"While many of us who believe strongly in human spaceflight might have hoped that still further funding would have been possible, this is obviously a demanding period from a budgetary standpoint. Importantly, the president's proposed program seems to match means to ends, and should therefore be executable."

Alliant Techsystems, or ATK, the prime contractor for the shuttle-derived solid-fuel boosters that would have helped power both the manned Ares I and unmanned Ares V launch vehicles, criticized the decision to cancel Constellation, saying the Ares I rocket would be "10 times safer than any launch vehicle in existence or on the drawing board."

"NASA's own Aerospace Safety Advisory Panel recently concluded that 'The Ares I vehicle has been designed from the beginning with a clear emphasis on safety. To abandon Ares I as a baseline vehicle for an alternative without demonstrated capability nor proven superiority (or even equivalence) is unwise and probably not cost-effective.'

"In the weeks and months ahead we are hopeful that the Congress and Administration will work together to deliver a budget that supports a program that capitalizes on the investments the nation has made in the Constellation program, closes the gap in US capability to return to space, and best assures continued U.S. leadership in space."

But in a startling break with the past, the Obama administration ordered NASA to focus on a new initiative that would effectively outsource manned flight, turning to private industry to design and develop the rockets and spacecraft needed to carry U.S. astronauts to and from the space station.

Between the shuttle's retirement and the emergence of a new manned rocket system, U.S., European, Japanese and Canadian astronauts will be forced to hitch rides on Russian Soyuz rockets at more than \$50 million a ticket.

"The budget funds NASA to contract with industry to provide astronaut transportation to the International Space Station as soon as possible, reducing the risk of relying solely on foreign crew transports for years to come," the budget summary stated.

"A strengthened U.S. commercial space launch industry will bring needed competition, act as a catalyst for the development of other new businesses capitalizing on affordable access to space, help create thousands of new jobs, and help reduce the cost of human access to space."

The only U.S. rockets currently flying that are powerful enough to step into the roll of crew transport in the near term are Boeing-built Delta 4 and Lockheed Martin Atlas 5 boosters used to launch military, scientific and commercial satellites. Neither family of rockets is certified to carry humans.

Other companies are in the process of developing new spacecraft to carry supplies to the space station after the shuttle's retirement. But it remains to be seen how long it might take any of the commercial interests to develop, test and deploy a manned rocket system.

It also is not yet clear what sort of control and oversight NASA will have in the new commercial arena, whether astronauts will remain government employees or private contractors or how the agency's decades of operational experience might be leveraged by commercial operators.

"I think the primary way it translates over is for the winners in this commercial competition to hire the people that have the

institutional memory," Logsdon said. "Second, we're going to be operating station until at least 2020. So there's a core of operational folks inside NASA that will still be very much involved."

Contractors already occupy key positions in mission control at the Johnson Space Center in Houston and at other NASA facilities, but it's not yet known how commercial manned space flights will be managed, who will have responsibility for mission design, safety and execution or how government facilities might be utilized.

Bolden and Garver provided no details on how the new program will be executed, but Bolden insisted safety will remain a top priority.

"NASA will set standards and processes to ensure that these commercially built and operated crew vehicles are safe," he said. "No one cares about safety more than I. I flew on the space shuttle four times. I lost friends in the two space shuttle tragedies. So I give you my word these vehicles will be safe."

Against this backdrop of uncertainty, the shuttle program is on schedule to end with a final flight to the space station in September. Up to 7,000 jobs in the Kennedy Space Center are expected to be lost, along with several thousand more at other NASA field centers.

An administration official told CBS News last week the new initiative "could lead to as many as 1,700 new jobs in Florida ... and will catalyze the development of other new businesses that capitalize on affordable human access to space."

"We will also make strategic new investments at Kennedy Space Center that will lead to hundreds of new jobs, upgrade facilities for the 21st century, and help ensure that KSC remains a world-class launch port for decades to come," he said.

That apparently includes upgrades to launch complex 39 that would support flights by commercial rockets.

"A major focus of this effort will be to create the 21st Century launch facilities and infrastructure needed at Kennedy Space Center, transforming the facility to more effectively support future NASA, commercial, and other government launches," the budget summary said.

Edwin "Buzz" Aldrin, the second man on the moon, strongly endorsed the new program, saying "the truth is, that we have already been to the Moon - some 40 years ago. A near-term focus on lowering the cost of access to space and on developing key, cutting-edge technologies to take us further, faster, is just what our nation needs to maintain its position as the leader in space exploration for the rest of this century."

But many NASA supporters sharply disagreed and Logsdon predicted a "vociferous" fight in Congress.

"The President's proposed NASA budget begins the death march for the future of US human space flight," said Sen. Richard Shelby, an Alabama Republican. "Congress cannot and will not sit back and watch the reckless abandonment of sound principles, a proven track record, a steady path to success, and the destruction of our human space flight program."

Shelby noted the anniversary of the Columbia disaster, saying "it is ironic that Constellation, a program borne out of the recommendations of the Columbia Accident Investigation Board, would be eliminated in lieu of rockets repeatedly deemed unsafe for astronauts by NASA's own Aerospace Safety Advisory Panel."

Rep. Suzanne Kosmas, a Florida Democrat, welcomed increased spending at the Kennedy Space Center but added that "leaving NASA with no detailed plan or timeline for exploring beyond Earth's orbit will cede our international leadership in space."

"Though I welcome the investments in infrastructure at Kennedy Space Center, not knowing when, or even if, the next human spaceflight launches will occur makes it difficult to retain the Space Coast's highly skilled workforce and maintain America's international leadership in space.

"The President's proposal is unacceptable, and I will work with my colleagues from both parties to develop a plan for space exploration that maintains a robust human spaceflight program, minimizes the gap (between the shuttle and its replacement), and protects jobs."

Rep. Bill Posey, a Florida Republican, said the new budget "represents a giant step backwards."

"Many of us had hoped that a stronger budget commitment to space might have been included, but this budget simply falls far short of what is needed for a robust human space flight program," he said in a statement. "I am concerned that this budget represents a slow death to our nation's human space flight program. This budget effectively ends America's leadership in human space exploration."

Surprisingly, perhaps, astronaut Steve Robison, scheduled for launch next Sunday aboard the shuttle Endeavour, said in an

interview Friday that "we have an exciting future. It's not well defined, but it's exciting."

"I kind of refuse to be disappointed in something that hasn't shown itself to be actually disappointing yet," he said. "We don't really know how we should use the small amount of money that American citizens are willing to pay for a space program. But I do know that for at least 50 years, American citizens have wanted a space program with humans flying in space. And I really am confident that will continue in some way."

10:55 AM, 1/14/10, Update: Spacewalk ends; Poisk module ready for use

Space station cosmonauts Maxim Suraev and Oleg Kotov completed a successful five-hour 44-minute spacewalk Thursday, completing work to outfit a new Russian docking module. The International Space Station now boasts four ports for visiting Soyuz crew ferry craft and unmanned Progress supply ships, a requirement for expanded crews of up to six astronauts and cosmonauts.

The spacewalk, the 137th devoted to station assembly and maintenance, began at 5:05 a.m. EST and ended at 10:49 a.m. when Kotov and Suraev returned to the Pirs docking compartment and closed the hatch. The cosmonauts completed all of their major objectives, rigging docking targets, rendezvous system antennas, handrails and cables to turn the new Poisk module into an active docking compartment.

Launched last November, Poisk was attached to the upward-facing port of the Zvezda command module directly across from Pirs, which is attached to Zvezda's Earth-facing, or nadir, port. Additional ports are available on the aft end of Zvezda and on the Zarya module.

Suraev and Expedition 22 commander Jeff Williams plan move the Soyuz TMA-16 spacecraft from Zvezda's aft port to Poisk next Thursday.

5:30 AM, 1/14/10, Update: Spacewalk begins

Space station cosmonauts Maxim Suraev and Oleg Kotov opened the hatch of the Pirs docking compartment at 5:05 a.m. EST Thursday to officially kick off a planned five-hour 50-minute spacewalk. The primary goals of the excursion are to configure cables, antennas and docking targets on a new Russian module to give the station a fourth port for Russian Progress and Soyuz spacecraft.

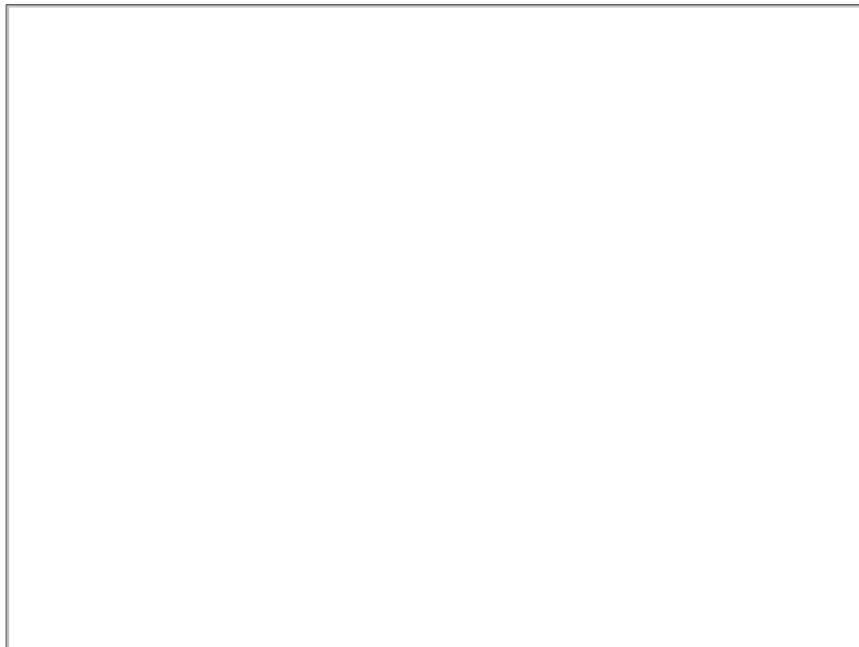
"What's the weather there, Max?" a translator quoted a Russian flight controller before the hatch was opened.

"The weather is beautiful" Suraev joked. "It's dark so far."

"As long as it doesn't rain it will be fine because we didn't take any umbrellas with us," said someone, presumably Kotov.

"Well, that's what I was counting on, getting (a) sun tan."

For identification, Kotov is wearing a spacesuit with red markings while Suraev is wearing a suit with blue stripes. This is the 137th spacewalk devoted to station assembly and maintenance since construction began in 1998, the third for Kotov and the first for Suraev.



Cosmonaut Maxim Suraev, floating head down in this frame grab, makes his way to the new Poisk module. (Photo: NASA TV)

The Russian segment of the International Space Station currently has three active docking ports, one on the Earth-facing side of the Zarya module, one on the Earth-facing end of the Pirs compartment attached to the Zvezda command module and an aft port at the back end of Zvezda.

On Nov. 12, a new docking compartment called Poisk - "explore" in Russian - docked at an upward-facing port on the command module directly across from Pirs. A similar module, scheduled for launch later this year aboard the shuttle Atlantis, will be attached to Zarya's downward-facing port.

To support full-time crews of up to six astronauts and cosmonauts, two three-seat Soyuz capsules must be docked at all times to serve as lifeboats. Additional ports are needed for unmanned Progress supply ships.

Suraev and Kotov plan to configure docking system antennas, cables and insulation during today's spacewalk to rig Poisk for dockings by Soyuz and Progress spacecraft. They also plan to retrieve an experiment package.

If all goes well, a Soyuz spacecraft currently docked at Zvezda's aft port will be moved to Poisk on Jan. 21.

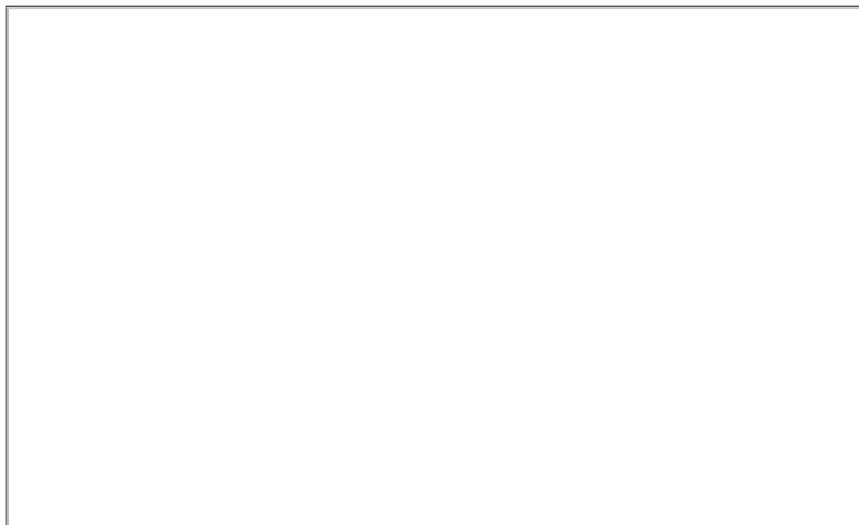
06:00 PM, 12/22/09, Update: Soyuz TMA-17 docks with space station (UPDATED at 9:30 p.m. with hatch opening, welcome ceremony)

A veteran Russian cosmonaut, a Japanese shuttle flier and a NASA astronaut making his first space flight docked with the International Space Station Tuesday after a two-day orbital chase, donning Santa hats to mark the holiday season.

With commander Oleg Kotov monitoring a problem-free automated approach to the huge lab complex, the Russian Soyuz TMA-17 spacecraft docked at an Earth-facing port on the Russian Zarya module at 5:48 p.m. EST as the two spacecraft sailed 220 miles above the Atlantic Ocean east of Rio De Janeiro, Brazil.

Hatches were opened about an hour and a half later, after leak checks to make sure the Soyuz was firmly latched in place.

Expedition 22 commander Jeffrey Williams and cosmonaut Maxim Suraev were standing by to welcome Kotov and his two crewmates - Japanese astronaut Soichi Noguchi and NASA astronaut Timothy Creamer - on board to boost the lab's complement back up to five.



Oleg Kotov, left, chats with family members after docking. Crewmates Timothy Creamer and Soichi Noguchi are visible to Kotov's left while Maxim Suraev and commander Jeffrey Williams float in the foreground. (Photo: NASA TV)

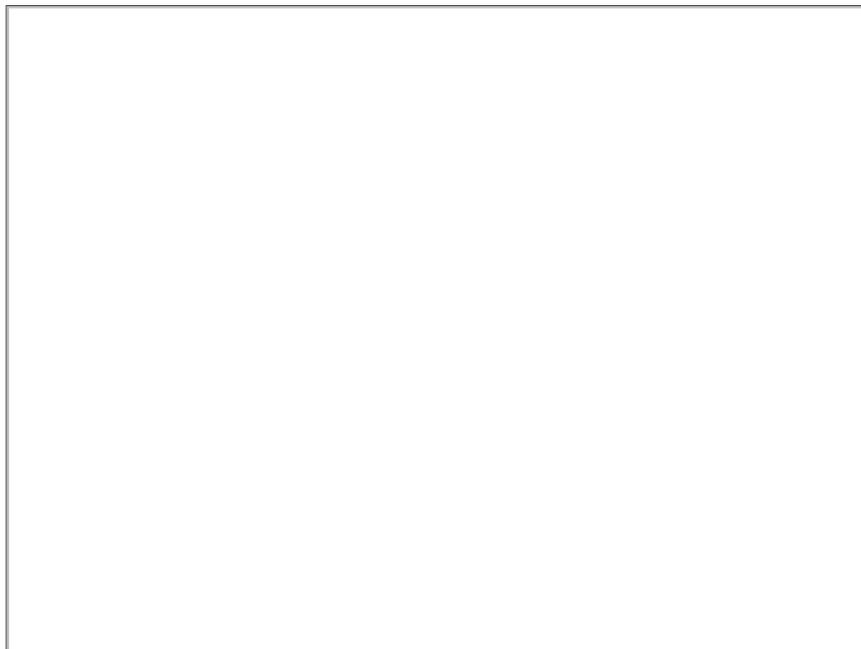
"It's great to see all you guys on orbit," Bill Gerstenmaier, NASA's chief of space operations, radioed from the Russian mission control center near Moscow. "Have a great Christmas, a good New Year. I can't think of a better family to have in space than you. I'm here with your families in the control center, so have a great expedition."

"Thank you, Gerst, it's good to hear your voice, it's great to have these guys on board," Williams replied. "It completes the complement of Expedition 22."

"Oleg, hello, we're so happy to see you aboard the station one more time," a family member radioed Kotov. "Daddy, I'm so proud of you. You're the best father in the world! We wish you the best of luck."

"Thanks to you for coming, thank you for your words, I love you very much and I'll talk to you soon," Kotov replied.

Said Creamer: "Everything's doing really great here. It's better than great, it's 154 times better than great. So thanks for the well wishes."

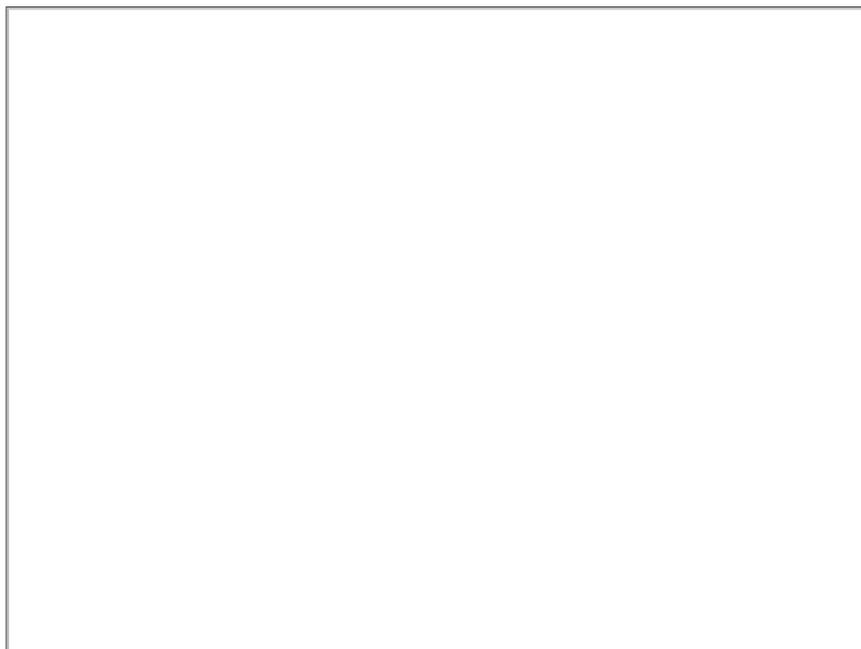


The Soyuz TMA-17 spacecraft's view of the International Space Station during final approach. (Photo: NASA TV)

Williams and Suraev have had the station to themselves since Dec. 1 when cosmonaut Roman Romanenko, European Space Agency astronaut Frank De Winne and Canadian Robert Thirsk returned to Earth after a six-month stay in space.

The expanded crew faces a busy schedule in 2010 as NASA works to complete the station's assembly and retire the space shuttle.

On Jan. 5, a NASA pressurized docking adapter currently attached to the left side of the central Unity module will be moved to clear the way for attachment of a new U.S. module in February.



The view from a space station camera as the Soyuz spacecraft neared its docking port. (Photo: NASA TV)

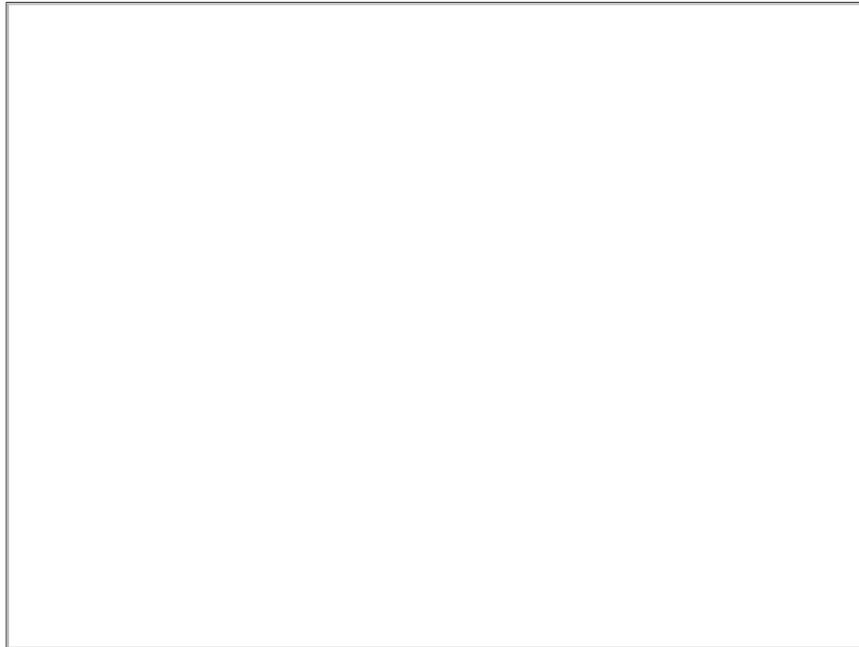
Suraev and Kotov plan a spacewalk Jan. 14 to finish outfitting a new Russian docking port known as Poisk, or MRM-2, that was recently attached to the Zvezda command module's upward-facing hatch. Once that work is done, the Soyuz TMA-16 spacecraft now docked to Zvezda's aft port - the capsule that carried Williams and Suraev to the station - will be moved to Poisk on Jan. 20.

The shuttle Endeavour is scheduled for launch from the Kennedy Space Center on Feb. 7 to deliver node 3, or Tranquility, a roomy module that will be attached to Unity's left-side port. Once installed and checked out, an enclosed toilet now located in the Destiny lab module will be moved into Tranquility, along with exercise equipment and other life support gear that has been temporarily housed elsewhere.

11:25 AM, 12/20/09, Update: Soyuz spacecraft readied for launch to space station (UPDATED at 5:10 PM with launch)

A Russian Soyuz spacecraft carrying three fresh crew members bound for the International Space Station blasted off from the Baikonur Cosmodrome in Kazakhstan early Monday local time, lighting up a cold, pre-dawn sky with a torrent of flame visible for miles around.

With Soyuz commander Oleg Kotov, a station veteran, Japanese astronaut Soichi Noguchi, a shuttle veteran, and rookie astronaut Timothy Creamer strapped into the Soyuz TMA-17 capsule, the rocket roared to life at 4:52 p.m. EST Sunday (3:52 a.m. Monday local time) and quickly climbed away from the same pad used by Yuri Gagarin at the dawn of the space age.



(Photo: NASA TV)

Liftoff was timed for roughly the moment Earth's rotation carried the launch pad into the plane of the space station's orbit. Kotov, seated in the spacecraft's center seat, was flanked by Creamer to his right and Noguchi on his left.

The climb to space appeared normal and live television views from inside the TMA-17's central module showed all three crew members relaxed and at ease as they monitored their cockpit instrument displays. Noguchi flashed a thumbs up and Creamer waved.

A little less than nine minutes after liftoff, the spacecraft slipped into its planned preliminary orbit and Kotov reported "everyone feels great, no problems." Later this evening, Kotov planned to oversee two rendezvous rocket firings to fine-tune the craft's approach to the lab complex.

A third rocket firing is planned for Monday and if all goes well, the TMA-17 spacecraft will execute an automated approach to the Earth-facing port of the station's Zarya module Tuesday for a docking around 5:54 p.m.

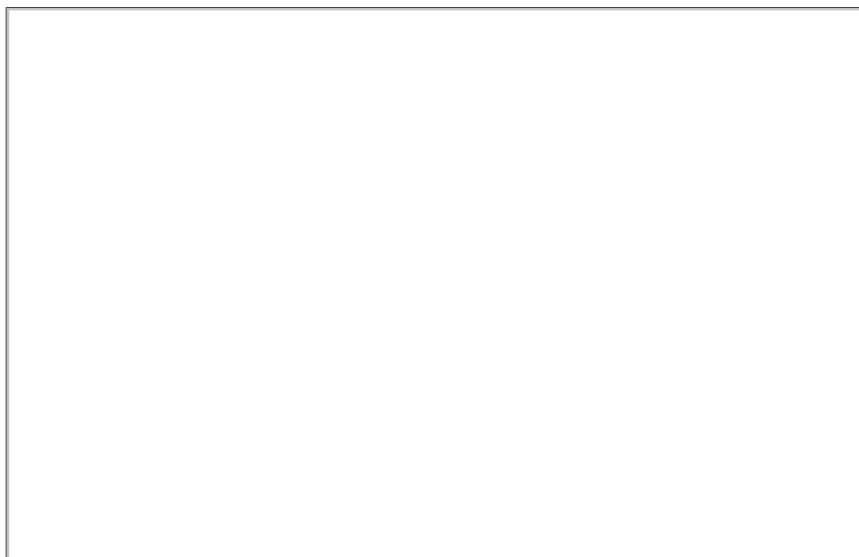
Waiting to welcome the new crew members on board will be Expedition 22 commander Jeffrey Williams and Maxim Suraev, launched to the outpost Sept. 30. Suraev and Williams, who has a previous station flight to his credit, have had the lab to themselves since Dec. 1 when cosmonaut Roman Romanenko, European Space Agency astronaut Frank De Winne and Canadian Robert Thirsk returned to Earth after a six-month stay in space.

"One of the things we've learned over the last couple of years is it's really beneficial to have (experienced) crew members (on board) when a new crew arrives," said Kirk Shireman, deputy manager of the space station program at the Johnson Space Center in Houston.

"So while it'll be a new experience for these guys, the fact that Max and Jeff have already been up there, they'll know where everything is, they'll know how things work and that'll allow these three guys to quickly adapt and be able to hit the ground running."

According to an Associated Press report, Creamer told reporters he would miss his family over the Christmas holidays, but "we are going as a family together to a family in space." He has been using Twitter to keep friends, family and the public up to date and plans to continue posting from space.

"I thought if I can give you the status of what I am doing, what we are hoping for, what we are looking forward to seeing, those would be good little teasers," he said.



The Soyuz TMA-17 crew during a pre-launch news conference. Left to right: Timothy Creamer, Oleg Kotov and Soichi Noguchi.(Photo: NASA)

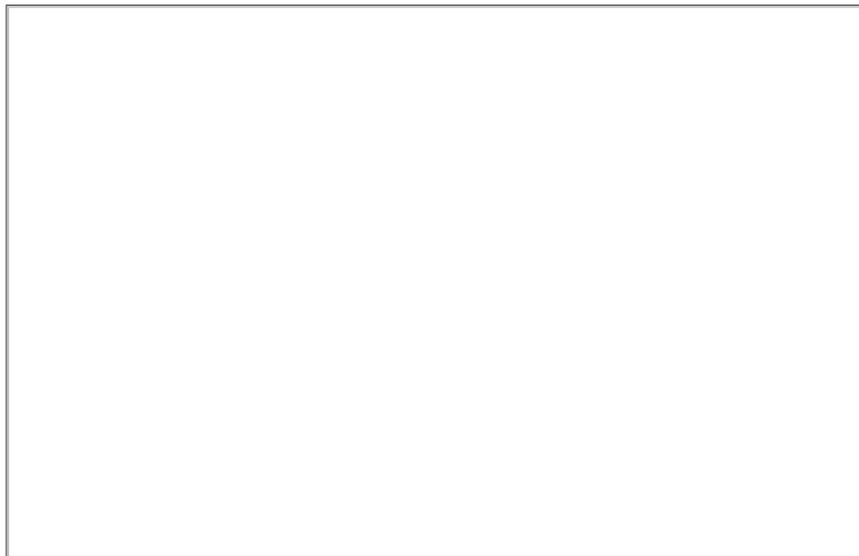
After a break for Christmas and the New Year holidays, the crew will face a busy month in January.

Using the station's robot arm, a NASA pressurized mating adapter currently attached to the left side of the central Unity module will be relocated Jan. 5 to clear the way for attachment of a new U.S. module in February.

Suraev and Kotov plan a spacewalk Jan. 14 to finish outfitting a new Russian docking port known as Poisk, or MRM-2, that was recently attached to the Zvezda command module's upward-facing hatch. Once that work is done, the Soyuz TMA-16 spacecraft now docked to Zvezda's aft port - the capsule that carried Williams and Suraev to the station - will be moved to Poisk on Jan. 20.

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"This increment really sets the stage for the last year of the shuttle program," Shireman said. "It's a big growth year ... the last major growth spurt for the International Space Station. ... We're looking forward to a really, really exciting year."



The Soyuz TMA-17 awaiting launch. (Photo: NASA)

As it currently stands, four Soyuz flights to the station are planned in 2010, NASA's final five shuttle missions and up to six unmanned Progress supply ships. Along with Tranquility, a new Russian module will be delivered by the shuttle, along with a cargo transfer module that will be left aboard the station after the final shuttle visit.

"This is the beginning of another phase where we learn to operate with a larger crew size, more demands on the hardware, more demands on the space station," said Bill Gerstenmaier, NASA's associated administrator of space operations. "So for the systems to work right requires a lot of extra preparation and this is the beginning of that preparation."

Said chief astronaut Peggy Whitson: "It's obviously very complicated. I think we have done in the past several years a fantastic job of making very difficult things look easy. We always have problems, but we always seem to be able to overcome them and I think that's kind of NASA's theme for survival.

"We expect that adding on a new module, two new modules this year ... it's going to be pretty exciting, expanding the station even further. I know when I was up there when we increased the station volume with three new modules it was just really exciting, opening up this huge new space to live in and explore."

Here is a timeline showing countdown highlights and the latest rendezvous plan leading to docking Tuesday (in EST; countdown events are generic and subject to change):

EST.....EVENT

Sun 12/20

10:52 AM.....Batteries installed in booster
 11:22 AM.....State commission 'go'
 11:37 AM.....Crew arrives at site 254
 11:52 AM.....Tanking begins
 12:32 PM.....Spacesuit donning
 12:52 PM.....Booster is loaded with liquid oxygen
 01:12 PM.....Crew meets delegations
 01:42 PM.....Reports to the state commission
 01:47 PM.....Transfer to launch pad
 01:52 PM.....1st/2nd stage oxygen fueling complete
 02:17 PM.....Crew arrives at launch vehicle
 02:22 PM.....Crew ingress
 02:52 PM.....Crew in re-entry vehicle
 03:07 PM.....Re-entry vehicle hardware tested; suits are ventilated
 03:22 PM.....Hatch sealed and tested
 03:52 PM.....Launch vehicle control system preps; gyro activation
 04:07 PM.....Launch pad service structure halves lowered
 04:12 PM.....Suit leak checks; re-entry vehicle testing complete
 04:22 PM.....Emergency escape system armed
 04:27 PM.....Service towers retracted
 04:37 PM.....Suit leak checks complete; escape system to auto
 04:42 PM.....Gyros uncaged; on-board recorders activated
 04:45 PM.....Prelaunch operations complete
 04:45 PM.....Final launch countdown operations to auto
 04:46 PM.....Launch complex and vehicle systems ready
 04:47 PM.....CDR's controls activated; helmets closed; launch key inserted
 04:48 PM.....Combustion chamber nitrogen purge
 04:49:30 PM...Booster propellant tank pressurization begins
 04:49:45 PM...Ground propellant feed terminated
 04:51:00 PM...Vehicle to internal; 1st umbilical tower sep; auto sequence start
 04:51:20 PM...Ground power umbilical to 3rd stage separates
 04:51:40 PM...Launch command given; central/side pod engines on
 04:51:45 PM...Second umbilical tower separates
 04:51:50 PM...Engine turbopumps at flight speed
 04:51:55 PM...Engines at maximum thrust

04:52:00 PM...LAUNCH

05:00:45 PM...Orbital Insertion

08:32:19 PM...DV1 (19.5 mph)

09:12:12 PM...DV2 (44.3 mph)

Mon 12/21

05:27:30 PM...DV3 (4.5 mph)

Tue 12/22

02:50:00 PM...US-to-Russian attitude control handover

03:30:26 PM...AR&D Automated Rendezvous start (T0)

03:40:00 PM...ISS maneuvers to docking attitude

03:52:24 PM...AR&D DV4/Impulse 1 (2.9 mph)

04:14:00 PM...AR&D Impulse 2 (2.9 mph)

04:17:00 PM...Soyuz Kurs-A rendezvous system activation (T1)

04:19:00 PM...SM Kurs-P activation (T1)

04:36:53 PM...AR&D DV5/Impulse 3 (35.4 mph)

04:37:06 PM...Range = 62 miles - Soyuz VHF-2 link

04:41:26 PM...Good Kurs-P data at 49.7 miles

05:01:27 PM...Daily Orbit 1 Russian ground station loss of signal

05:02:06 PM...Kurs-A & Kurs-P short test at 9.3 miles

05:09:06 PM...Range = 5 miles - Soyuz TV activation

05:16:39 PM...AR&D Impulse 4 (14.9 mph)

05:20:26 PM...AR&D Ballistic Targeting Point

05:22:33 PM...AR&D Impulse 5 (8.0 mph)

05:24:21 PM...AR&D Impulse 6 (4.2 mph)

05:26:30 PM...AR&D Fly around mode start

05:32:00 PM...AR&D Stationkeeping start

05:45:30 PM...AR&D Final approach start

05:49:33 PM...Sunset

05:54:30 PM...Docking

06:11:44 PM...Daily Orbit 2 RGS acquisition of signal

06:14:30 PM...Soyuz and FGB hooks closed

06:25:32 PM...Russian-to-US attitude control handover

02:00 PM, 12/7/09, Update: Virgin Galactic unveils SpaceShipTwo (UPDATED at 10:15 p.m.)

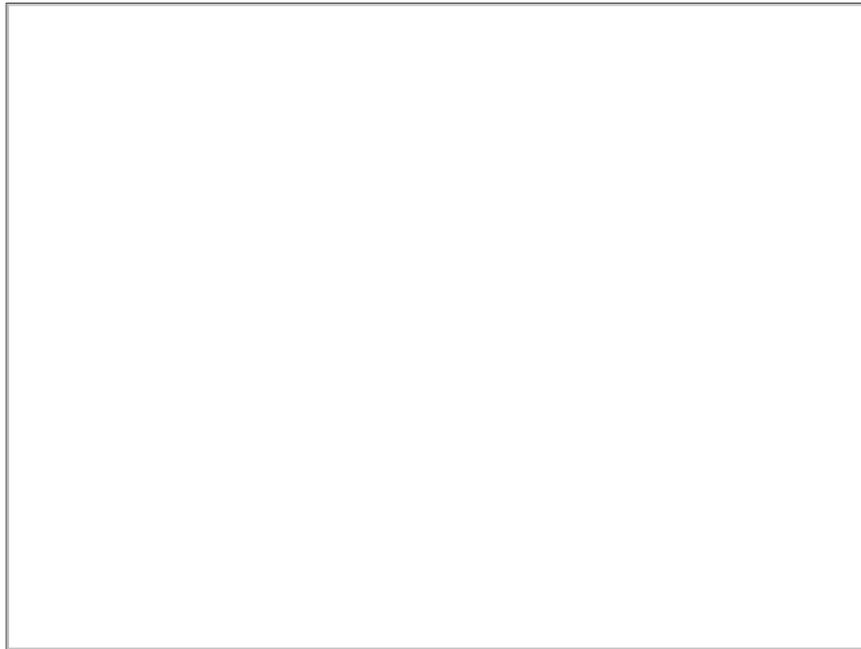
MOJAVE, Calif.--Virgin Galactic founder Richard Branson and legendary aircraft designer Burt Rutan, whose SpaceShipOne took the \$10 million Ansari X Prize in 2004, unveiled the VSS Enterprise Monday, a sleek commercial rocket plane that represents the ultimate thrill ride for well-heeled space tourists and amateur astronauts.

Seating six passengers and two pilots, Virgin Space Ship Enterprise - also known as SpaceShipTwo - will begin test flights next year with commercial launchings carrying paying customers starting after government regulatory requirements are met. More than 300 people have already put down deposits or paid the full \$200,000 cost of a ticket for future sub-orbital up-and-down flights aboard the new spacecraft.

Most of those ticket holders, along with California Gov. Arnold Schwarzenegger and New Mexico Gov. Bill Richardson, were on hand for the SpaceShipTwo unveiling Monday at Mojave airport, braving rain, high winds and frigid temperatures to witness the long-awaited rollout.

Branson told the enthusiastic crowd that safety was Virgin Galactic's No. 1 priority and that "we will not be putting anybody into space until the test pilots have done many, many, many trips on this spaceship."

"Only when we are absolutely certain we can safely go to space will we go into space," he said. "I promise you, it will be well and truly tested before we go into space."



California Gov. Arnold Schwarzenegger and Richard Branson, right, inspect a model of SpaceShipTwo prior to its rollout Monday. Designer Burt Rutan stands to their left. (Photo: William Harwood)

Schwarzenegger said attending the unveiling was "one of the coolest things I've ever done." Describing Branson as "an extraordinary visionary," he called Rutan "one of the greatest space engineers of our time."

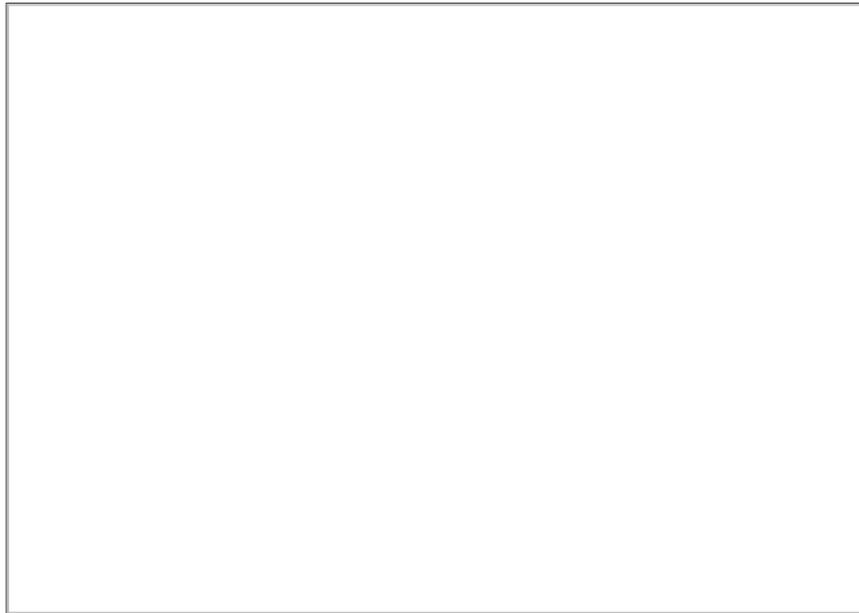
"Space is our next great frontier," he said. "When it comes to space enterprise, California is and always has been at the forefront and leading the way."

Virgin Galactic reportedly plans to spend some \$400 million to build a fleet of five or six rocket planes. Commercial flights will be launched from taxpayer-funded spaceport under construction in New Mexico. Assuming test flights go well and government requirements are met, commercial launchings could begin by 2011.

"My state is energized and raring to go," Richardson said. "We're proud to be on the ground floor of the second space age. ... I call on the Obama administration to embrace commercial space travel. We're opening up an opportunity that before now was only available to a select few, a chance to travel in space. Three hundred have already jumped at the chance, signing up to be among the first space tourists."

Turning to Schwarzenegger, Richardson said, "Governor, you should join me in going into space. But I want you to go first."

Construction of SpaceShipTwo, carried out in near-total secrecy at Rutan's Scaled Composites facility in Mojave, began in 2007. The first spacecraft, named VSS Enterprise on Monday, is a scaled-up version of the three-seat SpaceShipOne Rutan designed, with funding from Microsoft founder Paul Allen, to compete for the \$10 million Ansari X Prize.



**A comparison of SpaceShipOne and SpaceShipTwo.
(Photo: Virgin Galactic)**

The X Prize required competitors to complete two manned flights to an altitude of 100 kilometers, or 62 miles, the somewhat arbitrary "boundary" of space. After Rutan won the X-Prize, Branson launched Virgin Galactic and announced plans to build a fleet of larger spacecraft to carry space tourists on sub-orbital flights.

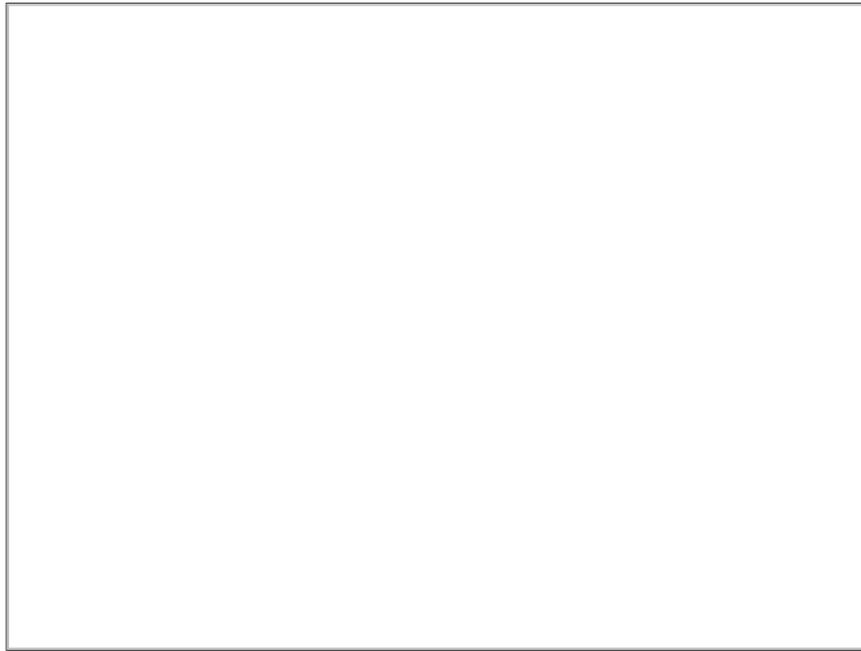
Looking to the future, Rutan said "I believe, to satisfy this market, there will need to be between 40 and 50 spaceships. Assuming we have enough spaceports and assuming we work the cost numbers appropriately we can attract that large number of people. That's what will be required" for the long-term success of commercial manned spaceflight.

Peter Diamandis, who directed the Ansari X Prize program, hailed SpaceShipTwo as an "incredible milestone" and said the industry will flourish despite the high initial cost.

"There is definitely a business model, he said in an interview. "We've got more billionaires on the planet and millionaires than ever before in the history of humanity. It's the same thing with every new technology, whether it's cellphones or airplanes, the wealthy step up first, they pay the higher ticket price and eventually it becomes available to everybody. We need to demonstrate the market and the technology will follow."

SpaceShipTwo will be carried aloft by a futuristic-looking mothercraft called WhiteKnightTwo, a four-engine jet-powered aircraft unveiled last year that features twin fuselages mounted on either side of a huge wing.

For the unveiling Monday, WhiteKnightTwo, with the rocket plane attached to the center of the wing, was rolled into view amid soaring music and floodlights.



SpaceShipTwo rolls out Monday with the WhiteKnightTwo carrier plane. (Photo: William Harwood)

SpaceShipTwo will be released at an altitude of 50,000 feet. A hybrid rocket motor burning solid propellant with nitrous oxide then will boost SpaceShipTwo onto a steep trajectory to an altitude of more than 62 miles.

The roomy cabin of SpaceShipTwo, about the same size as a large executive jet, features multiple portholes to give its passengers a spectacular view of Earth and space.

After about five minutes of weightlessness as the spaceplane arcs through the top of its ballistic trajectory, the rocket plane will fall back into the atmosphere, pivoting its wings upward in a technique invented by Rutan to ease the stress of re-entry. From there, with the wings back down in their normal orientation, the spacecraft will glide to a runway landing.



An artist's rendering showing SpaceShipTwo's wings pivoted up for re-entry. (Photo: Virgin Galactic)

Rutan said the spacecraft is being built with a design philosophy that requires a much greater factor of safety than government standards for manned space flight.

"I believe it's not enough, in terms of developing something for the public, to say we'll just do the best that we can," he said. "I

believe you also have to have a goal. And clearly the goal of meeting the safety of government manned spaceflight is not anywhere near acceptable, where 4 percent of the people who have left the atmosphere have died. I believe we need to set our sights more on the goal of the safety of the early airliners, and that's an extremely difficult goal.

"That's what we're shooting for, that's what has (guided) our decisions on redundancy and on quality and on training," he said. "What we will achieve now is based on how well we do in our best efforts. But at least we have a proper goal. Making sure spaceflight can attract customers and can fly safely is a much bigger job than doing a research program like we've done before."

How the budding commercial space market might react to a failure early in the program remains to be seen. But Diamandis said he is optimistic.

"If anybody can, Scaled can build a vehicle that's robust and highly reliable," he said.

3:15 PM, 11/30/09, Update: Three station crew members return to Earth (UPDATED at 8:45 p.m. with hatch closure; UPDATED at 11 p.m. with undocking; UPDATED at 2:55 a.m. with landing)

Outgoing space station commander Frank De Winne, cosmonaut Roman Romanenko and Canadian astronaut Robert Thirsk strapped into a Russian Soyuz capsule, undocked and fell back to Earth Tuesday, braving icy weather in Kazakhstan to close out a 188-day stay in space.

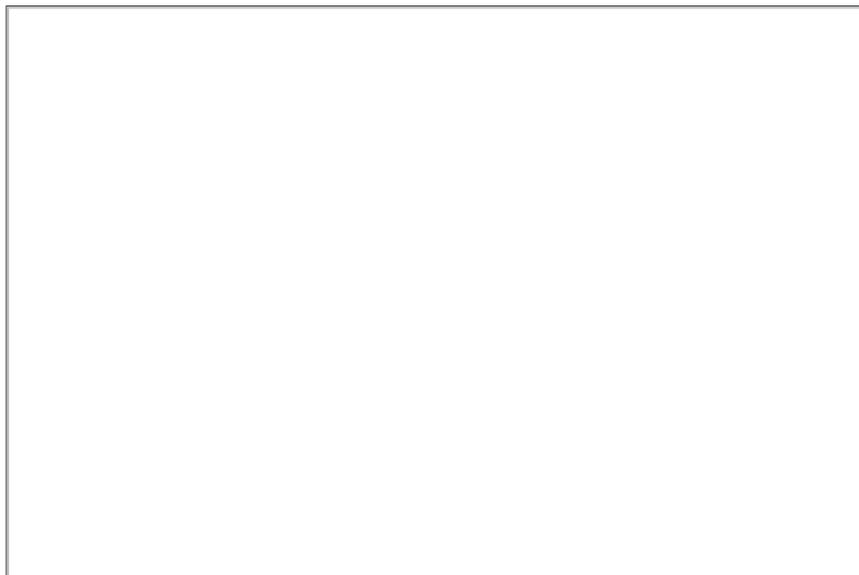
Descending under a large orange-and-white parachute, Soyuz TMA-15 spacecraft made a rocket-assisted touchdown about 50 miles northeast of Arkalyk, Kazakhstan, at 2:15:34 a.m. EST, about three hours and 20 minutes after undocking from the International Space Station.

Recovery forces, including U.S. and Russian flight surgeons, were standing by near the landing site to help the returning spacemen out of the spacecraft's cramped descent module. Despite icy weather that forced authorities to ground the helicopters normally used, recovery crews in all-terrain vehicles reached the spacecraft within about 15 minutes of touchdown.

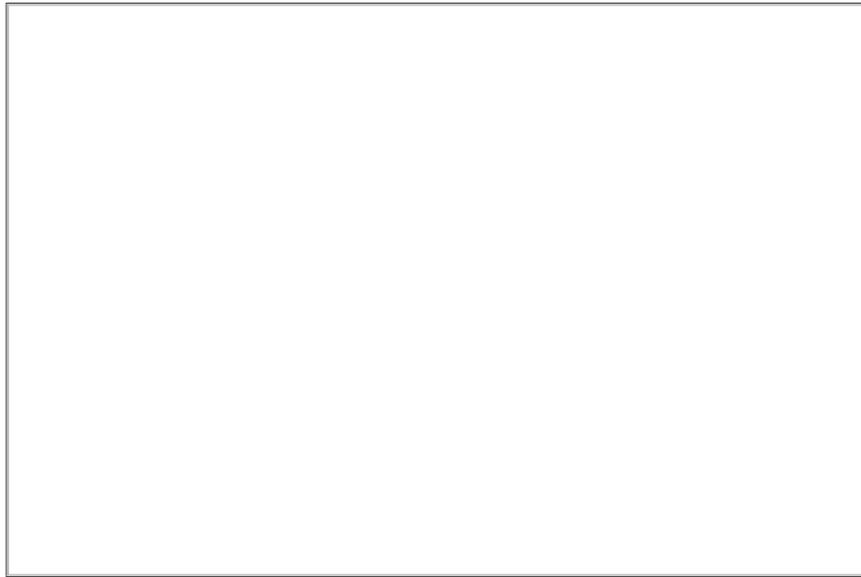
It was the first December landing of a Soyuz since 1990 but the Russians said the weather was acceptable for a safe descent.

Monitoring the re-entry and landing from the International Space Station were Expedition 22 commander Jeffrey Williams and flight engineer Maxim Suraev, who arrived at the outpost in early October.

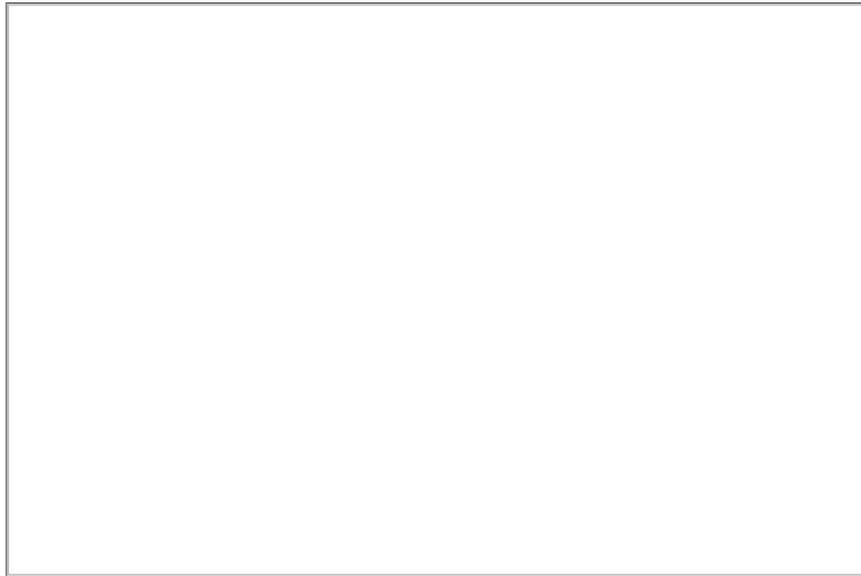
"Four more months, guys, then it's your turn," De Winne said before departing. "Have a good flight. It's wonderful in space, enjoy it."



Roman Romanenko, right, and Frank De Winne, left, wave farewell from inside the Soyuz TMA-15 spacecraft. (Photo: NASA TV)



The Soyuz TMA-15 spacecraft, foreground, docked to the nadir port of the Russian Zarya module. A Progress supply ship can be seen in the background, docked to the Pirs module. (Photo: NASA TV)

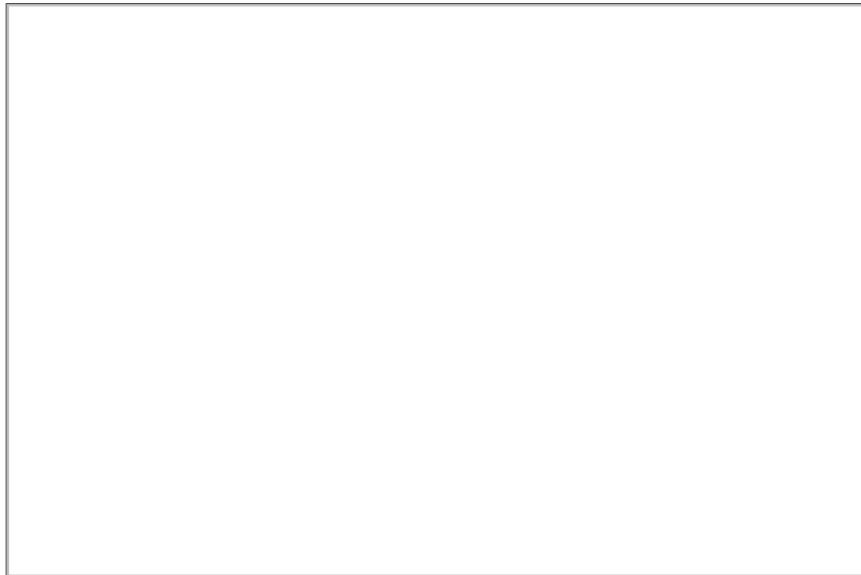


The Soyuz TMA-15 departs the space station. (Photo: NASA TV)

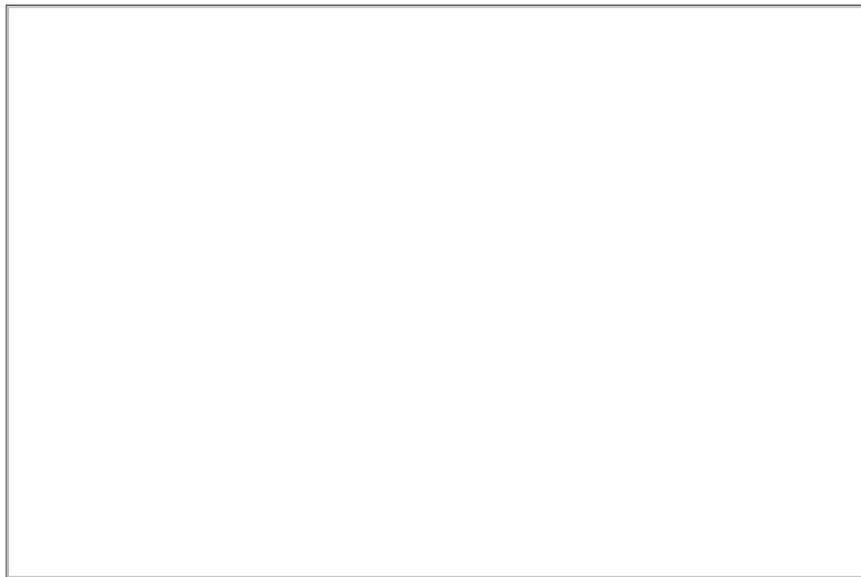


The space station recedes in this view from the Soyuz TMA-15 spacecraft shortly after undocking. (Photo: NASA TV)

The Soyuz descent module landed upright and recovery crews extracted Romanenko, Thirsk and then De Winne one at a time, transporting them on stretchers to nearby vehicles.



Recovery crews work to assist the station crew out of the descent module after landing. (Photo: NASA TV)



Frank De Winne is helped from the Soyuz capsule. (Photo: NASA TV)

Preparations for the Soyuz TMA-15 re-entry began Monday evening.

"Expedition 21 is about to leave the International Space Station," De Winne radioed ground controllers just before floating into the Soyuz capsule. "Thank you very much."

"Have a safe trip home," a controller replied.

"Thank you very much. All the best to everybody there."

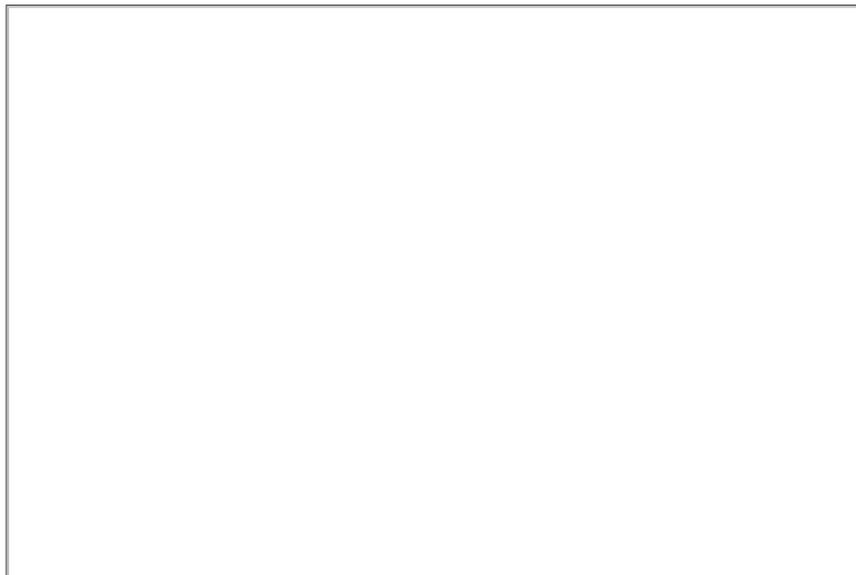
Hatches between the spacecraft and the International Space Station were closed at 7:43 p.m. Monday and the craft undocked from the Zarya module's Earth-facing port at 10:56 p.m.

Romanenko monitored a four-minute 19-second deorbit rocket firing starting at 1:26 a.m. Tuesday, slowing the capsule by about 258 mph and dropping the far side of its orbit deep into Earth's atmosphere. The Soyuz TMA-15's three modules separated at an altitude of 87 miles and three minutes later, around 1:53 a.m., the descent module carrying the crew fell into the discernible atmosphere at an altitude of 63 miles.

Over the next five minutes and 38 seconds, G loads built up to their maximum level of up to five times the normal pull of Earth's gravity as the spacecraft falls to an altitude of 25.6 miles. Commands to begin opening the craft's pilot, drogue and braking parachutes came just after 2 a.m., at an altitude of about 6.6 miles, followed by touchdown near Arkalyk.

Because NASA is responsible for arranging Canadian, Japanese and European Space Agency rides to and from the space station aboard Russian Soyuz spacecraft, NASA flight surgeons and managers joined Russian recovery crews stationed nearby to assist the returning station fliers and carry out initial medical checks.

With the departure of Romanenko, Thirsk and Belgium's De Winne, the European Space Agency's first station commander, the International Space Station was left in the hands of Williams and Suraev, the first time since July 2006 the station has been staffed by just two crew members.



ISS 22 commander Jeffrey Williams (right, light brown shirt) and flight engineer Maxim Suraev (front, light brown shirt). Nicole Stott (center) returned to earth last week aboard the shuttle Atlantis. She is surrounded by ISS-21 commander Frank De Winne, Roman Romanenko and Robert Thirsk. (Photo: NASA)

But the solitude will not last long. Three more crew members - cosmonaut Oleg Kotov, NASA flight engineer Timothy Creamer and Japanese astronaut Soichi Noguchi - are scheduled for launch aboard the Soyuz TMA-17 spacecraft on Dec. 20 U.S. time. Docking is expected two days later.

Here is a timeline of major re-entry events for De Winne, Thirsk and Romanenko (in EST and mission elapsed time):

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EST.....DDD...HH...MM...SS...EVENT.....
11/30/09
09:00:00 PM...187...15...25...07...USOS to RS MCS Handover
09:19:00 PM...187...15...44...07...ISS to free drift for FGB hooks opening
09:26:00 PM...187...15...51...07...ISS mnvr to duty attitude LVLH
10:06:27 PM...187...16...31...34...Sunrise
10:12:00 PM...187...16...37...07...Sunrise at landing site
10:23:00 PM...187...16...48...07...ISS mnvr to undocking attitude LVLH
10:45:19 PM...187...17...10...26...Daily Orbit 15 AOS
10:52:00 PM...187...17...17...07...ISS to free drift
10:53:00 PM...187...17...18...07...Undock Command
10:56:00 PM...187...17...21...07...Physical Sep (dv: 0.12 m/s)
10:59:00 PM...187...17...24...07...Soyuz sep burn #1 (15 sec, 0.54 m/s)
11:01:00 PM...187...17...26...07...ISS mnvr to duty attitude LVLH
11:51:00 PM...187...18...16...07...RS to USOS MCS Handover

12/01/09
01:26:02 AM...187...19...51...09...Soyuz deorbit burn start (257.7 mph)
01:30:21 AM...187...19...55...28...Deorbit burn complete
01:49:55 AM...187...20...15...02...Separation of Modules (87 sm)
01:52:50 AM...187...20...17...57...Atmospheric Entry (63.3 sm)
01:54:35 AM...187...20...19...42...Entry guidance start (49.8 sm)
01:58:28 AM...187...20...23...35...Maximum G-load (25.6 sm)
02:01:13 AM...187...20...26...20...Command to Open Parachute (6.6 sm)
02:15:31 AM...187...20...40...38...Landing
06:28:00 AM...188...00...53...07...Sunset at Landing Site
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04:30 PM, 11/17/09, Update: China, United States agree to explore cooperation in space (UPDATED at 8:50 p.m. with NASA response)

The United States and China have agreed to discuss expanded cooperation in space science and to start a "dialogue" on human space flight and exploration, according to a joint statement released in Beijing Tuesday. The [U.S.-China Joint Statement](#) said both nations looked forward to reciprocal visits by the NASA administrator and appropriate Chinese space leaders in 2010.

"The United States and China look forward to expanding discussions on space science cooperation and starting a dialogue on human space flight and space exploration, based on the principles of transparency, reciprocity and mutual benefit," the joint statement said. "Both sides welcome reciprocal visits of the NASA administrator and the appropriate Chinese counterpart in 2010."

John Logsdon, a space policy analyst at George Washington University, said expanded cooperation makes sense, but only if both sides are open with each other and share the technical data necessary to ensure safe operations.

"I think it's great," he said in a telephone interview. "It opens the door to see whether, in fact, there's a basis for cooperation. I think the operative word in there is 'transparency.' If China is willing to provide the information we need to work with them and vice

versa - they were the ones who have been somewhat reticent to do that - I think it makes total sense."

The future direction of the U.S. manned space program is unclear as NASA waits for the Obama administration to make a decision on how the agency should proceed after the space shuttle is retired next year.

The Bush administration directed NASA to finish the space station and retire the shuttle by the end of 2010 and to develop a new family of safer, less expensive rockets to service the International Space Station and to help launch manned moon missions by the early 2020s.

NASA developed the Constellation program and the Ares family of manned and unmanned rockets to meet that challenge, but the agency has not been given the funding needed to carry out the program under the original schedule.

An independent review of manned space options was carried out this summer at the request of the Obama administration. The panel concluded NASA would need an additional \$6 billion a year to fund the Constellation program and extend the International Space Station program through 2020.

The panel presented four other options as well, including one to encourage private industry to take over launching astronauts to low-Earth orbit while NASA focuses on long-term deep space exploration.

The Obama administration has not yet indicated a favored option. In the meantime, NASA is proceeding with plans to finish the space station and retire the shuttle next year.

No matter what happens, it appears the United States will not have a shuttle replacement ready to fly for at least five to seven years. In the interim, NASA plans to pay the Russians to launch U.S. astronauts to the space station aboard Soyuz capsules at \$50 million a seat.

The International Space Station is operated as a cooperative venture between the United States, Russia, the European Space Agency, Canada and Japan. Complex inter-agency agreements govern the lab's operation, the nationalities of the international crews and how data is exchanged.

The Chinese have launched three manned space missions since 2003, boosting one, two and three crewmen into orbit respectively and staging a spacewalk during the most recent flight in 2008.

Responding to a query from CBS News, a NASA spokesman said "adding any international partner to the International Space Station program would require a formal decision by the U.S. government and consultation and agreement among the governments of all of the International Space Station partners. To date, discussions of any type of human space flight cooperation with China has been outside the scope of our bilateral discussions."

Questions about how China might participate in the space station program "need to be discussed, especially since it seems we are going to be operating the station for the next decade," Logsdon said. "If the terms and conditions can be mutually agreed to, I think it would be a great thing."

As for whether U.S. astronauts might one day ride Chinese rockets and vice versa, Logsdon said "20 years ago, launching U.S. astronauts on Russian rockets was inconceivable. But we're doing it, and it's soon going to be the only way to get to station."

"The more systems we have to carry people into space, the better off I think the world is," he said.

Speaking to reporters in Japan, NASA Administrator Charles Bolden, a former shuttle commander, said cooperation on the high frontier could pay dividends for both countries.

"I am perfectly willing, if that's the direction that comes to me, to engage the Chinese in trying to make them a partner in any space endeavor," Bolden said, according to AFP. "I think they're a very capable nation.

"They have demonstrated their capability to do something that only two other nations that have done, that is, to put humans in space. And I think that is an achievement you cannot ignore."

He said China is a nation "that is trying to really lead" and that if the two space powers cooperate, "we would probably be better off than if we would not."

B>07:40 PM, 11/13/09, Update: LCROSS impact kicks up water ice on moon

Making a bigger splash than expected, the crash of an empty rocket stage in a permanently shadowed crater near the moon's south pole last month kicked up a surprising amount of water ice and vapor, confirming the presence of a potentially valuable resource for future space travelers.

"I'm here today to tell you that indeed, yes, we found water," said Anthony Colaprete, the project scientist and principal investigator for the Lunar Crater Observation and Sensing Satellite. "And we didn't find just a little bit, we found a significant amount."

Holding up water jugs to make the point, he said "if you remember, a month ago we were talking about teaspoons going into glasses over football fields. Well, now I can say today that in the 20- to 30-meter (65- to 100-foot-wide) crater LCROSS made, we found maybe about a dozen of these two-gallon buckets worth of water."

And more than water. Data from the LCROSS instruments show signs of other compounds that may shed light on the moon's evolution.

"It's a whole lot more beyond the water," Colaprete said. "That's the exciting part in my mind, it's not only about the water now. There's actually a lot more here that we're going to be talking about in the months ahead, looking at the LCROSS data."

Said Greg Delory, a researcher at the University of California, Berkeley: "This is not your father's moon. Rather than a dead and unchanging world, it could in fact be a very dynamic and interesting one that could tell us unique things about the Earth-moon system and the early solar system."

Michael Wargo, chief lunar scientist at NASA headquarters in Washington, said the discovery holds promise for future exploration. Using solar energy, future astronauts could, in theory, break down recovered ice and in effect live off the land.

"Water can be used for the kind of things we think about every day, drinking water if we have extended crews on the surface," he said. "You can break it down and have breathable air for crews to breathe. But also, if you have significant quantities of this stuff, water really is the constituents of one of the most potent rocket fuels: oxygen and hydrogen."

Whether the water ice detected by LCROSS might be accessible to future astronauts remains to be seen. But scientists were elated with the initial findings.

The \$79 million LCROSS mission was launched June 18 as a companion payload to NASA's \$504 million Lunar Reconnaissance Orbiter spacecraft. Working in a 31-mile-high orbit, LRO is designed to create a high-resolution map of the moon's surface to help identify sites for future manned missions.

It also is measuring the solar and cosmic radiation that future lunar explorers will face and mapping out the surface topology, mineralogy and chemical composition of Earth's nearest neighbor. One year will be spent scouting future landing sites followed by three years of purely scientific observations.

While LRO was launched directly to the moon by an Atlas 5 rocket, LCROSS and the booster's empty Centaur upper stage were sent into a looping four-month orbit back around the Earth.

The spacecraft aimed itself and the attached Centaur stage back at the moon, targeting a permanently shadowed crater near the south pole. Data from previous spacecraft indicated the presence of hydrogen in the polar regions, possibly associated with water ice just below the surface.

LCROSS mission managers initially selected a target crater known as Cabeus A, but after additional analysis of topographic data, the target was switched to nearby Cabeus, a crater measuring some 62 miles across and about two-and-a-half miles deep.

LCROSS successfully separated from the Centaur stage the night before impact, rotated 180 degrees to aim its instruments forward and then followed its doomed companion to the surface, trailing it by about four minute.

The Centaur is believed to have hit the moon within about 650 feet of the planned target, blasting out a crater 65 feet to 100 feet across. Colaprete showed photographs from LCROSS Friday that clearly showed the plume of debris kicked up by the crash. Another photo showed the crater itself. LCROSS flew through the ejecta cloud, collecting data all the while, before crashing a short distance away.

The Centaur impact was not particularly impressive to the untrained eye - a pinpoint flash of light in the inky darkness of the crater's shadowed terrain - and many observers, expecting a more dramatic show as indicated in NASA animations, were disappointed.

But Colaprete said Friday the impact more than lived up to scientific expectations. Spectroscopic data from two instruments aboard LCROSS clearly showed the presence of water ice, along with a variety of other materials, in the ejecta plume.

"We can constrain right now how much water we think is in the field of view of our instrument," he said. "Based on these measurements, there is more than 100 kilograms in the field of view of our instrument. What does that mean, a hundred kilograms? That's the dozen or so two-gallon buckets I described."

"But what we need to do next is take all the information, the amount of ejecta, the size of the crater, how this all changed over time and actually reconstruct the entire event, understand how it all fits back into the ground along with all the other things we've seen in the ejecta plume to really understand this whole thing."

Delory said more analysis will be needed to figure out where the water ice originated.

"One possible source of the water is from comets," he said. "If that's true, and the lunar polar regions really are repositories for this material, they are a literal treasure trove of information in terms of the composition of comets, which are themselves indicative of early solar system conditions. That would be of extreme interest to many planetary scientists."

Another possibility, he said, is that the water ice is the result of chemical reactions that start with the solar wind, "which is basically an ionized gas streaming from the sun composed mainly of hydrogen."

"It impacts the lunar surface, undergoes chemistry, eventually these molecules hop around the moon and end up concentrated around the poles," he said. "Studying those deposits would tell us something about solar history, also about the history of chemical reactions occurring on the surface of the moon. Two completely different theories, we don't know which one is right yet."

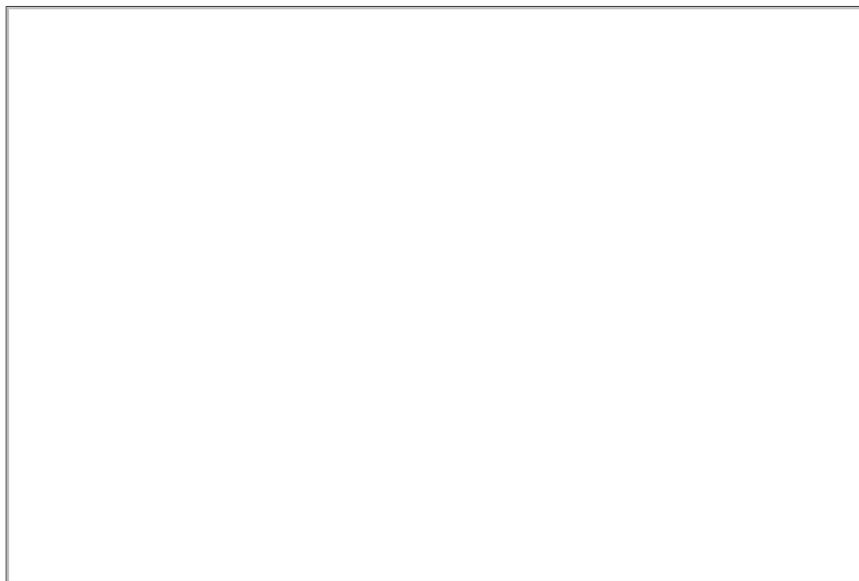
Other sources are also possible, he said, including deposits from molecular clouds the solar system may have passed through earlier in its evolution as well as subtle chemical processes on the moon itself.

04:00 PM, 11/12/09, Update: Engineers set for attempt to free stuck Mars rover

After months of tests and analysis, engineers plan to beam commands to NASA's Spirit Mars rover Monday, kicking off a long-awaited attempt to free the hardy craft from the talcum powder-like soil of a hidden crater that trapped it last April.

"Spirit's facing the most challenging situation it's seen yet on the surface of Mars," said Doug McCuiston, director of NASA's Mars exploration program. "We know a lot of people around the world ... view Spirit with great affection, exploring the red planet along with it, experiencing the excitement, seeing new and exciting vistas, seeing new landscapes, uncovering some incredible new knowledge about our sister planet."

"I'd like everybody to be hopeful, but I'd also like them to be realistic," he said. "If Spirit cannot make the great escape from this sand trap, it's likely that this lonely spot, straddling the edge of this crater, might be where Spirit ends its adventures on Mars."



The view from the Spirit rover, stuck in the martian soil, facing north. A hidden crater lies to the left. (Photo: NASA)

Designed to operate for just three months on the frigid surface of Mars, Spirit and its twin rover, Opportunity, have been exploring opposite sites of the red planet since early 2004, collecting data in concert with orbiting spacecraft to help scientists understand the role of water in the martian environment.

Chalking up a steady stream of discoveries over the past five years, the unexpectedly long-lived rovers are held in high esteem by the scientists and engineers who drive them across the surface of Mars and eagerly await the data they send back.

"In many ways, we think of these rovers kind of as our children that we've sent off into the world way too early," said Ashley

Stroupe, a rover driver at the Jet Propulsion Laboratory in Pasadena, Calif. "And like most parents when their kids go off to college, we can't reach out to help them every time they really need us. So it really is a bond, not just between us and the rover but also the team has become a very close family as well."

Last April 23, the six-wheeled Spirit was slowly rolling backwards on the western side of a feature known as "Home Plate," heading toward the south and a pair of volcanic structures that scientists wanted to examine. The rover was driving backward because its right front wheel stopped working in 2006.

The ground to the south of Spirit looked normal, but as it crept along, its wheels broke through an upper crust-like layer of soil and into a softer, unseen material.

"Essentially, the rover was driving on what we call a dirt crust," said John Callas, the project manager of the Mars exploration rovers at JPL. "It was a hard surface that we broke through and underneath this material, camouflaged underneath, was this loose, fine material where the rover is challenged right now."

Scientists later determined that Spirit's path was straddling the rim of an ancient, 26-foot-wide crater just beneath the surface. The crater was filled in with sulfate sands that formed layers with different compositions.

Initial attempts to drive out in a crab-like fashion by turning the front and back wheels in the same direction only made matters worse.

Pictures from navigation cameras on the rover show its forward and rear wheels almost buried in the soil, their treads caked with a powdery coating that reduces traction. Even worse, photographs show a pyramid-shaped rock sticking up from the soil directly below Spirit's body that threatens to rub against the belly, possibly lodging in an indentation. If the rock ends up bearing any of the weight of the rover, traction could be reduced even more.



**A protruding rock below the Spirit rover could cause problems.
(Photo: NASA)**

NASA managers decided to halt any additional attempts to free Spirit until engineers could complete a thorough analysis using a full-scale mockup and simulated martian soil.

"Unfortunately, Spirit may have met its match in this one," McCuiston said. "We will see if we can get it out of this talcum powder-type soil that laid beneath a seemingly innocuous surface crust that we broke through."

"The rover teams have been working very hard since April, they've been testing, strategizing, analyzing and modeling to figure a way out. We even called experts in soil mechanics and mechanical systems in to try to help us understand the environment. But there's only so much you can do on Earth to simulate Mars."

Late Monday, commands will be uplinked to Spirit in an attempt to drive north, back along the furrows its wheels dug as the rover moved into the sand trap last April. Engineers will find out how the move went on Tuesday. No one expects a quick extraction and engineers said it likely will take weeks or months to either free the rover or determine it can't be done.

"Our best plan at this point is to try to drive forward, retracing our steps as we drove in," said Stroupe. "And we believe this is our

best plan for several reasons. One is that we believe this softer material may be easier to plow through than trying to break through the crust and cut new tracks. So if we follow our old tracks out, we may be able to make better progress.

"We have very little ground clearance under the vehicle, wheel turns cause us to sink further into this material and there is no guarantee that any plan we come up with will succeed in extricating the vehicle," she said. "This is going to clearly be a very long process to either get to extrication or perhaps even to determine if extraction is going to work."

The team's progress will be assessed in February. Depending on the success or failure of the work at that point, NASA could opt to continue with additional attempts or decide to call it off. Even in that worst-case scenario, scientists could still use Spirit's instruments to study nearby rocks and soil and to monitor the martian weather.

But Stroupe hopes it won't come to that.

"I think a lot of us, while we're waiting for that plan to execute (Monday), will not get a lot of sleep," she said. "But regardless of the outcome, none of us can have anything but primarily positive emotions about this mission. It's been such an incredible experience, we've come so far beyond what we thought we would accomplish.

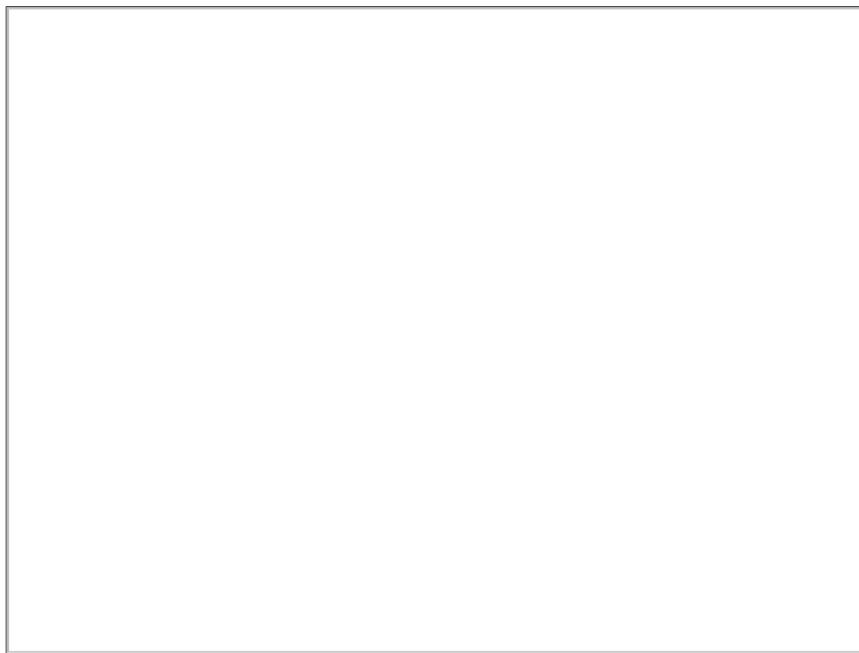
"So even at someday when these rovers come to an end, perhaps the best word was used earlier, which is 'bittersweet.' We're so proud of them and we're so thrilled to have been part of this project. It will be sad to see them go. But we're not ready to let go yet and we don't plan to let go yet. We still have a lot of work to do."

12:15 PM, 11/12/09, Update: Russian Poisk module docks with space station

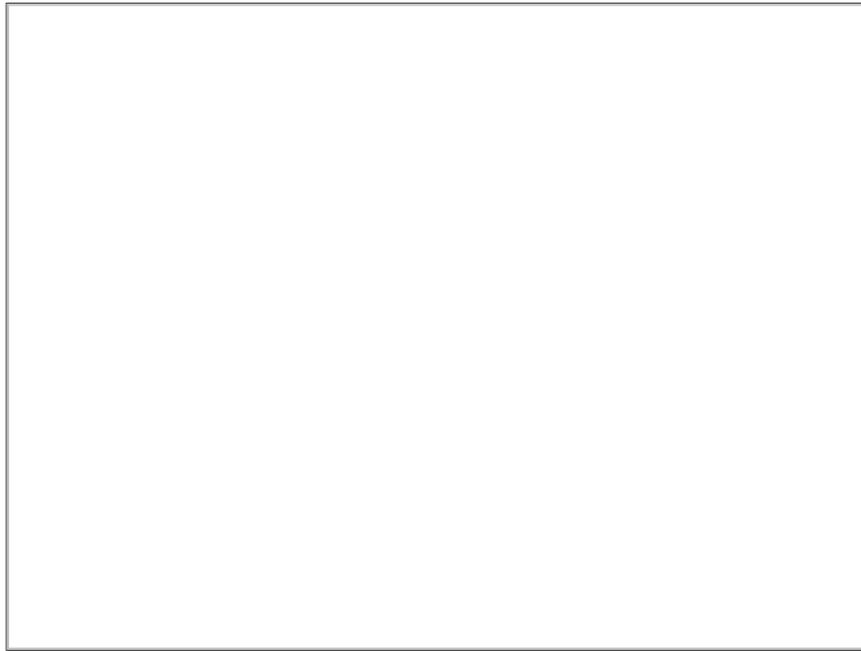
A new Russian module successfully docked with the International Space Station today, a needed addition that will give the lab complex a fourth docking port for Soyuz crew capsules and Progress supply ships.

The 8-ton Poisk mini research module, launched Tuesday from the Baikonur Cosmodrome in Kazakhstan, carried out an automated approach to the zenith, or upward-facing port of the Russian Zvezda command module, docking at 10:41 a.m. as the two spacecraft sailed 222 miles above northern Kazakhstan.

Hooks and latches then retracted as planned to firmly lock the new module in place.



**The Poisk module approaching the International Space Station.
(Photo: NASA TV)**

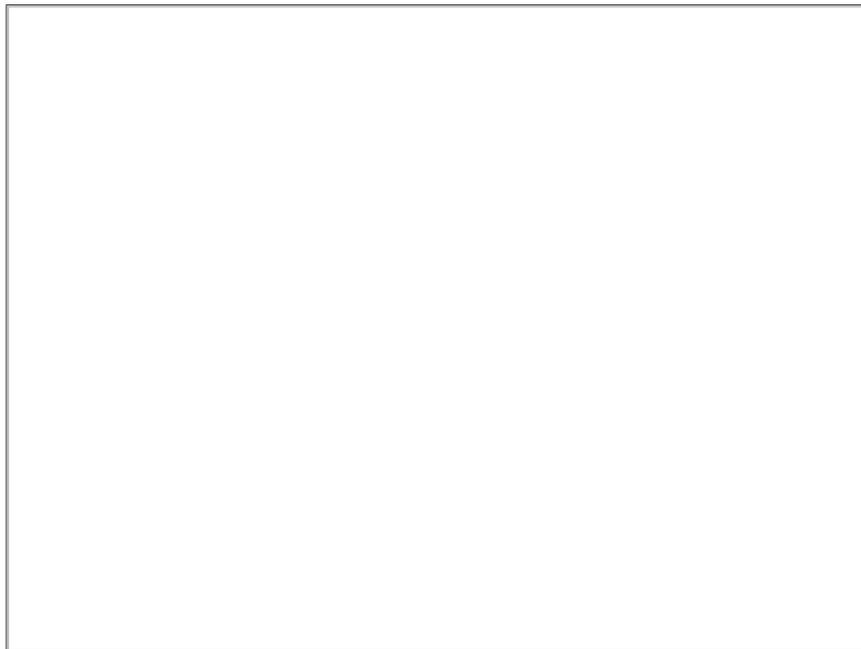


The view of the space station from Poisk during the new module's final approach. (Photo: NASA TV)

Loaded with 1,800 pounds of supplies, Poisk - "explore" in Russian - will be used as a docking port, airlock and experiment platform. A similar module, scheduled for launch next year aboard the shuttle Atlantis, will be docked to the downward-facing port of the Russian Zarya module.

To support a full-time crew of six, two three-seat Soyuz capsules must be docked at all times to serve as lifeboats. Additional ports are needed for unmanned supply ships.

With the arrival of Poisk, four docking ports are now available on the Russian segment of the space station: one on the Earth-facing port of the Zarya module; one on the Earth-facing Pirs module attached to Zvezda; one on the aft end of Zvezda; and now Poisk on the command module's zenith port.



A drawing of the Russian segment of the space station showing its four docking ports. (Graphic: NASA)

A spacewalk is planned Jan. 14 to add rendezvous equipment to the Poisk module. If all goes well, the Soyuz TMA-16 spacecraft currently docked to the aft port of Zvezda will be moved to Poisk on Jan. 20.

The Soyuz TMA-15 capsule currently docked to Zarya's nadir port is scheduled to depart Dec. 1 to carry European Space Agency commander Frank De Winne, cosmonaut Roman Romanenko and Canadian astronaut Robert Thirsk back to Earth. Soyuz TMA-17, scheduled for launch Dec. 21, will dock at Zarya on Dec. 23, bringing three fresh crew members to the station: cosmonaut Oleg Kotov, NASA astronaut Timothy Creamer and Japanese astronaut Soichi Noguchi.

An unmanned Progress supply ship currently is docked to the Pirs module.

In 2011, the Russians plan to discard Pirs and replace it with a much larger multi-purpose laboratory module, or MLM, that was built in part from spare components left over from the assembly of the Zarya module.

6:20 PM, 11/6/09, Update: Trajectory analysis shows space debris no threat to space station; plans for Soyuz sheltering shelved
(UPDATED at 10:10 p.m. with crew comments)

Analysis of the trajectory of a piece of space junk that was believed to pose a possible threat to the International Space Station showed the debris would not pass close enough to the lab complex to force the crew to seek refuge in their Soyuz lifeboats, flight controllers concluded late Friday.

The station's six-member crew was awakened early, at 10 p.m. EST as planned, but the astronauts were told to go back to bed and not to press ahead with a tentative plan to shelter in place aboard the station's Soyuz ferry craft.

"Good news," mission control radioed. "Tracking data has come through and shown that the conjunction's no longer a threat to station. We have no actions for you tonight, we'll let you get back to sleep. However, Houston and Moscow are standing by in case you have any questions."

"OK, thank you very much," European Space Agency commander Frank De Winne replied. "I'll get around to all my crew members here and we can go back to sleep. Thanks a lot for working all this tonight, Houston."

"Thank you, Frank. Good night."

Earlier Friday, NASA flight controllers predicted the debris, of unknown origin, could pass within about six-tenths of a mile of the space station at 10:48 p.m., toward the end of the crew's normal sleep period. During the evening planning conference Friday afternoon, the astronauts were told to plan on getting up early so they could make their way to the Soyuz lifeboats by around 10:30 p.m. if necessary.

But after the crew went to bed, additional analysis showed the unidentified debris would not pose a threat to the station.

11:45 AM, 11/6/09, Update: NASA monitors space debris, possible close approach to International Space Station (UPDATED at 2:45 p.m. with initial decision to put crew in Soyuz craft for debris encounter) (UPDATED at 5:40 p.m. with additional tracking; debris may not pose a threat to station crew)

The six-member crew of the International Space Station was told to get a few hours sleep Friday while flight controllers continued to assess the trajectory of a piece of space debris that was expected to pass close by the lab complex at 10:48 p.m. EST.

The crew was told to be prepared to take refuge aboard the lab's two three-seat Soyuz lifeboats if the analysis indicated a clear threat. But late Friday, flight controllers gave the crew a more upbeat report, saying "the news is getting better."

"We've had two more sites that have tracked the object and they're indicating it is not a valid threat," Ricky Arnold told the crew from mission control in Houston shortly before 5:30 p.m.

"Though due to the uncertainty, we'd like to take the opportunity to get more data in about an hour, we've got another pass that we'll get a look at it. We'd like to have you guys go to bed and we'll wake you at 0300 (GMT; 10 p.m. EST) as planned, even if it's just to tell you to go back to sleep. We don't know when the analysis is going to get in."

"OK, that sounds good," replied station commander Frank De Winne, a European Space Agency astronaut. "So we'll wake up at 0300 and we'll get further words at that moment if we will proceed to our Soyuzes and closing the hatches, or if you want us to just go back to sleep."

"That's a great plan and we thank you guys for the late night and all your hard work," Arnold said. "Hopefully we'll be waking you up here in a few hours with some good news."

Earlier Friday, NASA flight controllers predicted the debris, of unknown origin, could pass within about six-tenths of a mile of the lab complex toward the end of the crew's normal sleep period. Because all objects in low-Earth orbit, including the space station, are moving at roughly five miles per second, close encounters, or "conjunctions," are carefully monitored and subjected to extensive

analysis.

During the evening planning conference Friday afternoon, the astronauts were told to plan on getting up early so they can make their way to the Soyuz lifeboats by around 10:30 p.m.

"The ballistics are saying they are looking at conjunction with space debris," Russian mission control radioed. "As you know, this is something we are prepared for. In the past, we have performed avoidance maneuvers, but this time maneuvering away from the path of the debris is not an option.

"Because we cannot perform avoidance maneuver, you will have to ingress Soyuz vehicles. Both Soyuz crews should be in their vehicles. This is what we have. We are going to work on the ballistics data to get greater precision, but right now we are in the red box. The probability of collision is non zero."

NASA flight controllers told the astronauts the tracking data is uncertain and that engineers did not yet have confidence in the trajectory projections. Pending additional analysis later in the afternoon, the crew was told to play it safe and plan on boarding the Soyuz lifeboats after shutting internal hatches in the U.S. segment of the lab complex.

The Soyuz sheltering plan called for cosmonaut Roman Romanenko, Canadian astronaut Robert Thirsk and De Winne would make their way to the Soyuz TMA-15 spacecraft docked to the Earth-facing port of the Zarya module. Cosmonaut Maxim Suraev and NASA astronauts Jeffrey Williams and Nicole Stott would seek safe haven in the Soyuz TMA-17 spacecraft docked to the aft port of the Zvezda command module.

"Unfortunately, the particular object is not easy to track, it's not visible by all the different tracking stations every time, and so there's not a lot of confidence in the data on the exact location of this piece of debris," NASA spokesman Kelly Humphries said earlier Friday.

Last March, the station's three-man crew - Mike Fincke, Yury Lonchakov and Sandra Magnus - faced a similar situation and briefly took refuge in the lab's single Soyuz lifeboat when another piece of debris from an old rocket motor made a close approach.

There are more than 18,000 pieces of space junk in low-Earth orbit the size of a baseball and larger. U.S. Strategic Command prioritizes radar tracking to protect manned spacecraft first, followed by high-priority military and civilian payloads.

NASA monitors an imaginary volume around the space station roughly the shape of a pizza box measuring 0.466 miles thick and 15.5 miles square.

"Initially, we have a screening box, which is .75 kilometers radial miss, which would be up or down, by 25 kilometers in cross track, which would be left or right, by 25 kilometers down track, which is either in front or behind us," space station Flight Director Ron Spencer said in September.

"Space Command will alert us of any debris objects out there that are going to get that close to us. Then they increase tasking on those objects to try to get a better solution and decrease the uncertainty. Then we calculate a probability of collision based on the data Space Command gives us."

Spencer said NASA has two levels of concern.

"We have two thresholds, yellow and red," he wrote in an email exchange. "The yellow is 1-in-100,000 and the red is 1-in-10,000. We will not take any action if it is below the yellow threshold. If it between the yellow and red, we will only take action if it is easy to do so without impacting the mission. For a red threshold violation we will take action in most cases."

02:50 PM, 10/30/09, Update: Quick-look analysis shows Ares I-X test rocket met or exceeded expectations; official says parachute anomaly, casing damage not significant

An initial look at data from NASA's Ares I-X test flight Wednesday shows the towering rocket performed as well or better than computer modeling predicted during the climb out of the dense lower atmosphere, a senior NASA manager said Friday.

One of three huge parachutes failed to inflate during the spent booster's descent to the Atlantic Ocean and a second chute only inflated halfway, resulting in a hard splash down that caused the rocket's case to buckle.

But Mission Manager Bob Ess said the parachute system, flying for the first time, was designed for NASA's planned Ares 1 rocket, which is 15 percent lighter than the test version, and that engineers will have plenty of time to correct whatever went wrong.

"No one is concerned about it," Ess said. "In fact, the parachute guys were ecstatic, was their words, (about) the information they got from this flight. They really wanted to test this out."

The Ares I-X rocket was designed to match the characteristics of NASA's planned shuttle replacement, the more powerful Ares I. The test version featured a four-segment shuttle booster, a dummy fifth segment housing guidance and control equipment and an unpowered mockup of the rocket's upper stage and crew capsule.

The 327-foot-tall test rocket was launched Wednesday from shuttle complex 39B at the Kennedy Space Center. The major goals of the unmanned six-minute flight were to collect engineering data on how the tall, slender rocket flew through the lower atmosphere, how the structure responded to aerodynamic and acoustic forces and how the new parachute system, scaled for the planned Ares I, performed.

During the initial seconds of flight, the rocket's nozzle moved 1 degree as planned to help the booster "walk off" the pad, preventing its hot exhaust plume from hitting the upper sections of the shuttle service gantry. As expected, the plume caused minor damage to the lower sections of the gantry, but Ess said that would not be a problem for the new service tower that will be used for Ares rockets.

Six seconds after liftoff, the vehicle rose above the gantry and the rocket's roll control system fired to rotate the booster about its vertical axis, ensuring that antennas relaying telemetry would remain in line of sight with ground stations throughout the flight.

The 5-degree-per-second roll maneuver went off with out a hitch and Ess said the rocket remained "very, very stable" after that. The booster experienced a maximum aerodynamic pressure of about 900 pounds per square foot just after it accelerated through the sound barrier.

"The booster guys have been looking at all the data," Ess said. "Everything looked great. This was the oldest booster we've ever flown, it looked just like a shuttle flight. All the parameters were right in the middle, there were no dispersions, all the pressures, the oscillations were what we typically see for a shuttle flight."

One major concern early in the development of the Ares system was a phenomenon known as thrust oscillation, which can cause unwanted vibrations toward the end of powered flight as the booster exhausts its load of solid propellant. Data from a few test firings early in the shuttle program indicated potentially excessive vibrations, but data from recent shuttle flights and ground firings, including one using a five-segment Ares I booster, show only minor disturbances.

Based on a quick look at the Ares I-X data, "the oscillations look very small, similar to what we see for shuttle data or that one test firing we did," Ess said. "So we didn't see anything unusual. ... It was very benign, there was very little there. Again, we'll get the data back from the recorder, which is high speed data, and we'll verify that. But at this point, there's nothing to indicate thrust oscillation was even a factor."

The first stage lofted Ares I-X to an altitude of about 24 miles and a velocity of 4.6 times the speed of sound in two minutes of powered flight. Explosive charges then fired, separating the spent first stage from the dummy second stage. An instant later, small upward-facing rockets fired to pull the first stage away.

"We did a separation at 125,000 feet, about mach 4.6, and both of those were pretty much as predicted," Ess said. "We looked at the video, multiple video views, and we did not see any recontact between the upper stage and the first stage."

"The rates of the vehicle at separation were supposed to be within 2 degrees per second in pitch and yaw and 3 degrees per second in roll. And indications we had are those were all within less than half a degree per second. So the flight control (system) kept the vehicle very, very stable, it wasn't rotating at all during the separation, so it was very solid."

In what appeared to be a surprise at the time, the upper stage went into a slow, flat spin instead of continuing upward on a nose-forward trajectory. Ess said Friday engineers, in fact, expected that behavior and had seen it in scores of computer simulations.

"Two days ago at the (post-flight) press conference I used the phrase "a little different," Ess said, describing the upper stage tumble. "We went back and looked at all the (computer simulations) we ran and we found thousands of them that matched what we saw. So my comments were incorrect when I said 'a little different.'"

The upper stage was loaded with 30,000 pounds of ballast near the bottom to simulate a full load of liquid oxygen rocket propellant and another 30,000 pounds higher up to simulate liquid hydrogen fuel.

"So the center of gravity is very far aft in this thing once it's by itself and the center of pressure is more towards the middle, so it's inherently unstable," Ess said. "With about 90 or so pounds per square foot of dynamic pressure (at that altitude) and an unstable vehicle, it's no wonder the simulations showed just what we saw, that when you separated there's nothing to control it."

"As a reminder, for Ares I there's an attitude control system on it. So as soon as you separate, there are attitude control motors that will keep the upper stage where it needs to be and then the J2 engine will kick off as well and we'll have active control. So that is something that's very, very different between I-X and Ares I."

After separation, small rockets at the base of the first stage fired to put the booster in a flat spin of its own to prevent a nose-down descent that might interfere with parachute deployment.

Ess said a pilot chute deployed as planned, pulling out a larger drogue parachute to slow and stabilize the rocket. The three main parachutes then were pulled out, each one initially inflating to about 50 percent of their full 150-foot width as planned to ease the shock on the system.

"The parachutes came out in the reefed position and they all inflated, all three of them," Ess said. "So that was good. Soon thereafter, one of the parachutes failed. It's tough to tell exactly from the video, we're hoping to look at the parachutes sometime over the weekend, or Monday or Tuesday. It appears the suspension lines themselves may have failed as opposed to the parachute material.

"So we had two parachutes then in the reefed position, one was just kind of trailing, it wasn't open. Then as we went and disreefed to the fully open position, a second chute appeared to have some damage. It was still pretty much intact, but part of it, it seemed like the riser lines or suspension lines seemed to get fouled or cut, and so part of the parachute was not inflated.

"So we had one good one, one completely failed one and then one was probably about halfway (inflated)," Ess said. "So that caused the booster to hit the water at a higher speed than expected, it was a pretty hard impact. We think because this one parachute was partially inflated, we got a little more horizontal velocity than nominal. ... What that caused was a hard impact and the vehicle slapped down pretty hard in the water. So that caused some damage on the booster."

The impact apparently damaged the nozzle steering actuators and caused one of the booster's fuel segments to buckle.

Ess said the damage was of no immediate consequence because NASA had no plans to reuse any of the hardware. As for the test, he said the parachutes were subjected to a heavier load than what is expected for the actual Ares I.

"I-X empty is about 15 percent heavier than Ares I empty," he said. "That's because of the fifth segment simulator, our dummy simulator, is full of electronics and avionics. We also added a bunch of ballast in the back end of it to make it more stable. So this was an overtest of the Ares I chutes. Again, there's 15 percent more weight it had to carry than it would for Ares I. And so, therefore, there's a whole lot more load on the chutes."

Because the parachutes are so large, NASA was unable to carry out any pre-flight drop tests with a full-scale cluster of three at the altitudes and dynamic pressures experienced during the launching.

"It was a great flight," Ess said. "And the parachute thing is a very, very minor thing. We're not really dwelling on it, it's just something we'll go look at, we have a few years to go look more into it. That's a very minor aspect. People like to dwell on things that are not perfect."

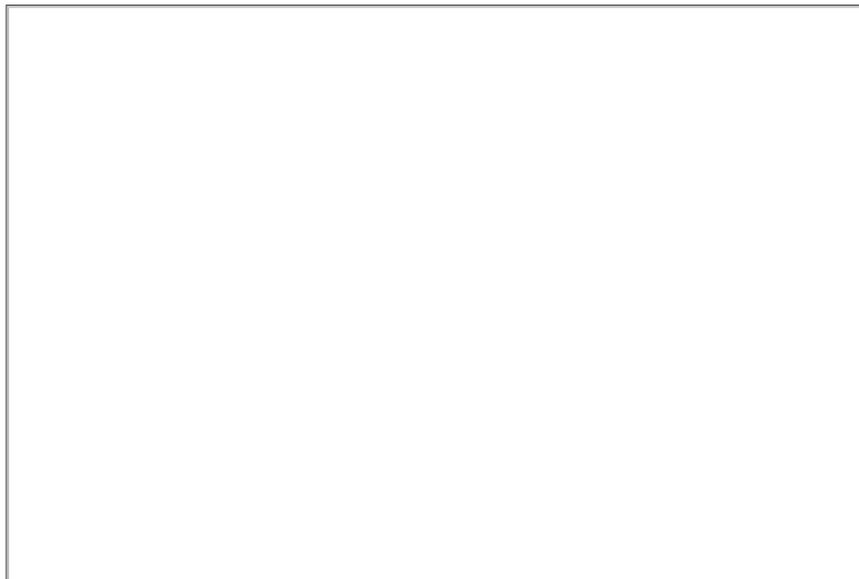
But overall, he said, "everything went really, really well. In fact, everything flew just right down the middle of the pipe. Everyone's still pretty ecstatic. It just showed we got our models right in all areas, the ascent part of it, the (guidance and control) part of it, the flexible body interaction, all the really hard stuff."

The rocket was towed back to a processing facility at the Cape Canaveral Air Force Station Friday for a detailed inspection. Ess said the team hopes to remove the on-board data recorder next week.

3:40 PM, 10/29/09, Update: Ares I-X booster recovered; engineers assess dented casing (UPDATED at 8:15 p.m. with additional details)

One of the three 150-foot-wide parachutes designed to gently lower NASA's Ares I-X first stage booster to the Atlantic Ocean after a dramatic six-minute test flight Wednesday deflated after deployment, officials said Thursday, resulting in a harder splashdown than expected.

Photographs taken by the recovery crew show the four-segment shuttle booster floating upright in the Atlantic Ocean shortly after splashdown. An initial inspection, sources said, revealed the sort of paint blistering that is typically found on shuttle boosters, along with an area of apparent buckling in the lower segment.



Left: An underwater view of a large dent in the lower segment of the Ares I-X booster. Right: The rocket seen floating upright after splashdown.

The test of the new parachute system was one of several major objectives of the Ares I-X test flight, intended to generate data needed to perfect the design of NASA's planned shuttle replacement, the more-powerful Ares I rocket.

While the I-X test version featured a less powerful first stage booster and a dummy upper stage, it weighed roughly the same as an Ares I. The full-scale parachute system used for its first flight test was designed to handle the heavier weight of the Ares I and its fall from a higher altitude.

A NASA spokeswoman said late Thursday the test rocket's drogue parachute, used to slow and stabilize the vehicle before the main parachutes are released, deployed normally. All three main chutes then released and began inflating as planned in a two-step procedure. Two of the mains apparently inflated fully, but the third collapsed.

A source said the deflated parachute contacted one of the others as it whipped about in the wind, causing a partial deflation. That could not be immediately confirmed, although a splashdown in that condition might explain the buckling seen in the lower segment of the rocket's case.

Shuttle boosters, which are lowered to the ocean by two 130-foot-wide parachutes, can be damaged depending on the impact angle and sea state, engineers say. But it's not yet known what caused the problem with the Ares I-X booster.

The 327-foot-tall Ares I-X was launched Wednesday from launch complex 39B at the Kennedy Space Center. The major goals of the unmanned test flight were to collect engineering data on how the tall, slender rocket flew through the dense lower atmosphere, how the structure responded to aerodynamic and acoustic forces and how the new parachute system, scaled for the planned Ares I rocket, performed.

The first stage boosted Ares I-X to an altitude of about 25 miles and a velocity of 4.5 times the speed of sound in two minutes of powered flight. Explosive charges then fired to separate the spent first stage from the dummy second stage and small upward-facing rockets fired to pull the first stage away.

In a surprise, the upper stage went into a slow, flat spin instead of continuing upward on a nose-forward trajectory as expected. A moment after separation, another set of small rockets fired as planned to put the first stage into a similar spin to prevent a nose-down re-entry that might interfere with parachute deployment.

The two stages appeared to come close to each other as they tumbled, but that could have been an illusion due to the viewing angle of a long-range tracking camera.

The behavior of the first stage appeared normal during powered flight and after separation. A drogue parachute, used to slow and stabilize the rocket before main parachute deployment, could be seen in video from the rocket, but the on-board views cut off before the main chutes could be seen.

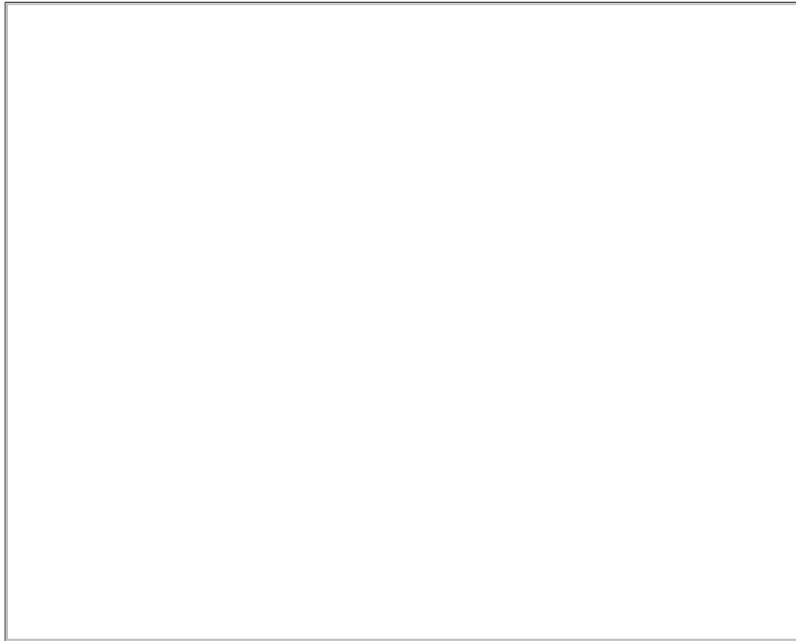
Recovery crews expect to finish towing the big rocket back to a processing facility at the Cape Canaveral Air Force Station early Friday. Engineers will be standing by to remove an on-board data recorder that is expected to provide a wealth of information about

the rocket's performance.

12:10 PM, 10/28/09, Update: Ares I-X launched on spectacular test flight (UPDATED at 4 p.m. with news conference; additional details; parachute deploy)

Running a day late, NASA launched its 33-story Ares I-X rocket on a \$445 million unmanned test flight Wednesday, a spectacular six-minute sub-orbital mission to collect data needed for the design of NASA's proposed shuttle replacement.

"Oh, man! Well, how impressive is that?" Program Manager Jeff Hanley told the launch team after the spent rocket fell back to the Atlantic Ocean. "I hope you appreciate that you've accomplished a great step forward for exploration."



NASA's Ares I-X rocket blasts off on \$445 million test flight.
(Photo: Justin Ray/Spaceflight Now)

Said Launch Director Ed Mango: "Think about what we just did. Our first flight test, and the only thing we're waiting on is weather. That says you all did frickin' fantastic! So thank you very much."

The 327-foot-tall rocket roared to life at 11:30 a.m. EDT and majestically climbed away from launch complex 39B at the Kennedy Space Center atop a torrent of 5,000-degree flame and a cloud of churning exhaust.

Liftoff came three-and-a-half hours behind schedule because of overnight thunderstorms and nearby lightning strikes that required unplanned tests, along with cloudy weather that posed a risk of static charge buildups that could have interfered with communications.

The weather went in and out of limits all morning, but a break in the cloud cover gave Mango the window he needed to come out of a hold at the T-minus four-minute mark and proceed on to launch.

When the countdown hit zero, four massive hold-down bolts exploded, the booster's load of solid propellant ignited and the rocket began climbing away.

An instant after booster ignition, the rocket's nozzle moved slightly to steer the Ares I-X away from the gantry, preventing the hot exhaust from hitting launch pad structures. The maneuver was apparent to the unaided eye and the rocket stayed well away from the gantry.

Using a four-segment space shuttle solid-fuel booster as the first stage and a dummy upper stage simulator, the unusual-looking rocket - the tallest launcher since NASA's huge Saturn 5 moon rocket - cleared the gantry in about six seconds and then soared away to the East.

It was the first launching in NASA's post-Columbia Constellation program, which calls for development of manned and unmanned Ares rockets, Orion crew capsules and landers designed to support Antarctica-style moon bases in the 2020s.

But the Obama administration is re-evaluating NASA's manned space program and whether it makes sense to return to the moon

while assessing a report from an independent panel of experts that concluded NASA did not have enough money to carry out the Constellation program.

The panel suggested it would make more sense to abandon the Ares I rocket in favor of rockets and crew capsules provide by private industry on a commercial basis. Under that approach, NASA could focus on development of the heavy lift rockets needed to carry astronauts a variety of deep space targets.

Given the political uncertainty in Washington, it's unclear if the Ares I rocket that Tuesday's test flight was designed to support will ever actually fly.

But NASA managers and engineers were elated to get the huge test rocket off the ground and the towering booster lived up to expectations, putting on a spectacular show for space center workers, area residents and tourists.

"Vindication really does not describe it well," Hanley said after the flight. "It's a sense of validation that the course that we had laid out is executable. An early demonstration like this puts aside any doubt in our minds, if we had them, as to the flyability of this particular design.

"We have a design that will do the country service, if it is put into service," he said. "The performance of the vehicle was very pleasing, to put it mildly, and I think incredibly satisfying for the Ares project office team at Marshall Space Flight Center (in Huntsville, Ala.) that has put so much into that flight test vehicle."

Added Constellation Program Manager Doug Cooke: "This is a huge step forward for NASA's exploration goals."

"Ares I-X provides NASA with an enormous amount of data that will be used to improve the design and safety of the next generation of American spaceflight vehicles," he said in a statement. "Vehicles that could again take humans beyond low Earth orbit."

Twenty seconds after liftoff, the rocket reached its maximum thrust of 3.16 million pounds of push with an internal pressure of 895 pounds per square inch.

The flight plan called for the rocket's nozzle to move back and forth 0.12 degrees 34 seconds after liftoff in a "programmed test input" to collect data on the stiffness of the vehicle and how it responded to dynamic changes.

The results of the nozzle deflections were too subtle to be visible to the unaided eye and the rocket appeared to stay solidly on course as it accelerated through the sound barrier 39 seconds after liftoff.

Long-range tracking cameras showed the rocket making only slight rolling motions about its long axis as small roll control rockets fired to maintain the proper orientation. Roll control was a question mark early on in the rocket's development, but engineers said it was not a problem in flight.

Another "programmed test input" - moving the nozzle by 0.12 degrees - presumably began at 55 seconds into flight. Five seconds after that, the Ares I-X was expected to experience maximum dynamic pressure of 850 pounds per square foot, subjecting the booster to the greatest stress it would experience in flight.

A 0.35 degree programmed test input was planned for 75 seconds into flight with a final 1-degree side-to-side yaw maneuver scheduled for 93.6 seconds.

The rocket accelerated to a peak velocity of about 4.5 times the speed of sound, reaching an altitude of 25.2 miles. At that point, when the rocket's thrust fell to less than 40,000 pounds of push, an explosive charge fired to separate the first stage from the dummy upper stage.

An instant later, eight upward-firing rockets at the base of the booster ignited to pull the first stage away from the second, a maneuver clearly visible in long-range tracking camera views.

But in a departure from the expected flight program, the dummy second stage went into a flat tumble as it continued along its ballistic trajectory instead of maintaining its nose-forward orientation. The dummy upper stage rose to a maximum altitude of about 150,000 feet before arcing over and plunging back to Earth 150 miles east of the space center.

A few seconds after separation, another set of rockets at the base of the first stage fired, putting the booster in a flat spin to prevent a nose down re-entry that could interfere with parachute deployment.

In a final major test, three 150-foot-wide parachutes were designed to deploy to lower the spent booster casing to the Atlantic Ocean where a NASA recovery ship was standing by to tow it back to Port Canaveral. A camera on the rocket showed a smaller drogue parachute deployed, but video stopped moments later and the main chutes were not seen.

But the recovery ship quickly located the booster and a NASA spokesman said the crew of an aircraft flying over the floating rocket later said all three parachutes were visible in the water. An initial assessment, sources said, indicated normal blistering and a dent of unknown origin in the aft segment.

"We completely met our success criteria, in fact we blew them away," said Mission Manager Bob Ess. "The first one was to roll out (to the launch pad), obviously we did that one. Clear the pad, we did that without a problem. Fly the intended flight path, we certainly did that, we confirmed that. And the last one was to learn from the flight.

"So far, we're on a path to learn a lot. The separation seemed a little different than we predicted as far as how the upper stage reacted after separation. So right there's an opportunity for us to jump in and figure out what was different in the actual flight from our models. So, hugely successful."

It will take engineers several weeks to complete a quick-look analysis of data from more than 700 sensors that measured pressures, stresses, temperatures and other factors throughout the flight. But the initial results indicated no major problems.

"The team is tired, but extremely satisfied as you might imagine with the result," Hanley said. "We were ready when mother nature was ready and we took our opportunity and what a great outcome. It flew straight as an arrow, and we're very proud of the result."

5:25 AM, 10/28/09, Update: NASA gears up for second Ares I-X launch attempt (UPDATED at 5:55 a.m. with additional details)

Faced with another day of marginal weather, engineers are gearing up for a second attempt to launch NASA's Ares I-X rocket today, but work at pad 39B is running 45 minutes to an hour behind schedule because of an overnight thunderstorm with multiple lightning strikes near the pad.

"Ares I-X has been a struggle all along and last night's weather was no different," said Jon Cowart, deputy mission manager. "What happened last night, of course, showers came through along with associated thunderstorms and what we found was within a five mile radius, we had about 154 strikes around the pad. "We can measure the magnitude of all those and the relative distance from where the pad is and looking at all that data, we're very encouraged. There were none closer than point three miles, there were none that attached to the catenary wire system, there's no evidence to suggest we had any attachments to the rocket itself or anywhere to the pad. So from that perspective we're very, very good." But lightning strikes closer than 0.6 miles of the pad require specific retest and engineers are proceeding through an incremental power-up procedure to make sure no critical systems were affected. So far, no problems have been found in the electrical systems and the components they power.

The only other issue of any significance is trouble tightening bolts holding a purge port cover in place on the first stage. Engineers are evaluating if the bolts are tight enough for launch as is.

The four-hour launch window opens at 8 a.m., but Cowart said he expects launch to slip 45 minutes to an hour or so because of the unplanned work and re-test activity. Forecasters, meanwhile, say the weather has not improved as expected, predicting more high-level clouds and rain that could prevent a launch attempt today.

11:55 AM, 10/27/09, Update: Ares I-X launch delayed by weather, errant freighter

Launch of NASA's Ares I-X rocket on a planned \$445 million test flight was delayed 24 hours Tuesday because of bad weather and an errant freighter that briefly strayed into the off-shore danger area.

"For everyone, great job today. You gave it a great shot," Launch Director Ed Mango told the team. "We had some opportunities and just couldn't get there, weather didn't cooperate. But good work today."

Launch was rescheduled for 8 a.m. Wednesday. Forecasters are predicting a 60 percent chance of acceptable weather during a four-hour launch window, with lighter winds and less cloud cover. It is not yet clear whether Thursday is an option if additional problems force another delay Wednesday.

NASA began Tuesday's launch campaign at 1 a.m. with the start of a seven-hour countdown. With forecasters concerned about high clouds, showers and friction-induced static charge buildups, NASA passed up the 8 a.m. opening of the window and the countdown remained in an extended hold at the T-minus four-minute mark in hopes conditions would improve.

In a bit of a surprise given a 60-percent "no-go" forecast, conditions improved and NASA was preparing to come out of the hold and proceed to launch when a freighter strayed into the launch danger zone.

The ship was contacted and immediately began moving out of the area. NASA reset launch for 10:49 a.m., but the delay caused by the freighter held things up long enough for clouds to move in. Two minutes and 37 seconds before liftoff, weather officer Kathy Winters ordered a hold.

The countdown was recycled back to T-minus four minutes and holding in hopes conditions would improve.

Throughout the morning, clouds rolled over the Kennedy Space Center from the west and while occasional breaks were seen on radar, the timing didn't work out for NASA. Around 11:20 a.m., launch managers called off the attempt.

"It looks like we're not going to get there with weather on these opportunities and per our discussions, I guess we're looking for your recommendations and what you would like us to implement from a launch perspective," Test Director Jeff Spaulding said to Mango.

"Your team has done outstanding getting the vehicle ready," Mango said. "Weather (officer) has been outstanding in trying to help us. We're not going to be go today. So we can set up for a scrub."

There are no technical issues with the Ares I-X rocket. But in attempting to launch Tuesday, engineers pulled a sock-like cover from an air data probe at the very tip of the rocket that is designed to measure the atmospheric conditions ahead of the launcher.

Because of the booster's height, and the need to use a shuttle launch pad with a gantry that is much shorter than the rocket, the cover had to be removed by technicians, atop the pad's service gantry, manually pulling a long lanyard. The protective cover hung up at the base of the probe, but the technicians were able to pull it free after a few minutes of energetic tugging.

The cover cannot be re-installed. If rain water gets into the probe between now and launch, it could prevent accurate readings. NASA managers said earlier that was an acceptable condition and that the data, while desirable, was not required for launch.

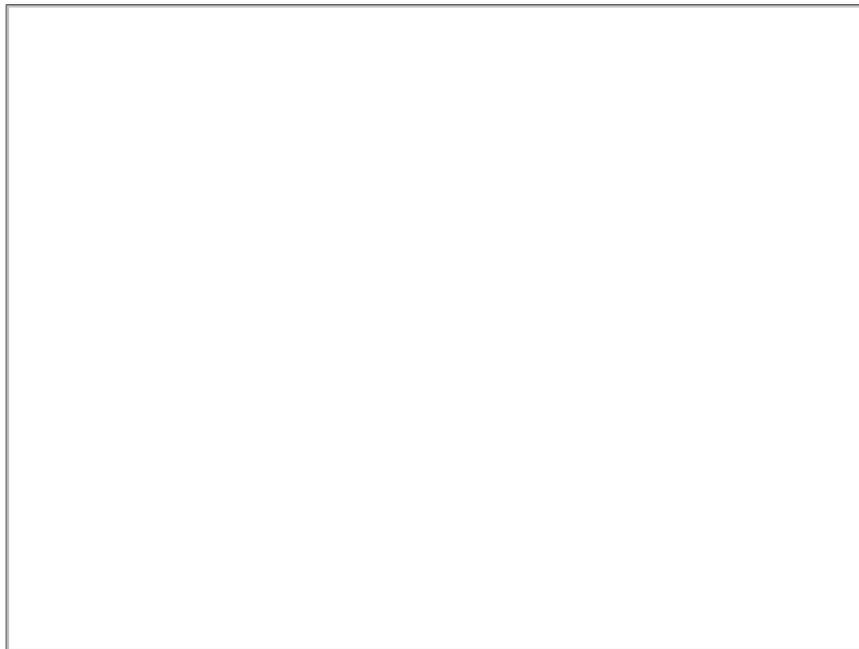
11:05 PM, 10/25/09, Update: Ares I-X poised for launch

Editor's note: *Portions of the following were posted here in an earlier story.*

Engineers are making final preparations for the long-awaited launch of NASA's towering Ares I-X rocket Tuesday, the 33-story centerpiece of a \$445 million test flight expected to generate valuable engineering data for development of a post-shuttle replacement.

By coincidence, the planned launching comes on the heels of a report by a presidential panel of space experts that concluded NASA's current plans to build new Ares rockets and establish bases on the moon by the early 2020s is not feasible without an additional \$3 billion to \$6 billion a year.

While the current program was included among five options presented to the White House, several panel members made it clear they believe it would make more sense to scrap the planned Ares I rocket in favor of commercially developed boosters and capsules that could carry U.S. astronauts to and from the International Space Station.



**The Ares I-X rocket, poised for launch atop pad 39B.
(Photo: Bill Ingalls/NASA)**

NASA then could concentrate on developing a heavy-lift rocket in support of a so-called "flexible path" architecture that would forego near-term moon landings in favor of manned missions to orbit or fly by the moon or even Mars with possible landings on

martian moons or asteroids. The long-term goal - landings on Mars - would be developed in parallel in a more incremental fashion.

That approach, too, would require additional funding and while many observers believe the Ares I will be abandoned, the Obama administration has not yet announced what changes might be ordered.

"My crystal ball is that Obama will, at least for fiscal 2011, add a billion or so to the NASA budget - the key will be the out-year budget - and endorse something like the flexible path," said John Logsdon, a space policy analyst at George Washington University and a member of the Columbia Accident Investigation Board.

"There's no doubt that we're going to extend station (beyond 2015) and I think there is little doubt that we're going to depend on what people are calling commercial providers to be the transport system for crew to station as soon as they're ready," he said.

But Leroy Chiao, a former astronaut and member of the U.S. Human Spaceflight Plans Committee chartered by the Obama administration, said in an interview that "it's important to emphasize that we were presenting options, not recommendations."

"Despite what's been going on in the blogosphere, the panel didn't come up and saying (NASA) should cancel Ares I, which a lot of people think we actually did," Chiao said. "As far as the flight test ... there are definitely things to be learned. And I think no matter what, it's certainly worthwhile going forward with the test because frankly, it would probably have cost just as much money to stand down."

In the end, he said, "it's really up to the decision makers as to which path to go down. So Ares I is not dead by a long shot."

As currently envisioned, the operational Ares I rocket will be made up of a five-segment solid-fuel shuttle booster and a new second stage powered by a hydrogen-fueled Apollo-era J-2X engine. An Apollo-like Orion capsule will sit atop the second stage, equipped with a solid-fuel abort rocket designed to pull a crew to safety at any point during the climb to space.

The slender rocket, its second stage wider than the first, stands twice as tall as a space shuttle "stack." But its pencil-thin appearance quickly led to a somewhat derisive nickname: the "stick."

For the first test flight - Ares I-X - NASA is using a standard four-segment shuttle booster with an empty fifth segment, housing guidance and navigation equipment adapted from Lockheed Martin's Atlas 5 rocket, and new 150-foot-diameter parachutes to lower the spent rocket to the ocean for recovery.

A dummy second stage loaded with ballast and topped off with a make-believe Orion capsule and abort rocket are bolted to the top of the first stage.

More than 700 sensors are mounted on the Ares I-X to record an enormous amount of engineering data on all phases of flight, from launch through motor burn out two minutes later, through stage separation, parachute deployment and ocean impact. Multiple video cameras are mounted on the rocket to provide realtime views of critical elements.

Engineers say the short flight will help them resolve questions about first stage vibration, roll control, aerodynamic forces and thermal effects, as well as stage separation systems and recovery of the first stage using new 150-foot-wide parachutes.

"One test is worth a thousand expert opinions," said Jon Cowart, Ares I-X deputy mission manager at the Kennedy Space Center. "It's brand new, it's a long, thin rocket. We want to make sure we can guide this thing. Balance a broomstick on the end of your finger, you'll get some idea of what we're dealing with here."

Said former NASA Administrator Mike Griffin, the man who approved the Ares architecture: "This is a vehicle that, when you look at it, is long and slender. That has caused, quite rightly, of course, at the top level, a lot of concern that it will be difficult to control."

"People think of launch vehicles as solid objects and they aren't, really," he said in an interview. "What you're really doing is pushing a pasta noodle up a hill. So you're pushing a pasta noodle up hill and you have to do it carefully. That's really what I'm talking about. I'm not talking about the ability of the nozzle to effect the proper control authority, that's a slam dunk. The issue is the reaction of the vehicle in a stability and control sense."

While engineers are confident the slender rocket will, in fact, clear the launch pad service gantry and follow its programmed trajectory, "we're not going to guarantee this is going to work," said Bob Ess, the mission manager.

"This is a flight test and for the first time, we're testing many systems in the same vehicle simultaneously," he said. "We have very high confidence it's going to work, but there are some areas we're testing for the first time. That's why we're doing the test."

Added Launch Director Ed Mango: "We wouldn't go if we didn't think the vehicle is going to fly right."

A seven-hour countdown is scheduled to begin at 1 a.m. EDT Tuesday, targeting the opening of a four-hour launch window at 8

a.m.

Forecasters, however, are predicting a 60 percent chance of clouds and rain that could prevent good visibility, needed for precise optical tracking, and cause static charges to build up around the rocket, interfering with communications, including the self-destruct system if needed.

The static charge phenomenon, known as triboelectrification, is a factor for the Ares I-X launch because the rocket's coatings have not been subjected to the required analysis needed to prove the charging phenomenon is not an issue.

If the weather prevents a launch Tuesday, engineers will recycle for another attempt at 8 a.m. Wednesday, when forecasters expect a 60 percent chance of acceptable weather. NASA does not yet have a third launch date booked with the Air Force Eastern Range, which provides telemetry and tracking support for all rockets launched from Florida. Assuming Thursday is available, forecasters are predicting a 70 percent chance of good weather.

"Our weather on Tuesday is going to be a little bit of a problem," said NASA weather officer Kathy Winters. "We are expecting a weather system that is coming into the western Gulf to pull a trough up north from the Caribbean up into the Gulf of Mexico. Now, the models differ on where this trough will be located as we get to launch day. ... But as that does come through the area, we do have a threat for having more clouds in the area and precipitation in the area."

If the Ares I-X fails to get off this week, the rocket will remain at pad 39B until another window opens in late November, after already-booked launches of commercial and military communications satellites and a flight by the shuttle Atlantis.

Whenever it flies, the Ares I-X should put on quite a show as the thin rocket climbs away atop a plume of fiery exhaust. Engineers are confident the rocket will fly, but no one knows exactly what to expect.

"Are we confident? Sure," Ess said. "Would I bet my house? No. We do this for a reason. This is all about verifying these models. Everything shows good, all the loads show good, all the dynamics and the controls all show good. But it's the first time we've done it and we've done a unique mix of shuttle heritage hardware, the Atlas program hardware, the Peacekeeper program, put it together in a very unique way, flying the Ares 1 flight control algorithms on board. It's quite a hybrid.

"So while we have good confidence, there's no guarantee and there are several things that could go wrong. In this high Q (aerodynamic pressure) region with a long vehicle, if we get more bending than we thought we would then it could affect our thrust vector control and how it affects the flight. It could make things worse instead of better. Or our aerodynamics could be off enough that we get some strange dynamics. All of those are part of the test. It'll be a good day, but it'll be an interesting day no matter what."

Ares I-X is the first major flight test in NASA's embattled Constellation program, born in the wake of the 2003 Columbia disaster and a Bush administration decision to complete the International Space Station and retire the shuttle by the end of 2010. The long-range was to develop new rockets to replace the shuttle and to use them to establish lunar research stations by the early 2020s.

The Constellation program is a radical departure from the world of shuttle operations. Instead of one rocket designed to carry astronauts and heavy payloads, two rockets were envisioned: the manned Ares I, designed to boost Apollo-like Orion crew capsules to low-Earth orbit; and the unmanned Ares V, a huge heavy lift rocket built to carry a four-person lunar lander into space.

For a moon shot, an Ares V would be launched from one pad at the Kennedy Space Center, followed 90 minutes later by launch of the crew in an Orion capsule atop an Ares I.

After linking up in low-Earth orbit, the Ares V upper stage would propel the Altair lunar lander and astronauts in the attached Orion capsule to the moon. The astronauts would descend to the lunar surface in the lander and, when their mission is complete, blast off, rendezvous with the orbiting Orion capsule and return to Earth for a parachute descent reminiscent of the Apollo program.

But Bush administration did not give NASA much in the way of additional funding to pay for initial Constellation development. Quite the contrary, according to Griffin, a Bush appointee.

"After a small increase this year, Exploration Systems at NASA goes down by \$3.5 billion over the next four years," he said in an April speech. "When combined with earlier reductions of almost \$12 billion during the Bush administration, well over \$15 billion has been extracted from the Exploration Systems budget in the five short years since the new space policy was announced."

It is that funding shortfall, not major technical problems, that led the manned spaceflight review panel to conclude that NASA would be unable to implement the Constellation program as currently planned, along with extending the International Space Station program beyond 2015, without a significant increase in funding.

Moon missions aside, NASA will not be ready to begin initial operations with Ares I until 2015 even if the Obama administration

sticks with the Constellation program. The Augustine panel said it would be more like 2017, too late to provide more than token service to the International Space Station.

During the now-unavoidable gap between the end of shuttle operations and the debut of whatever replaces it, NASA will be forced to buy seats on Russian Soyuz spacecraft, at \$50 million a ticket, to ferry U.S. and international astronauts to and from the space station.

Given the uncertain political backdrop, the Ares I-X rocket could be viewed as a major step on the road to Ares I, the Constellation program and eventual missions to the moon. Or it could be seen as a dead end, depending on how one assesses the political environment.

Either way, NASA managers steadfastly claim the mission will help engineers validate the models that will be used to refine the design of any post-shuttle launcher regardless of the fate of the Ares I.

"We're going to measure the external pressures all over the vehicle, accelerations all over the vehicle, temperatures all over the vehicle, over 700 different sensors across the vehicle," Ess said. "It's unprecedented to get that much information from one flight.

"Inside, we have sensors as well to measure strains, basically how the vehicle's structure bends and twists during flight. All of this is tied to different math models and computer models we have for designing rockets such as Ares I. From that, we'll be able to know if we're getting closer to our actual goals for the design."

Logsdon doesn't buy that argument.

"It's a rationalization," he said of NASA's Ares I-X justification. "But we've already paid for it."

Ares I-X stands 327.2 feet tall and weighs 1.8 million pounds. It is held to a mobile launch platform at pad 39B by four massive explosive bolts at the base of the rocket. To keep the tall rocket from swaying in high winds, a one-use \$13 million stabilization system was built on the side of the pad's gantry that will be released about 90 minutes before launch.

At ignition, the hold-down bolts will explode followed an instant later by ignition of the rocket's propellant. In a quarter of a second, the booster's thrust will exceed the weight of the rocket and Ares I-X will begin climbing away. Two tenths of a second later, the pressure inside the burning core of the rocket will reach its maximum level of 930 pounds per square inch.

To protect the launch gantry from the damaging plume of 5,000-degree rocket exhaust, the Ares I-X flight system is programmed to tilt the booster's nozzle slightly, causing the rocket to "walk off" the pad slightly, away from the gantry.

The walk-off maneuver will address one area of concern earlier in the program about the possible effects of worst-case winds from the south, which might push the rocket toward the gantry as it climbs away. Decades of weather records indicate worst-case conditions would only be expected about 0.3 percent of the time and in any case, engineers say the rocket's guidance system can easily steer the vehicle away from any close encounters with its gantry.

For the test flight, winds must be less than 20 knots from any direction and Winters said she does not expect any violations.

Climbing rapidly, the rocket will rise above the launch pad gantry in a scant six seconds. Twenty seconds after liftoff, the rocket will reach its maximum thrust of 3.16 million pounds of push with an internal pressure of 895 pounds per square inch.

Thirty-four seconds after launch, the rocket's nozzle will be moved back and forth 0.12 degrees for 10 seconds to collect data on the stiffness of the vehicle and how it responds to dynamic changes.

"Thirty nine seconds after T-0 it goes supersonic," Cowart said. "You'll see it arcing off to the east. You see the shuttle on a lot of their flights, they go up and then head for the northeast because they're going towards the International Space Station. We're just a simple flight test, we're going to go east, get out there (over) the ocean."

Another "programmed test input" - moving the nozzle by 0.12 degrees - will begin at 55 seconds into flight. Five seconds after that, the Ares I-X will experience maximum dynamic pressure of 850 pounds per square foot, subjecting the booster to the greatest stress it will experience in flight.

A 0.35 degree programmed test input is planned for 75 seconds into flight with a final 1-degree side-to-side yaw maneuver scheduled for 93.6 seconds.

The rocket will accelerate to a peak velocity of about 4.5 times the speed of sound, reaching an altitude of 130,000 feet. When the rocket's thrust falls to less than 40,000 pounds of push, an explosive charge and eight upward-firing rockets at the base of the booster will pull the first stage away from the second. The dummy second stage will continue along a ballistic trajectory, rising to a maximum altitude of about 150,000 feet before it begins arcing over and plunging back to Earth.

A few seconds after separation, another set of rockets at the base of the first stage will fire, putting the booster in a flat spin to prevent a nose down re-entry that could interfere with parachute deployment. Assuming new 150-foot-wide parachutes release and inflate as planned, the spent booster will make a jarring splashdown about 130 miles from the space center.

"We have a separation that occurs just beneath the frustum and then the deceleration motors will fire, which will slow the first stage down a little bit and then we'll fire some tumble motors to get it spinning," Cowart said.

"We need that to happen so the parachutes will properly deploy. If we don't get it spinning enough, there's always a chance they might get fouled on the rocket. Because we've got these tumble motors, we've got a very high degree of confidence that the parachutes are going to deploy properly. The upper stage continues on like a giant lawn dart and it's going to hit the water about 140 miles out going a pretty good clip."

The spent booster will be towed back to Cape Canaveral for detailed inspections, but there are no plans to recover the dummy upper stage.

"Any human being around here knows you learn a lot more from things that don't go right than you do from things that do," Cowart said. "There are a whole category to things, obviously, which could not go the way we think they will. But that is why we design in and work around and make sure those things, to the best of our ability, that those things won't happen."

Said Ess: "The only failure on this flight is the failure for us to learn from it."

"No matter what happens, we will learn a lot from it, he said. "We expect it to go well, we've done all the analysis to say it will go well, but that's why we're doing it. That's why it's a development flight test. There's no people on board, this is not a prototype, this is an opportunity to learn some pretty unique things."

Among the areas of special interest are a phenomenon known as thrust oscillation, roll control, stage separation and the performance of the new parachutes, designed to help slow and stabilize the larger five-segment booster when it falls back to Earth from a higher altitude.

For roll control, Ares I-X is equipped with thrusters on each side of the rocket near the base of second stage. To keep costs down, the system was borrowed from the Peacekeeper ICBM program.

"There's a flow circulation as the flow comes out through the nozzle," said Charles Precourt, a former shuttle commander who now runs the shuttle/Ares solid-fuel booster program for builder ATK. "I'm going to use a real crude analogy, but when water goes down the drain you know how it circulates? Well, in a similar fashion, you get a torque force generated by the flow coming out the motor. We understand what it is, we've measured it and we've sized that for this roll control system on I-X."

Like the space shuttle, Ares I-X will execute a deliberate "roll program" to put it in the proper orientation as it arcs to the East and climbs toward space, a maneuver needed to keep antennas properly oriented with respect to ground stations.

Another question mark is thrust oscillation and vibration, the result of vortices forming inside the booster as part of the complex supersonic exhaust flow. Engineers are designing spring-like dampers to "de-tune" the first stage booster and the upper stage/Orion components to minimize amplification effects that might otherwise occur toward the end of the first stage burn.

No such dampers will be in place on the Ares I-X rocket. Instead, sensors will characterize the thrust oscillation present in a four-segment motor to help engineers properly model the sort of acoustic environment present in a five-segment booster.

Constellation Program Manager Jeff Hanley said recent shuttle boosters, and a five-segment booster test fired in Utah for the Ares project, showed lower thrust oscillation than initially expected.

"I don't consider it to be a top risk of the program any more," he said.

Asked to name the top issues, or uncertainties, he hopes to learn more about with Ares I-X, Hanley said liftoff acoustics and the rocket's passage through the region of maximum aerodynamic pressure, or "max Q."

"As this thing lifts off the pad, when it gets to be 80 feet or so off the pad, you have a lot of reflected noise off the ground and off the launch pad, back up at the rocket," he said in an interview. "And those sound levels get to be, according to our models, very high. So the sound hits where the instrumentation is, the service module is a particularly vulnerable place for us. So part of what we're trying to understand is that reflection, the sound levels, and how can we attenuate it?"

Computer modeling indicates flooding the launch platform with water just before liftoff can attenuate some of that sound, "but we're unsure exactly how effective it will be. We got some data from shuttle, a lot of the data we have in terms of noise levels comes from Saturn."

"The other thing we're trying to understand is the transmission," he said. "Once the sound waves, for example, hit the command module, how is that energy transmitted through the structure down to the components? And it's the components we have to write specs for so we can go buy the components and make sure when they're delivered they can take a certain environment."

Sound also is an issue during the rocket's passage through the region of maximum aerodynamic pressure.

"The protuberances, the things that stick out on the rocket, there's wind noise that goes past those," Hanley said. "That wind noise is transmitted through the structure to the components. So that's another noise generation phenomena we have to be able to deal with in our modeling and our test program. That whole subject of vibro-acoustics is probably our biggest technical issue right now that we're working."

Even so, Hanley said he didn't view the issue as a show stopper.

"By the time we're done with this thing," he said, "it's going to be one of the best characterized rockets ever flown."

6:30 PM, 10/23/09, Update: Ares I-X rocket cleared for flight

NASA's Ares I-X rocket, a test version of the embattled booster NASA is designing to replace the space shuttle, was cleared Friday for an unmanned \$445 million test flight Tuesday, weather permitting. The primary goals of the brief sub-orbital flight are to find out how the slender 32-story rocket responds to the rigors of launch, the initial climb out of the dense lower atmosphere and the booster's fall back into the Atlantic Ocean under huge new parachutes.

Liftoff from pad 39B at the Kennedy Space Center is targeted for 8 a.m. EDT Tuesday, the opening of a four-hour launch window. A backup launch window is available Wednesday if necessary, and possibly Thursday.

Senior NASA managers held a flight readiness review Friday and cleared the towering rocket for flight. While there are no technical problems at the pad, forecasters are predicting a 60 percent chance of clouds, rain and high winds that could cause a delay Tuesday, improving somewhat to 60 percent "go" on Wednesday.

"The team is ready to go fly," said Launch Director Ed Mango. "We're in very good shape in terms of the hardware and in paper. Right now, we're not working anything outside of what's in front of us. And so, as we work through the next few days, we will get all that work done and get ready to go fly on Tuesday."

As for the weather, Mango said "we're five days out and a lot can change in those five days, and that's what we're looking forward to."

"We need a pretty clear sky, really," Mango said. "Right now, our requirements for winds are 20 knots from any direction at liftoff. The reason for that, we're trying to validate some of the (computer) models and the models have been anchored in some wind tunnel data and some analysis that says 20 knots will give us margin to make sure we don't get in trouble when we first lift off. So we have to put all those together. Now, how long do we need to have a hole in the sky, if you want to put it that way? Probably about 10 minutes."

The 1.8-million-pound Ares I-X is made up of an extended four-segment space shuttle booster, a dummy upper stage and a mock Orion crew capsule. It is rigged with more than 700 sensors to record the mechanical and aerodynamic stresses and strains the thin rocket will experience as it accelerates to 4.5 times the speed of sound during two minutes of powered flight.

The rocket will reach an altitude of about 25 miles when the booster exhausts its fuel. Small rocket motors will help pull the spent booster from the dummy upper stage for a parachute descent to the Atlantic Ocean. The upper stage simulator and the mock crew capsule will continue along a ballistic trajectory, crashing into the sea about 150 miles due east of the space center.

"We're going to measure the external pressures all over the vehicle, accelerations all over the vehicle, temperatures all over the vehicle, over 700 different sensors across the vehicle," said Mission Manager Bob Ess. "It's unprecedented to get that much information from one flight. Inside, we have sensors as well to measure strains, basically how the vehicle's structure bends and twists during flight. All of this is tied to different math models and computer models we have for designing rockets such as Ares I. From that, we'll be able to know if we're getting closer to our actual goals for the design."

NASA's post-Columbia Constellation program calls for finishing the International Space Station and retiring the shuttle by the end of 2010. The agency hopes to replace the shuttle with the Ares I rocket, using it to launch astronauts to low-Earth orbit in Apollo-like Orion capsules. The long-range plan calls for developing huge Ares V rockets to propel Orion capsules and lunar landers to the moon.

But a presidential panel charged with assessing manned space flight options concluded in September that NASA doesn't have the funding necessary to pursue Constellation architecture as it now stands. The panel presented five options to the White House this

week, saying NASA would need an additional \$3 billion a year starting in 2014 to make the Ares/lunar architecture viable.

The panel suggested turning to private industry to launch astronauts to low-Earth orbit and a so-called "flexible path" option that would forego lunar landings in the near term in favor of orbital flights or flybys of the moon and Mars while longer-range landing options are developed.

Depending on the architecture ultimately endorsed by the Obama administration, the Ares I-X could end up being a one-shot test flight. Or the shape of things to come.

04:50 PM, 10/22/09, Update: Augustine panel submits final report to president

Amid work to ready NASA's Ares I-X rocket for a long-awaited test flight next week, a presidential panel charged with reviewing the nation's manned space program submitted its completed report Thursday, concluding NASA's planned shuttle replacement will cost too much and take too long to build to be a viable option.

Even so, panel members said they looked forward to the \$445 million test flight Tuesday and the data it will generate to help validate computer models and processes that will be useful in any future rocket design efforts.

"We do think it's appropriate to fly the Ares I-X," said Norman Augustine, former CEO of Lockheed Martin and chairman of the U.S. Human Spaceflight Plans Committee. "We think there are important things to be learned that will help the program."

The panel's completed report contained no major surprises - an executive summary was released in late September that included the same five basic options for future manned space activity - but the coincidental timing of the report and next week's test flight highlighted the uncertain future of NASA's plans to replace the space shuttle and return to the moon.

"The premier conclusion of the committee is the human spaceflight program the United States is currently pursuing is one that's on an unsustainable trajectory," said Augustine. "We say that because of a mismatch between the scope of the program and the funds to support the program. That's of great concern to us because human spaceflight, where safety accounts for everything, is a very unforgiving sort of pursuit."

In the wake of the 2003 Columbia disaster, the Bush administration ordered NASA to finish the International Space Station and retire the shuttle by the end of 2010 and to develop new rockets and spacecraft to return astronauts to the moon by the early 2020s.

The plan NASA developed - the Constellation program - calls for a new rocket known as the Ares I, and a Apollo-like crew capsule called Orion, to ferry astronauts to and from low-Earth orbit. A large, unmanned heavy lift rocket known as the Ares V then would be built to launch Orion capsules and lunar landers to the moon.

President Obama expressed general support for the Constellation program during the presidential campaign, but earlier this year he ordered an independent review of NASA's manned space program in the context of the current budget environment. At the same time, the Office of Management and Budget cut some \$3 billion from NASA's projected "out-years" budget, money earmarked for development of the Ares V.

Against that uncertain backdrop, NASA pressed ahead with development of the Orion capsule and the Ares I booster envisioned as a replacement for the space shuttle. The new rocket features an extended shuttle solid-fuel booster, a hydrogen-fueled upper stage and an escape rocket that could pull the crew capsule to safety in an emergency.

NASA plans to launch a test version of the rocket Tuesday on a sub-orbital flight to verify computer models being developed to help design the Ares I. For the test flight, a standard four-segment shuttle booster is being used, along with a dummy upper stage and an Orion capsule simulator that duplicate the mass and shape of the Ares I rocket.

"We've reviewed the Ares I and Orion elements of that program, which are the two parts that are principally underway," Augustine said Thursday. "We found those programs to be reasonably well managed, we found them to have technical problems of a nature that's probably not uncommon for complex undertakings of this type."

"It's our belief that given ample time and funds, the engineers at NASA and their contractors are certainly capable of solving those problems. So we think the program within itself has a very good likelihood of succeeding. The issue that comes up under Ares I is whether the program is useful when it has succeeded because of a mismatch of the time schedules and the costs with what will be needed for it to do."

While that observation suggests Augustine and the panel do not support continued development of Ares I, panel member Leroy Chiao, a former astronaut, said "it's important to emphasize that we were presenting options, not recommendations."

"Despite what's been going on in the blogosphere, the panel didn't come up and saying (NASA) should cancel Ares I, which a lot of people think we actually did," he said in a telephone interview. "It's really up to the decision makers as to which path to go down."

So Ares I is not dead by a long shot."

NASA believes the Ares I could be ready to fly by 2015. The Augustine panel concluded it would take until at least 2017 to complete the work, coming on line too late to provide more than token support to the International Space Station. In the meantime, NASA will be forced to buy seats on Russian Soyuz rockets, at \$50 million per ticket, to get U.S. astronauts to and from the lab complex.

The Augustine report also concluded that NASA will be unable to extend human exploration beyond low-Earth orbit without additional funding, suggesting an additional \$3 billion per year, plus a hedge against inflation, to fund a realistic space exploration program.

The panel did not make recommendations, but members seem to favor a commercially developed launch system to get astronauts to low-Earth orbit and a government-developed heavy lift rocket to extend human exploration to the moon and beyond.

The so-called "flexible path" option presented by the Augustine panel would allow NASA to launch orbital moon missions and even flights around Mars or to its moons by the early to mid 2020s, while long-term development of landers and associated hardware is developed in parallel.

"The current plan focuses on going to the moon (with) the longer term goal of going to Mars," Augustine said. "There are a lot of things one could do along the way that are very interesting, that let you build up gradually to the immense undertaking of the Mars program.

"The sort of thing we're thinking of, one could fly circumlunar missions, you could circumnavigate Mars, you could land on an asteroid, a near-Earth object, you could land on Phobos or Deimos, the martian moons, and do some very exciting science from there. It seems to us that is a more sensible program than to wait 15 years or so for the first major event."

Panel member Edward Crawley of the Massachusetts Institute of Technology said the panel did not oppose the Constellation architecture per se or believe NASA faced any insurmountable technical hurdles. But given the current budget environment, he said, Ares I was not the most cost-effective option for transportation to low-Earth orbit.

"We do not think there are any technical problems with the Ares I that NASA cannot overcome with time and budget," he said. "So we actually expect the Ares I-X flight to go off and be successful. That's really not the central question. The central question is not whether can NASA build the Ares I? Really, the question is, should NASA build the Ares I?"

At the time the Constellation architecture was initially developed, "it was a sound decision, it was a clever architecture combining the Ares I and the Ares V," Crawley said. "And under the cost assumptions and the correct perspective that crew safety in from launch to orbit was the premier criteria for design, it was a wise choice at the time.

"But times have changed," he said. "The budgetary environment has become much more tight and the understanding of the costs and schedule to develop the Ares I has matured. Under the best of circumstances, the Ares I and Orion would be available in 2017 ... the last few years of the ISS. It's a very capable vehicle, arguably too capable for use as a crew taxi to low-Earth orbit. Really, the question as framed by the committee is are there alternatives that would deliver a capability earlier and at lower cost but with the same criteria for safety?"

The Augustine committee concluded "the most likely alternative that would work would be to form a partnership between NASA and the commercial industry."

"This has the potential for producing a safe vehicle," he said. "It has the potential for significant cost savings."

A White House spokesman thanked the panel for its report, saying "the president has on numerous occasions confirmed his commitment to human space exploration, and the goal of ensuring that the nation is on a vigorous and sustainable path to achieving our boldest aspirations in space." "Against a backdrop of serious challenges with the existing program, the Augustine committee has offered several key findings and a range of options for how the nation might improve its future human space flight activities," he said. "We will be reviewing the committee's analysis, and then ultimately the president will be making the final decisions."

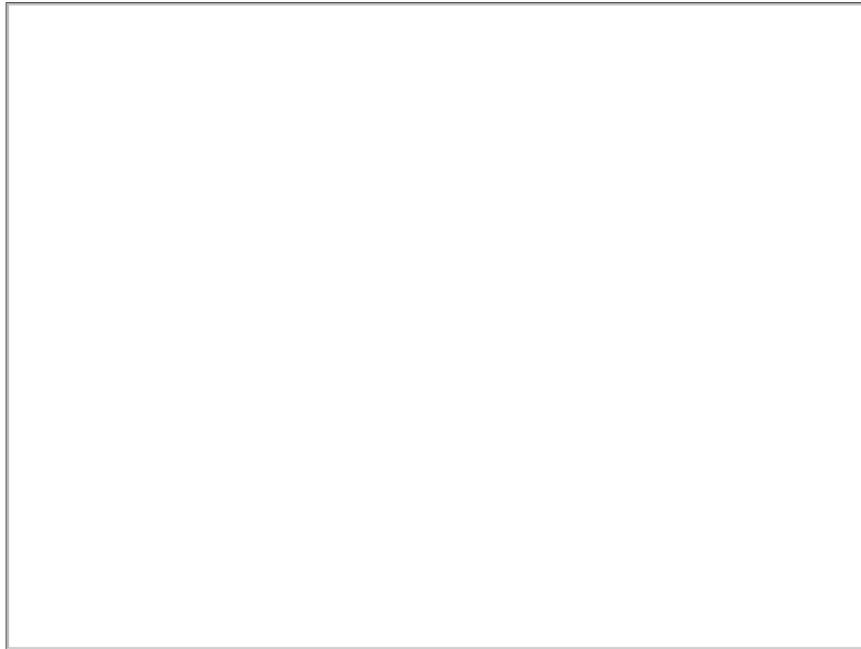
John Logsdon, a space analyst at George Washington University, said "my crystal ball is that Obama will, at least for fiscal 2011, add a billion or so to the NASA budget - the key will be the out-year budget - and endorse something like the flexible path."

"There's no doubt that we're going to extend station (operations beyond 2015)," he said, "and I think there is little doubt that we're going to depend on what people are calling commercial providers to be the transport system for crew to station as soon as they're ready."

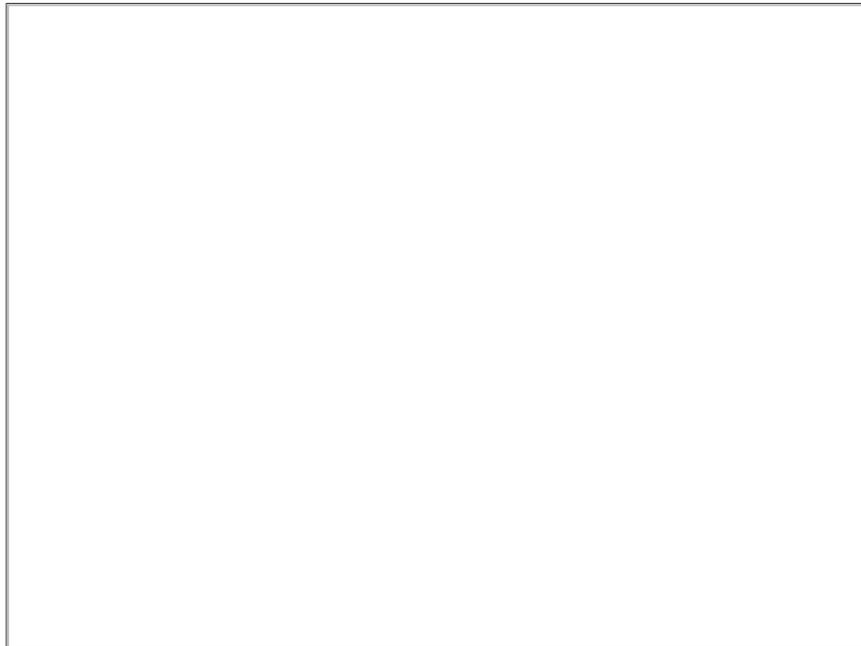
10:45 AM, 10/20/09, Update: Ares I-X rocket hauled to launch pad for critical test flight

NASA's towering Ares I-X rocket was hauled to the launch pad early Tuesday for blastoff next week on a \$445 million unmanned test flight, a major milestone in the space agency's drive to replace the shuttle with a safer, lower-cost booster.

The slow trip to pad 39B began at 1:39 a.m. EDT Tuesday when a powerful crawler-transporter carrying the Ares I-X rocket and its mobile launch platform slowly pulled out of the Vehicle Assembly Building at the Kennedy Space Center. Powerful spotlights illuminated the vehicle as it emerged from the VAB, providing a spectacular view of the slender white rocket against the dark of a cloudy night.



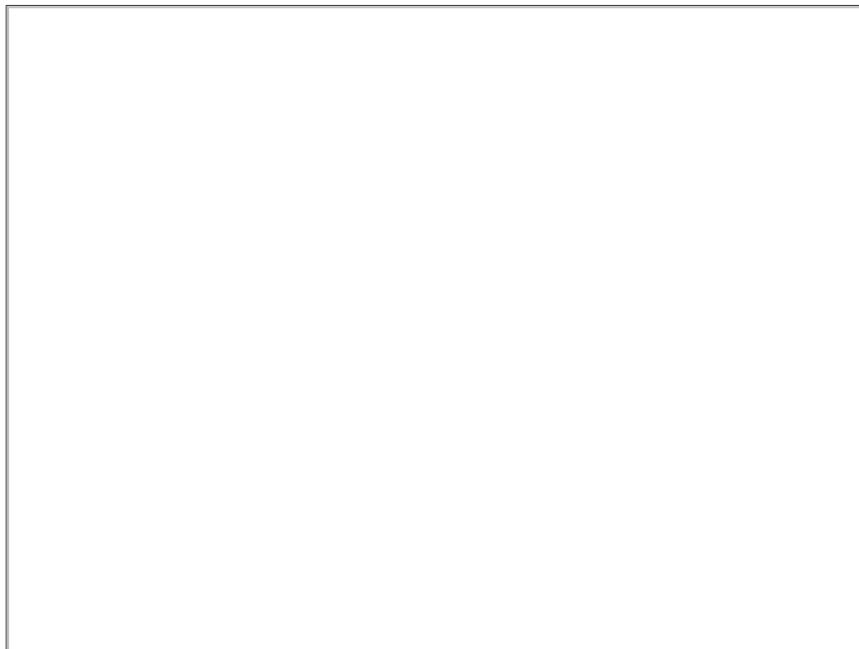
**The Ares I-X rocket emerges from the Vehicle Assembly Building.
(Photo: William Harwood)**



**The Ares I-X rocket beginning its trip to launch pad 39B.
(Photo: Justin Ray/Spaceflightnow.com)**

The tip of the 327-foot-tall rocket, anchored to the mobile launch platform by four massive bolts at the base of the booster's flared aft skirt, was expected to sway back and forth up to a foot during rollout, depending on the wind and other factors. But data from sensors measuring stresses on the four hold-down posts indicated the rocket was stiffer than computer models suggested and the booster was mounted atop pad 39B without incident by 9:17 a.m.

"This is great, this is huge," said Bob Ess, the Ares I-X mission manager. "This is a milestone that's been in our planning for years, rollout to the pad. It's hard to believe it's here. We've been doing this for three-and-a-half, four years and there it is, all done. It's ready to fly."



**The Ares I-X rocket nearing the top of pad 39B.
(Photo: William Harwood)**

Launch on a brief sub-orbital test flight is targeted for 8 a.m. on Oct. 27. Backup opportunities are available Oct. 28 and 29 if needed. See the 4 p.m. 10/19 update below for an overview of the Ares I-X mission.

04:00 PM, 10/19/09, Update: NASA set for Ares 1-X rollout; 10/27 launch now top priority; November shuttle flight no earlier than 11/16

Engineers at the Kennedy Space Center are gearing up to haul the towering Ares I-X rocket to launch pad 39B early Tuesday for an unmanned \$445 million test flight Oct. 27 that likely will play a major role in the ongoing debate about NASA's post-shuttle manned space program.

NASA managers met early Monday and agreed the Ares I-X flight was now NASA's top near-term priority. Because many engineers supporting the Ares test also are needed for shuttle processing, work to ready Atlantis for launch on the next space station assembly and resupply mission will be stretched out a bit. NASA had been targeting Nov. 12 for launch, but managers today agreed on Nov. 16 as a more realistic "no-earlier-than" launch date, officials said.

But as of this writing, NASA does not have a slot on the U.S. Air Force Eastern Range launch schedule. A United Launch Alliance Atlas 5 rocket carrying an Intelsat communications satellite has the range booked for launch tries Nov. 14-15 and a Delta 4 carrying a military communications satellite is scheduled for launch Nov. 18.

Because of time needed to reconfigure range tracking and telemetry systems to support a different launch operation, the Delta would have to slip for NASA to have a shot at launching Atlantis on Nov. 16 at 2:28 p.m. EST.

Even if the Delta is delayed, NASA will have a relatively short launch window. Because of temperature constraints related to the space station's orbit, Atlantis must take off by Nov. 19 at the latest or the flight will be delayed to Dec. 6. The December launch window closes after Dec. 11 because of a conflict with the planned launch and docking of a Russian Soyuz spacecraft carrying three station crew members.

Hoping for the best, Atlantis' six crew members flew to the Kennedy Space Center on Monday to review emergency procedures at pad 39A. A dress-rehearsal countdown, originally planned for Wednesday, has been delayed to Nov. 3 because of the decision to prioritize the Ares I-X launch and the resulting slip of the shuttle's no-earlier-than launch date from Nov. 12 to Nov. 16.

At the Vehicle Assembly Building, NASA and contractor engineers spent the day Monday retracting access platforms and readying the Ares I-X rocket for the planned move to launch complex 39B. First motion is targeted for 12:01 a.m. Tuesday.

The towering rocket, anchored to a modified shuttle launch platform by four massive bolts at the base of the booster's flared aft

skirt, stands more than twice as tall as an assembled space shuttle and it is expected to sway slightly as NASA's crawler-transporter carries the "stack" to the launch pad. Officials say the tip of the rocket is expected to move back and forth about a foot depending on the wind and other factors.

While the rocket was engineered to withstand winds of up to 45 knots, the Ares I-X rollout constraint is 20 knots and forecasters are predicting a 90 percent chance of acceptable weather. Once at the pad, a new \$13 million shock absorber system utilizing locomotive springs will be hooked up to hold the rocket steady until just before launch.

Liftoff is targeted for 8 a.m. on Oct. 27. Backup opportunities are available Oct. 28 and 29 if needed.

The Ares I rocket is a key element in NASA's post-shuttle Constellation program, which calls for replacing the shuttle with a safer, lower-cost rocket to ferry astronauts to low-Earth orbit and development of a large, unmanned heavy lift rocket - the Ares V - that would support eventual expeditions to the moon.

The Obama administration currently is reassessing NASA's manned space program and evaluating five options developed by an independent panel of space experts led by former Lockheed Martin CEO Norman Augustine. Only one of the five options includes the Ares I. But in recent hearings, lawmakers expressed reluctance to scrap the Constellation architecture and it's not yet clear what action the Obama administration might take, or when a decision will be made.

Given that backdrop in the policy arena, the planned test flight of the Ares I-X could prove critical to the future of the Constellation program. While a success would not guarantee a continuation of Constellation, a failure could prove fatal.

"You can't avoid that," former NASA Administrator Mike Griffin, who oversaw the implementation of the Constellation program, said in an interview. "Now, I'll say right on the heels of that remark I think that's regrettable. You don't hinge decision making on one test flight. I mean, that's not good engineering. But I think it's unavoidable that policy makers will look to the success or failure of this flight as a key to future decisions."

The 1.8-million-pound 327-foot-tall Ares I-X rocket is made up of a four-segment shuttle solid-fuel booster, a dummy fifth segment, a dummy second stage and a mockup of an Orion crew capsule and escape rocket. More than 700 sensors are mounted on the rocket to determine actual performance and the stresses the vehicle experiences, along with three television cameras.

Like any shuttle booster, the Ares I-X will fire for two minutes, boosting the vehicle to an altitude of about 130,000 feet and a velocity of nearly five times the speed of sound. At that point, roughly 43 miles due east of the Kennedy Space Center, the first stage will separate from the dummy upper stage and fall to the Atlantic Ocean in a test of new parachutes designed for the operational Ares I. The dummy upper stage, which will not be recovered, will crash into the ocean some 147 miles from the space center.

The cost of the Ares I-X project, including the rocket, launch pad modifications, computer modeling and data analysis, is expected to be around \$445 million.

"We're incredibly excited to be on the cusp of flying the system, seeing what Ares I can do," Jeff Hanley, Constellation program manager at the Johnson Space Center in Houston, told CBS News.

The goal of the test flight is to verify computer models and flight characteristics during the critical first two minutes of flight when aerodynamic stresses are most severe.

While the real Ares I rocket features a first-stage booster with five fuel segments, engineers say the four-segment Ares I-X vehicle will closely mimic the flying characteristics of the manned version.

Engineers are especially interested in the acoustic environment a few seconds after launch, when the reflected sound of the accelerating booster hits the vehicle, causing vibrations that will be transmitted through the structure, and later, when the rocket accelerates through the speed of sound and experiences maximum dynamic pressure, or "max Q."

A space shuttle typically experiences between 720 and 750 pounds per square foot at max Q, but Ares I-X will experience around 850 psf. Data from the test flight will tell engineers what sort of environmental conditions sensitive electronics might be subjected to and whether mitigations are needed.

Other areas of interest are longitudinal thrust oscillations and how much the vehicle rolls about its long axis.

Based on data from recent shuttle flights and the test firing of a five-segment Ares booster in Utah, Hanley said engineers do not believe thrust oscillation, a phenomenon that occurs toward the end of a booster's firing, is a major problem. Even so, current plans for the Ares I rocket call for springs, part of a passive "soft-ride" system, to be used between the first and second stages and between the second stage and the Orion crew capsule to damp out any significant vibrations.

Engineers also are studying an innovative system that would use the mass of the second-stage liquid oxygen in an eventual manned rocket to damp out unwanted vibration.

Roll control also doesn't appear to be a major issue, engineers say. All solid-fuel rockets experience some amount of roll due to the behavior of the high-speed exhaust plume and Ares I-X is equipped with roll control thrusters on the dummy second stage to counteract any unwanted motion.

Another issue involves the rocket's sideways drift as it climbs away from the launch pad. For the Ares I-X launch, the booster's nozzle will be canted slightly just after ignition to ensure a "walk-off" away from the launch pad gantry. This is not intended to prevent a crash into the tower, which engineers say is not a concern. Rather, it is to prevent the rocket's exhaust plume from damaging the pad if the launch-day winds push it toward the gantry.

6:45 PM, 10/10/09, Update: Padalka, Barratt, Laliberte prepare for landing (UPDATED at 9:20 p.m. with undocking; UPDATED at 1:05 a.m. with landing)

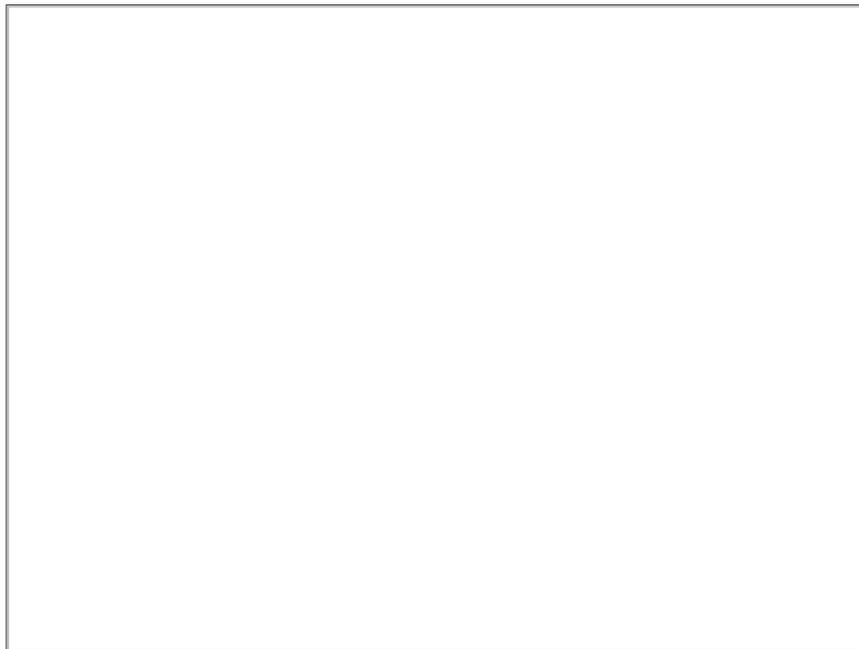
A Russian Soyuz spacecraft carrying commander Gennady Padalka, flight engineer Michael Barratt and Cirque du Soleil founder Guy Laliberte undocked from the International Space Station Saturday and plunged to a successful landing in Kazakhstan early Sunday.

Descending under a big orange-and-white parachute, the Soyuz TMA-14's descent module settled to a jarring rocket-assisted touchdown at 12:32 a.m. EDT (10:32 a.m. local time) Sunday to close out a 50-minute descent from orbit. Russian recovery forces, including U.S. and Russian flight surgeons, monitored the final stages of the descent before moving in to provide assistance, opening the capsule's hatch within about six minutes.

A few minutes after that, video from the landing site showed the crew members resting comfortably in chairs draped with blankets, with Laliberte wearing his familiar red clown nose. Padalka could be seen enjoying an apple as he and Barratt chatted with support personnel.

For Padalka and Barratt, launched March 26, touchdown closed out a marathon 199-day stay in orbit that was highlighted by the expansion of the crew from three to six astronauts and cosmonauts. Padalka, veteran of a flight to the old Mir space station and two expeditions aboard the ISS, boosted his spaceflight total to 586 days, putting him sixth on the list of most experienced space fliers.

Laliberte, a Canadian billionaire, is believed to have paid around \$35 million to spend nine days aboard the station as a tourist. He took off Sept. 30 with cosmonaut Maxim Suraev and NASA flight engineer Jeffrey Williams, who remained behind aboard the station as part of the six-member Expedition 21 crew.



Cirque du Soleil founder Guy Laliberte, left, wearing his now-familiar clown nose; Soyuz commander Gennady Padalka, center; and flight engineer Michael Barratt. (Photo: Bill Ingalls/NASA)

Padalka, Barratt and Laliberte undocked from the space station's Pirs airlock module at 9:07 p.m. Saturday. Padalka made the trip

back to Earth strapped into the central descent module's center seat with Barratt, serving as flight engineer, to his left and Laliberte to his right.

"Gennady, good luck," Suraev radioed from the station as the Soyuz pulled away. "You look wonderful against the backdrop of black space. It's amazing, I don't have enough words."

"You'll do great, I just know it," Padalka replied.

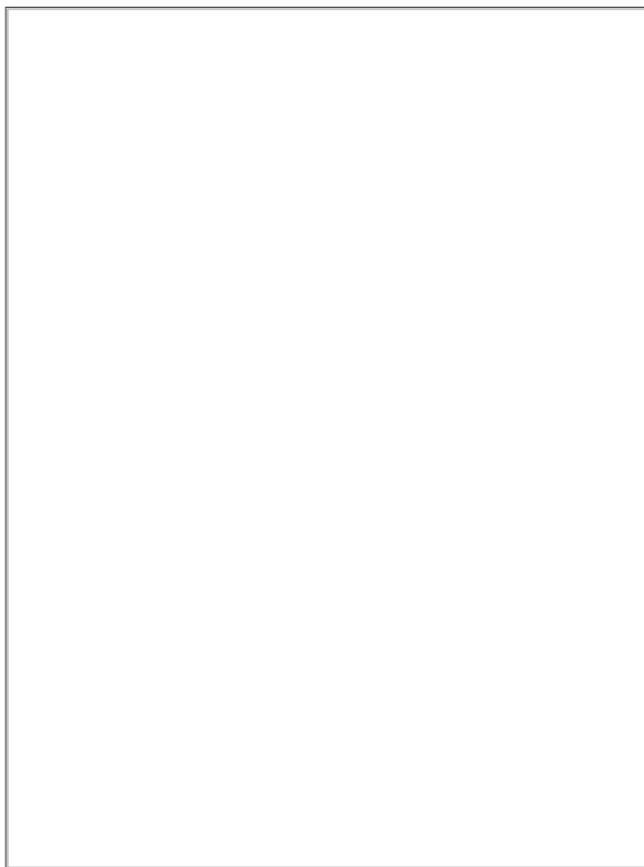
"Good luck to all of you," Suraev said. "Stay safe, have a nominal landing. I hope you do well after you get back and I hope you'll be running later today, once you're on the ground."

"OK, well Max, we wish you a great time aboard the station," Padalka said. "We'll see you sometime in spring. And by the way, call me if you have any questions, because I know you will."

The Soyuz TMA-14's braking rockets fired on time at 11:40 p.m. for about four minutes and 24 seconds, slowing the ship by about 258 mph to drop it out of orbit.

The lower propulsion module and the upper orbital module separated from the central descent module just after midnight, about three minutes before the components fall into the discernible atmosphere at an altitude of 64 miles. The separation sequence went smoothly, setting up a normal descent to the planned landing site as opposed to a steeper "ballistic" trajectory.

Landing near Arkalyk, Kazakhstan, was uneventful, although a brisk wind pulled the craft over on its side after touchdown.



The Soyuz TMA-14 spacecraft descending to touchdown. (Photo: Bill Ingalls/NASA)

In an interview with CBS News earlier this week, Barratt said he was looking forward to a reunion with his wife and five children.

"I'm really going to miss the station," he said. "Just floating and flying here are tremendous and I would say after six-and-a-half months up here, I can now float and fly fairly proficiently. It takes a little bit of time to really adapt to this, what my friend Shannon Lucid would call 'deep adaptation' to space flight, it really does take some time and I think I've finally gotten there."

"The Earth views are just amazing, I'm going to miss those. As much as anything, I'm going to miss the time around the galley table with this crew. We really worked well together and had a lot of fun. But the big magnet on the ground, of course, is my family. I have a wonderful, crazy family that I've really missed a lot that I'm looking forward to getting back to them."

Asked about re-adaptation to gravity after an extended stay in weightlessness, Barratt, a flight surgeon, said a new resistive exercise machine had helped him stay in shape.

"I'm in about as good shape as I can be up here," he said. "We've got a new resistive exercise machine which I've been working on fairly diligently for the last six-and-a-half months and it's the first time we've really had that kind of loading in space. We have the treadmill, of course, and the bike and I've tried to hit every session of exercise I can and I think I'm about as good as I can be.

"I'm not a young guy anymore and there are certainly some challenges associated with re-entry and getting back to the gravity vector. But I'm certainly going to give it my best shot and hopefully go through it OK and as always, try to take meticulous notes about it."



Departing space station commander Gennady Padalka (light green shirt) and Guy Laliberte, wearing his familiar clown nose, bid farewell to station commander Frank De Winne and cosmonaut Roman Romanenko respectively. Jeffrey Williams, in red shirt at left, looks on. (Photo: NASA TV)

Padalka was replaced as commander of the space station by European Space Agency astronaut Frank De Winne. His crew, known as Expedition 21, includes Suraev, Williams, NASA astronaut Nicole Stott, cosmonaut Roman Romanenko and Canadian astronaut Robert Thirsk.

"Our mission was very, very long and very productive and, I would say, very eventful," Padalka said earlier this week. "The main goal of our mission was six-person crew, which was started up in June. ... Right now, we are ready to go home, and I hope space station will be left in a great operational condition for the next commander and the next crew."

Romanenko, Thirsk and De Winne were launched to the station on May 27. Stott was launched aboard the shuttle Discovery Aug. 28 and she plans to return to Earth in November with the crew of the shuttle Atlantis. De Winne, Thirsk and Romanenko are scheduled to come home Dec. 1, briefly leaving the station with just two crew members - Williams, serving as commander of Expedition 22, and Suraev. Three fresh crew members - cosmonaut Oleg Kotov, astronaut Timothy Creamer and Japanese astronaut Soichi Noguchi - are scheduled for launch Dec. 21.

8:15 AM, 10/9/09, Update: LCROSS, Centaur stage crash into moon (UPDATED at 6:15 p.m. with post-impact news briefing; detection of crater, ejecta plume by Lunar Reconnaissance Orbiter)

In a brute-force search for ice on the moon, an empty 5,000-pound rocket stage traveling twice as fast as a rifle bullet crashed into a permanently shadowed crater near the moon's south pole Friday, presumably blasting out tons of debris for examination by an instrumented probe that carried out its own kamikaze plunge four minutes later.

While the initial impact did not prove especially dramatic - it was not even visible in realtime video from the Lunar Crater Observation and Sensing Satellite, or LCROSS - scientists said a camera sensitive to temperature variations clearly recorded the

flash of the Centaur rocket's catastrophic crash.

More important, spectroscopic data indicated the presence of material of some sort above or near the impact point in a murky crater known as Cabeus and instruments aboard NASA's Lunar Reconnaissance Orbiter observed the Centaur crater and confirmed a plume of debris.

Principal investigator Anthony Colaprete said it would take several days to analyze the data from the \$79 million LCROSS experiment and reach a consensus on whether or not water ice was, or was not, detected.

"Life is full of surprises, we want to be careful and not make a false negative or a false positive claim," he told reporters after the impact. "I'm excited we saw variations in the spectra because that means we saw something, and it was not just blackness. The information's there, we just need to get to it."

Asked if he had seen anything in the initial data to indicate the presence of ice, Colaprete said he had not yet had time to look for the tell-tale signals.

"We're going to take our time and build up a case for water in the ejecta, if it's there, or a case against it if it's not there," he said. "And then understand if we're seeing variations, what do these variations mean? We've got to understand that before we say anything."

Interestingly, a close-up of the thermal flash of the Centaur impact showed an elongated smear of light and not a concentrated flare as one might expect from a near straight-in impact. Topographic data collected by other satellites indicated a relatively flat floor where the impact occurred.

"The flash is actually several pixels across," Colaprete said. "Interesting, don't know what that means, it could just be a smear, it's a 30-frame-per-second camera, we have to look. Interesting, though."

LCROSS was launched June 18 as a companion payload to NASA's \$504 million Lunar Reconnaissance Orbiter spacecraft. Working in a 31-mile-high orbit, LRO is designed to create a high-resolution map of the moon's surface to help identify sites for future manned missions.

It also will measure the solar and cosmic radiation that future lunar explorers will face and map out the surface topology, mineralogy and chemical composition of Earth's nearest neighbor. One year will be spent scouting future landing sites followed by three years of purely scientific observations.

While LRO was launched directly to the moon by a powerful Atlas 5 rocket, LCROSS and the booster's empty Centaur upper stage were sent into a looping four-month orbit back around the Earth.

The spacecraft was designed to aim itself and the attached Centaur stage back at the moon, targeting a permanently shadowed crater near the south pole. Mission managers initially selected a crater known as Cabeus A, but after additional analysis of topographic data, the target was switched to nearby Cabeus, a crater measuring some 62 miles across and about two-and-a-half miles deep.

LCROSS successfully separated from the Centaur stage at 9:50 p.m. Thursday and then rotated 180 degrees to aim its instruments forward. A small rocket firing slowed LCROSS to ensure the proper four-minute separation from the Centaur.

Analysis of telemetry indicated the trajectory was right on the money - the Centaur is believed to have hit the surface within about 210 feet of the planned target - and LCROSS presumably flew through an ejecta cloud of some sort.

"Everything really worked out well," Colaprete said earlier. "The spacecraft flew perfectly, the instruments performed, honestly, better than expected in some cases. We got interesting results. But again, these are just initial results. ... I can certainly report there was an impact, we saw the impact, we saw the crater and we got good measurements, spectroscopic measurements, which is what we needed of the impact event.

"So we have the data we need to actually address the questions we set out to address. That's the fundamental bottom line. I'm not going to say anything about water, or no water, but we got the measurements we need to address the questions."

Instruments aboard the Lunar Reconnaissance Orbiter, passing within 50 miles of the impact site later in the morning, saw the newly formed Centaur crater as well as a plume of debris.

"LRO successfully observed the impact plume after the LCROSS impact," Project Manager Craig Tooley wrote in a status report Friday, presumably referring to the Centaur. "LRO was rolled 81 degrees to view the plume at LRO's closest approach (76.5 km to impact site). The LAMP instrument (UV spectrometer) has already confirmed detection of the ejecta plume and has begun analyzing their data. The Diviner instrument (Imaging Radiometer) has confirmed they have detected the LCROSS impact crater."

Before the impacts Friday, NASA released computer animations showing dramatic plumes of debris being blasted away by the Centaur. Scientists cautioned Thursday that the realtime imagery from LCROSS would not live up to the animations. They were right - nothing obvious was visible in the live television downlink or in initial observations from ground-based telescopes.

The absence of any immediately visible event prompted some to wonder if the experiment had failed to kick up enough dust for a successful analysis.

"You are all talking as though it was a big success, but one of the things the public was out there to see today, and that we were expecting to see, was the debris cloud and we saw nothing," one reporter observed during NASA's post-impact briefing. "How do you know this is a success, that it didn't just hit bedrock and nothing came up?"

"Well, we need to go back and look at the data and see what it says," Colaprete said. "Exploration has surprises in it. I'm certainly glad we built our mission plan, our science plan, around all aspects of the impact, for sure, we built in that robustness. We need to go and carefully look at the images, see what's in them. Certainly what's streamed out to the video is not at the same fidelity as what we get fresh off the spacecraft. So we just need to look a little bit more closely before we conclude anything about an ejecta cloud or not."

The search for water ice on the moon is one of the holy grails of modern lunar exploration. Data from other spacecraft, including the Lunar Reconnaissance Orbiter, show the presence of hydrogen, possibly from water ice, in the top three feet or so of lunar soil. Scientists initially believed ice from comets could be expected primarily in permanently shadowed craters near the moon's poles, but more recent data indicated the presence of trace amounts over broad regions.

"It could be water, it could be methane, it could be hydrocarbons or organics," Colaprete said during a pre-impact briefing. "From a scientific standpoint, this is incredibly important. Whatever the moon has collected over the last three-and-a-half billion years in terms of water, organics, materials from comets, asteroids, the sun, could be trapped in these pockets on the moon. It's a time capsule, it's a window into the past of the entire inner solar system, of Earth."

Finding ice on the moon could be critical to future exploration or even colonization. With unlimited solar power, ice can be converted into water, oxygen and hydrogen rocket fuel. Finding ice on the moon also would raise the possibility of similar deposits in similar environments across the solar system.

"Water in terms of exploration is very important," Colaprete said. "Even if we don't go back to the moon, it is a principle resource throughout the solar system. On Mars and beyond. The old Mars mantra was 'follow the water.' And really, that extends in my mind through the entire solar system and the entire universe. And so really LRO and LCROSS are the first directed, focused steps in that direction on the moon."

12:45 AM, 10/09/09, Update: LCROSS satellite hurtles toward lunar impact

A small NASA spacecraft shepherding an empty 5,000-pound rocket stage hurtled toward the moon Thursday, on course for a kamikaze plunge into a dark, permanently shadowed crater near the moon's south pole. Blasting tons of debris into direct sunlight for detailed analysis, the \$79 million experiment is designed to find out if ice is mixed in with the lunar soil, a critical resource for future astronauts or colonists.

"We're really excited," said principal investigator Anthony Colaprete. "There is hydrogen down in that crater and we're going to go dig some up."

Accelerated by lunar gravity to a velocity of some 5,600 mph - more than twice the speed of a rifle bullet - the Centaur rocket stage is expected to crash into the shadowed crater Cabeus around 7:31:19 a.m. EDT Friday.

The Centaur stage, with the mass of a large sport-utility vehicle, will blast out a new crater more than 60 feet wide and 13 feet deep. The excavated soil and debris will be blown skyward by the impact, some of it reaching an altitude of four miles or more - into direct sunlight - before settling back to the surface.

The Lunar Crater Observation and Sensing Satellite - LCROSS - will be trailing the doomed Centaur by 300 to 400 miles. If all goes well, it will fly through the debris cloud, measuring its constituents with a suite of compact but sophisticated instruments, before it, too, crashes to the surface four minutes later, at 7:35:38 a.m.

"The impact sounds spectacular, and it will be," said Colaprete. "But you have to consider impacts of this size hit the moon three or four times a month, essentially once a week. What's unique about the LCROSS impact is we know exactly where and when, so we can actually get and coordinate all of these eyes to look at it."

"The actual event will be done in four minutes, meaning the ejecta, the physical material that comes up, will be all but settled out in four minutes. It's just like any other natural impact of the moon, it will not damage the moon in any way."

Looking on from afar will be the Lunar Reconnaissance Orbiter, launched with LCROSS in June and currently mapping the moon from a 31-mile-high-orbit. The Hubble Space Telescope will also observe the crash, along with at least two other satellites and telescopes in observatories around the world. The impact will not be visible east of the Mississippi, but amateur astronomers in the west using telescopes with mirrors larger than eight to 10 inches should be able to see a small flash when the Centaur crashes.

But Colaprete cautioned armchair astronomers not to expect a dramatic spectacle.

"There's not going to be these grand, spectacular images of ejecta flying, kind of what you've seen in animations or cartoons," he said Thursday. "It's going to be more of a muted shimmer of light. But that muted shimmer of light contains all the information we need to answer our questions."

The LCROSS satellite will have a bird's eye view, albeit briefly.

"It's a relatively short event," Colaprete said in an earlier briefing. "It will be visible from our vantage point (with LCROSS) from the get go. The LCROSS spacecraft has the unique vantage point being directly over the impact and coming in fast. We actually get to fly through the remnant vapor cloud, imaging the crater the Centaur made all the way down to just several seconds before we impact ourselves.

"The actual duration of the ejecta cloud where it is visible from most assets, including ground-based observatories and amateur observatories, is about 90 seconds," Colaprete said. "It will be its brightest between the 10- and 60-second timeframe. From the Earth, we anticipate it will be approximately magnitude five for those astronomers out there, which is quite visible, maybe as bright as magnitude four. That brightness will last about 30 seconds of so before it slowly fades away as the ejecta cloud settles back to the surface."

It will take scientists several days to a few weeks to sift through data from the impact and identify water or any other compounds in the excavated soil.

"We don't anticipate saying anything about the presence or absence of water immediately, it's going to take us some time," Colaprete said. "In the next couple of days, immediately after the impact, we'll be able to say yeah, we saw ejecta, yeah we saw the flash, we hit where we wanted to hit, report on that sort of thing. But it's going to take at least a couple of days for the team to see what they got in the data, what's really there, and then probably the next couple of weeks to really come to a consensus as to the detection and the amount of hydrogen-bearing compounds in general."

The \$79 million LCROSS was launched June 18 as a companion payload to NASA's \$504 million Lunar Reconnaissance Orbiter spacecraft. The LRO mission is designed to create a high-resolution map of the moon's surface to help identify sites for future manned missions.

It also will measure the solar and cosmic radiation that future lunar explorers will face and map out the surface topology, mineralogy and chemical composition of Earth's nearest neighbor. One year will be spent scouting future landing sites followed by three years of purely scientific observations.

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LCROSS successfully separated from the Centaur stage at 9:50 p.m. Thursday and then rotated 180 degrees to aim its instruments forward. A small rocket firing was designed to ensure the proper separation from the Centaur.

"On the day of impact, we will finally separate from that impactor, it'll be drawn into the moon by lunar gravity," said Daniel Andrews, the LCROSS project manager. "We will slow down the shepherding spacecraft so we give time for the impactor to go in. It will kick up whatever is on the floor of the crater, that may very well include water ice, kick it up into the sunlight so that we can monitor it. And then finally, about four minutes after the first impact, the shepherding spacecraft impacts and game over. We're done."

During the impact Friday, sunlight will be shining into the crater through a break in the rim wall. That sunlight will provide the illumination necessary to study the debris thrown up by the Centaur impact.

"The sun will be shining in through a cleft, a valley, right along the rim of the crater," Colaprete said. "This valley lets sunlight in, it streams across the valley floor just above 500 meters to 1,000 meters above the valley floor so our ejecta actually gets into sunlight quite early, only after about a kilometer rise. That's great news. Then we looked at exactly where we would want to impact to

maximize the coldest temperatures, the highest amount of hydrogen, a smooth, flat floor."

The search for water ice on the moon is one of the holy grails of modern lunar exploration. Data from other spacecraft, including the Lunar Reconnaissance Orbiter, show the presence of hydrogen, possibly from water ice, in the top three feet or so of lunar soil. Scientists initially believed ice from comets could be expected primarily in permanently shadowed craters near the moon's poles, but more recent data indicated the presence of trace amounts over broad regions.

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Finding ice on the moon could be critical to future exploration or even colonization. With unlimited solar power, ice can be converted into water, oxygen and hydrogen rocket fuel. Finding ice on the moon also would raise the possibility of similar deposits in similar environments across the solar system.

"Water in terms of exploration is very important," Colaprete said. "Even if we don't go back to the moon, it is a principle resource throughout the solar system. On Mars and beyond. The old Mars mantra was 'follow the water.' And really, that extends in my mind through the entire solar system and the entire universe. And so really LRO and LCROSS are the first directed, focused steps in that direction on the moon."

NASA dedicated the LCROSS mission to CBS anchorman Walter Cronkite after the newsman's death in July.

"He was the face of exploration for many decades starting in the early Mercury days, of course, through Apollo," said Andrews. "We all remember seeing him on television during the Apollo 11 landing on the moon. And so this notable figure, who represented so much for the American public in making space exploration digestible, understandable, is someone NASA and the LCROSS team would like to dedicate the LCROSS mission to."

Cronkite's son, Walter Leland "Chip" Cronkite III, said the dedication was "a great honor."

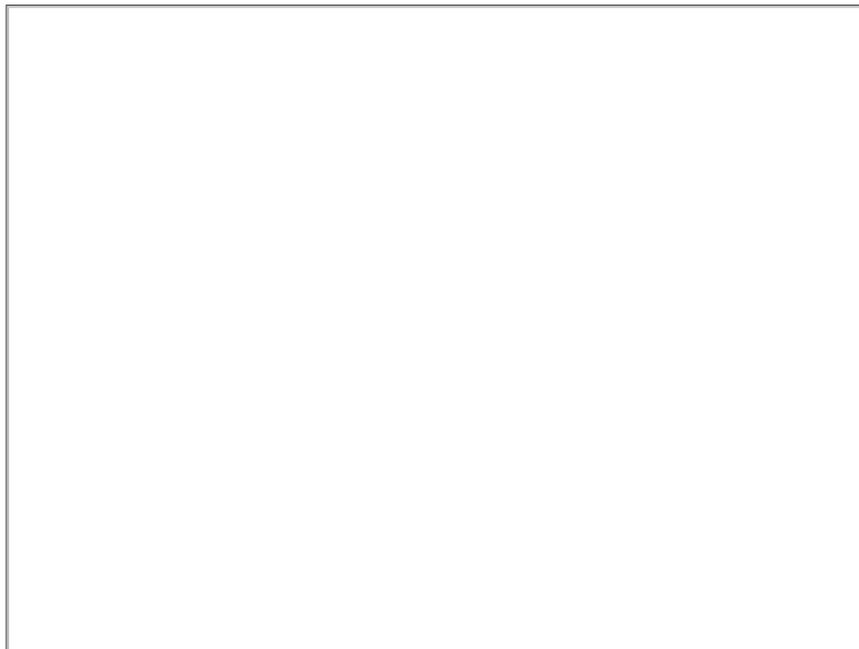
"Dad would be very pleased to be part of this ongoing process," he said. "(If) we find water, so close, it's an attractive oasis for further exploration. So once you build that refueling station up there, whatever it is, we'll come back and we can have another renaming ceremony. Thank you very much and good luck."

11:00 AM, 10/8/09, Update: Barratt ready for trip home; Laliberte enjoying station visit

Preparing to return to Earth this weekend after six months in space, NASA flight engineer Michael Barratt said Thursday he's in good shape and ready for the rigors of re-adaptation to gravity. While he will miss working in space, seeing his wife and five children are at the top of his agenda.

"I'm really going to miss the station," he said in a crew interview with CBS News. "Just floating and flying here are tremendous and I would say after six-and-a-half months up here, I can now float and fly fairly proficiently. It takes a little bit of time to really adapt to this, what my friend Shannon Lucid would call 'deep adaptation' to space flight, it really does take some time and I think I've finally gotten there."

"The Earth views are just amazing, I'm going to miss those. As much as anything, I'm going to miss the time around the galley table with this crew. We really worked well together and had a lot of fun. But the big magnet on the ground, of course, is my family. I have a wonderful, crazy family that I've really missed a lot that I'm looking forward to getting back to them."



Space station astronauts discuss their on-going mission with CBS News. Front row, left to right: Michael Barratt and Jeffrey Williams. Back row, left to right: Nicole Stott, Frank De Winne and Robert Thirsk. (Photo: NASA TV)

Barratt and outgoing Expedition 20 commander Gennady Padalka were launched to the International Space Station last March aboard the Soyuz TMA-14 spacecraft. Barratt, Padalka and Cirque du Soleil founder Guy Laliberte, who was launched to the station Sept. 30 with two fresh crew members, are scheduled to undock at 9:04 p.m. EDT Saturday. Landing in Kazakhstan is expected around 12:31 a.m. Sunday.

Asked about re-adaptation to gravity after an extended stay in weightlessness, Barratt, a flight surgeon, said a new resistive exercise machine has helped him stay in shape.

"I'm in about as good shape as I can be up here," he said. "We've got a new resistive exercise machine which I've been working on fairly diligently for the last six-and-a-half months and it's the first time we've really had that kind of loading in space. We have the treadmill, of course, and the bike and I've tried to hit every session of exercise I can and I think I'm about as good as I can be.

"I'm not a young guy anymore and there are certainly some challenges associated with re-entry and getting back to the gravity vector. But I'm certainly going to give it my best shot and hopefully go through it OK and as always, try to take meticulous notes about it."

Laliberte is believed to have paid around \$35 million for his trip to the space station. Jeff Williams, a long-duration station crew member who accompanied Laliberte to orbit, said the entertainer had adapted well to weightlessness.

"Guy definitely brings a unique aspect to the whole experience here, he's got a perspective and a completely different background than we do," Williams said. "We tend to think technically about what we're doing and what not and of course, he brings his entertainment background, his art background, so we've learned a lot from him, I think it's broadened all of our horizons.

"He's adapting very well. In fact, he was telling me this morning he wishes he could stay a couple of more weeks because now he's just feeling very comfortable here and he's ready to start teaching us some tricks. But unfortunately, he's going to have to leave here pretty soon."

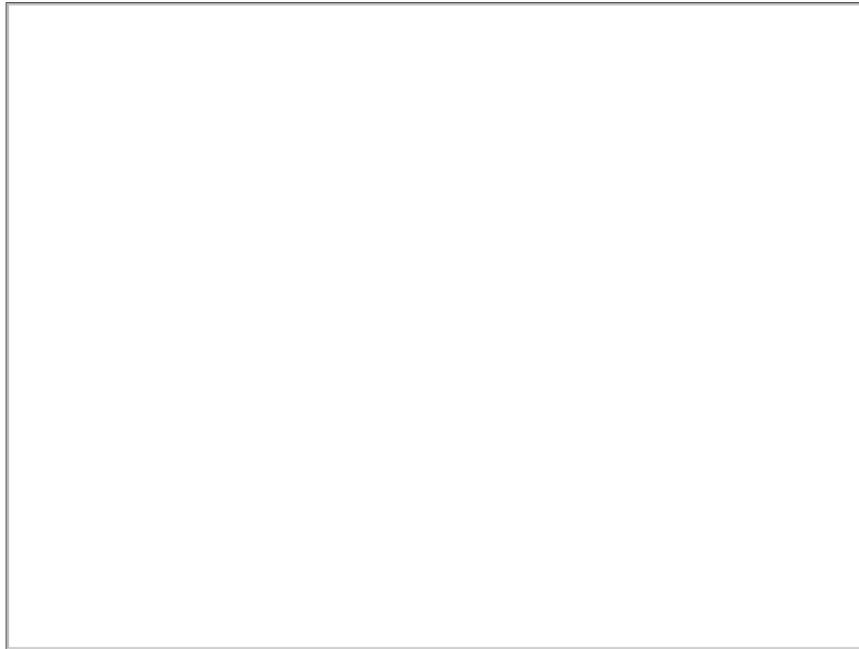
Asked if hosting space tourists detracted from the station's mission, Canadian astronaut Robert Thirsk said "it's important."

"Our space agencies appeal quite well to the public that are interested in science and technology, but that's not everyone out there that's supporting the space program," he said. "There's a large arts community in Canada whose tax dollars also go towards supporting our program. So if we can reach out to them, explain why it's important to venture out into space and develop space through gifted people like Guy Laliberte, I'm a hundred percent behind it."

4:45 AM, 10/2/09, Update: Soyuz TMA-16 docks with space station (UPDATED with hatch opening, crew comments)

The Soyuz TMA-16 spacecraft carrying cosmonaut Maxim Suraev, NASA flight engineer Jeffrey Williams and Cirque du Soleil founder Guy Laliberte maneuvered to a smooth docking with the International Space Station early Friday to close out a two-day orbital chase.

With Suraev and Williams closely monitoring the final stages of the automated rendezvous, the small capsule's docking mechanism engaged its counterpart at the aft port of the Zvezda command module at 4:35 a.m. EDT as the two spacecraft sailed high above northeast Kazakhstan. Hooks and latches then engaged to pull the Soyuz firmly into place.



The Soyuz TMA-16 spacecraft closes in on the International Space Station. (Photo: NASA TV)

"We're here, we arrived," Williams could be heard saying.

"Congratulations, guys," someone in mission control near Moscow radioed.

After leak checks, hatches between the two spacecraft were opened at 6:57 a.m., allowing Suraev, Williams and Laliberte, wearing a familiar red clown nose, to float into the space station.

They were welcomed aboard by outgoing commander Gennady Padalka, NASA flight engineer Michael Barratt, cosmonaut Roman Romanenko, European Space Agency astronaut Frank De Winne, Canadian astronaut Robert Thirsk and NASA astronaut Nicole Stott.

"It's good to see you all, looking very good," NASA Administrator Charles Bolden called from mission control near Moscow.

"Hello Charlie, yeah, we had a great trip up here and we're happy to be on board, with good company," Williams replied.

"Well Jeff, Max and Guy, just want to let you all know we enjoyed a superb launch (Wednesday)," Bolden said. "Your families behaved well, they laughed all the way back from Baikonur to Moscow. You all should rest well and know they're being taken care of."

Suraev's father then congratulated his son on his first spaceflight, saying "all of us here are very happy that so far the mission is very successful ... All the best to you, son, please do a good job there."

Laliberte, once again putting on his clown nose, told his family he was enjoying the trip and feeling "pretty good, actually. I'm adapting pretty good." Then he joked, "but I am staying six months, though."



Cirque du Soleil founder Guy Laliberte, wearing his ever-present red clown nose, chats with his children by phone in Moscow. (Photo: NASA TV)

Suraev and Williams are replacing Padalka and Barratt, who plan to return to Earth with Laliberte on Oct. 11. De Winne will take over as the European Space Agency's first commander in Padalka's place.

"I just wanted to say thanks to the Expedition 19 crew for all you've done," Bill Gerstenmaier, NASA's chief of space operations, called from Moscow. "You guys have done just a phenomenal job."

"Thank you, Bill," Padalka replied. "Space station is ready for next crew, 20 and 21, so right now space station's ready."

"We've had a fabulous time up here, the station is in great shape and really well supplied," Barratt said. "We're just really impressed that everything has worked so far with a couple of shuttles, the (Japanese) HTV (cargo ship), and everything worked on that thing, it was a beautiful spaceship and we're really lucky to have such visitations up here and a lot of firsts. So we're ready to come home, but it's been a great time."

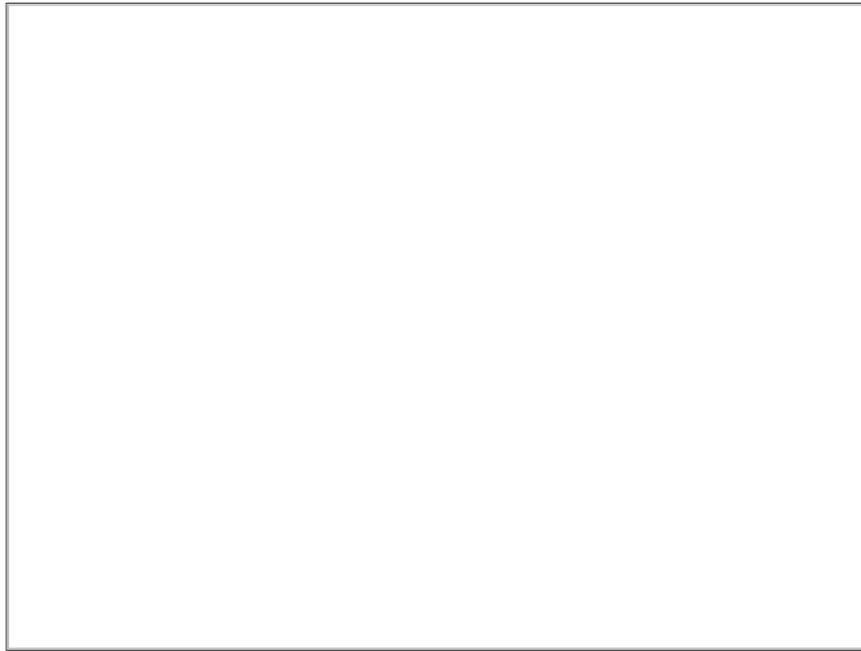
"You guys enjoy all your time together this week," Gerstenmaier said. "Take good care of space station."

03:40 AM, 9/30/09, Update: Soyuz takes off with two station crew members and Cirque du Soleil founder (UPDATED with launch; revised HTV undocking date; replaces earlier story)

A Russian Soyuz rocket blasted off from Yuri Gagarin's launch pad in Kazakhstan Wednesday, carrying two fresh crew members and the founder of Cirque du Soleil on a voyage to the International Space Station.

Under a cloudless blue sky, the Soyuz TMA-16 rumbled to life and soared away from the Baikonur Cosmodrome in Kazakhstan at 3:14:42 a.m. EDT, roughly the moment Earth's rotation carried the launch pad into the plane of the station's orbit.

Soyuz commander Maxim Suraev, making his first flight, monitored the ascent from the cramped capsule's center seat, assisted by NASA flight engineer Jeffrey Williams to his left. Space tourist Guy Laliberte made the climb to space seated in the capsule's right seat.



The Soyuz TMA-16 spacecraft takes off from the Baikonur Cosmodrome in Kazakhstan. (Photo: NASA TV)

The nine-minute ascent went smoothly as the launcher arced away to the east, shedding its liquid-fueled strap-on boosters and core stages without incident. In live television views from inside the spacecraft's central compartment, Laliberte could be seen smiling and giving ground controllers an enthusiastic thumbs up, telling Suraev he felt "super."

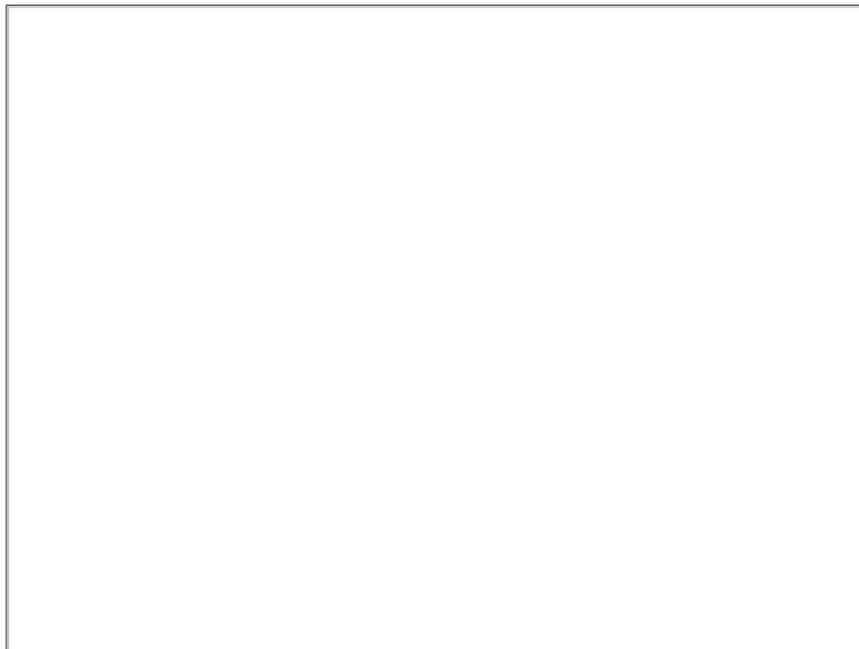
After separating from the rocket's third stage, the Soyuz TMA-16's two solar wings and radio antennas deployed as planned and flight controllers in the Russian mission control center near Moscow reported the vehicle was in good shape and operating normally.

If all goes well, Suraev, a Russian air force colonel, and Williams, a veteran shuttle and space station astronaut, will oversee an automated docking at the aft port of the station's Zvezda command module around 4:37 a.m. on Oct. 2.

"This is a very exciting day for me," Laliberte said during a pre-launch news conference Tuesday. "I just turned 50 years old a couple of weeks ago and for celebrating that half of my life, hopefully, I have approaching the great privilege to fly in space.

"I was only 10 years old when the first man put his foot on the moon. I was in summer camp and I was watching that on a black-and-white TV. And for me, it nurtured not the dream of going in space, but it nurtured the understanding and the belief that fairy tales are possible to live."

Asked if he was frightened at the risk of launching aboard a rocket and flying through space at five miles per second, Laliberte, who frequently whips out and wears a red clown nose, said "I'm not scared of anything up there."



Cirque du Soleil founder Guy Laliberte, left, waves at the camera inside the Soyuz TMA-16 spacecraft. (Photo: NASA TV)

"That question's been asked many, many times," he said. "As you know, I'm not a professional, but the one question you have to answer is if you will nurture fear or not? I'm not there to be scared at all. I'm there after evaluating danger. There is, of course, risk coming up there, there are things that you have to be careful of, but I've been well trained."

Williams said he looked forward to watching Suraev and Laliberte experience weightlessness and the view of Earth from 220 miles up.

"I'm very happy now to be getting ready to go again with Max and Guy," he said. "The training has gone very well and we're going to have a great time. I look forward to enjoying their first experiences on orbit."

Suraev and Williams will replace outgoing Expedition 20 commander Gennady Padalka and NASA flight engineer Michael Barratt, who were launched to the station March 27. Laliberte will enjoy just nine days aboard the lab complex before returning to Earth Oct. 11 with Padalka and Barratt aboard the TMA-14 capsule that carried the two professionals into orbit last March.

Laliberte, a Canadian worth an estimated \$2.5 billion, is believed to be paying upward of \$35 million to visit the International Space Station as a "spaceflight participant," or space tourist, in a deal with the Russian space agency arranged through Space Adventures Ltd.

Toward the end of his stay aboard the orbital lab, Laliberte plans to remotely oversee a five-continent, 14-city extravaganza as part of his "poetic social mission" to raise awareness of water as a critical cultural and environmental issue.

Beginning in Montreal at 8 p.m. on Oct. 9 and closing in Moscow, "we will travel the world, unveiling part of a poetic tale to a voice of international personality," Laliberte said during a news conference in August. "We will also be presenting ... artistic presentations linked to water as an inspiration and as a source of life."

Among those Laliberte said had agreed to participate are former Vice President Al Gore, U2, Shakira, Canadian astronaut Julie Payette and Peter Gabriel. The theme of the production is "Moving Stars and Earth for Water."

The Soyuz TMA-16 flight is the latest chapter in an especially busy few months aboard the space station.

European Space Agency astronaut Frank De Winne will assume command of the outpost from Padalka when the veteran cosmonaut, Barratt and Laliberte depart. The Expedition 21 crew will be made up of De Winne, Williams, Suraev, Canadian astronaut Robert Thirsk, cosmonaut Roman Romanenko and NASA flight engineer Nicole Stott.

On Oct. 30, the crew will oversee the departure of Japan's HTV-1 cargo craft, an unmanned spacecraft that was captured by Stott, operating the station's robot arm, on Sept. 17 and then berthed at the Harmony module's Earth-facing port. The HTV will be undocked by the robot arm and released so it can maneuver away on its own for re-entry and atmospheric burn up on Nov. 1.

Nine days later, on Nov. 10, the Russians plan to launch a new docking compartment that will be attached to the upper port of the Zvezda module, providing a fourth port for visiting Soyuz ferry craft and unmanned Progress supply ships. The module is scheduled to make an automated approach and docking on Nov. 12, the same day NASA hopes to launch the shuttle Atlantis on a mission to deliver critical spare parts.

Stott is scheduled to return to Earth aboard Atlantis on Nov. 23, leaving the station with a crew of five. De Winne, Thirsk and Romanenko are scheduled to come home a week later on Dec. 1, leaving Williams and Suraev behind on the station as the core members of the Expedition 22 crew. Three more crew members - cosmonaut Oleg Kotov, NASA astronaut Timothy Creamer and Japanese astronaut Soichi Noguchi - are scheduled for launch Dec. 21.

"We'll complete the operations with the HTV module, getting it completely unpacked and repacked with some trash and garbage that will end up burning up in the atmosphere after the undock," Williams said Tuesday. "Then we've got two shuttles during the expedition.

"In November, we've got STS-129 (Atlantis) coming up, its primary mission will be to bring up spare parts, primarily for the outside, the external spares in case of failures. This is in the plan to sustain the space station well into the future years after the shuttle retires in a little over a year.

"We have a second shuttle (visit) planned during our stay, currently planned in February, STS-130, which will bring up the final module for the U.S. orbiting segment, what we call node 3. And in node 3, it will have some of the life support equipment as well as some exercise equipment and the toilet."

Williams said a major focus of his expedition will be science.

"Just like in the Russian segment, we have a lot of experiments and scientific research that will be going on during our time," he said. "This is a transition between the assembly of the space station (to) the full utilization of the space station as this international orbiting laboratory."

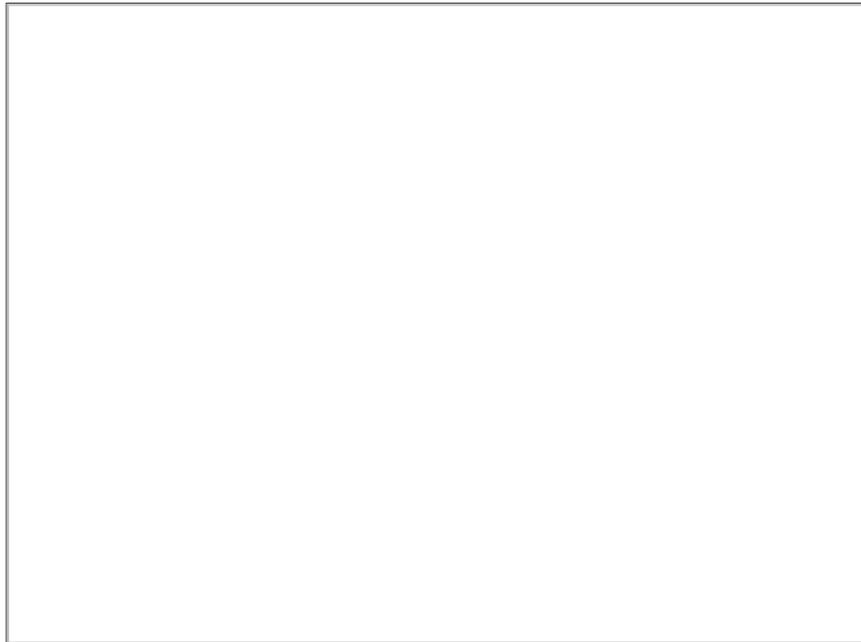
8:50 AM, 9/25/09, Update: NASA launches Missile Defense Agency tracking satellites (UPDATED at 11:20 a.m. with news conference)

A United Launch Alliance Delta 2 rocket roared to life and thundered away from the Cape Canaveral Air Force Station Friday, successfully boosting a pair of experimental missile tracking satellites into orbit for the U.S. Missile Defense Agency.

With its roots in the old "Star Wars" program, the goal of the \$1.5 billion Space Tracking and Surveillance System mission is to demonstrate the ability to detect and track enemy missiles from launch, through the so-called mid-course phase of flight to atmospheric entry, providing more accurate targeting data for interceptors.

"The purpose of these satellites is to enable acquisition and precision tracking from space, tracking of a sufficient quality to enable an interceptor to close the fire control loop, that is, to be able to determine a fire control solution based on information from space," said Rear Adm. Joseph Horn, deputy director of the Missile Defense Agency.

The results of the demonstration mission, he added, "will guide our decisions on the development of an affordable, continuously available, operational, precision-track space sensor constellation."



**A United Launch Alliance Delta 2 rocket carrying two missile tracking satellites blasts off from the Cape Canaveral Air Force Station.
(Credit: NASA TV)**

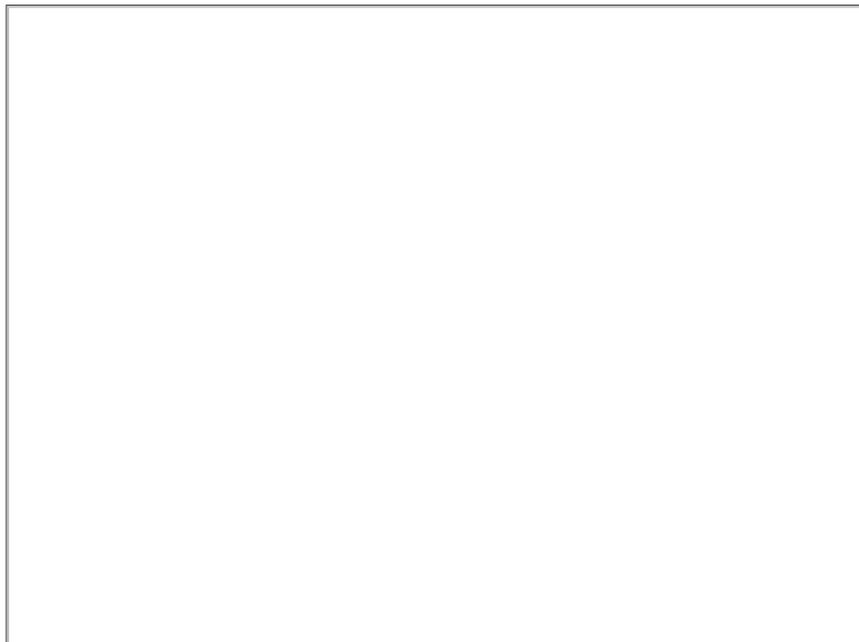
Running two days late because of bad weather and a small ground system fuel leak, the Delta 2 blasted off at 8:20 a.m. EDT from launch complex 17B at the Cape Canaveral Air Force Station, 20 minutes late because of morning rain showers. NASA managed the launching for the Missile Defense Agency.

Built by Northrup Grumman Aerospace Systems, the two solar-powered satellites boosted into space by the Delta 2 trace their heritage to President Ronald Reagan's Strategic Defense Initiative, which envisioned a constellation of missile tracking satellites in low-Earth orbit.

The original tracking satellite concept evolved into the "Brilliant Eyes" program, which later was transferred to the Air Force and ultimately became part of the Space-Based Infrared System, or SBIRS.

SBIRS had two components: satellites in geosynchronous orbit intended to replace aging Defense Support Program - DSP - early-warning spacecraft, and a constellation of tracking satellites in low-Earth orbit. Brilliant Eyes was redesigned to become the lower-altitude component of the system.

Work on two demonstration satellites was started under the Brilliant Eyes program and later put on hold in favor of a different approach. In 2002, mission managers decided to press ahead with the demonstration satellites under management of the U.S. Missile Defense Agency.



The Delta 2 climbs away from pad 17B. (Credit: NASA TV)

The 2,200-pound satellites are equipped with horizon-to-horizon missile detection sensors and a narrow-angle tracking telescope that can follow an enemy missile in flight, even during the mid-course phase of flight when it is most difficult to detect. The sensors were built by Raytheon.

By combining tracking data from two spacecraft, computers can assemble a three-dimensional view of a missile's trajectory and quickly provide targeting information to future interceptors.

At least that's the idea. The new spacecraft will spend two to four years carrying out a series of tests to demonstrate the effectiveness of the technology, working in concert with two earlier experimental satellites. Whether the STSS demonstration program will spur funding and development of an operational constellation remains to be seen.

"The greatest hedge against missile defense threats of all ranges remains a highly available, early missile tracking capability from space," Horn said. "With the successful launch of these two demonstrator satellites, we enter into an orbit checkout period after which we plan to use both targets of opportunity and dedicated targets to demonstrate STSS capabilities."

The requirements for an operational constellation are not yet defined, Horn said, but "what we expect to learn from these two demonstrators is exactly that, the (number) of satellites necessary to support a constellation and provide that continuous precision tracking information."

05:00 PM, 9/24/09, Update: Water on moon detected; buried ice sheets seen on Mars

Data from a comet-bound NASA probe, a robotic mission to Saturn and a U.S. instrument aboard an Indian spacecraft have provided clear evidence that at least trace amounts of water exist on the moon's surface, researchers said Thursday.

While scientists have long suspected water ice from comet impacts is trapped in cold, permanently shadowed craters near the moon's poles, the new data shows water molecules form and dissipate across broader areas, even in lunar daylight.

While the data represent a major surprise and "really profound discovery," one scientist said, researchers cautioned that the moon remains an extremely dry place by human standards.

"The observations presented here show a combination of hydroxyl, OH (oxygen-hydrogen molecules), and H₂O (water) that resides in the upper few millimeters of the lunar surface," said Jim Green, director of NASA's Planetary Science Division. "The average amount of water reported, if we were to extract it, is about a quart of water per ton (of surface soil)."

To put it another way, he said, about 16 ounces of water might be present for every 1,000 pounds of surface soil near the moon's poles. For soil near the equator, only about two tablespoons of water is believed to be present in every 1,000 pounds.

"Please keep this in mind, that even the driest deserts on the Earth have more water than are at the poles and the surfaces of the moon," Green said.

But scientists agreed the results open a new chapter in humanity's understanding of the moon and the processes at work across the entire solar system that could lead to water formation on other airless asteroids and moons.

"Having any water or hydroxyl in the sunlit areas of the moon is as surprising as it is intriguing," Bruce Betts, director of projects for the Planetary Society, said in a statement. "Will such results turn out to be the tip of the iceberg, or will the moon remain a dry desert with slightly more moisture than we thought?"

On a related front, NASA unveiled new findings from the Mars Reconnaissance Orbiter on Thursday that show clear evidence of huge sub-surface ice sheets extending from the poles of the red planet halfway to its equator.

The buried ice was spotted in debris thrown up in five recent northern hemisphere impact craters. The ice is surprisingly pure and easy to see in high-resolution pictures from the Mars Reconnaissance Orbiter. Scientists believe the ice is a remnant of a more humid period in Mars' recent history, when the planet's polar ice caps extended much farther toward the equator.

"Every indication is that this is forming a broad, continuous sheet beneath the surface," said Ken Edgett, a camera team member with Malin Space Science Systems of San Diego. "We have five separate impact sites, all showing more or less the same thing.

"I'd say the volume of water, and this is a guess, the volume of water is probably comparable to the volume we would have in, say, the Greenland ice sheet on the Earth, in the buried ice deposits (and the north polar ice cap)." Even more would be expected in the southern hemisphere.

Shane Byrne, a member of the High Resolution Imaging Science Experiment team at the University of Arizona, said the ice sheet is probably about a yard or so thick.

"These buried ice sheets that extend from the poles all the way down to 45 degree or so (north and south latitude) don't quite cover half of the planet, but come close," he said. "So we're talking about maybe a (half) million cubic kilometers of ice in total."

Water ice is a critical resource for future space travelers as well as a requirement for the development of life as it is currently known. The presence of ice on Mars is not a surprise, although the purity and extent of the buried ice sheets is. Water on the moon, however, is another matter.

Three spacecraft - India's Chandrayaan-1 lunar orbiter, NASA's Saturn-bound Cassini probe and the agency's Deep Impact comet mission - all detected evidence of water molecules on the moon's surface. In a surprise, it appears water molecules are present even in the heat of direct sunlight.

"Finding water on the moon in daylight is a huge surprise, even if it is only a small amount of water and only in the form of molecules stuck to soil," Jessica Sunshine, an astronomer at the University of Maryland who helped analyze data from NASA's Deep Impact spacecraft, said in a statement. "In the Deep Impact data we're essentially watching water molecules form and then dissipate right in front of our eyes."

What causes the water to form is not yet clear, but Sunshine said the mechanism might involve electrically charged hydrogen ions in the solar wind interacting with oxygen-rich minerals in the lunar soil to form water and hydroxyl molecules.

"We aren't certain yet how this happens," she said in a University of Maryland press release, "but our findings suggest a solar-driven cycle in which layers of water only a few molecules thick form, dissipate and reform on the surface each lunar day.

"This water is formed in the morning, substantially lost by lunar mid-day, and re-formed as the lunar surface cools towards evening."

Finding water on the moon has long been one of the holy grails of modern lunar exploration because solar power and ice deposits, assuming they are close enough to the surface, could provide a source of water, air and rocket fuel for future moon explorers or colonists.

The discoveries announced this week don't necessarily mean abundant water supplies are available across the moon's surface - the solar-driven cycle implied by Deep Impact would only produce trace amounts - but they show the moon isn't the totally dry place scientists long thought it was.

Earlier data indicated possible ice deposits in permanently shadowed craters near the moon's poles where water from comet impacts could have been trapped over the moon's long history.

In June, NASA launched two new spacecraft to the moon, the \$504 million Lunar Reconnaissance Orbiter and the \$79 million Lunar Crater Observation and Sensing Satellite, or LCROSS.

Orbiting the moon at an altitude of just 31 miles, the LRO spacecraft is designed to map the lunar surface in unprecedented detail to

help identify possible landing sites for future manned missions. LCROSS is focused specifically on water.

If all goes well, the spent second stage of the rocket that boosted LRO and LCROSS to the moon will crash into a permanently shadowed crater on Oct. 9, blasting presumably ice-bearing soil into sunlight for direct analysis by LRO, the Hubble Space Telescope and ground-based observatories. LCROSS will fly through the plume, beaming back data before it, too, crashes to the surface.

3:50 PM, 9/18/09, Update: NASA names crew for final shuttle mission

Chief astronaut Steven Lindsey, a veteran of four shuttle missions, will command an all-veteran six-member crew for the final planned space shuttle flight next year, NASA announced Friday. Peggy Whitson, a veteran space station commander, will take over as chief astronaut as the shuttle program winds down.

Lindsey will be joined by pilot Eric Boe and mission specialists Benjamin "Al" Drew, Michael Barratt, Nicole Stott and Timothy Kopra, all space veterans. Barratt and Stott are currently in orbit aboard the International Space Station while Kopra just returned from a long-duration stay.

Launch aboard the shuttle Discovery on mission STS-133 is targeted for September 2010. During the eight-day flight, a modified logistics module used to ferry equipment and supplies to and from the space station will be permanently mounted on the Earth-facing port of the central Unity module. No spacewalks are currently planned.

Barratt, who launched to the station aboard a Russian Soyuz spacecraft last March, is scheduled to return to Earth with Expedition 20 commander Gennady Padalka on Oct. 11. Stott, who replaced Kopra aboard the station during Discovery's just-completed mission, is scheduled to come home with the crew of the next shuttle flight in November.

Only six shuttle flights remain before the program is retired, all bound for the International Space Station. With Friday's announcement, all of the crews are now assigned and no unassigned rookies remain in NASA's astronaut office at the Johnson Space Center in Houston.

Here is the shuttle manifest as it currently stands:

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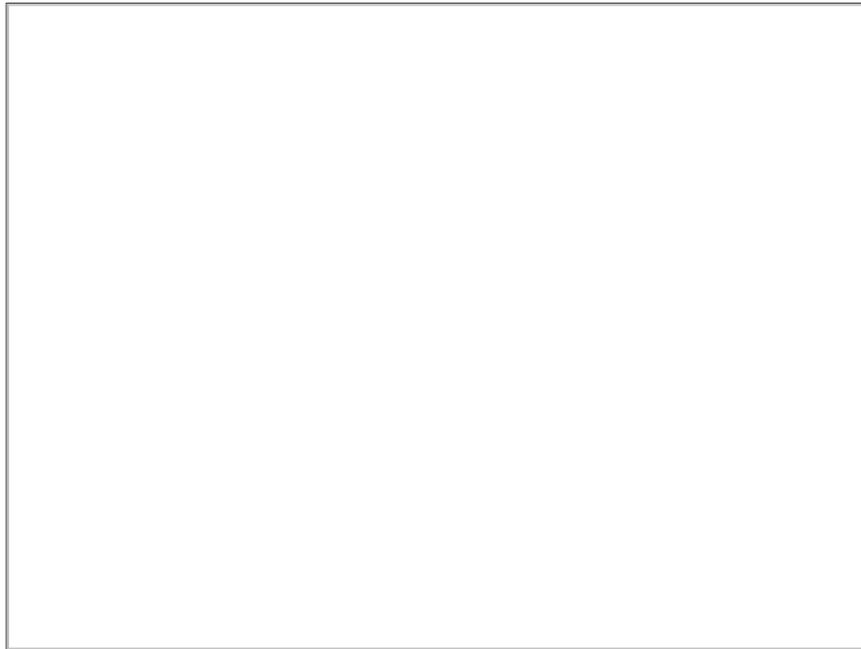
Launch..Shuttle.....Mission.....EVAs...Payloads
2009
11/12...Atlantis....STS-129/ISS-ULF3...3....ELC-1; ELC-2 (external spares)
2010
02/04...Endeavour...STS-130/ISS-20A....3....Node 3 (Tranquility); cupola
03/18...Discovery...STS-131/ISS-19A....3....Logistics module; science racks
05/14...Atlantis....STS-132/ISS-ULF4...3....Russian research module; spares
07/29...Endeavour...STS-134/ISS-ULF6...3....Alpha Magnetic Spectrometer; spares
09/16...Discovery...STS-133/ISS-ULF5...0....Permanent Logistics Module; spares

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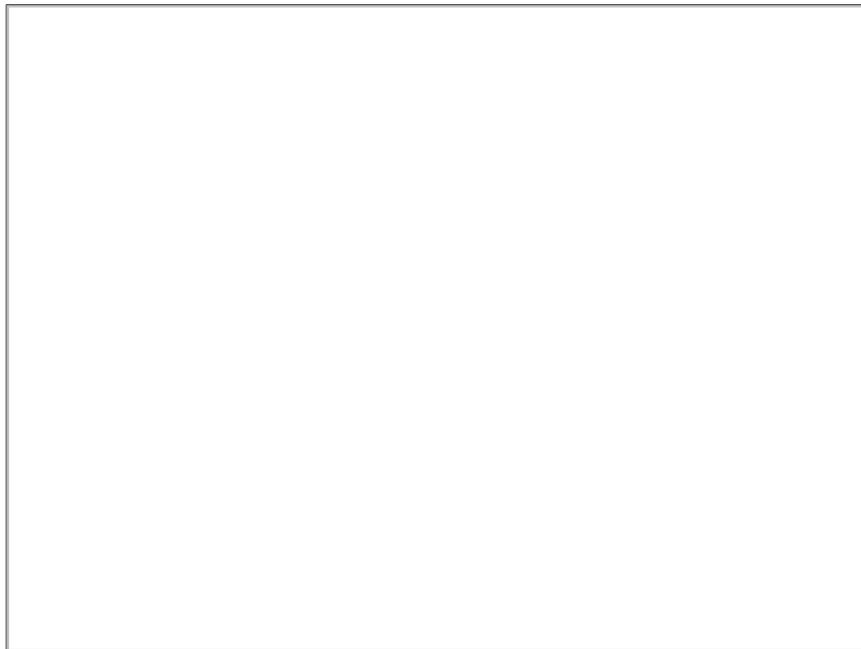
4:40 PM, 9/17/09, Update: Japanese HTV grappled by space station arm after smooth rendezvous (UPDATED at 6:30 p.m. with docking)

Japan's new HTV cargo ship, carrying more than 7,000 pounds of supplies and equipment, was plucked out of open space by the International Space Station's robot arm Thursday to complete a near-flawless automated rendezvous marking a major milestone for the station program.

Arm operator Nicole Stott, working inside the Destiny laboratory module, locked the station's space crane onto the HTV cargo ship at 3:47 p.m. EDT as the two spacecraft moved into orbital darkness 220 miles above Eastern Europe.



The HTV completes its automated rendezvous and awaits capture by the space station's robot arm. (Photo: NASA TV)



The HTV is docked to the the Harmony module. (Photo: NASA TV)

"It's a real example of international cooperation with a Japanese vehicle captured by a Canadian arm with American and European astronauts ... under the command of a Russian commander," said Frank De Winne, a European Space Agency astronaut. "It's really true international cooperation."

A few moments later, Stott, De Winne and their crewmates posed in front of the robot arm work station and thanked flight controllers for their support.

"We're all here and we all just want to say congratulations to the entire (team)," Stott said. "We had an amazing time doing this. We are so, so happy to have this beautiful vehicle here with us now and we look very forward to going in tomorrow and finding all the surprises I'm sure you've stowed there for us.

"So we're going to wave our drink bags, our HTV 'special reserve' drink bags, and we're going to drink a special drink of our very special water here to all of you," Stott said. "Thanks again and we really look forward to tomorrow."

Canadian astronaut Robert Thirsk, taking over arm operations from Stott, then slowly moved the HTV to a docking port on the station's forward Harmony module. After correcting for a minor misalignment, 16 motorized bolts were driven home to firmly lock the HTV to the station. Docking was complete at 6:26 p.m.

If all goes well, the astronauts will enter the cargo ship Friday and begin unloading supplies.



Robot arm operator Nicole Stott and her five crewmates toast the capture of the Japanese HTV cargo ship. (Photo: NASA TV)

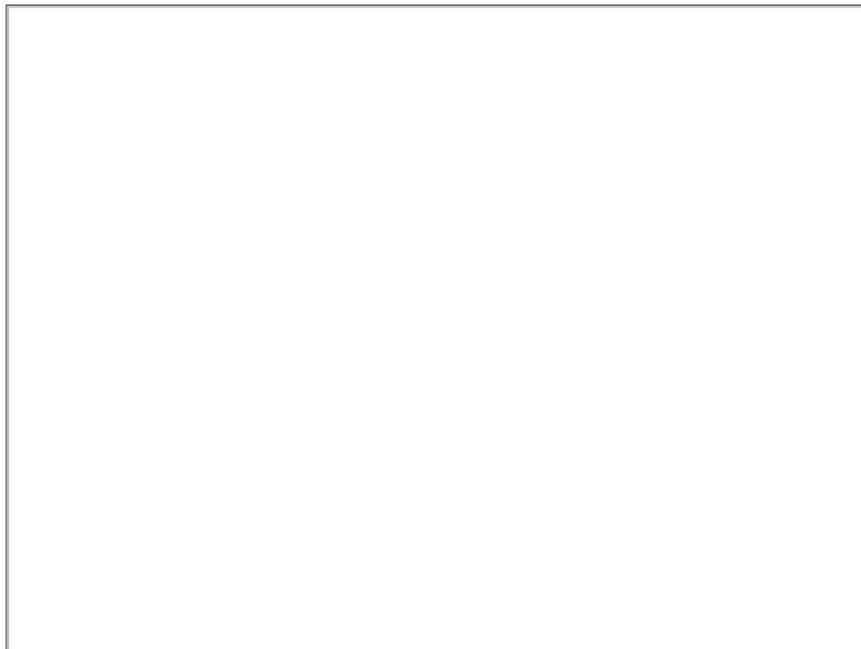
The HTV was launched on its maiden voyage last Thursday by a Japanese H-2B rocket, also making its first flight. The rocket and the cargo craft performed well and after a week of tests and checkout, the spacecraft moved into the terminal phase of its rendezvous sequence.

Unlike Russian Progress cargo craft and the European Space Agency's Automated Transfer Vehicle, or ATV, the Japanese ship was not designed to dock with the station on its own. Instead, the spacecraft autonomously maneuvered to a position just below the station and waited for the lab's robot arm to grapple it and move it to a docking port.

"On this particular flight, we've got about two-and-a-half tons of pressurized cargo flying to orbit and almost a metric ton of payloads externally coming to ISS," said space station Program Manager Mike Suffredini. "So it's a significant amount of up mass to us.

"Almost 20 percent of the pressurized volume is research hardware. Also, the two payloads externally (in the HTV's cargo bay) are very unique and new capabilities for ISS. There's been quite a bit of talk about the use of ISS for Earth research and in fact, the two payloads flying ... are intended to do that very thing."

One of the payloads in the HTV's unpressurized cargo bay is a NASA experiment to map the constituents of the upper atmosphere and the other is a JAXA payload designed to study the effects of trace gases on the ozone layer. Both will be extracted from the HTV cargo bay by the station's robot arm and installed on an external porch by a Japanese robot arm on the Kibo lab module.



Overlays as seen on a space station computer screen showing the HTV inside the capture "box" just before capture Thursday.

(Photo: NASA TV)

"Those are very critical things for us to understand relative to understanding our environment and how we affect it and it's good to be able to finally start having this kind of research on board ISS," Suffredini said.

Developed by the Japan Aerospace Exploration Agency, or JAXA, as a contribution to the station program, the HTV measures some 32 feet long, 14.4 feet wide and weighs some 23,000 pounds when carrying a full 13,200-pound load of cargo. For its maiden flight, the HTV-1 is carrying about 3.5 metric tons of equipment and supplies.

3:30 PM, 9/17/09, Update: Lunar Reconnaissance Orbiter begins primary mission; delivers early surprise about hydrogen distribution

After two months of checkout and calibration, NASA's \$504 million Lunar Reconnaissance Orbiter was maneuvered into a circular 31-mile-high mapping orbit Tuesday and scientists said Thursday the spacecraft's instruments are delivering intriguing clues about the possible presence of water ice.

"The moon is starting to reveal her secrets, but some of those secrets are tantalizingly complex," said Michael Wargo, NASA's chief lunar scientist.

Scientists expected the spacecraft to find signs of hydrogen - an indicator of possible water ice deposits - in permanently shadowed craters near the moon's south pole. Ice could be expected from cometary impacts over the past few billion years.

Indeed, one of LRO's instruments shows the temperature in such craters never rises above about 33 kelvin, or minus 400 degrees Fahrenheit. But in a surprise, the spacecraft is detecting signs of hydrogen both inside and outside of such craters.



A high-resolution map indicating the presence of hydrogen (right) shows water ice, or hydrogen-bearing materials of some sort, exist both inside and outside of permanently shadowed craters near the moon's south pole. (Credit: NASA)

The observations confirm "there is hydrogen near the lunar south polar region," said Project Scientist Richard Vondrak. "What it also seems to indicate is that the hydrogen is not confined to permanently shadowed craters. Some of the permanently shadowed craters do indeed contain hydrogen. Others, on the other hand, do not appear to have hydrogen. And in addition, there appears to be concentrations of hydrogen that are not confined to the permanently shadowed regions."

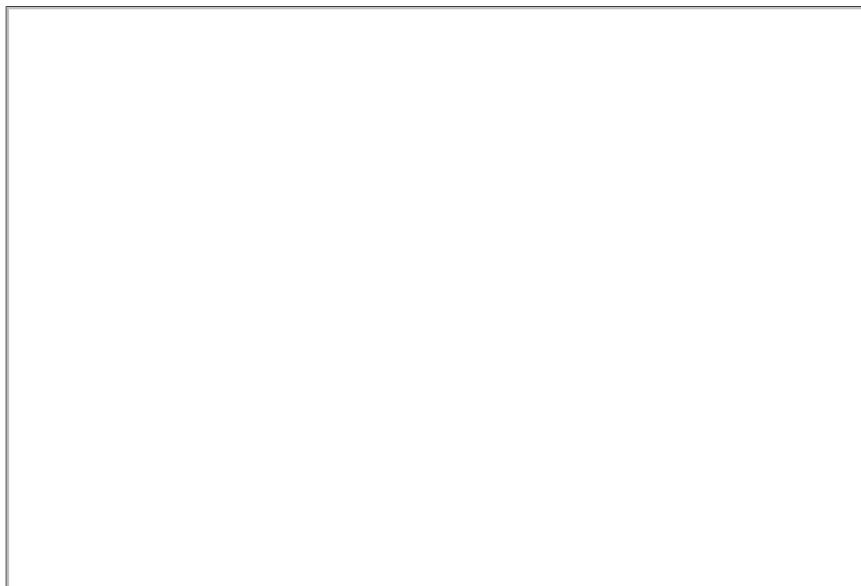
Water ice cannot exist in direct sunlight on the surface of the moon.

"However, it can exist below the surface even if the surface is warm," Vondrak said. "So you may have had water deposited, or some other hydrogen-bearing compound like methane or ammonia, that was deposited from a comet or some other event and then was promptly buried."

"And so you could have this buried hydrogen that then would be lasting for long, long periods of time. It would be very durable there. What we don't know is the abundance and how deep it is buried."

The issue is of critical importance to scientists and engineers who envision some day building permanent research stations on the moon, using solar power to break down mined water ice to provide oxygen, water and hydrogen rocket fuel. Scientists do not yet know if water ice is, in fact, mixed in with the moon's upper soil, only that hydrogen-bearing material of some sort seems to be present.

Equipped with seven state-of-the-art cameras and other instruments, LRO was built to look for suitable landing sites for future manned missions while creating the most detailed lunar atlas ever assembled.



A laser altimeter aboard the Lunar Reconnaissance Orbiter shows low spots (in blue) and higher elevations near the moon's south pole. (Credit: NASA)

The 4,200-pound solar-powered spacecraft also will measure the solar and cosmic radiation that future lunar explorers will face and map out the surface topology, mineralogy and chemical composition of Earth's nearest neighbor. One year will be spent scouting future landing sites followed by three years of purely scientific observations.

LRO was launched by an Atlas 5 rocket from the Cape Canaveral Air Force Station, Fla., on June 18 along with a companion spacecraft, the \$79 million Lunar Crater Observation and Sensing Satellite, or LCROSS. The two spacecraft separated shortly after launch.

LCROSS is designed to guide the Atlas 5's spent Centaur second stage to an impact in a permanently shadowed crater near the moon's south pole on Oct. 9. Instruments aboard LCROSS, LRO, the Hubble Space Telescope and at observatories on Earth will study the debris thrown up by the crash to look for evidence of ice.

"It could be water, it could be methane, it could be hydrocarbons or organics," said LCROSS Project Manager Dan Andrews. "And so actually from a scientific standpoint, this is incredibly important. Whatever the moon has collected over the last three-and-a-half billion years in terms of water, organics, materials from comets, asteroids, the sun, could be trapped in these pockets on the moon.

"It's a time capsule, it's a window into the past of the entire inner solar system, of Earth," he said. "I see LCROSS and LRO combined as a gateway, a pathfinder to truly understanding even the origins of volatiles, of water, in the inner solar system. The moon is right there, it's right next to us, we can go there much more easily than a lot of other places and make these studies."

LRO Project Manager Craig Tooley said the lunar orbiter is operating in near flawless fashion, with all seven of its instruments now activated and trained on the moon. The craft was maneuvered from its initially elliptical commissioning orbit into a 31-mile-high circular orbit last Tuesday with a three-minute rocket firing over the south pole.

"Commissioning is now complete and all of our seven instruments as well as our spacecraft (are) essentially performing flawlessly," he said Thursday. "So we are certainly ready to proceed on into the mission."

11:45 PM, 9/15/09, Update: Augustine offers no 'compelling' reasons to halt Constellation program, but says lost funding must be restored for viable space program

NASA's embattled Constellation moon program, thought by many to be on life support in the face of ongoing budget cuts, is technically feasible, "soundly" managed and capable of putting American astronauts back on the moon as planned in the 2020s, the chairman of a manned space review said Tuesday.

But only if the Obama administration and Congress restore some \$3 billion in lost funding and maintain politically stable, long-term support. Without the additional money, the chairman said, NASA will be unable to carry out Constellation or any other meaningful manned space program.

Norman Augustine, former CEO of Lockheed Martin and chairman of Review of U.S. Human Space Flight Plans Committee, told the House Committee on Science and Technology that he would not endorse any one of the panel's five options and their variants, but he agreed there should be "compelling reasons" to cancel a program, like Constellation, that is already in motion.

And neither he nor Edward Crawley, a panel member and engineering professor at the Massachusetts Institute of Technology who oversaw the development of the options submitted to the White House, offered any such compelling reasons.

"There were on our committee a number of people who actually built space flight hardware and their general consensus on the assessment of the Constellation program technically is it has problems, all real programs where you're really building hardware encounter developmental problems, but that we didn't see any ... that were not surmountable with proper engineering talent and skill, which we believe NASA can bring to bear," Crawley said.

Rep. Bart Gordon (D-TN), chairman of the Science and Technology committee, observed that Constellation was a congressionally authorized program that represented a significant expenditure to date.

"I don't think you trade what you know for what you don't know if it's equal or a little bit better," Gordon said. "So are you prepared to say that one or all of the other options are substantially better than Constellation and worth having a major turn now?"

"I think it would be our view, just what you said, there should be a compelling reason to change an existing program," Augustine replied. "We believe the existing program, given adequate funds, is executable and would carry out its objectives."

A key element in the Constellation program is development of a heavy lift rocket, the unmanned Ares 5 booster. Augustine said the highest priority for the nation's space program is development of a new heavy lifter, but "to answer your question, given additional funds ... we believe the existing program would be a fine program."

Gordon and virtually every other committee member who spoke Tuesday questioned the wisdom of changing direction and expressed support for trying to come up with the money needed to turn Constellation into reality.

"I'm not a fan of increased spending, but I've always thought our human space flight program gives the United States so much to be proud of, and carried within it is the promise of significant breakthroughs in healthcare, defense and alternative energy technologies," said Rep. Ralph Hall (R-TX), the committee's ranking Republican.

"Mr. Chairman, in many ways it's hard for me to understand why the president is seeking new options at all when there's been an agreed upon plan for several years. Why don't we just fund the program we've all agreed to? Why should multi-billion-dollar bailouts of banks and insurance companies come at the expense of our talented scientists, our engineers and technicians who make the impossible look easy.

"I think many of us think it would take a very small fraction of our federal budget, just tenths of one percent, to make a significant difference in our human spaceflight goals," Hall said. "But even if that level of funding is not forthcoming, we have to be very careful how we proceed because we have a lot at stake."

Mike Griffin, NASA's former administrator and the man in charge when the Constellation program was developed, put the debate in stark terms. Since 1994, he said, NASA's annual budget has suffered a 20 percent decline in real dollars.

"At this time a year ago, the original budget for exploration had already been eroded by some \$12 billion to pay for other things," he said. "The budget submitted this past May erodes that further to the point where some \$30 billion has, if those plans go forward, been removed from space exploration.

"The issue is money. That issue renders moot all other debate as to what other destinations we might pursue, whether they're the moon, near Earth asteroids, Mars or any debate about how we might get there. On the 40th anniversary of Apollo 11, this is a sobering thought. ... I hope I'm not the only one who finds it shameful we're in this position."

Griffin brought up President Kennedy's speech to a joint session of Congress in 1961 when he called on the nation to commit itself to landing a man on the moon and by the end of the decade.

"With the budget in front of us, we're poised to behave not like the Kennedy administration but the Nixon administration where, after spending literally a fortune to develop the spaceships for Apollo, we threw them away," Griffin said. "We spent 80 percent of the money building them, 20 percent of the money using them and they're gone. So, do today's leaders want to be remembered like John Kennedy or Richard Nixon? That's the choice before us."

The Science and Technology Committee members who spoke agreed with Griffin's assessment that more money is needed. As Rep. Brian Baird (D-WA) put it, "we've got to fish or cut bait."

"I believe passionately it's the mission of our species to explore and to actually leave the solar system at some point, but it's going to cost us and we have to decide whether we want to spend that," he said. "And I believe it's the mission of this country to lead the world in that."

The Constellation program was born in the wake of the 2003 Columbia disaster. The accident review board recommended that if NASA chose to fly the shuttle past 2010, the agency should re-certify the spacecraft. Re-certification would have required re-examining the engineering rationale that went into every aspect of the shuttle's design to identify areas that needed improvements to boost safety.

Instead, the Bush administration decided in January 2004 to finish the International Space Station and to retire the shuttle in 2010. At the same time, NASA was told to begin development of a replacement system that could ferry astronauts to and from the space station and eventually, on to the moon, a system that would be safer and less expensive to operate than the shuttle. The long-range goal was establishment of Antarctica-type lunar research stations where astronauts can live and work for months at a time.

NASA's answer to this new direction was the Constellation program, a radical departure from the world of shuttle operations. Instead of one rocket designed to carry astronauts and heavy payloads, two rockets were envisioned: the manned Ares 1, designed to boost Apollo-like Orion crew capsules to low-Earth orbit; and the unmanned Ares 5, a huge heavy lift rocket that will carry a four-person lunar lander into space.

For a moon shot, the Ares 5 would be launched from one pad, followed a few hours later by launch of the crew in an Orion capsule atop an Ares 1.

After linking up in low-Earth orbit, the Ares 5 upper stage would propel the Altair lunar lander and astronauts in the attached Orion capsule to the moon. The entire crew would descend to the lunar surface in the lander and, when its mission is complete, blast off, rendezvous with the orbiting Orion capsule and return to Earth for an ocean splashdown reminiscent of the Apollo program.

The Bush administration did not give NASA much in the way of additional funding to pay for initial Constellation development and the agency was forced to cut back in other areas to kick start the new program.

Given the lack of funding up front, development of the Ares 1 has lagged and now won't be available until 2015. During the five-year gap between the end of shuttle operations and the debut of Ares 1/Orion, NASA will be forced to buy seats on Russian Soyuz spacecraft, at \$50 million each, to ferry U.S. and international astronauts to and from the space station.

During the presidential campaign, Obama expressed support for the Constellation program and it's long-range goal of returning to the moon. But after his election, the Office of Management and Budget cut another \$3.1 billion from NASA's long-range budget, money that was critical to initial development of the new Ares 5 booster. Those cuts, on top of earlier reductions, have left NASA in what the Augustine panel described as an untenable position.

"The reluctant bottom line conclusion of our committee is that the current program as it's being pursued is not executable, that we're on a path that will not lead to a useful, safe human exploration program and the reason for that is the mismatch between the tasks to be performed and the funds available to support those tasks," Augustine said Tuesday.

"It also came as a considerable disappointment to this committee that we were unable to find any alternative space programs that would be worthy of this country that could be conducted for the funding profile now in place."

The Review of U.S. Human Space Flight Plans Committee was set up by the Obama administration to examine NASA's current plans for retiring the shuttle, completing the space station and returning to the moon, as well as alternative strategies for moving beyond low-Earth orbit.

The committee also considered how long NASA and its partners should operate the International Space Station. NASA currently has no money in its projected downstream budget to operate the space station beyond 2015.

In its executive summary - the group's final report is not yet complete - the panel did not make any recommendations. Instead, it listed five options, or architectures, and the pros and cons associated with each. The first two options assume NASA is forced to live within current 2010 budget projections.

In one, the shuttle is retired on schedule and the space station is deorbited in 2015 or 2016. Under that scenario, the panel concluded, NASA would not be able to return to the moon until the 2030s or later. In the other "constrained budget" case, the shuttle is retired, the station is extended through 2020, the Ares 1 is canceled and NASA relies instead on the commercial development of new rockets to carry astronauts to low-Earth orbit. Under that scenario, the panel said, a heavy lift rocket is delayed to the late 2020s and no money is available to develop lunar landing technologies.

The panel's final three options assume NASA's exploration budget is boosted by \$3 billion and then allowed to grow each year at 2.4 percent to offset inflation.

Option No. 3 is basically NASA's Constellation program as currently envisioned, with shuttle retirement in early 2011 and no additional money for operation of the International Space Station past 2015. In that case, the panel concluded, NASA could, in fact, return to the moon in the mid 2020s.

Option No. 4 would extend the station through 2020 and retain the moon as the nation's primary target beyond low-Earth orbit. But it would rely on development of commercial access to low-Earth orbit. In one variant, the shuttle is retired and NASA builds an Ares 5 Lite to launch crew and cargo to the moon. In the other, the shuttle program is extended and a new heavy lifter based on shuttle technology is developed for moon flights.

Option No. 5 represents a so-called "flexible path" architecture that would explore the inner solar system with long-duration flights to a variety of targets, ranging from lunar orbit to the moons of Mars. The long-range goals could include lunar landings and eventual flights to Mars itself. This scenario assumes development of commercial launchers, shuttle retirement and no station extension.

Gabrielle Giffords (D-AZ), chairwoman of the House subcommittee on space and aeronautics, was critical of the Augustine panel's options, saying "I thought we were going to take a hard, cold, sobering look at the Constellation program and tell us exactly what we needed to do here in Congress, with our budget, in order to maximize the chances of success. But that's not what I see."

"Instead of focusing on how to strengthen the exploration program in which we've invested so much time - four years, billions of dollars - we have a glancing attention to Constellation, even referring to it in the past tense in your summary report and instead

spending the bulk of the time crafting alternative options that do little to illuminate the choices that I think are really confronting the Congress and the White House.

"So where does that leave us? I think in place of a serious review of potential actions that could be taken to strengthen and improve the Constellation program, we've been given a set of alternatives that in some sense look almost like cartoons, lacking detailed costs, schedule, technical, safety, other programmatic specifics that can't be subjected to the rigorous and comprehensive analysis and validation that NASA's required to go over.

"So I guess I'll ask my colleagues on this committee, what are we going to do with this report? I know that we are going to see more details. But in the absence of mismanagement or technological show stoppers ... none of which the Augustine panel has indicated has occurred in this program, can any of us in good conscience recommend canceling the exploration systems development programs that Congress has funded and supported over the past four years?"

Giffords said she did not see "the logic of scrapping what the nation has spent years and billions of dollars to develop."

"And for the nation's sake, I hope we can break this cycle of false starts that was mentioned by many of my colleagues before," she said. "The future of America's human spaceflight is really at risk. And I'm hoping before the panel is dismantled we can get some real, solid numbers ... so we can make the decisions as to what to do with our future in manned spaceflight."

Keeping the \$75 billion International Space Station operational through at least 2020 seems to be a given regardless of which option is ultimately approved. In his written remarks to the Science and Technology Committee, Griffin reflected the views of many when he said "any discussion of decommissioning and deorbiting the ISS is irrelevant to the consideration of serious programmatic options."

"The United States is now the majority owner of a 450 ton laboratory in space, a facility without compare," he wrote. "The fact that it took too long to build and that we spent more money on it than we should have is irrelevant to future decisions. We have it. We should use it to the maximum possible extent, for as long as we can make it last.

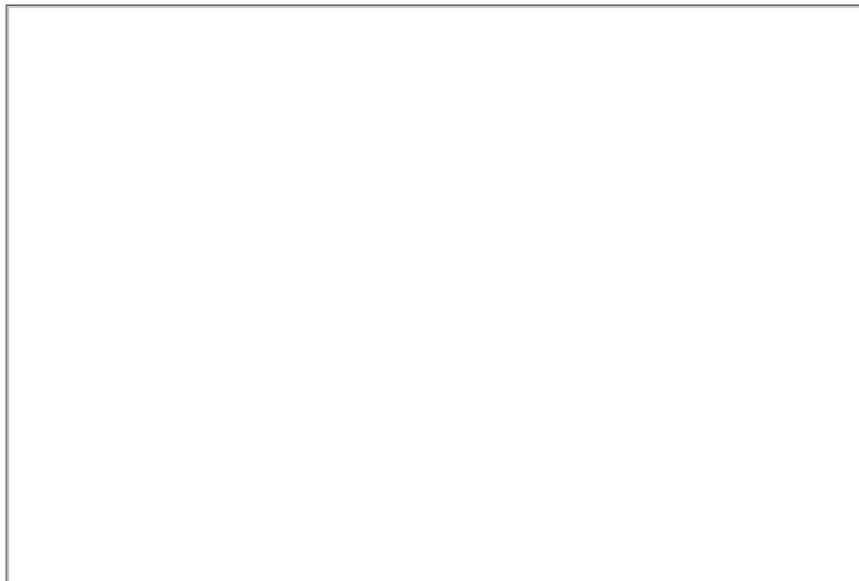
"But we must also go beyond ISS. The existence of future exploration programs cannot be traded against sustenance of the ISS on an 'either-or' basis, as if that were a realistic option. If the nation is to have a viable human spaceflight program, the requirement to sustain ISS while also developing new systems to go beyond low Earth orbit is the minimally necessary standard. If the nation can no longer meet that standard, then it should be so stated, in which case any further discussion of U.S. human exploration beyond LEO (low-Earth orbit) is moot for the next two decades."

4:00 PM, 9/10/09, Update: ATK test fires Ares 1 five-segment booster

With the future of NASA's embattled moon program in doubt, Alliant Techsystems test fired a huge five-segment solid-fuel booster in Utah Thursday, a ground-shaking demonstration designed to collect performance data for a new rocket intended to replace the space shuttle.

Generating 22 million horsepower, the lengthened 154-foot-long shuttle booster ignited with a torrent of flame at 3 p.m. EDT, sending a towering column of dirty brown exhaust into the Utah sky as hundreds of spectators looked on. Two minutes later, after consuming 1.4 million pounds of solid propellant, the rocket burned out.

"After witnessing what we just saw, it's pretty easy to become speechless," said Alex Priskos, first stage manager for Ares Projects at NASA's Marshall Space Flight Center in Huntsville, Ala. "That was quite remarkable. This did exactly what we wanted to do. We are confident we're going to get all the data we wanted to get out of this test. I think the team did a great job, we got the test we wanted to get. ... We are very, very pleased. The data looks great."



**ATK's five-segment DM-1 booster is test fired in Utah.
(Photo: Alliant Techsystems)**

Said Charles Precourt, vice president and general manager of space launch systems for ATK: "It's a very humbling experience when you think about harnessing the kind of energy we just unleashed today, 3.6 million pounds of thrust. Our engineers in the back rooms are ecstatic, the preliminary indications look wonderful."

NASA plans to use a five-segment shuttle booster as the first stage of its Ares I rocket, one of two being designed as part of the post-shuttle Constellation program. Carrying a hydrogen-fueled second stage, the Ares I is designed to boost Orion crew capsules into low-Earth orbit for flights to the International Space Station and eventual trips to the moon.

Two five-segment boosters would be used to help launch a huge new unmanned rocket called the Ares V designed to loft Altair lunar landers into orbit. After docking with an Orion capsule, the Ares V would boost the combined spacecraft to the moon. NASA hopes to establish long-duration research stations on the moon in the early 2020s.

But a presidential panel reviewing manned space flight options submitted an executive summary to the White House earlier this week saying NASA does not have enough money in its projected budget to pay for the Constellation program.

In a list of five options, the panel strongly favored development of commercial launch vehicles and capsules, although no such systems currently exist and even though shuttle boosters have chalked up a record of just one failure in 256 launchings.

Until the White House and the Office of Science and Technology Policy make a decision on what space architecture to support, NASA is pressing ahead with development of the Constellation program and the Ares 1 rocket.

An Ares 1-X test rocket, made up of a standard four-segment shuttle booster, a dummy second stage and a mock-up of an Orion capsule, currently is stacked and undergoing check out in the Vehicle Assembly Building at the Kennedy Space Center. NASA plans to launch the rocket from complex 39B around Oct. 31.

"Here in another six weeks or so, we're going to be taking the next great step with a flight test of the prototype of this vehicle," said Precourt, a former shuttle commander. "We're just really, really thrilled we've achieved this milestone."

01:45, 9/10/09, Update: Japan launches new station cargo craft on maiden flight

The Japanese space agency successfully launched a powerful new rocket Thursday carrying an unmanned space station cargo ship on a complex maiden voyage to deliver some 7,400 pounds of equipment and supplies to the orbital outpost.

With four strap-on boosters gushing white-hot exhaust and a pair of hydrogen-fueled main engines roaring at full throttle, the H-2B rocket thundered away from launch pad 2 at the Tanegashima Space Center in southern Japan at 1:01:46 p.m. EDT.

"The launch was beautiful," Stephen Clark, a U.S. journalist representing Spaceflight Now, said in an instant message. "The boosters lit with the typical orange glow and away she went. The rocket went into a thick cloud layer around 25 seconds after liftoff, but the rumble shook us for a couple minutes more."

The H-2B's first and second stages worked as planned and 15 minutes after liftoff, the HTV cargo craft was released into its planned

preliminary orbit, prompting an enthusiastic round of applause in the Japanese control center.

The \$680 million mission represents a critical milestone for the post-shuttle space station program as NASA and its international partners work to keep the lab complex resupplied after the space shuttle is retired late next year.



Japan's new H-2B rocket blasts off from the Tanegashima Space Center.
(Credit: Stephen Clark/Spaceflight Now)

The HTV cargo craft, developed by the Japan Aerospace Exploration Agency, or JAXA, as a contribution to the station program, measures some 32 feet long, 14.4 feet wide and weighs some 23,000 pounds when carrying a full 13,200-pound load of cargo. For its maiden flight, the HTV-1 is carrying about 3.5 metric tons of equipment and supplies.

Unlike Russian Progress supply ships of the European Space Agency's automated transfer vehicle, or ATV, the Japanese HTV features a pressurized section accessible by the station crew and an unpressurized cargo bay to carry experiments and hardware that can be mounted on the station's hull.

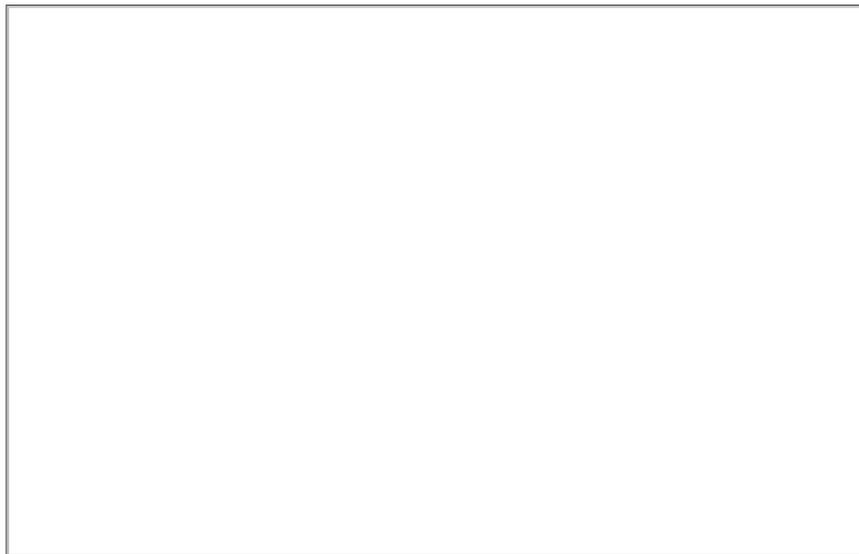
And unlike the Progress and the ATV, the Japanese ship is not designed to dock with the station on its own. Instead, the spacecraft autonomously maneuvers to a position just below the station and waits for the lab's robot arm to grapple it and move it to a docking port.

"On this particular flight, we've got about two-and-a-half tons of pressurized cargo flying to orbit and almost a metric ton of payloads externally coming to ISS," said space station Program Manager Mike Suffredini. "So it's a significant amount of up mass to us and it's not only important logistics for the crew, which is a major part of the pressurized capability, but also quite a bit of payloads.

"Almost 20 percent of the pressurized volume is research hardware. Also, the two payloads externally (in the cargo bay) are very unique and new capabilities for ISS. There's been quite a bit of talk about the use of ISS for Earth research and in fact, the two payloads flying ... are intended to do that very thing."

One of the payloads in the HTV's unpressurized cargo bay is a NASA experiment to map the constituents of the upper atmosphere and the other is a JAXA payload designed to study the effects of trace gases on the ozone layer. Both will be extracted from the HTV cargo bay by the station's robot arm and installed on an external porch by a Japanese robot arm on the Kibo lab module.

"Those are very critical things for us to understand relative to understanding our environment and how we affect it and it's good to be able to finally start having this kind of research on board ISS," Suffredini said.



The HTV-1 cargo craft. (Credit: JAXA)

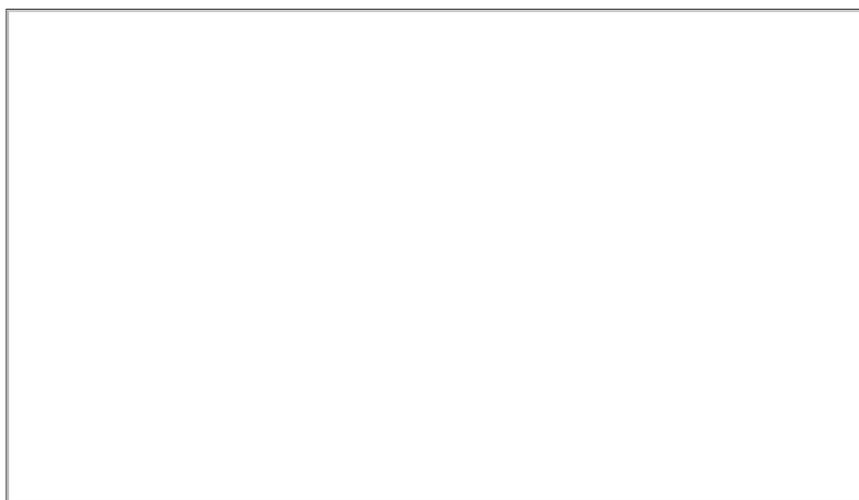
Not only is the flight a maiden voyage for the HTV, it's also the maiden flight of Japan's new H-2B rocket, a much more powerful version of JAXA's hydrogen-fueled H-2A booster. The new rocket features four strap-on solid-fuel boosters instead of two and two hydrogen-fueled first stage engines instead of one. The upper stage features a single hydrogen-powered engine.

"The H-2B launch vehicle is the largest new model rocket in Japan to maintain and improve the previous high reliability of the H-2A launch vehicle," said Masazumi Miyake, a JAXA project manager. "We are so proud of taking this new responsibility to provide cargo transportation capability to ISS program. HTV-1 has opened up a new horizon for JAXA in its undertaking of human spaceflight activities. JAXA is now entering a new era."

JAXA currently plans to build and launch one HTV craft per year, although the agency could support two flights annually if necessary.

The HTV-1 flight plan calls for a full week of orbital tests and checkout before final approach to the space station, including tests to exercise the craft's abort modes. Capture is planned for flight day eight.

Final approach will begin at a point about 3.1 miles directly behind the International Space Station. The HTV-1 will maneuver itself to a position about 1,000 feet below the lab complex and then carry out a 180-degree yaw maneuver to permit an abort, if necessary, when the craft is closer to the station.



The HTV-1 cargo craft, positioned for capture. (Credit: JAXA)

From there, it will continue the approach to a point about 100 feet below the station and pause once again before proceeding to the capture point just 29 feet from the laboratory complex.

At that point, with the HTV-1 in free drift, station flight engineer Nicole Stott will use the lab's robot arm to lock onto a grapple

fixture. Canadian astronaut Robert Thirsk then will take over and guide the HTV-1 to a docking at the Harmony module's nadir, or Earth-facing, port.

"A few minutes after capture, Bob Thirsk will begin positioning HTV for inspection of its passive common berthing mechanism, or PCBM," said station Flight Director Dana Weigel. "During this time period, the HTV team will take all of HTV's free flight systems to a dormant mode in preparation for the attached phase.

"The crew will perform the PCBM inspection from the nadir hatch window. When the inspection is complete, the HTV will be positioned for berthing with (flight engineer) Frank De Winne operating the berthing mechanism latches. After berthing, the crew will install all the power and data connections and then overnight, the ground will activate the vehicle."

The HTV-1 features triple redundancy in critical systems, but an abort will be automatically implemented if two failures occur in a common system.

"All the aborts the vehicle does look the same, they have the same magnitude, so it's very simplistic in terms of the type of burn, what the vehicle's trying to do," Weigel said. "In terms of criteria for an abort, if the vehicle suffered two system failures in a common system, for example, if I had two propulsion strings that went down, in that case I'd still have a third string but that's my only remaining string, the vehicle would automatically do an abort.

"So the overall philosophy is that any point I get down to zero fault tolerance for a certain given critical system, the vehicle will automatically do an abort."

The day after capture, the crew will open hatches between Harmony and the HTV and begin moving equipment and supplies into the station.

"HTV's going to deliver food, laptops, payloads, the Japanese small flying arm and a number of other key items," Weigel said. "A few days after capture, we'll begin our exposed pallet operations and the transfer of the two payloads."

The two experiments mounted in the HTV's unpressurized cargo bay are mounted on a sliding shelf. The station's robot arm will grapple the platform, pull it out and move it over to the outboard end of the Kibo lab module. At that point, De Winne will use Kibo's robot arm to move the experiments to an external porch, plugging them into power and data ports.

The day after the transfer, the station arm will move the empty experiment pallet back to the HTV and re-insert it in the cargo bay.

After removing the equipment and supplies delivered aboard the HTV, the astronauts will prepare it for undocking and re-entry.

"Bob Thirsk will be flying the station arm," Weigel said. "He'll position HTV at the release position, that's about 12 meters (40 feet) below the station. During this maneuver and while HTV is at the release point, the HTV flight control team will re-activate all the free flight systems that were dormant during the attached phase.

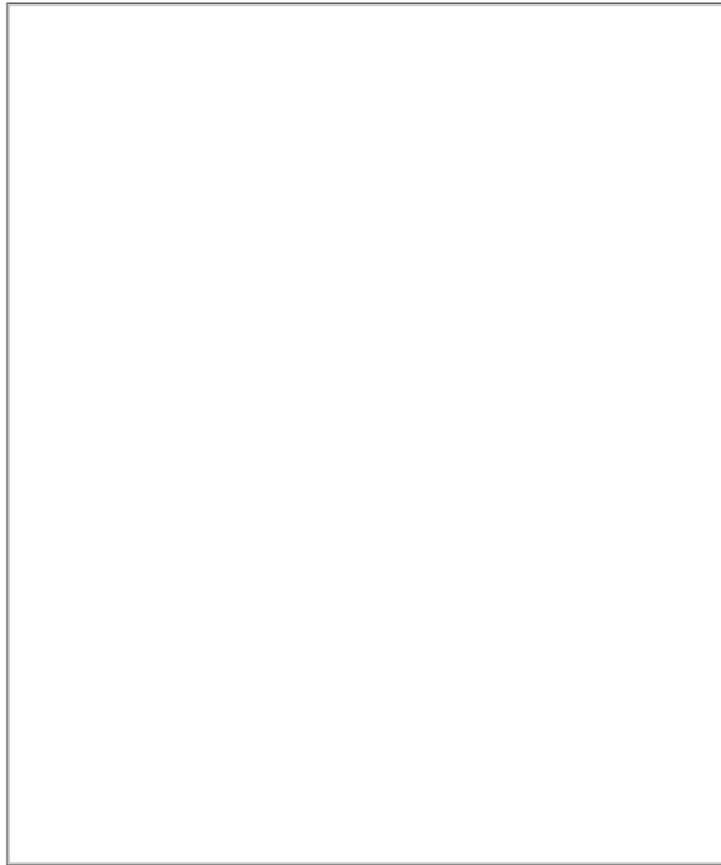
"Once we get the vehicle to the release position, the SSRMS will release it and then back away. The crew will then send a retreat command, which activates (HTV's) propulsion system and starts a series of four burns. HTV initially moves away along the r-bar (directly below) and then it moves out in front of ISS.

"It'll do a series of deorbit and re-entry burns and then about two days after release, HTV will re-enter Earth's atmosphere ... over the southern portion of the Pacific Ocean."

3:30 PM, 9/9/09, Update: Repaired Hubble Space Telescope back in action

NASA scientists showed off spectacular new pictures from the Hubble Space Telescope Wednesday, a stunning gallery of remote galaxies, an enormous globular cluster packed with countless pinpoint stars and a dying sun blowing off its outer atmosphere in butterfly-like wings of debris.

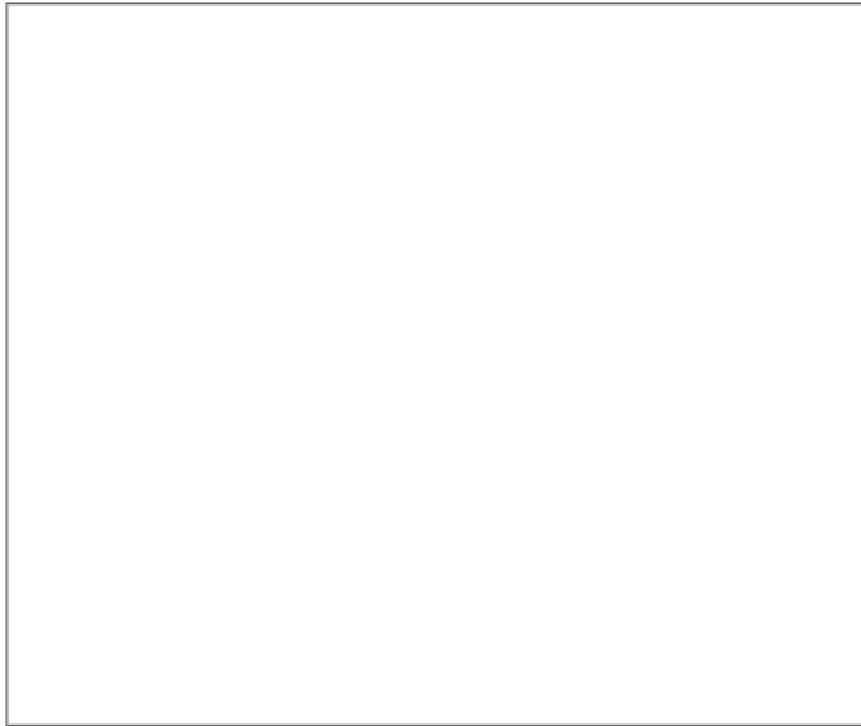
The pictures clearly show the fabled telescope is back in action and resuming its role as one of the most productive observatories on or off the planet, thanks to a dramatic five-spacewalk shuttle repair mission last May.



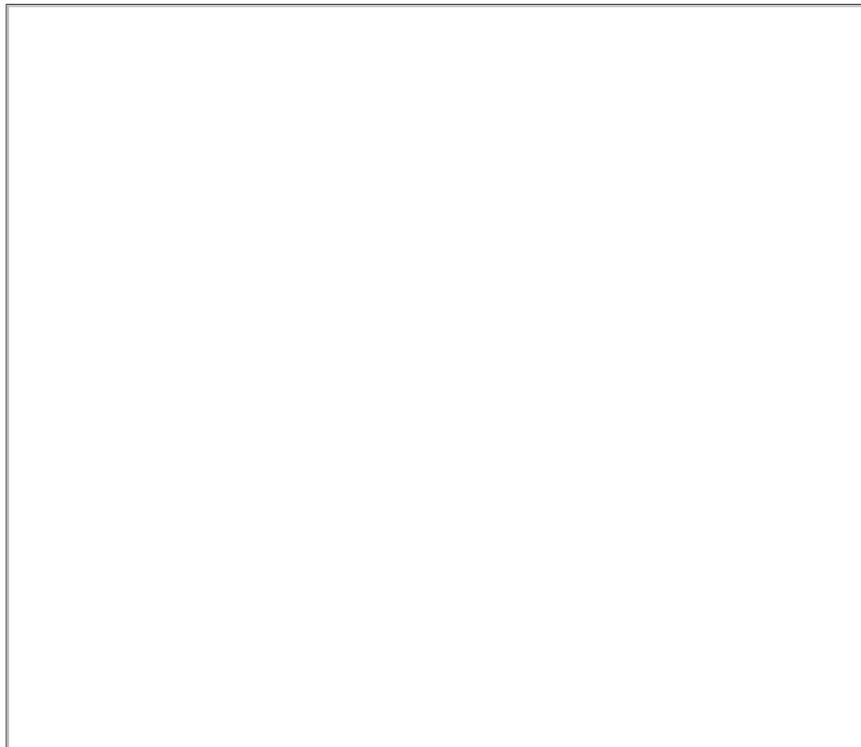
**Planetary nebula NGC 6302, a star in the final stages of its life, in a dramatic new photo from the repaired Hubble Space Telescope.
(Photo: NASA)**

"Every field of astrophysics, whether it's our local neighborhood of planets, nearby stars and their attendant planets, galaxies, clusters of galaxies, out to the edge of the universe, every field has questions that are awaiting the power of Hubble," said astronomer Heidi Hammel, senior research scientist at the Space Science Institute in Boulder, Colo. "You're only getting the tiniest taste of what the astronomers are planning to do with Hubble over as many years as it can last.

"We're giddy with the quality of the data that we have with this new telescope," she said. "We're especially excited to have the spectrographic data restored to Hubble. ... We are entering a new era of astronomy. Hubble's new beginning is just setting the stage for what's going to be coming."



A portion of the Omega Centauri globular star cluster as viewed by the Hubble Space Telescope. (Photo: NASA)



Optical and near-infrared views showing the interior of a star-forming region. (Photo: NASA)

The shuttle Atlantis roared into orbit May 11 on a fifth and final mission to service and upgrade the space telescope. The flight was canceled by former Administrator Sean O'Keefe in the wake of the 2003 Columbia disaster because heat shield repair techniques were not available and because a Hubble crew, operating in a different orbit, could not seek safe haven aboard the space station if a major problem prevented a safe re-entry.

Michael Griffin, O'Keefe's successor, reinstated the repair mission after spacewalking astronauts demonstrated heat shield repair techniques. He also ordered engineers to process a second shuttle in parallel to serve as an emergency rescue vehicle if needed.

During Atlantis' mission, four spacewalkers, working in two-man teams, carried out five back-to-back spacewalks to install six new stabilizing gyroscopes, six new nickel-hydrogen battery packs, a replacement data computer and two new instruments, the \$131 million Wide Field Camera 3 and the \$88 million Cosmic Origins Spectrograph. Like all modern Hubble instruments, both were equipped with corrective optics to counteract the spherical aberration that prevents Hubble's 94.5-inch mirror from achieving a sharp focus.

The Atlantis astronauts also repaired two other instruments: the Space Telescope Imaging Spectrograph, which suffered a power supply failure in 2004, and the Advanced Camera for Surveys, which broke down in 2007. Neither instrument was designed to be serviced in orbit, but engineers devised custom tools and an ingenious plan that allowed the spacewalkers to bypass the failed electronics.

The repair crew also installed an upgraded fine guidance sensor, new insulation and a grapple fixture that will permit attachment of a rocket motor or even NASA's new Orion manned spacecraft in the future to drive Hubble out of orbit when it is no longer able to do science.

"Bottom line, these professionals left Hubble as a new state-of-the-art telescope," said Ed Weiler, NASA's associate administrator for space science. "This is the fifth time we've had a new telescope up there, capable of continuing its historic scientific journey for at least five more years and, I would bet, a long time after that."

While enormous ground-based telescopes currently on the drawing boards will dwarf Hubble's relatively modest mirror, Weiler said its position above the atmosphere guarantees it will remain at the forefront of astronomy for years to come.

Along with unparalleled wide-field views of the cosmos, "the other thing Hubble can do that can never, ever be done from the ground is imaging in the ultraviolet and imaging in some of the near infrared wavelengths of light," Hammel said. "Because our Earth's atmosphere absorbs the photons before they get to the surface of the Earth.

"So you could make a football field-sized telescope and never collect a photon because they aren't there. Hubble is absolutely unique, we must have a telescope in space to complement the very large telescopes on the ground. Hubble is absolutely unique at those wavelengths. Nothing else can do it."

Asked to predict how Hubble will be remembered a century from now, senior Project Scientist David Leckrone said "we need to be humble. But in all humility, I truly believe that Hubble has fundamentally changed the course of modern astronomy and astrophysics. And it's taken it in new directions."

"I think we have basically shoved aside the old textbooks and the old concepts of the universe we live in that were based entirely on this distorted view we have through the Earth's atmosphere. And we have laid a foundation of clear vision that is the starting point from which all future UV/optical and near-infrared astronomy will proceed."

NASA spent some \$887 million on the final Hubble servicing mission, pushing the total cost of the project to around \$10 billion since its inception in the late 1970s.

7:45 PM, 9/8/09, Update: Augustine panel presents five manned space options; concludes none viable without significant new funding, long-term commitment

A presidential panel assessing U.S. manned space flight presented five options to the White House today, ranging from NASA's current plan to build outposts on the moon to a "flexible path" approach to explore a variety of targets in the inner solar system.

But in its executive summary, the panel warned that without significant additional funding and a long-term commitment to exploration, none of the options is viable.

"The Committee has found two executable options that comply with the FY 2010 budget," the panel wrote in its executive summary. "However, neither allows for a viable exploration program. In fact, the Committee finds that no plan compatible with the FY 2010 budget profile permits human exploration to continue in any meaningful way."

The Review of U.S. Human Space Flight Plans Committee, chaired by former Lockheed Martin CEO Norman Augustine, was set up by the Obama administration to examine NASA's current plans for retiring the shuttle, completing the space station and returning to the moon, as well as alternative strategies for moving beyond low-Earth orbit.

The committee also considered how long NASA and its partners should operate the International Space Station. NASA currently has no money in its projected downstream budget to operate the space station beyond 2015.

In its executive summary - the group's final report is not yet complete - the panel did not make any recommendations. Instead, it listed five options, or architectures, and the pros and cons associated with each. The first two options assume NASA is forced to live

within current 2010 budget projections.

In Option No. 1, essentially the Bush administration's Constellation program, the International Space Station would be deorbited in 2015 and a new Ares I rocket would be developed to launch Orion crew capsules to low-Earth orbit.

NASA then would develop a huge heavy lift Ares V rocket to boost Orion capsules and Altair lunar landers to the moon for long-term exploration starting in the early 2020s. The Augustine panel notes that this option was effectively derailed by previous budget cuts that withdrew expected funding.

If NASA is forced to live within the current budget projection, "Ares I and Orion are not available until after the ISS has been deorbited," the panel concluded. "The heavy-lift vehicle, Ares V, is not available until the late 2020s, and worse, there are insufficient funds to develop the lunar lander and lunar surface systems until well into the 2030s, if ever."

A second "constrained budget" option calls for NASA to operate the space station until 2020. Under this scenario, the space agency would forego development of the Ares I rocket and instead rely on private industry to develop manned spacecraft to reach low-Earth orbit. NASA would develop a manned heavy lift rocket called Ares (Lite).

"The option assumes shuttle (retirement) in FY 2011, and it includes a technology development program, a program to develop commercial crew services to low-Earth orbit, and funds for enhanced utilization of ISS," the panel wrote. "This option does not deliver heavy-lift capability until the late 2020s and does not have funds to develop the systems needed to land on or explore the Moon."

The remaining three options, and several variants, all assume the White House and Congress approve additional funding, increasing NASA's budget to \$3 billion a year above the current projections by fiscal 2014 and then growing with inflation at 2.4 percent per year.

Under that scenario, assuming the shuttle is retired in 2011 and the station deorbited in 2015, NASA could, in fact, press ahead with the current Constellation program. But the Ares I/Orion vehicle would not be ready before 2017 and manned flights to the moon would slip into the mid 2020s.

Option No. 4, known as "Moon First," would extend the station through 2020 and retain the moon as the nation's primary target beyond low-Earth orbit. But it would rely on development of commercial access to low-Earth orbit. Two variants were considered.

In one, Option 4A, the shuttle is retired and NASA develops the Ares V (Lite) rocket to boost manned spacecraft to the moon. In Option 4B, the shuttle program is extended through 2015 at a "minimum safe flight rate" and a new heavy lifter based on shuttle technology is developed to reach the moon.

In both of the "Moon First" variants, astronauts could return to the moon by the mid 2020s.

Option No. 5, the one the Augustine panel seems to favor, represents a so-called "flexible path" architecture that would explore the inner solar system with long-duration flights to a variety of targets, ranging from lunar orbit to the moons of Mars. The long-range goals could include lunar landings and eventual flights to Mars itself.

There are three variants to option No. 5, differing only in which heavy lift rocket is used: Ares V (Lite), an evolved expendable launch vehicle, or EELV, or a shuttle-derived rocket.

"All variants of Option 5 begin exploration along the flexible path in the early 2020s, with lunar fly-bys, visits to Lagrange points and near-Earth objects and Mars fly-bys occurring at a rate of about one major event per year, and possible rendezvous with Mars's moons or human lunar return by the mid to late 2020s," the panel wrote.

The panel concluded:

"Human exploration beyond low-Earth orbit is not viable under the FY 2010 budget guideline.

"Meaningful human exploration is possible under a less constrained budget, ramping to approximately \$3 billion per year above the FY 2010 guidance in total resources.

"Funding at the increased level would allow either an exploration program to explore Moon First or one that follows a Flexible Path of exploration. Either could produce results in a reasonable timeframe."

But it will not be easy, even with additional funding. The project gap between the end of shuttle operations and the debut of a new spacecraft to replace it will stretch at least seven years, the panel said. A heavy-lift rocket is a requirement for any exploration scenario and in all but a few cases, so is development of commercial access to low-Earth orbit.

"Commercial services to deliver crew to low-Earth orbit are within reach," the panel wrote. "While this presents some risk, it could provide an earlier capability at lower initial and lifecycle costs than government could achieve. A new competition with adequate incentives should be open to all U.S. aerospace companies. This would allow NASA to focus on more challenging roles, including human exploration beyond low-Earth orbit, based on the continued development of the current or modified Orion spacecraft."

The panel stressed that Mars remains the "ultimate destination" for human exploration of the inner solar system. "But it is not the best first destination."

"Both visiting the Moon First and following the Flexible Path are viable exploration strategies," the panel wrote. "The two are not necessarily mutually exclusive; before traveling to Mars, we might be well served to both extend our presence in free space and gain experience working on the lunar surface."

The panel's full report is expected to be presented to the White House around the end of the month. When the Obama administration might act is not yet known.

5:30 PM, 9/2/09, Update: Laliberte outlines 'poetic social mission' to space station

Cirque du Soleil founder Guy Laliberte, training for a nine-day stay aboard the International Space Station next month, said Wednesday he plans to orchestrate a five-continent, 14-city extravaganza Oct. 9 as part of his "poetic social mission" to raise awareness of water as a critical cultural and environmental issue.

"As soon as I arrive on board of the International Space Station, I will actively prepare my segment of a planetary artistic event that will happen on Oct. 9, two days before I land back on Earth," Laliberte said during a webcast from Moscow.

"On Oct. 9, for 120 minutes - just a little longer in time than it takes to circle the Earth in space - we will be presenting a unique artistic event in 14 cities on five continents and space. Beginning in Montreal, closing in Moscow, we will travel the world, unveiling part of a poetic tale to a voice of international personality. We will also be presenting ... artistic presentations linked to water as an inspiration and as a source of life."

Among those Laliberte said had agreed to participate are former Vice President Al Gore, U2, Shakira, Canadian astronaut Julie Payette and Peter Gabriel. The theme of the production is "Moving Stars and Earth for Water."



Guy Laliberte, in a lighter moment, during training for launch to the space station. (Photo: Space Adventures Ltd.)

"They will take part in the event either by reading part of the poetic tale, performing, or sharing an artistic work," Laliberte said. "At the heart of the mission is a poetic tale.

"People will have access to a great poem, a great tale that will star the moon, the sun and a drop of water," he said.

The program will focus on the "life sustaining powers of water, the importance of water in agriculture and food security, water pollution ... access to water as a human right, the crisis of melting polar ice caps, the infinite fragility and beauty of the blue planet," he said.

"I truly believe that through art, an artistic event, you can touch the heart of people. I truly believe that through emotion, it stays longer in the head and soul of people. And then change can take place."

By coincidence or not, Oct. 9 also is the day NASA's Lunar Crater Observation and Sensing Satellite is scheduled to crash into a permanently shadowed crater near the moon's south pole in a dramatic project to look for signs of water ice in the lunar soil. Soil and debris blasted from the surface by the impact of LCROSS and its Centaur upper stage booster will be studied for evidence as to whether ice is present on the moon.

Laliberte's production is scheduled to begin roughly 12 hours later, at 8 p.m. EDT, in Montreal, Moscow, Santa Monica, Calif., New York City, Johannesburg, Mumbai, India, Marrakesh, Morocco, Sydney, Tokyo, Tampa, Mexico City, Rio de Janeiro, Paris, London and the International Space Station.

"Every special event in each city will feature an artistic performance, a poetic tale reader and some videography of the artistic elements of water," Laliberte said. "In my 25 years at Cirque du Soleil, I've met and worked with some amazing artists, individuals and leaders. I knew that I could call on them when the time was right. I am so impressed that they have generously (agreed) to participate in my mission."

Laliberte, a Canadian worth an estimated \$2.5 billion, is believed to be paying upward of \$35 million to visit the International Space Station as a "spaceflight participant," or space tourist, in a deal with the Russian space agency arranged through Space Adventures Ltd.

He is scheduled for launch Sept. 30 aboard the Soyuz TMA-16 spacecraft from the Baikonur Cosmodrome in Kazakhstan. His crewmates will be rookie spacecraft commander Maxim Suraev, a colonel in the Russian air force, and NASA astronaut Jeffrey Williams, a shuttle veteran making his second long-duration voyage on the station.

Laliberte will spend nine days aboard the lab complex before returning to Earth aboard the Soyuz TMA-14 capsule Oct. 11 with outgoing station commander Gennady Padalka and NASA flight engineer Michael Barratt. Williams and Suraev will remain aboard the space station as part of the Expedition 21 crew.

9:00 PM, 8/25/09, Update: LCROSS lunar mission malfunction assessed

Engineers are investigating what caused a malfunction aboard NASA's innovative Lunar Crater Observation and Sensing Satellite, or LCROSS, that caused the probe to use an excessive amount of rocket fuel to maintain the proper orientation in space. But officials say the spacecraft "still contains sufficient fuel to complete the full mission."

The \$79 million LCROSS was launched June 18 as a companion payload to NASA's \$504 million Lunar Reconnaissance Orbiter spacecraft, currently undergoing checkout and calibration in lunar orbit. The LRO mission is designed to create a high-resolution map of the moon's surface to help identify sites for future manned missions.

It also will measure the solar and cosmic radiation that future lunar explorers will face and map out the surface topology, mineralogy and chemical composition of Earth's nearest neighbor. One year will be spent scouting future landing sites followed by three years of purely scientific observations.

While LRO was launched directly to the moon, LCROSS was sent into a looping four-month orbit back around the Earth.

The spacecraft is designed to aim itself and its Centaur upper stage rocket back at the moon, targeting a permanently shadowed crater near the south pole for a dramatic crash landing Oct. 9. With LRO looking on from lunar orbit, the 5,000-pound Centaur is expected to hit the dark surface at some 5,600 mph, blasting out a 66-foot-wide crater some 13 feet deep.

The debris excavated by the impact will be blown high above the lunar surface, some of it above the crater's rim and into sunlight for the first time in two billion years or more.

LCROSS, following close behind the Centaur on a virtually identical course, will fly through the debris cloud, spending four precious minutes studying the composition of the material and looking for signs of water ice with a suite of nine instruments.

Then it, too, will crash to the moon less than two miles away after dutifully transmitting its data back to Earth. The Hubble Space Telescope will monitor the impact, as will amateur and professional astronomers in the western hemisphere, looking for the flash that will signal the Centaur's demise.

LCROSS has been operating normally during its cruise phase, but during a communications session on Aug. 22, engineers discovered a problem of some sort had triggered a fault in the spacecraft's inertial reference unit, or IRU. The IRU is used by the probe's attitude control system to determine its orientation in space.

The fault in the IRU caused LCROSS to use a star tracker for attitude information instead and that, in turn, "caused the spacecraft's thruster to fire excessively, consuming a substantial amount of fuel," NASA said in a statement.

"LCROSS mission operations declared a 'spacecraft emergency' and were allocated additional communications time on the Deep

Space Network," the statement said. "The team conducted procedures to mitigate the problem and were able to restart the IRU and reduce fuel consumption to a nominal level. Automatic operations procedures also were implemented to minimize the possibility of another IRU anomaly from occurring while the spacecraft is out of contact with the ground. Since the re-start, IRU has not experienced any additional problems.

"The team continues to actively assess and mitigate the situation and is in contact with the manufacturers of the IRU and star tracker to investigate the root cause of the problems. Mission managers remain optimistic the LCROSS mission can reach its successful conclusion with projected impact at the lunar south pole currently set for 4:30 a.m. PDT on Oct. 9, 2009."

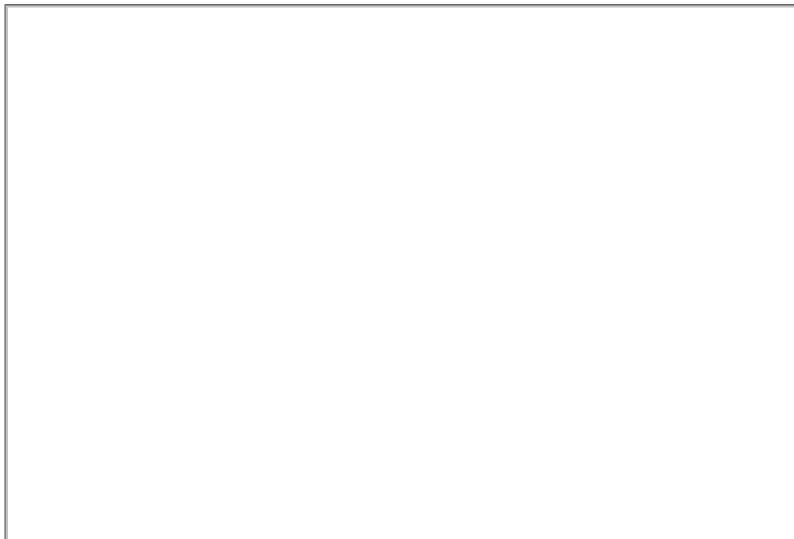
7:45 AM, 8/17/09, Update: Final Air Force Delta 2 rocket carries GPS satellite into orbit

Putting on a spectacular dawn sky show, a workhorse United Launch Alliance Delta 2 rocket carrying a Global Positioning System navigation satellite streaked into orbit early Monday in the final Air Force launch of the venerable booster.

After a smooth countdown, the Delta 2's main engine and six of its nine solid-fuel strap-on boosters roared to life at 6:35 a.m. EDT, instantly pushing the slender blue-and-white rocket away from launch complex 17A at the Cape Canaveral Air Force Station.

Taking off 18 minutes before sunrise, the Delta 2 climbed away through a pinkish-orange sky, streaking past the crescent moon and Venus and then into direct sunlight, its exhaust trail turning brilliant white atop a tongue of flame from the rocket's solid-fuel boosters.

The rocket's arcing trajectory was a familiar sight to residents along Florida's "Space Coast," the 108th launching of a Delta 2 from Cape Canaveral since flights began in 1989, but one of the most spectacular in recent memory thanks to the pre-dawn lighting and a generally clear sky.



The final Air Force Delta 2 rocket blasts off. (Credit: Stephen Clark/Spaceflight Now)

The Delta 2 closed out the Air Force program with a flawless flight, the 89th in a row over the past 12 years since a failure in 1997, successfully boosting the GPS 2R-21 satellite into its planned orbit. The Delta 2 record now stands at 142 successes in 144 flights.

Overall, this was the 343rd Delta rocket launch since 1960. According to [Spaceflight Now](#), this was:

- The seventh Delta launch in 2009
- The 144th Delta 2 rocket mission since 1989
- The 69th Delta 2 rocket fly in the 7925 configuration
- The 60th GPS satellite to launch
- The 49th time a Delta 2 has launched with a GPS satellite
- The 21st GPS Block 2R satellite
- The 108th Delta 2 rocket to fly from Cape Canaveral
- The 62nd Delta 2 launch from pad 17A

Seven more Delta 2 missions are planned, five from the Vandenberg Air Force Base in California and two from Cape Canaveral, five of them for NASA payloads and two for commercial customers. But today's flight was the final chapter in an Air Force program developed in the wake of the 1986 Challenger disaster specifically to boost GPS satellites into orbit.

The next generation of Global Positioning System satellites will be carried by more powerful Delta 4 and Atlas 5 rockets starting early next year.

"While we celebrate the tremendous success the Delta 2 rocket has provided the Air Force over the past many years, we are saddened to say goodbye to what we feel like is a very dear friend," Mission Director John Wagner told reporters before launch. "The Delta 2 rocket provided the military a highly reliable and capable launch service that has directly contributed to our warfighting capability and national defense."

The Air Force now plans to disband the 1st Space Launch Squadron at the Cape Canaveral Air Force station, which managed Delta 2 launches for the Air Force.

"With this mission, the 45th Space Wing is accomplishing another major milestone in our national quest to improve and maintain our space capabilities," said Lt. Col. Erik Bowman, the Air Force launch director. "The GPS constellation has tremendous national security and economic importance. This launch is one of the many ways space operators, and the 45th Space Wing specially, contribute to ongoing combat operations overseas.

"We are planning on inactivating the 1st Space Launch Squadron the day after the GPS 2R-21 launch," Bowman said. "After that, we'll be permitting many of our facilities over to NASA to support its Delta 2 missions."

NASA plans to launch a space tracking demonstration flight for the Missile Defense Agency on September 15 and a lunar mission in 2011 to study the moon's gravity field.

9:25 PM, 8/12/09, Update: Augustine panel narrows options; Constellation 'not executable' with current funding

A presidential panel wrapping up a review of options for future U.S. manned space flight operations delivered a grim assessment today, showing NASA's current plan to retire the shuttle, finish the space station and return to the moon by the early 2020s is not even remotely feasible without a significant increase in funding.

"Our view is that it will be difficult with the current budget to do anything that's terribly inspiring in the human spaceflight area," said Norman Augustine, chairman of the Review of U.S. Human Space Flight Plans Committee.

Augustine's committee was set up by the Obama administration to examine NASA's current plans for retiring the shuttle, completing the space station and returning to the moon as well as alternative strategies for moving beyond low-Earth orbit.

The committee also is assessing how long NASA and its partners should operate the International Space Station. NASA currently has no money in its projected downstream budget to operate the space station beyond 2015.

The Augustine committee believes the station cannot be operated without direct U.S. mission control and management and that it will cost some \$1.5 billion to safely drive the huge complex out of orbit at the end of its life, whenever that might be.

NASA's current long-range plan, developed in the wake of the 2003 Columbia disaster as a Bush administration initiative, is to complete the space station, retire the shuttle fleet and develop a new Orion crew capsule that will be launched to the station by Ares 1 rockets.

During the gap between shuttle operations and the debut of Ares-1/Orion, U.S. astronauts will have to hitch rides to the station aboard Russian Soyuz rockets. NASA managers have assumed all along the station program would be extended and Ares 1/Orion would be used to deliver crews and supplies.

NASA also plans to develop a huge new unmanned heavy lift rocket called the Ares 5 that eventually will boost Orion capsules and Altair lunar landers to the moon for long-duration exploration.

But during a final public hearing today in Washington, the Augustine panel provided a sobering look at NASA's projected budget and the requirements of various manned space flight scenarios.

Considering the Constellation program as the "program of record," panel member and former astronaut Sally Ride said NASA would need an additional \$50 billion or so through 2020 to implement the program as currently planned. This scenario is known as the "unconstrained budget" case.

It assumes the shuttle is retired on schedule and that the space station is deorbited in early 2016, an option no one on the panel seems to favor. In that scenario, the new Orion/Ares 1 system would have no destination until the Ares 5 heavy lifter debuted and moon flights began after 2021.

"In the unconstrained budget, Orion and Ares 1 arrive shortly after ISS is deorbited," Ride said. "And then you get human lunar

return in 2021."

Assuming NASA is forced to live within the 2010 budget guidelines provided by the Obama administration, the Ares 5 heavy lift moon rocket would not be ready until the 2028 timeframe.

"You get, again, Orion and Ares 1 capability of crew to LEO a couple of years after ISS is gone, so there's nothing for Ares 1 and Orion to go to," Ride said. "You do get heavy lift (Ares 5) out in 2028, but you'll notice there are no lunar systems that have been developed, there was not enough money to even start the lunar systems.

"So you have a heavy lift vehicle in 2028 but absolutely nothing to put in it to send to the moon. So this says it pretty well. You cannot do this program on this budget. If you want to do something, you have to have the money to do it."

The Office of Management and Budget deleted more than \$3 billion from NASA's long-range budget projections - money needed for development of the Ares 5 heavy lifter - last spring, before the Augustine panel was formed.

Putting that \$3 billion a year back in the budget would put the Constellation program back on track for a return to the moon in the 2020s, but it would still require the termination of space station operations in early 2016.

"We had quite a discussion about what budget line to choose," Ride said of the "enhanced budget" scenario. "We decided to kind of split the difference. We didn't want to make that budget line too small because then we were afraid we would not be able to accomplish any exploration. We didn't want to make it too large because then we would just be laughed off the stage.

"So it ramps up slowly to \$3 billion a year over the budget that we've been given. Then it stays at a constant \$3 billion a year over that budget out until 2020 and then we allow that redline to grow with inflation at a rate of 2.4 percent per year."

Under that scenario, NASA could return astronauts to the moon in the 2025 timeframe, resulting in a program very similar to what was originally envisioned for Constellation.

But even an additional \$3 billion a year would not cover space station operations past 2015. NASA's international partners in the project - Russia, Japan, Canada and the European Space Agency - want to extend station operations at least through 2020, a goal Augustine panel members endorsed today.

If the White House ultimately adopts an "ISS-focused" approach, development of the Ares 1 rocket likely would be suspended because money needed for the booster's development would be funneled into space station operations instead. Under this scenario, the Ares 1 would not be available until near the end of the station's life.

Instead, the Augustine panel favors development of commercial rockets and capsules to ferry astronauts to and from low-Earth orbit, a major departure from past practice.

Along with presenting options for lunar exploration and extension of the space station, the Augustine panel also is assessing the tradeoffs associated with flying one or two shuttle missions a year past 2011 to reduce the gap before new rocket systems are developed.

Finally, the panel is assessing options for deep space exploration that might bypass the moon in favor of near-Earth asteroids, lunar reconnaissance flybys and even flybys of Mars, with "off ramps" for development of systems for use on the lunar surface and eventual manned landings on Mars.

In this family of scenarios, a slightly different version of the Ares 5 would be used and the rocket would be "man rated" to carry astronauts. The Ares 1 rocket would not be developed for any of these cases.

"We kept coming up with a common theme, which is this budget is very, very, very hard to fit and still have an exploration program," Ride said. "In fact, we are still looking for an existence proof that we can actually find one. We haven't found one yet, but we're still looking."

The panel agreed that Mars is the ultimate objective for human spaceflight in the foreseeable future, but members decided to stop short of suggesting budgets or timetables, concluding manned flights to Mars are simply beyond the scope of current planning.

Augustine said he plans to brief the Office of Management and Budget on the proposed options Friday. The commission's report is scheduled to be completed by the end of the month. When the Obama administration might act on the options is unknown, but the goal of the review was to assess scenarios before the next budget cycle this fall.

12:08 PM, 7/17/09, Update: Cirque du Soleil founder eager to visit space station

JOHNSON SPACE CENTER, Houston--Guy Laliberte, a former street entertainer who founded the enormously successful Cirque

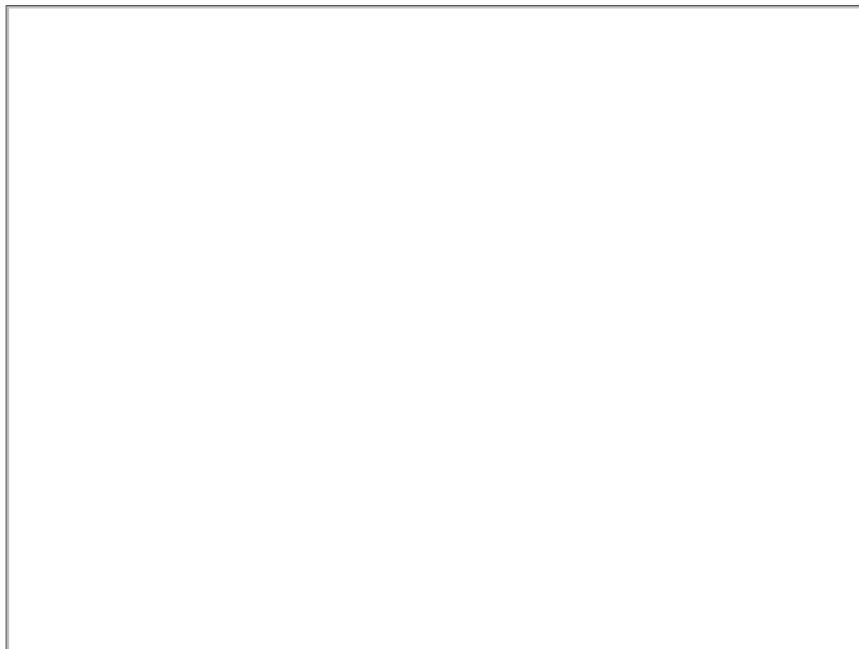
du Soleil, says he doesn't plan any fire eating or stilt walking aboard the International Space Station when he visits this fall.

But he might try to teach his crewmates a few card tricks if he can figure out how to do it in weightlessness.

"Take out the fire part!" he laughed during a news conference Thursday at the Johnson Space Center in Houston. "I think this is out of the question by far. The stilts, I don't know how we we'll be using stilts up there.

"But I think there are a couple of little things, hopefully, that I have learned in my career of street entertainer that I will try to apply up there. ... I think I will be more like a kid in a candy store discovering things that those guys (professional astronauts already) know.

"I know what I can do on Earth, but what I'm really interested in is learning what their world is," he said. "Maybe I'll teach them a couple of tricks of cards, but I don't know in weightlessness how those things can take place."



Cirque du Soleil founder Guy Laliberte (left), astronaut Jeffrey Williams (center) and Soyuz commander Maxim Suraev (right) are scheduled for launch to the International Space Station at the end of September. (Photo: NASA)

Laliberte, a Canadian worth an estimated \$2.5 billion, is believed to be paying upward of \$35 million to visit the International Space Station as a "spaceflight participant," or space tourist, in a deal with the Russian space agency arranged through Space Adventures Ltd.

He is scheduled for launch Sept. 30 aboard the Soyuz TMA-16 spacecraft from the Baikonur Cosmodrome in Kazakhstan. His crewmates will be rookie spacecraft commander Maxim Suraev, a colonel in the Russian air force, and NASA astronaut Jeffrey Williams, a shuttle veteran making his second long-duration voyage on the station.

Laliberte will spend nine days aboard the lab complex before returning to Earth aboard the Soyuz TMA-14 capsule Oct. 11 with outgoing station commander Gennady Padalka and NASA flight engineer Michael Barratt. Williams and Suraev will remain aboard the space station as part of the Expedition 21 crew.

"First of all, I would like to say how privileged and honored I am to be flying with these two men," Laliberte said in Houston, where he is training for his upcoming flight. "I feel totally confident. They have been generous sharing with me their knowledge and their advice."

He said his primary objective is to complete his training, pass the exams and make sure he can take care of himself without bothering the station's professional astronauts.

"The first time that we met I said my intention, my first priority, is to be able to take care of myself up there," Laliberte said. "They helped me to focus on what I should know. At the end, I don't think I'll be a burden. I'm there and I'm committed, I'm a perfectionist. I intend to be ready."

"Yes, I'll probably need help at certain moments," he said. "But I think I'll be a contributor to the success of that mission. Hopefully I'll be well received. I intend to behave as a guest who has good manners. Simple as that."

Laliberte is the founder of the One Drop Foundation, dedicated to improving water conservation. He said he plans to hold a news conference in August to discuss his "Poetic Social Mission" to the space station and to unveil its theme and objectives.

He would not discuss specifics Wednesday, but the One Drop web site says "Laliberte's mission in space is dedicated to making an impact on how water, our most precious resource, is protected and shared. And he will be applying tools he has used so well for most of his life to bring about change: arts and culture."

While some professional astronauts have complained in the past that space tourists have no place on the station, Williams and Suraev both said they welcomed Laliberte.

"So far, my assessment has been very favorable," Williams said. "I think physically, mentally, emotionally he's getting himself prepared and he will be prepared for this adventure in his life."

Said Suraev: "He is really very eager to fly and he is charged with a lot of positive energy. ... He's just a good guy. Since (meeting him) my opinion hasn't changed. As the flight participant, as a crew member, he's a very, very good candidate."

Asked what he is looking forward to the most, Laliberte said "enjoying looking at planet Earth and space."

"I think this is a great, great opportunity of inspiration," he said. "And I intend to inspire myself as much as possible. And also, I would say living a human experience with the people I will be up there (with) and living that moment fully like I do on Earth."

He said his Poetic Social Mission "is a project that I'm very proud of, it is a mission that hopefully will bring and create awareness in regard to the situation of water around the world. As you know, I'm not a scientist, I'm not a doctor, I'm not an engineer. I'm an artist, a creator. And I'll try to accomplish this mission with my creativity and what life has given me as a tool."

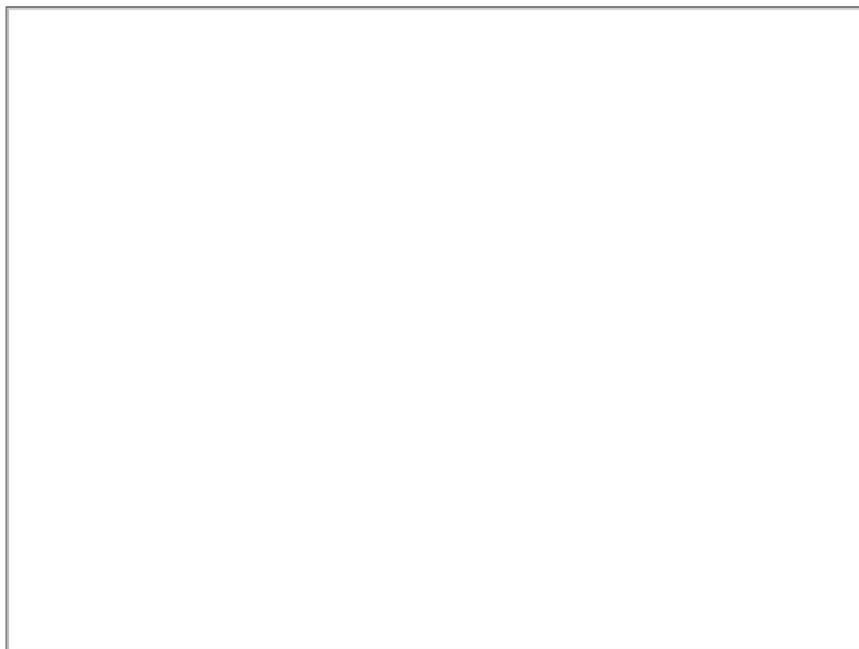
07:10 PM, 6/27/09, Update: GOES satellite launched

Running a day late because of stormy weather, a United Launch Alliance Delta 4 rocket boosted a new GOES weather satellite into space Saturday to serve as an orbital spare for the National Oceanic and Atmospheric Administration's fleet of hurricane-tracking weather sentinels.

The Delta 4, equipped with two strap-on solid-fuel boosters, ignited with a rush of flame and smoke at 6:51 p.m. and quickly climbed away from launch complex 37B at the Cape Canaveral Air Force Station, arcing to the east and accelerating toward orbit.

"Three, two, one and liftoff of the Delta 4 rocket with GOES-O, enhancing quality and reliability of the weather satellite for the forecaster," said NASA launch commentator George Diller.

It was the 10th flight of a United Launch Alliance Delta 4 rocket and the second of three launchings planned for this year.



A United Launch Alliance Delta 4 rocket carrying NOAA's GOES-O weather satellite roars to life. (Photo: NASA TV)

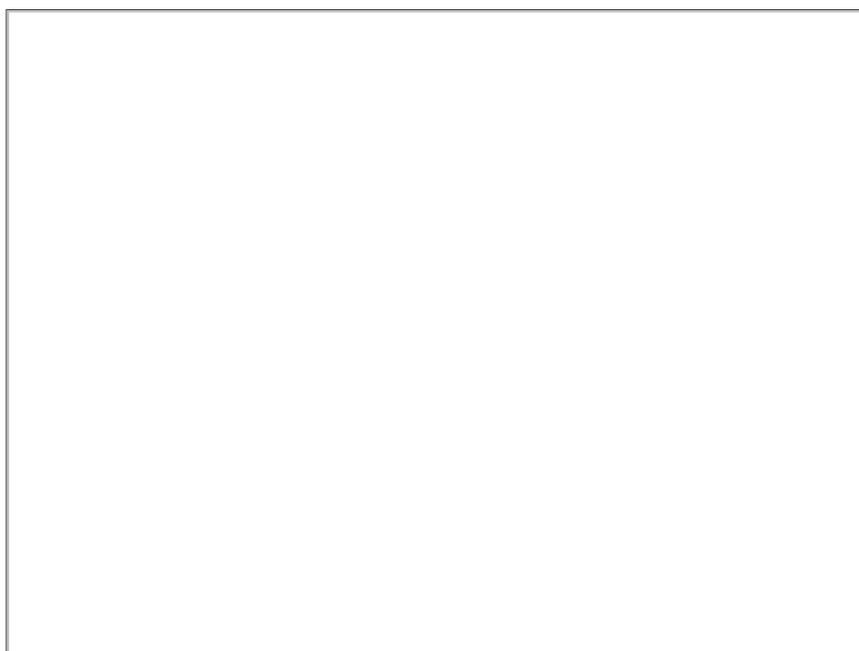
A launch attempt Friday was called off because of thunderstorms and electrical activity near the Cape Canaveral Air Force Station. More of the same was on tap today and forecasters initially predicted a 70 percent chance of a launch delay.

Thunderstorms rolled over the launch pad during fueling but conditions improved as the afternoon wore on and after a 37-minute delay to allow a storm cell to move past to the south, NASA and United Launch Alliance proceeded with launch.

The Delta 4's first stage performed normally, boosting the vehicle to an altitude of about 90 miles before falling away four-and-a-half minutes after liftoff.

The rocket's second stage then lofted the spacecraft into an initial parking orbit before two additional firings needed to place the 7,000-pound GOES-O satellite into an elliptical transfer orbit with a high point of about 21,800 miles and a low point of 4,100 miles.

Spacecraft separation was targeted for four hours and 21 minutes after launch. On-board thrusters will be used to put the satellite in its final circular orbit 22,300 miles above the equator. That milestone is expected July 8 and if all goes well, Boeing Space and Intelligence Systems will turn the satellite over to the government on July 18.



The shuttle Endeavour, mounted atop pad 39A at the Kennedy Space Center, as the ULA Delta 4 rocket blasts off in the background. (Photo: NASA TV)

The Geostationary Operational Environmental Satellite system provides the hemispheric views familiar from television weathercasts. Observations of the Atlantic Ocean, the Gulf of Mexico and the East Coast are provided by the GOES-12 satellite - critical for hurricane tracking - with GOES-11 providing similar coverage of the the West Coast and the central Pacific Ocean past Hawaii.

GOES-O will be known as GOES-14 once on station, joining the GOES-13 satellite, launched three years ago, as an orbital spare.

"GOES-O will provide another important operational asset to NOAA and will become part of the nation's infrastructure for both weather and environmental forecasting," said Steve Kirkner, GOES project manager at NASA.

The latest GOES satellites feature an imaging system and a sounder that collects atmospheric data needed to predict surface and cloud-top temperatures, moisture content and ozone distribution. The imagers produce higher resolution pictures than earlier models, allowing forecasters to more accurately track small-scale features.

"The things we're looking for, tornadoes and severe thunderstorms are very small in scale," said Joe Schaefer, director of NOAA's Storm Prediction Center in Norman, Okla. "The increased resolution and accuracy that these satellites will present will help us pinpoint what's happening, and if we know what's happening, we can do a better job of making short-term and long-term forecasts

of where it's going to be."

Along with saving lives, improved resolution can lower costs as well.

"There's an old rule of thumb that if we can evacuate fewer people for a hurricane, for every mile we don't have to evacuate that saves you a million dollars on average," said Tom Wrublewski, technical acquisitions manager for the GOES project. "That translates into savings for you and I ... and being able to know where tornados and other storms are."

Like all recent GOES satellites, the two newest models also include space environment sensors to measure energetic particles blown off by the sun, to monitor Earth's geomagnetic field and to look for X-ray and ultraviolet emissions from powerful solar flares that can disrupt communications.

"GOES-O is going to better ensure that we have continuous coverage in the decade ahead, it's going to improve our imaging, atmospheric sounding, and our near-Earth space weather environmental measurements that are essential to accurate weather and solar forecasts," said Wrublewski.

Along with improve hurricane tracking and forecasting, the new satellites will provide "clearer cloud top and wind products and also better detection of aerosols."

"We'll be better able to watch where those volcanic plumes are going and that is very important to airline pilots not to foul their engines," he said.

Engineers will check out the new satellite and calibrate its instruments over the next two months to make sure the spacecraft is functioning normally. The first visible-light full-disk image of the Earth is expected around July 28 and an X-ray instrument that will monitor solar flares will send down its initial test image Aug. 6.

Once checkout is complete, the satellite will go into storage mode near GOES 13 to await call up as needed. Projections indicate GOES-12 will begin running into fuel-shortage issues late this year, followed by similar issues with GOES-11. The new satellites have a 10-year design life.

"We don't really know when we're going to need it," said Marty Davis, an advisor to the GOES project. "We know the two operational satellites that are up there now are not perfect and are becoming less perfect as time goes on. So the next one to be operational will be GOES-13, which was launched three years ago. We don't think we'll have two spares for very long. The prediction is GOES-13 will be made operational by the end of the year."

7:30 AM, 6/23/09, Update: Lunar Reconnaissance Orbiter brakes into orbit around the moon

Four-and-a-half days after launch, NASA's \$504 million Lunar Reconnaissance Orbiter fired its main thrusters for 40 minutes early Tuesday, successfully braking into an initial elliptical orbit around the moon.

The critical rocket firing began around 5:47 a.m. EDT and ended as planned at 6:27 a.m., putting the spacecraft into an orbit tilted 30 degrees from the moon's poles with a low point of 136 miles and a high point of 1,926 miles.

"All stations, this is flight," the mission flight director said. "Congratulations on a successful LOI (lunar orbit insertion) to return NASA to the moon."

Over the next five days, the Lunar Reconnaissance Orbiter will carry out four additional rocket firings to put the spacecraft in its so-called commissioning orbit with a low point of about 18.5 miles above the moon's south pole and a high point of 134 miles above the north pole. The orbit eventually will be circularized at about 31 miles above the moon.

"The tracking shows we're essentially where we planned to be, we're at the moon," said LRO project manager Craig Tooley. "It went like clockwork. With a mission like this, we spent literally years practicing for every possible contingency to be ready for this. In the end, it went exactly as planned."

LRO will spend two months in its commissioning orbit before maneuvering into the desired 31-mile-high mapping orbit.

Equipped with seven state-of-the-art cameras and other instruments, LRO will look for suitable landing sites for future manned missions while creating the most detailed lunar atlas ever assembled.

The 4,200-pound solar-powered spacecraft also will measure the solar and cosmic radiation that future lunar explorers will face and map out the surface topology, mineralogy and chemical composition of Earth's nearest neighbor. One year will be spent scouting future landing sites followed by three years of purely scientific observations.

LRO was launched by an Atlas 5 rocket from the Cape Canaveral Air Force Station last Thursday along with a companion

spacecraft, the \$79 million Lunar Crater Observation and Sensing Satellite, or LCROSS. The two spacecraft separated shortly after launch.

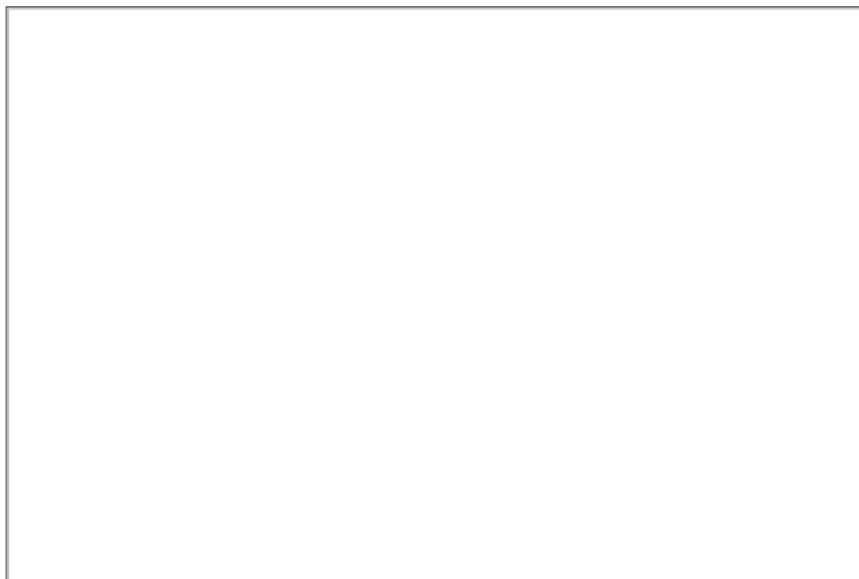
LCROSS is designed to guide the Atlas 5's spent Centaur second stage to an impact in a permanently shadowed crater near the moon's south pole on Oct. 9. Instruments aboard LCROSS, LRO, the Hubble Space Telescope and at observatories on Earth will study the debris thrown up by the crash to look for evidence of ice.

6:20 PM, 6/18/09, Update: Atlas 5 blasts off on lunar scouting mission

An Atlas 5 rocket thundered to life and majestically streaked into space today, boosting two NASA spacecraft toward the moon for an ambitious \$583 million mission to scout out landing sites for future manned missions and to search for evidence of hidden ice near its frigid poles.

One spacecraft will map the cratered surface from a perilously low 31-mile-high orbit while the other will blast out 350 tons of pulverized rock and soil for chemical analysis, digging a shallow 66-foot-wide crater in a kamikaze crash visible from Earth.

"What we're about is taking us all back to the moon," said Cathy Peddie, a deputy project manager at NASA's Goddard Space Flight Center.

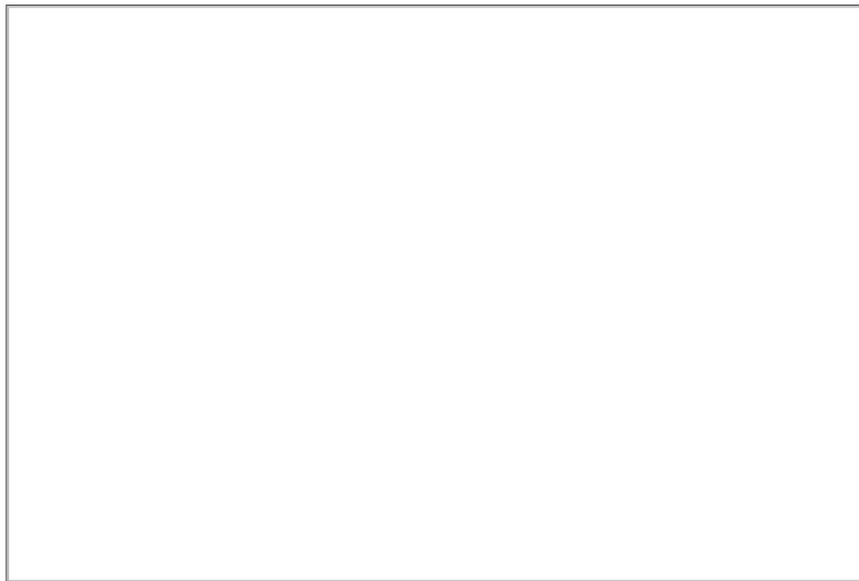


A United Launch Alliance Atlas 5 rocket takes off on a NASA moon mission. (Photo: NASA TV)

Delayed 20 minutes by nearby thunderstorms, the United Launch Alliance Atlas 5 rocket's RD-180 first stage engine ignited at 5:32 p.m., slowly pushing the towering rocket away from launch complex 41 at the Cape Canaveral Air Force Station. Shooting through low clouds and quickly disappearing from view, the rocket arced east over the Atlantis Ocean and accelerated toward space.

Spectacular rocket cam views showed the Atlas 5's fiery exhaust plume against the cloud-draped limb of planet Earth and the deep black of space. Another camera showed the nose cone fairing falling away, exposing the satellite payload to view.

Two firings by the Atlas 5's hydrogen-fueled Centaur second stage successfully boosted the dual-spacecraft payload onto a four-day trajectory to the moon.



A rocket cam view from the Atlas 5 as the vehicle climbed into space.
(Photo: NASA TV)

The \$504 million Lunar Reconnaissance Orbiter, equipped with seven state-of-the-art cameras and other instruments, will look for suitable landing sites for future manned missions while creating the most detailed lunar atlas ever assembled.

The 4,200-pound solar-powered spacecraft also will measure the solar and cosmic radiation that future lunar explorers will face and map out the surface topology, mineralogy and chemical composition of Earth's nearest neighbor. One year will be spent scouting future landing sites followed by three years of purely scientific observations.

While its cameras will not be able to detect the footprints of the 12 Apollo astronauts who once walked on the moon, they will be able to see the landing stages, rovers and other equipment that were left behind.

LRO's companion, the \$79 million Lunar Crater Observation and Sensing Satellite, or LCROSS, faces a much shorter lifetime. With LRO on its own, LCROSS will maneuver the spent Atlas 5's Centaur second stage into a looping four-month orbit back around the Earth.

If all goes well, LCROSS will aim itself and the Centaur back at the moon, targeting a permanently shadowed crater near the south pole for a dramatic crash landing Oct. 9. With LRO looking on from lunar orbit, the 5,000-pound Centaur will hit the dark surface at some 5,600 mph, blasting out a 66-foot-wide crater some 13 feet deep.

The debris excavated by the impact will be blown high above the lunar surface, some of it above the crater's rim and into sunlight for the first time in two billion years or more.

LCROSS, following close behind the Centaur on a virtually identical course, will fly through the debris cloud, spending four precious minutes studying the composition of the material and looking for signs of water ice with a suite of nine instruments.

Then it, too, will crash to the moon less than two miles away after dutifully transmitting its data back to Earth. The Hubble Space Telescope will monitor the impact, as will amateur and professional astronomers in the western hemisphere, looking for the flash that will signal the Centaur's demise.

The LRO/LCROSS mission is NASA's first trip to the moon since the more modest Lunar Prospector was launched in 1998. The new missions are part of NASA's post-Columbia program to send astronauts back to the moon to establish permanent Antarctica-style research station starting around 2020.

The Bush administration approved the new plan and President Obama endorsed the resumption of moon flights during his campaign.

But earlier this year, the White House Office of Management and Budget cut \$3.1 billion from NASA's projected budgets through 2013 - money needed to begin development of a heavy-life moon rocket - and the president ordered an independent re-assessment of NASA's long-range goals.

The review panel held its first public hearing Wednesday and its final report is expected by the end of the summer.

Regardless of the ultimate fate of NASA's manned moon program, the two spacecraft launched today promise to greatly advance understanding of the moon's history and evolution, along with making the first serious attempt to identify favorable landing sites for future long-duration visits.

Separating from the LCROSS/Centaur shortly after launch, LRO will fly to the moon on its own. After a long rocket firing Tuesday morning to brake into an elliptical orbit, engineers will spend up to two months checking out and calibrating the spacecraft's instruments and maneuvering it into a circular 31-mile-high orbit.

For comparison, the orbits used by Apollo command modules were about 70 miles high.

"As its name says, LRO is all about doing reconnaissance at the moon," said Craig Tooley, the mission's project manager at Goddard. "Reconnaissance, specifically, to bring us back the data and the information we need to plan and execute the human return to the moon.

"An inevitable question I get is 'why do we need LRO? Haven't we done this?' And, indeed, of course, we've been to the moon. But when we went to the moon for Apollo, we went to the equatorial regions and we intentionally planned to not stay for very long. And even at the onset of our renewed commitment to send human beings to the Moon back in 2004, we knew then if we were going to go to the moon with the more ambitious goals we have now of staying longer and perhaps establishing outposts, we were going to go to a different place."

Scientists and engineers thinking about future outposts on the moon are focused on the polar regions, where areas in permanent sunlight offer unlimited solar power. Conversely, permanently shadowed craters nearby offer the prospect of ice deposits and along with them, a source of water, oxygen and hydrogen rocket fuel.

"We actually have much better maps of Mars than we have of our own Moon's polar regions," Tooley said. "So the job of filling out that information set, making that atlas complete for planning safe and fruitful return to the Moon, that job fell to LRO."

The LCROSS mission is much more tightly focused.

Earlier lunar probes detected signs of hydrogen in the dark polar regions, an indirect indication of water ice. Scientists believe ice could indeed be trapped in polar craters that never see sunlight, brought in by comet impacts over the billions of years since the moon's formation.

The Centaur impact is designed to blast out material in the top few feet of a shadowed crater's floor where ice deposits are suspected.

"The impact sounds spectacular, and it will be," said Tony Colaprete, the LCROSS project scientist. "But you have to consider impacts of this size hit the Moon three or four times a month, essentially once a week. What's unique about the LCROSS impact is we know exactly where and when, so we can actually coordinate all of these eyes to look at it.

"The actual event will be done in four minutes, meaning the ejecta, the physical material that comes up will be all but settled out in four minutes. It's just like any other natural impact of the Moon, it will not damage the Moon in any way."

The amount of hydrogen detected in past missions implies the presence of enough water to possibly fill the Great Salt Lake basin in Utah. But no one knows if ice is really there.

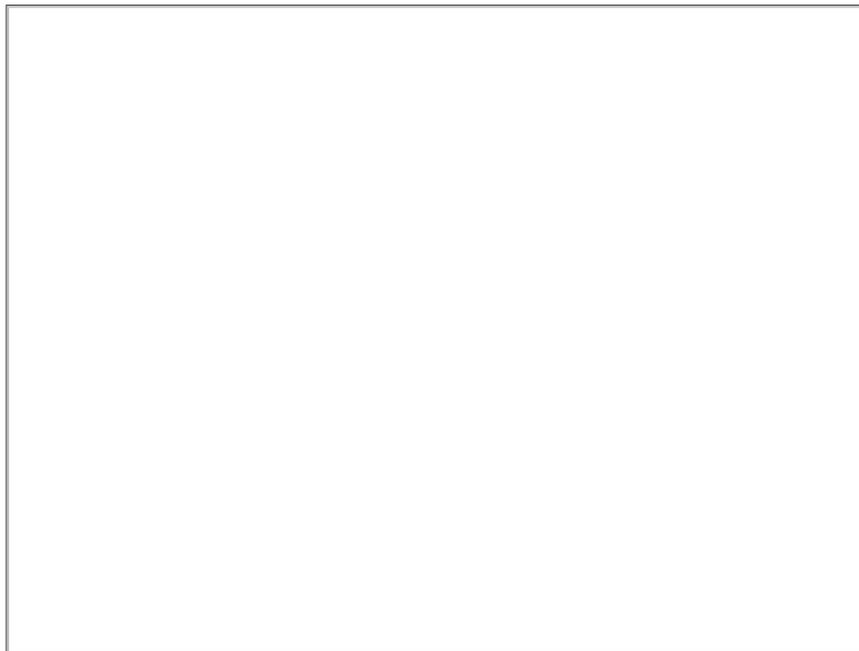
"There's data out there which could show it's potentially ice rinks," said LCROSS project manager Dan Andrews. "There's data out there that shows it's blocky. There's data out there that could support the fact that there might not be water ice there," said Dan Andrews, the LCROSS project manager. "So that illustrates the importance of this mission. Let's go see what it is.

"The benefit of having water ice there is self-evident. The availability of water right there on the moon, availability of producing oxygen, oxidizer for rocket fuel for other missions, it's very, very interesting if water ice is indeed there."

11:15 AM, 6/17/09, Update: Lunar Reconnaissance Orbiter/Atlas 5 moved to pad for Thursday launch

With the shuttle Endeavour grounded by a hydrogen leak, a United Launch Alliance Atlas 5 rocket carrying NASA's Lunar Reconnaissance Orbiter was hauled to launch complex 41 at the Cape Canaveral Air Force Station today for liftoff Thursday on an ambitious \$580 million moon mapping mission.

The short trip from ULA's towering processing facility to the pad started at 10:02 a.m. With forecasters predicting a 60 percent chance of good weather, the Atlas team will have three launch opportunities Thursday, at 5:12 p.m. EDT, 5:22 p.m. and 5:32 p.m.



A United Launch Alliance Atlas 5 rocket carrying NASA's Lunar Reconnaissance orbiter is hauled to pad 41 at the Cape Canaveral Air Force Station. (Photo: United Launch Alliance TV)

The forecast improves to 70 percent go Friday for launch opportunities at 6:41 p.m., 6:51 p.m. and 7:01 p.m. Three final opportunities are available Saturday, the last day in the current launch window. The next four-day launch window opens June 30.

The LRO spacecraft is scheduled to map the moon's surface in unprecedented detail from an orbit around the lunar poles just 31 miles above the cratered terrain. The primary goals are to identify possible landing sites for future manned missions and to characterize the composition and topography of the surface.

A companion mission, the Lunar Crater Observation and Sensing Satellite, or LCROSS, is designed to look for evidence of water ice and other materials by crashing the Atlas 5's Centaur upper stage into a permanently shadowed crater near the moon's south pole.

The small LCROSS spacecraft will aim the spent Centaur stage and monitor its demise, flying through the cloud of debris thrown up by the crash, before following it to a similar fate. Assuming a launch Thursday, the LCROSS mission will end with lunar impacts on Oct. 9.

03:00 AM, 6/10/09, Update: Internal spacewalk begins (UPDATED at 3:20 a.m. with end of spacewalk)

Working in spacesuits inside a compartment opened to vacuum, space station commander Gennady Padalka and NASA flight engineer Michael Barratt carried out a short 12-minute internal spacewalk today to finish rigging a port in the Zvezda command module for arrival of a new docking module in November.

Padalka and Barratt remained inside the station throughout today's spacewalk and both men's Orlan MK spacesuits were connected to umbilicals. The work began at 2:55 a.m. EDT and ended at 3:07 a.m.

But because they were working in vacuum, the activity was considered a spacewalk, the 125th since station assembly began in 1998, the sixth so far this year, the eighth for Padalka and the second for Barratt.

A new docking module, known as MRM-2, is scheduled for launch atop a Soyuz rocket on Nov. 10. Once attached to the station, it will add a fourth Russian docking port to support the increased traffic required by a full-time crew of six.

During an external spacewalk last Friday, Padalka and Barratt installed antennas as part of a system that will enable the MRM-2 docking module to home in on the station, line up and dock at the zenith port of the Zvezda module.

During today's spacewalk inside the evacuated transfer compartment at the forward end of Zvezda, the interior side of the hatchway was equipped with required docking system equipment.

The station currently has three Russian docking ports: an Earth-facing port on the forward end of the Zarya module and two on Zvezda, one facing Earth and the other at the rear of the lab complex.

One three-seat Soyuz lifeboat is docked at Zarya and another is berthed at Zvezda's aft port. An unmanned Progress supply ship is attached to the Pirs docking module on Zvezda's Earth-facing port. The MRM-2 docking module will go on the zenith port directly above and across from Pirs.

Yet another docking module, known as MRM-1, is scheduled for launch next year aboard a space shuttle. It will be attached to Zarya's downward facing port, providing the clearance needed for planned U.S. Orion crew capsules to dock at a downward-facing port in the station's U.S. Unity module.

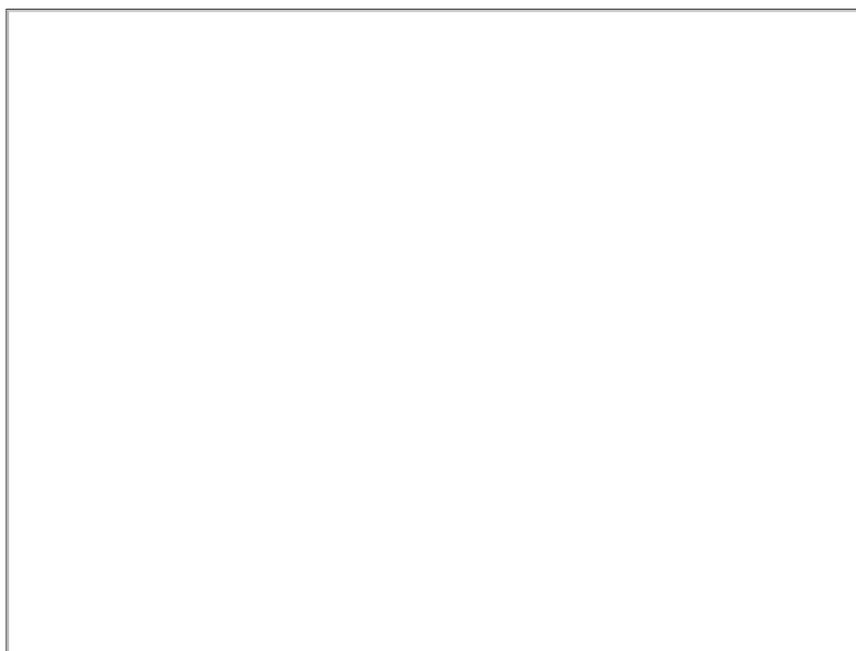
During today's spacewalk, the station crew was split up to make sure everyone had access to a Soyuz lifeboat at all times. Koichi Wakata joined Barratt and Padalka in the Russian segment of the station, with access to the Soyuz docked at the command module's aft port. Frank De Winne, Robert Thirsk and Roman Romanenko remained in the forward segment of the lab, with access to the Soyuz docked to the Zarya module's Earth-facing port.

8:55 AM, 6/5/09, Update: Successful spacewalk ends

Michael Barratt, wrapping up his first spacewalk, rode a telescoping boom high above the International Space Station today for a photo survey of newly installed docking antennas. In the process, he beamed down spectacular helmet cam views of the lab's Russian segment and the Earth 220 miles below.

"How's the view, Michael?" someone radioed.

"The station is so beautiful," Barratt replied.

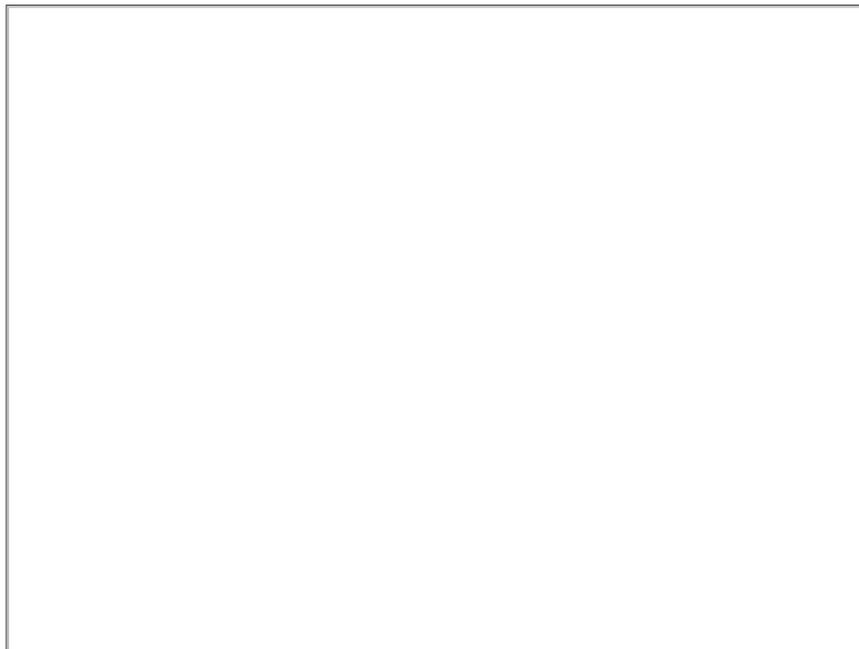


**Michael Barratt's helmet cam view of the space station, showing the circular brown upper docking port of the Zvezda module.
(Photo: NASA TV)**

Barratt and Expedition 20 commander Gennady Padalka began the spacewalk at 3:52 a.m., an hour behind schedule because of concern about higher-than-expected carbon dioxide levels in their new Orlan MK spacesuits. Russian engineers ultimately concluded the suits were good to go and the crew was cleared to proceed.

Working around the forward end of the Zvezda command module, Padalka and Barratt installed docking system antennas and cabling to permit a Russian docking module, scheduled for launch atop a Soyuz rocket in November, to home in on the station and dock at Zvezda's upward-facing port.

The MRM-2 module, similar to the Pirs module attached to Zvezda's Earth-facing port, will serve as a combination airlock and docking module for future visits by Soyuz crew ferry craft and unmanned Progress supply ships. The new module will provide a fourth docking port to support the increased traffic required by a full-time crew of six and permit Progress ships to dock at Pirs more frequently, providing improved roll control for the lab complex.



Barratt, on the end of the Russian Strela boom, is moved into place for a photo survey by crewmate Gennady Padalka. (Photo: NASA TV)

Padalka and Barratt had no problems installing the antennas needed for the automated rendezvous system. Russian engineers carried out electrical continuity checks to make sure the equipment was properly wired and Barratt, on the end of a Russian Strela boom, carried out a photo survey to make sure they were properly aligned.

The spacewalkers then returned to the Pirs module and closed its hatch at 8:46 a.m., ending a four-hour 54-minute spacewalk. Today's excursion, the 124th devoted to station assembly and maintenance, pushed total EVA time to 779 hours and 54 minutes.

Padalka and Barratt plan to carry out a short internal spacewalk Wednesday, working in vacuum inside Zvezda's forward compartment to complete the zenith port's outfitting.

6:35 AM, 6/5/09, Update: Spacewalk going smoothly after late start

Space station commander Gennady Padalka and flight engineer Michael Barratt are in the process of installing a second set of rendezvous antennas near the Zvezda command module's upper port to pave the way for attachment of a Russian docking module in November.

Two hours and 45 minutes into the planned five-and-a-half-hour spacewalk, Padalka and Barratt and working through their timeline with no major problems, installing passive antennas and routing cables.

The spacewalk began a bit more than an hour behind schedule because of indications of higher-than-expected carbon dioxide levels in their new Orlan MK spacesuits. But both spacewalkers have said throughout the morning that they feel fine and the suits appear to be operating normally.

3:55 AM, 6/5/09, Update: Station spacewalk begins

Running more than an hour late because of spacesuit troubleshooting, cosmonaut Gennady Padalka and NASA flight engineer Michael Barratt opened the hatch of the Pirs airlock module aboard the International Space Station at 3:52 a.m. EDT to officially begin a planned five-and-a-half-hour spacewalk.

The goal of the excursion is to mount rendezvous antennas on the upper side of the Russian Zvezda command module. A new docking module is scheduled for launch in November that will use the rendezvous system to home in on the station and dock at Zvezda's upper port. The docking module will be used later as a port for Soyuz crew ferry craft and Progress supply ships.

Today's spacewalk began a little more than an hour behind schedule because of readings indicating high carbon dioxide levels in the crew's new Orlan MK spacesuits, being used for the first time. Equipped with new computers and displays, both suits indicated higher-than-expected CO2 levels, but the spacewalkers said they felt fine.

"Michael, how are yo feeling? What do you think about the first time working in the suit?" a Russian flight controller called from

Moscow.

"So far so good," Barratt replied in Russian. "Sizing is good, so it just feels fine."

"So do you feel like maybe you can be nauseous, maybe there's not enough air to breathe inside the suit?"

"No, I wouldn't say that," Barratt said.

"So no discomfort whatsoever?"

"Not at all. So far so good," said Barratt, a former NASA flight surgeon. "I'm very familiar with the symptoms of high CO2 levels, but I'm not experiencing any."

"Michael, I'm very sorry because we're receiving information from several different sources," the ground surgeon replied. "So if you don't mind, I would like to ask you once in a while about what you're feeling. As a surgeon, I would like you to report to me your symptoms, or how you're feeling, and so on from time to time. ... Are you OK with that?"

"Yes of course," Barratt said. "That goes without saying."

After assessing the readings on the ground, along with frequent calls to the spacewalkers to make sure both felt normal, Russian flight controllers cleared the crew to depressurize the Pirs airlock module and begin today's spacewalk.

For identification, Padalka, call sign EV-1, is wearing a suit with red stripes. Barratt, EV-2, is wearing a suit with blue stripes that is equipped with a NASA helmet camera.

This is the 124th spacewalk devoted to station assembly and maintenance since construction began in 1998, the fifth so far this year, the seventh overall for Padalka and the first for Barratt. Going into Friday's excursion, more than 80 astronauts and cosmonauts representing the United States, Russia, Japan, Canada, Germany, France and Sweden had logged 775 hours of space station EVA time.

The KURS antennas being installed by Padalka and Barratt are passive elements in a system that will enable the Russian MRM-2 docking module to home in on the station in November.

The station currently has three Russian docking ports: an Earth-facing port on the forward end of the Zarya module and two on Zvezda, one facing Earth and the other at the rear of the lab complex.

At present, two three-seat Soyuz lifeboats are docked at the station, one at Zarya and the other at Zvezda's aft port. An unmanned Progress supply ship is attached to the Pirs module on Zvezda's Earth-facing port. The MRM-2 docking module scheduled for launch in November will go on the zenith port directly above and across from Pirs.

Yet another docking module, known as MRM-1, is scheduled for launch next year aboard a space shuttle. It will be attached to Zarya's downward facing port, providing the clearance needed for planned U.S. Orion crew capsules to dock at a downward-facing port in the station's U.S. Unity module.

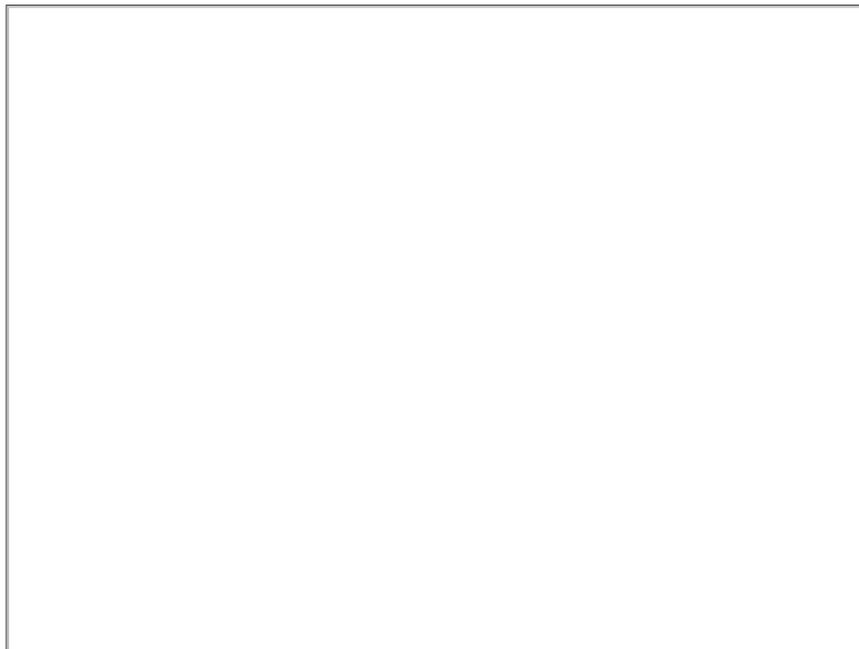
01:30, 6/1/09, Update: Station crew says life with six aboard similar to 'herding cats,' but systems working well

Orchestrating the work of six full-time astronauts aboard the International Space Station is a bit like "herding cats," a Canadian crew member told reporters Monday, adding that living in the surreal weightlessness of space was like floating in a Salvador Dali painting.

And then there's the part about recycling their sweat and urine for drinking and meal preparation.

"First of all, the water is great!" NASA flight engineer Michael Barratt said during the expanded crew's first orbital news conference. "It's probably as good as or better than anything you'd buy out of a fancy bottle on the ground."

"We try to use our water (regularly) to keep our processors primed and happy and we're all hydrating drinks and hydrating some of our sublimated food and it's a very convenient system. We've got hot water, cold water ... and absolutely no complaints about the water up here."



The Expedition 20 crew fields questions from reporters.
Front row (left to right): Koichi Wakata, Gennady Padalka and Michael Barratt
Back row (left to right) Frank De Winne, Roman Romanenko and Robert Thirsk
(Photo: NASA TV)

Barratt, space station commander Gennady Padalka and Japanese astronaut Koichi Wakata were joined Friday by three new full-time crew members - cosmonaut Roman Romanenko, European Space Agency astronaut Frank De Winne of Belgium and Robert Thirsk of the Canadian Space Agency.

The new crew members arrived aboard a cramped Russian Soyuz capsule launched last Wednesday from the Baikonur Cosmodrome in Kazakhstan. Shuttle-veteran Thirsk said the Russians provided first-class transportation.

"If you think of the space shuttle as a powerful SUV, then the Soyuz is a nimble sports car," he said. "It did an incredible job getting us into orbit. The ride was quite a bit smoother, I thought, than the shuttle. For the first two minutes of a shuttle flight, it's pretty bumpy, it's impossible to read. But in the Soyuz, it was smooth all the way up. ... I just regard the Soyuz as a miracle."

While visiting shuttle crews push the combined crew size even higher, the arrival of Romanenko, De Winne and Thirsk opened a new era of space station operations. With six full-time crew members, the lab's science output is expected to increase dramatically.

The station's complex life support systems are working well, including the critical urine recycling system referred to by Barratt, The problems encountered so far, he said, are the minor sort of growing pains one might expect when doing something for the first time.

"For me personally, I feel very much at home," Barratt said. "I come from a large family and I'm used to a lot of activity and 'busyness' and a lot of laughter, and we certainly have that now with these guys coming (aboard)."

The size of the station helps, he said, given the astronauts can work in three dimensions in a way impossible on Earth.

"The station is very large and six people still don't quite fill it, it's a very comfortable venue for six people to work with, I would say, pretty intensive timelines," Barratt said. "And these guys got to work right away, so I can tell you for sure that that's true."

Thirsk said the greatest challenge is simply becoming more efficient.

"I think for the newer members of the six person crew, it's a little bit like herding cats for Gennady, trying to get us all organized and getting us all to accomplish our tasks in a day," he said. "The learning curve is steep. We've been here, Roman says, five days now. I think we've learned an awful lot, so the working efficiency is coming.

"But believe me, this is a surreal world here. I sometimes feel like I'm in the middle of a Salvador Dali painting here. My greatest fear? Astronauts always have fear of injury or death, but our greatest fear is of making a mistake. So I just hope I can get through this six months without making any serious mistakes."

Overall, Barratt said, the crew's integration has gone smoothly, with no major hiccups. Sharing meals together, however, has been a

bit of a challenge. The galley in the Russian Zvezda command module, their usual place to eat, is a bit cramped for six.

"But we've set up another table in (the Unity module)," Barratt said. "Quite frankly, we didn't know how it was going to work until these guys arrived and we tried it out. So we've done a lot of tweaks to our food system and right now we're finding out that it does work pretty well.

"So I'd say we're starting out functional and we're going to make it more efficient and a little bit more palatable as we go along. But certainly no show stoppers. It's very comfortable having six people here right now."

Another long-term issue for the crew is staying in touch with family members.

"For people who have an interest in science and technology, there can't be a better job than astronaut," Thirsk said. "But there is a price to be paid, there is a sacrifice to be made and unfortunately, it's the family that needs to make that sacrifice. It is important to stay in touch.

"We communicate every day, we have email, we have an internet protocol, or IP, phone that allows us to phone any phone number in the world, including that of our family. Then once a week, we'll have a planned video conference as well."

The station crew faces a busy first few weeks in orbit, gearing up for a pair of spacewalks June 5 and 10 and arrival of the shuttle Endeavour, scheduled for launch June 13.

For the first spacewalk, which begins around 2:45 a.m. EDT June 5, Padalka and Barratt plan to route cables and mount an antenna to prepare an upper docking port on the Zvezda command module for eventual use by visiting Soyuz ferry craft.

A second, internal spacewalk is planned for June 10 to rig the upper hatch with a docking cone. For the second spacewalk, expected to last about an hour, Padalka and Barratt will remain connected to umbilicals while working in the depressurized transfer compartment between Zvezda and the Zarya module.

If all goes well, Endeavour's countdown will begin that same day, targeting a launch at 7:17 a.m. on June 13. Assuming an on-time liftoff, docking with the space station would be expected around 3:50 a.m. on June 15.

"With 13 people up here, it'll be a challenge," Barratt said. "Of course, we'll have the added volume of the shuttle added to the stack, it'll be a massive stack. But it'll be busy, and there will be a lot of coordination, a lot of activity, a lot of patience, but these are the guys to do that."

4:00 PM, 5/29/09, Update: NASA managers decide to press ahead with Endeavour launch preparations; June 13 launch target still possible, officials say, despite processing delays

NASA managers met Friday and decided to press ahead with work to ready the shuttle Endeavour for launch June 13 on a five-spacewalk space station assembly mission while continuing an analysis of a short circuit that knocked an avionics unit off line during the shuttle Atlantis' liftoff May 11.

An executive-level flight readiness review is planned for next Wednesday to assess the status of launch processing and to set an official launch date. While the short circuit analysis is not complete, engineers are optimistic it will have no impact on Endeavour's launch.

The weather, however, is another matter. To make the June 13 target, Endeavour must be moved from pad 39B, where it was on stand-by for emergency rescue duty during Atlantis' Hubble Space Telescope servicing mission, to pad 39A on Sunday.

Rollover had been targeted for Friday, but it has now slipped to Sunday, primarily because of stormy weather that delayed rollover preparations. With no contingency time left in the processing schedule to handle unexpected problems, another rollover delay - or any other significant issue - likely would delay launch.

As it now stands, NASA only has three days to get Endeavour off the ground in June or the flight will be delayed one month. The short window is the result of a conflict with another high-priority mission - launch of NASA's Lunar Reconnaissance Orbiter on June 17 - and temperature constraints due to the space station's orbit.

If Endeavour misses the three-day June launch window, the flight will slip to around July 11, based on the most recent analysis of the station's trajectory.

Along with moving Endeavour to pad 39A Sunday, NASA also plans to begin the shuttle Atlantis' ferry flight back to the Kennedy Space Center from Edwards Air Force Base, Calif., where the orbiter landed last weekend.

Because of its diversion to California and the time needed to prepare the ship for its cross country flight atop NASA's 747 transport

jet, engineers have not yet gained access to the aft avionics bay where aerosurface actuator No. 1, the unit that failed during launch, is located.

Based on telemetry, engineers believe a short circuit in the wiring leading to or from the box triggered the failure, not a problem with the box itself. The unit is part of a redundant system used to move the shuttle's elevons and rudder/speedbrake and its failure had no impact on Atlantis' climb to space or subsequent re-entry.

But engineers want to make sure the short is not the result of any kind of fleet-wide wiring problem. As a result, ASA-1 will be pulled from Atlantis after its return to Florida next week and subjected to inspections and electrical tests to help isolate the issue.

Built to replace the shuttle Challenger, Endeavour is NASA's newest space shuttle and engineers are confident its wiring is in good shape. But if any problems are found, engineers will re-assess the launch schedule and what, if anything, might be needed to clear the ship for flight.

Hoping for the best, Atlantis commander Mark Polansky, pilot Douglas Hurley, flight engineer Julie Payette, David Wolf, Christopher Cassidy, Thomas Marshburn and space station flight engineer Timothy Kopra plan to fly to Florida Tuesday to review launch pad emergency procedures and to participate in a practice countdown Thursday.

The primary goals of Endeavour's mission are to attach an external experiment platform to the Japanese Kibo laboratory, to replace batteries on the space station's oldest set of solar arrays, to deliver critical spare parts and to perform a variety of get-ahead tasks for upcoming assembly flights.

The space station program achieved a major milestone Friday with arrival of three fresh crew members, boosting the lab's full-time crew to six.

Before Endeavour's arrival, Expedition 20 commander Gennady Padalka and Michael Barratt plan to carry out two spacewalks June 5 and 10 - the day Endeavour's countdown is expected to begin - to prepare the Russian Zvezda command module for the attachment of a new docking port.

10:50 AM, 5/29/09, Update: Soyuz TMA-15 docks with space station

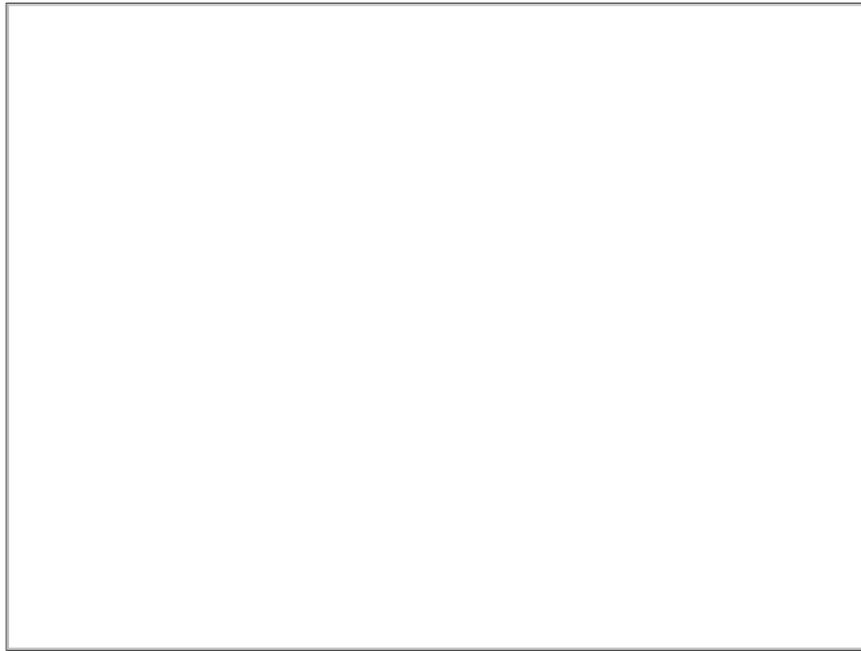
A Russian Soyuz capsule docked with the International Space Station Friday, doubling the lab's crew to six in a long-awaited milestone intended to boost productivity and science output.

With second-generation cosmonaut Roman Romanenko monitoring an automated approach, the Soyuz TMA-15 spacecraft docked with an Earth-facing port on the Russian Zarya module at 8:34 a.m. as the two spacecraft sailed through orbital darkness 218 miles above the Pacific Ocean east of Taiwan.

"And now, it's perfectly in the center, all the crosses have aligned," someone said, watching a docking target on the space station as the Soyuz closed in. "We are approaching the center, we are going a little bit lower for pitch and we expect contact. Start the timer... we have contact!"

The docking completed a carefully orchestrated rendezvous that began Wednesday when Romanenko, European Space Agency astronaut Frank De Winne of Belgium and Canadian astronaut Robert Thirsk blasted off from the Baikonur Cosmodrome in Kazakhstan.

After leak checks, hatches between the two spacecraft were opened at 10:14 a.m. and Expedition 20 commander Gennady Padalka, NASA flight engineer Michael Barratt and Japanese astronaut Koichi Wakata welcomed their new crewmates aboard with hugs and handshakes.



**Expedition 20 commander Gennady Padalka welcomes Roman Romanenko
aboard the International Space Station (Photo: NASA TV)**

"It is wonderful to see all six of you up there, all five partners working together, it's a historic day," radioed Canadian Space Agency President Steve MacLean, a veteran shuttle astronaut who helped build the station. "With eight vehicles coming up during your six-month mission, you're going to be very, very busy. I just want you to know all Canadians will be watching, especially you, Bob, for the next 180 days. Congratulations, great launch the other day, fantastic docking, and enjoy. Enjoy."

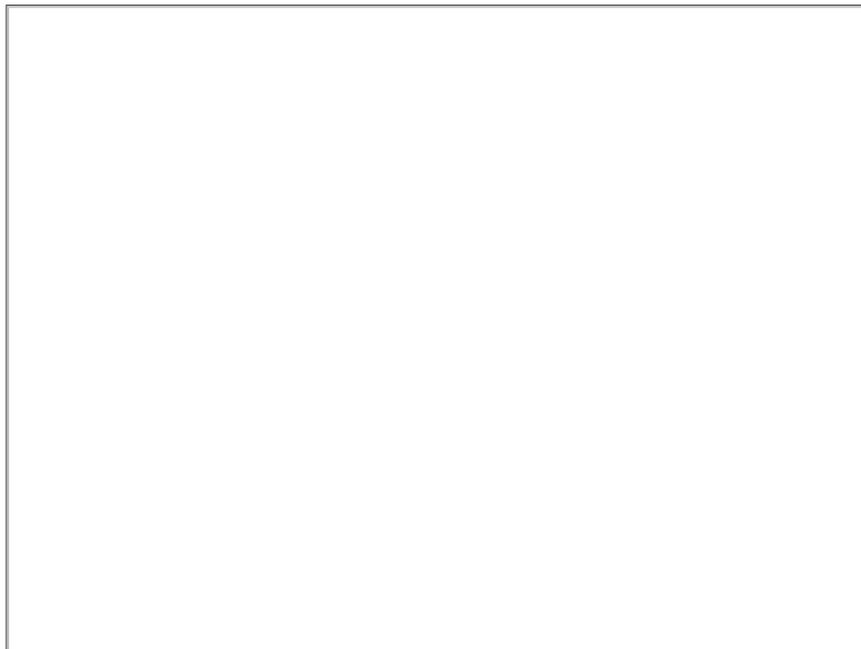
"I agree, it is a historic day," Thirsk replied from the Zvezda command module. "It's also a very happy day up here, you can't imagine the state of elation the six of us have right now. You know, amongst partners that have a passion for exploration, a proven track record on innovation and a desire to gain new knowledge, we've got an incredible potential for success here. This is going to be something incredible! You ain't seen nothing yet."

The wives of Romanenko, Thirsk and De Winne also congratulated their husbands - Romanenko promised to call back Sunday when he will have more time to chat - and Thirsk's mother added, "have a good time, and God bless."

"Thanks, Mom."

The arrival of Romanenko, De Winne and Thirsk marked a major milestone in the history of the space station project, boosting the lab's full-time crew to six for the first time since assembly began in 1998.

Up to this point, research aboard the station has been limited because of ongoing construction and maintenance requirements that have occupied previous two- and three-person crews. With six people on board, the time available for scientific research is expected to more than triple, jumping from 20 hours a week to more than 70.



The Expedition 20 crew chats with mission control after docking. From left to right: Frank De Winne, Robert Thirsk, Gennady Padalka, Mike Barratt, Koichi Wakata and Roman Romanenko (Photo: NASA TV)

"We've been building the International Space Station for 10 years now and we've finally gotten to a point now where it has some incredible laboratory facilities and six people on board the station to do some science," Thirsk said before launch.

"We're going to be doing life science work, we're going to be doing medical operations, plant biology, fluid physics, materials processing, exploiting this weightless environment of space. We're ... doing some great, fundamental science for preparing humans for the next venture into space."

At a post-docking news conference, MacLean said the international collaboration that built the space station shows "we can achieve so much more than any one nation."

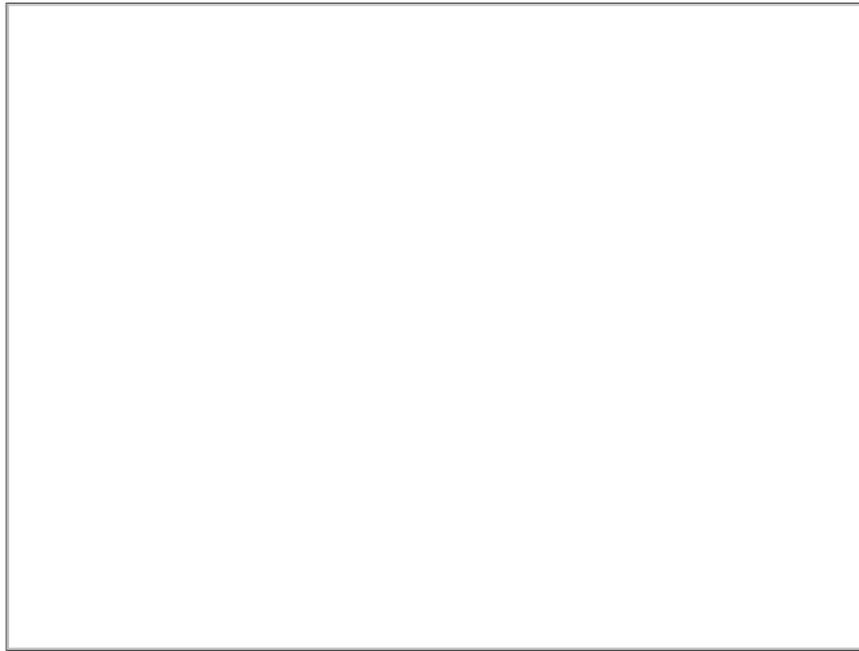
"There is so much potential in this beginning, in this historic milestone, in the sense that in the future, if we continue to collaborate like this, I think it represents what we will be able to achieve ... for the future exploration of space," he said.

A crew news conference is planned Monday.

7:30 AM, 5/27/09, Update: Soyuz TMA-15 takes off on milestone mission to boost space station crew to six

A Russian Soyuz rocket roared to life and streaked into orbit Wednesday, setting off after the International Space Station in a long-awaited mission to boost the lab's crew from three to six full-time residents.

With Apollo 11 moon walker Buzz Aldrin and a throng of dignitaries and well wishers looking on, the Soyuz TMA-15 spacecraft lifted off at 6:34:53 a.m. EDT and quickly climbed away from the Baikonur Cosmodrome in Kazakhstan.



Soyuz TMA-15 spacecraft roars to life (Photo: NASA TV)

Live television shots from inside the capsule showed Soyuz commander Roman Romanenko, son of a Russian cosmonaut, at the controls in the capsule's center seat, flanked on the left by European Space Agency astronaut Frank De Winne of Belgium and on the right by Canadian Space Agency astronaut Robert Thirsk, a shuttle veteran.

All three cosmonauts appeared comfortable and at ease as the spacecraft climbed toward orbit, monitoring checklists and cockpit controls. Nine minutes after liftoff, the Soyuz TMA-15 spacecraft slipped into its planned preliminary orbit and a few minutes later, its solar panels and antennas unfolded and locked in place as planned.

Over the next two days, Romanenko will oversee a series of rocket firings designed to bring the spacecraft to within a stone's throw of the space station. If all goes well, the Soyuz capsule will dock at an Earth-facing port on the front end of the space station's Russian Zarya module around 8:36 a.m. Friday.

Waiting to welcome their new crewmates aboard will be Expedition 20 commander Gennady Padalka, NASA physician-astronaut Michael Barratt and Japanese astronaut Koichi Wakata.

Padalka and Barratt were launched to the station March 26 aboard the Soyuz TMA-14 spacecraft, currently docked to the Zvezda command module's aft port. Wakata was launched aboard the shuttle Discovery on March 15, becoming Japan's first full-time crew member.

With the arrival of Romanenko, De Winne and Thirsk, all five of the space agencies building the International Space Station will be represented by full-time crew members for the first time.

"Six person crew is a milestone in the history of the International Space Station," Thirsk said before launch. "In a big way, the International Space Station will be able to fulfill it's primary purpose, which is to function as a world-class orbiting laboratory for medical science and materials science."

The lab complex has been stocked with enough food to last the expanded crew through October even if subsequent shuttle and unmanned resupply missions get delayed. Oxygen is generated on board by U.S. and Russian systems and fresh water is delivered by shuttle crews and automated Russian supply ships.

But in a major milestone, a sophisticated water recycling system was installed late last year and, after startup problems were resolved, the new hardware was cleared for everyday use. The system recycles condensate and urine from a U.S. toilet in the Destiny lab module, generating ultra-pure water for drinking, crew hygiene and oxygen generation.

The water recycling system will be critical to sustaining a six-person crew after the space shuttle is retired late next year.

"It will be a challenge for everybody to make sure we can sustain six persons on orbit," De Winne said before launch. "Of course, most of the questions (are) about us and how we will work together with six on board, but we (should not) forget that for us to be able to do this work, there are thousands and thousands of people around the globe working to make sure we have everything we

need."

He said a six-person space station was beyond the capabilities of any one nation and that international cooperation was the key to the project's success.

"I think it shows a great example to the rest of the world that if nations want to work together for something great, for something wonderful, for something for the future of our kids, that we can achieve incredible things," he said.

Up until now, the station's science output has been limited because assembly was ongoing and the lab's three full-time crew members were busy simply maintaining the growing complex. With a crew of six, the time devoted to scientific research is expected to triple, jumping from 20 hours a week to more than 70.

"We've been building the International Space Station for 10 years now and we've finally gotten to a point now where it has some incredible laboratory facilities and six people on board the station to do some science," Thirsk said. "So you're going to see over 1,000 hours (in the near term) of crew time devoted to research and development."

More than 100 experiments are planned for the Expedition 20 crew.

"We're going to be doing life science work, we're going to be doing medical operations, plant biology, fluid physics, materials processing, exploiting this weightless environment of space," Thirsk said. "We're ... doing some great, fundamental science for preparing humans for the next venture into space."

Romanenko and Padalka will bunk in the Russian Zvezda module, which is equipped with two sleep stations and a bathroom. Two more sound-proofed "cabins" are available in the Harmony module that serves as a hub between the European Columbus module, the Japanese Kibo lab and the U.S. Destiny module.

An additional U.S. sleep station is scheduled for launch in August. In the near term, one Expedition 20 astronaut will use a temporary sleep station in the Destiny module while another sleeps in Kibo. A second toilet is available in Destiny as well, extending out into the lab's center aisle.

While the space station is roomy compared to any previous spacecraft, a full-time crew of six will present challenges.

"Everyone knows what it's like to have the in-laws and friends and other family members over for the holidays for several days," Thirsk said. "There are line ups at the bathroom, meals have to be properly coordinated, there are even line ups for use of the phone, and everyone loses their personal space a little bit. But it's something we're willing to go through."

"We will have to coordinate amongst ourselves very well, meal preparation, use of the communication loops, more attention to stowage, more attention to trash management, managing the hygiene facilities and making sure we give everyone their personal space. We all have that kind of training ... so we're prepared for that."

English is typically used in the U.S. segment of the station while Russian is preferred in the Zvezda command module. All station crew members are able to speak both languages to some extent, but Romanenko said astronauts and cosmonauts had developed their own "space language" over the years.

"There is a special language which is a mixture of Russian and English, there are jokes about it in orbit," he said through a translator. "It is so-called 'Renglish.' We, in fact, have invented that language quite well. Moreover, we really know each other very well, we know what to expect from each other and how to be around each other because we have been working together, we have been training together for years now. ... We have been partners for a long time. Thus, we are this big international family, space family."

The expanded station crew faces a busy timeline over the next few weeks. Padalka and Barratt plan spacewalks June 5 and 10 to prepare an upward-facing port of the Zvezda command module for attachment of another docking module.

Three days after the second spacewalk, NASA plans to launch the shuttle Endeavour on a five-spacewalk assembly mission to attach an experiment platform to the Kibo module and change out batteries on the station's oldest set of U.S. solar arrays.

During the period Endeavour is docked, the space station will have to support 13 people.

Endeavour also will deliver a fresh crew member - Timothy Kopra - and bring Wakata back to Earth. Another crew swap is planned for a shuttle flight in August when NASA astronaut Nicole Stott replaces Kopra.

Stott, a former shuttle engineer at the Kennedy Space Center, said all of the Expedition 20 crew members were comfortable with each other, sharing a professionalism and sense of humor honed by years of training.

"Even the guys who are up there in orbit right now, we have spent loads of time with them training here on the ground," she said. "And I think one thing that I can say about everyone we'll be up there with, you've got that balance between the total professional and the humor.

"I think when things come right down to it, we know how to manage ourselves and to stay safe and we'll let that carry out through every day that we're up there. And then we also have the humor to keep us happy and working well together. I think it's going to be a great experience."

3:25 PM, 5/26/09, Update: Soyuz TMA-15 set for launch to space station to boost crew size to six

In a long-awaited milestone for the International Space Station, a Russian Soyuz rocket scheduled for launch early Wednesday will ferry three fresh crew members to the lab complex, boosting its crew size to six for the first time.

The Soyuz TMA-15 spacecraft, mounted atop the same launch pad used by Yuri Gagarin at the dawn of the space age, is scheduled for takeoff from the Baikonur Cosmodrome in Kazakhstan at 6:34:49 a.m. EDT.

Soyuz commander Roman Romanenko, son of a Russian cosmonaut, will be strapped into the center seat, flanked by European Space Agency astronaut Frank De Winne of Belgium and Canadian Space Agency astronaut Robert Thirsk, a shuttle veteran.

"I can't think of three finer gentlemen to help us realize our dream of six permanent crew on orbit," Mike Suffredini, NASA's space station program manager, told the Soyuz crew Tuesday. "So I wish you good luck and Godspeed."

Assuming an on-time liftoff, Romanenko plans to oversee an automated approach and docking to an Earth-facing port on the front end of the space station's Russian Zarya module at 8:36 a.m. Friday. Waiting to welcome their new crewmates aboard will be Expedition 20 commander Gennady Padalka, NASA flight engineer Michael Barratt and Japanese astronaut Koichi Wakata.

Padalka and Barratt were launched to the station March 26 aboard the Soyuz TMA-14 spacecraft. Wakata was launched aboard the shuttle Discovery on March 15, becoming Japan's first full-time station crew member.

With the arrival of Romanenko, De Winne and Thirsk, all five of the space agencies building the International Space Station will be represented by full-time crew members for the first time.

"Six person crew is a milestone in the history of the International Space Station," Thirsk said before launch. "In a big way, the International Space Station will be able to fulfill it's primary purpose, which is to function as a world-class orbiting laboratory for medical science and materials science.

"But there are also practical issues to consider as well with a crew of six and one of our goals, with our three colleagues on orbit, is to prove that the station can support six people for a long duration."

NASA television's public and media channels will carry pre-launch video footage from Baikonur starting at 4:45 a.m. Wednesday, followed by launch coverage beginning at 5:45 a.m. Assuming an on-time liftoff at 6:34:49 a.m., the Soyuz TMA-15 spacecraft should be in orbit by 6:44 a.m. NASA plans to feed a launch day b-roll package at 12 p.m.

Here is a generic Soyuz countdown timeline to give readers a sense of when major events are planned (in EDT; best viewed with fixed-width font; some times may be different for the TMA-15 launch):

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EDT.....EVENT
12:34 AM.....Batteries installed in booster
01:04 AM.....State commission 'go'
01:34 AM.....Tanking begins
02:34 AM.....Booster is loaded with liquid oxygen
03:34 AM.....1st/2nd stage oxygen fueling complete
03:59 AM.....Crew arrives at launch vehicle
04:04 AM.....Crew ingress through orbital module side hatch
04:34 AM.....Crew in re-entry vehicle
04:49 AM.....Re-entry vehicle hardware tested; suits are ventilated
05:04 AM.....Hatch sealed and tested
05:34 AM.....Launch vehicle control system preps; gyro activation
05:49 AM.....Launch pad service structure halves lowered
05:54 AM.....Suit leak checks; re-entry vehicle testing complete
06:04 AM.....Emergency escape system armed
06:09 AM.....Service towers retracted
06:19 AM.....Suit leak checks complete; escape system to auto
06:24 AM.....Gyros uncaged; on-board recorders activated
06:27 AM.....Prelaunch operations complete
06:28 AM.....Final launch countdown operations to auto
06:28 AM.....Launch complex and vehicle systems ready
06:29 AM.....CDR's controls activated; helmets closed; launch key inserted
06:31 AM.....Combustion chamber nitrogen purge
06:32:19 AM...Booster propellant tank pressurization begins
06:32:34 AM...Ground propellant feed terminated
06:33:49 AM...Vehicle to internal; 1st umbilical tower sep; auto sequence start
06:34:09 AM...Ground power umbilical to 3rd stage separates
06:34:29 AM...Launch command given; central/side pod engines on
06:34:34 AM...Second umbilical tower separates
06:34:39 AM...Engine turbopumps at flight speed
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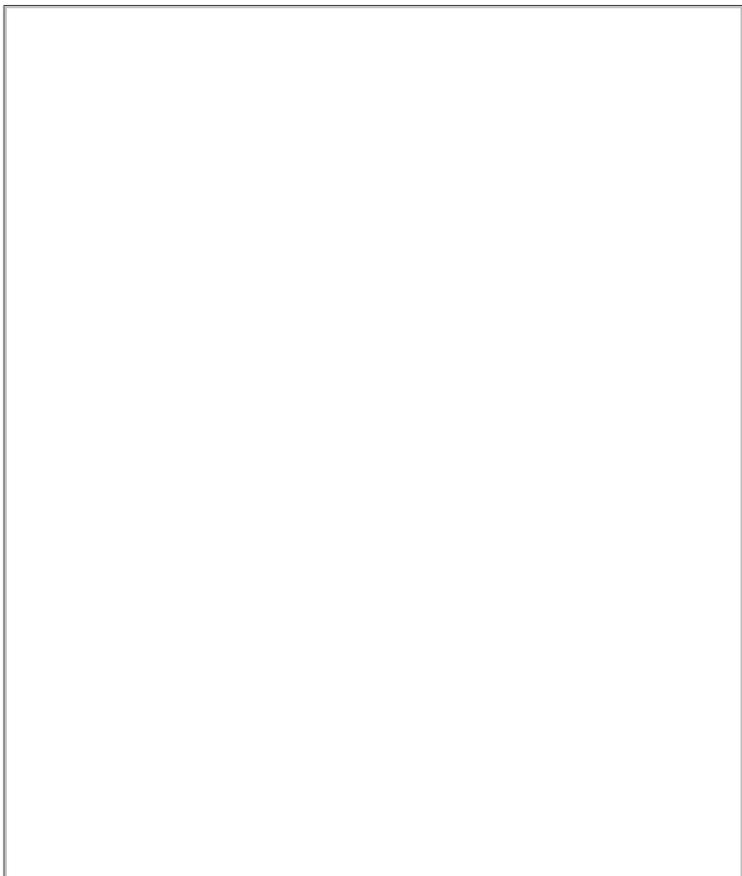
06:34:44 AM...Engines at maximum thrust
06:34:49 AM...LIFTOFF
06:35:59 AM...Velocity 1,118 mph
06:36:47 AM...Stage 1 strap-on boosters separate
06:36:49 AM...Velocity 3,355 mph
06:37:29 AM...Escape tower/launch shroud jettison
06:39:47 AM...Core booster separates at 105 statute miles
06:42:19 AM...Velocity 13,421 mph
06:43:49 AM...Third stage shutdown; Soyuz separation

10:00 AM, 5/23/09, Update: Charles Bolden to be nominated for NASA administrator

Nineteen years after helping launch the Hubble Space Telescope, Charles F. Bolden Jr., a former combat pilot, Marine Corps major general and veteran space shuttle commander, has been selected by the Obama administration to serve as the space agency's next administrator. Lori Garver, a former NASA associate administrator for policy and plans and a space policy advisor to the Obama campaign, will serve as Bolden's deputy.

"These talented individuals will help put NASA on course to boldly push the boundaries of science, aeronautics and exploration in the 21st century and ensure the long-term vibrancy of America's space program," Obama said in a statement Saturday.

In a moment of improbable symmetry, Bolden, the third African American to fly in space, met with President Obama at the White House Tuesday, the day the space telescope was re-launched from the shuttle Atlantis. The five-spacewalk overhaul marked NASA's fifth and final visit to the storied telescope since Bolden helped launch it in 1990.



Charles F. Bolden Jr. shuttle crew photo (Photo: NASA)

An announcement naming Bolden as Obama's candidate to head the civilian space agency came four months after the departure of former Administrator Mike Griffin, a rocket scientist appointed by the Bush administration to oversee the shuttle's 2010 retirement and a planned return to the moon.

"The president could not have made a better choice," Griffin told CBS News. "Charlie Bolden is an accomplished pilot, a veteran astronaut and an old friend. He has spent his life in the service of his country, and our nation is the better for it. NASA will be in good hands."

The Obama administration struggled to find an acceptable replacement after deciding not to ask Griffin to stay on, reportedly considering several candidates before settling on Bolden.

Widely respected within NASA for his engineering judgment, leadership skills and no-nonsense approach to thorny technical issues, Bolden's appointment was broadly welcomed by space agency insiders.

"I can't imagine anybody that would be a better choice than Charlie," said Jay Honeycutt, former director of the Kennedy Space Center. "He knows the business of flying in space as well as knows how to navigate his way around Washington. He has a good relationship with Congress as well as the guys in the administration."

Said John Logsdon, space policy analyst at George Washington University and a member of the Columbia Accident Investigation Board: "I think he's an extremely good choice. First of all, he's not that much of an outsider to Washington. He's been on the Aerospace Safety Advisory Panel and the National Academy of Engineering space board, so he's really up to speed with what's going on with the program."

Sen. Bill Nelson, D-FL, flew with Bolden during a 1986 shuttle flight and has been lobbying Obama for weeks to put Bolden in charge of NASA at a particularly critical time in the agency's history.

"In all the problems that are facing the president, it's hard to get attention on this one little agency," he told CBS News. "He certainly hears it from me, but he'll hear it then from his own administration (after Bolden is confirmed). And I believe then we've got a chance of getting us really back into the glory days."

In a statement released today, Nelson said Bolden will face "budgetary constraints, technical issues, the remaining shuttle launches and the pending retirement of the shuttle program. And, restoring the wonder that space exploration can provide, and to make sure the president's mission is carried out." "Charlie is the kind of dynamic leader I believe the president was looking for and I know he'll meet these challenges head on," Nelson said.

NASA is struggling to complete the International Space Station during the final eight shuttle missions between now and the end of 2010. At the same time, the agency is trying to develop a new rocket system for the Bush administration's Constellation program, which is aimed at resuming moon flights in 2020.

The Constellation architecture, calling for development of a new heavy lift unmanned Ares 5 booster, a lunar lander and a smaller Ares 1 rocket to boost Orion crew capsules into orbit, has come under fire from critics who claim alternative rocket systems can be developed faster at lower cost.

Complicating the political picture, the Ares 1/Orion system intended to replace the space shuttle will not be available until 2015, forcing NASA to buy seats on Russian Soyuz spacecraft to ferry U.S. astronauts to and from the space station. Griffin repeatedly warned Congress about this so-called "gap," but the money needed to accelerate development of Ares 1/Orion never materialized.

The Obama administration's first budget supported the Constellation program in general, endorsing shuttle retirement in 2010 and a return to the moon by 2020. But the administration's 2010 budget, while boosting near-term NASA funding, slashed spending by \$3.1 billion between 2011 and 2013. If that money is not restored, Ares 5 development will suffer and landings on the moon will be delayed if not eliminated.

Earlier this month, Obama ordered a 90-day independent review of NASA's manned space program headed by former Lockheed Martin CEO Norman Augustine. Options for how best to proceed will be presented to the administration later this summer. Depending on what the Augustine commission determines, some or all of the lost money could be restored to NASA's long-range budget.

Or none at all.

Despite the uncertain outlook, Nelson said he doubts Constellation will go away.

"That's just not going to happen," he told CBS. "You're not going to throw away four years of work on the Ares. So I'm not concerned about that. I think the Augustine commission will bless the Ares. The thing I am concerned about is to what extent Ares 5 will be rapidly developed so we can end up doing the lunar lander here and all of that on a target for 2020. And a lot of that's going to come out of the Augustine Commission.

"Even though we've got this concern, that the numbers are lean in the out years, I still have some optimism about us increasing that," Nelson said. "I think politics will play a part of it, because candidate Obama will be a candidate again in 2012 and I think Florida will be important. Florida will be bigger then, it will be 29 electoral votes and I believe ... they'll pay attention to us. So I'm concerned, but I'm not panicked about the out years."

Even so, Honeycutt cautioned that "I'm not sure anybody can handle this whole deal, but we'll see what comes out of the Augustine review. If they can pretty much stay the course, Charlie can do well with that."

Bolden's first space flight came when he and six crewmates, including then-Rep. Nelson, took off aboard the shuttle Columbia on Jan. 12, 1986. It was the last successful shuttle mission before Challenger's fatal Jan. 28 launch.

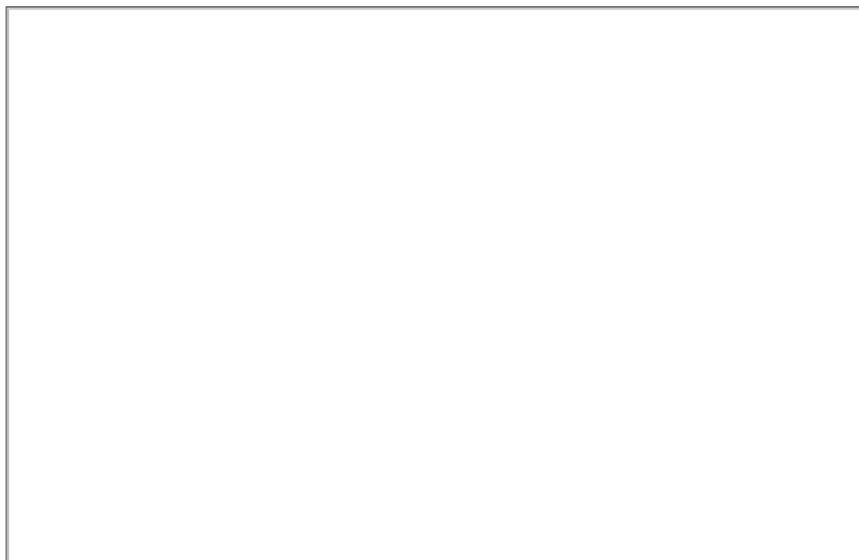
Bolden took off a second time on April 24, 1990, when he served as pilot of the shuttle Discovery to ferry the Hubble Space Telescope into orbit.

It is a given in the astronaut office at the Johnson Space Center in Houston that any flight assignment is a good flight assignment. But the Hubble Space Telescope, one of the most expensive civilian satellites ever built, was in a class by itself and Bolden clearly relished a chance to play a role in the showcase mission.

"Astronomy captivates everybody," he said in an interview at the time. "A kid in the ghetto, a kid on the farm, everybody at one time or another happens to glance up at the nighttime sky and they see these things we call stars and every once in a while a planet.

"You'd just have to be a non-human being not to go 'what the heck is that?' It has a fascination for everybody."

Bolden flew in space a third time as commander of the shuttle Atlantis for an atmospheric research mission that took off March 24, 1992. His fourth and final space mission was a historic flight as commander of the shuttle Discovery in 1994, a mission that included cosmonaut Sergei Krikalev, the first Russian to fly on a space shuttle.



Bolden (upper right) during his fourth shuttle flight (Photo: NASA)

The only other joint U.S.-Russian mission up until that time involved the linkup of an Apollo capsule and a Russian Soyuz spacecraft in 1975, a mission that symbolized the era of detente.

"I would imagine there was a lot of effort that went into the science that was conducted, but I think the politics of it probably was the overriding factor back then," Bolden said.

"Although politics plays a pretty important part in this one also, I would feel that our primary effort is geared toward pulling the two nations' (space) databases together in order to optimize what we're hoping to do in the future as far as space exploration is concerned.

"We think the joint scientific thrust ... is of most significance," he said. "I'd be naive to say the political significance is not there. What we are hoping to demonstrate is that two formerly very strong, rival nations can come together, work together toward a common goal and achieve much more than either could have done alone."

Born Aug. 19, 1946, in Columbia, S.C., Bolden earned a bachelor of science degree in electrical engineering from the Naval Academy in 1968 and a master's degree in systems management from the University of Southern California in 1978.

He accepted a commission in the Marine Corps following graduation from Annapolis in 1968 and after flight training at Pensacola, Fla., and other bases he was designated a naval aviator in May 1970.

In 1973, Bolden flew more than 100 missions into North and South Vietnam, Laos and Cambodia while based at Nam Phong, Thailand.

After returning to the United States, Bolden began a two-year tour as a Marine Corps selection officer in Los Angeles. He spent the

next three years at the Marine Corps Air Station in El Toro, Calif.

In 1979, Bolden graduated from the U.S. Naval Test Pilot School at Patuxent River, Md., and was assigned to the Naval Air Test Center's systems engineering and strike aircraft test directorates. He was selected as a NASA astronaut in 1980,

Bolden, who lists his hobbies as racquetball, running and first day cover collecting, is married to the former Alexis Walker of Columbia, S.C.. The couple has two children.

He is a member of the Marine Corps Association, the Montford Point Marine Association, the U.S. Naval Institute and he is a lifetime member of the Naval Academy Alumni Association. He is a recipient of the Air Medal, the Strike-Flight Medal, the University of Southern California Outstanding Alumni Award and the NASA Exceptional Service Medal.

Bolden left NASA in 1994 and returned to active duty in the Marine Corps. He retired from the corps in 2002.

5:20 PM, 5/20/09, Update: Station crew 'toasts' with recycled urine

The three-man crew of the International Space Station explored a strange new world Wednesday, boldly going where no other astronauts have gone before: toasting each other with sips of recycled sweat and urine in a major milestone for the lab complex.

With dozens of flight controllers and engineers joining them in a space-to-ground videoconference, station commander Gennady Padalka, flight engineer Michael Barratt and Japanese astronaut Koichi Wakata held a brief toasting ceremony, touching drink bags and sipping recycled water for the first time since laboratory analysis confirmed its purity and cleanliness.

"We're just really, really happy for this day and for the team that put this together," said Barratt, floating with his crewmates in the Destiny laboratory module. "I know it took a lot of work and a lot of time and a lot of very smart people. There were a lot of problems to overcome and it's all come to this. This is the kind of technology that'll get us to the moon and further, we hope. We're just really, really happy to be here drinking this today."

Before sampling the recycled water, he said "we are happy to have this water work through the system and we're looking forward to working it through our systems and doing it all over again."

Former space station science officer Donald Pettit told Barratt "we're getting ready to toast some of yesterday's coffee here with you guys."

"That's great to hear," Barratt said. "We're really fat with coffee up here, which is great for me, so we're going to be drinking yesterday's coffee frequently up here, and happy to do it. ... Here's to all of you who made this happen. Here we go, here's to you guys and here's to everybody."

The three station fliers then took a ceremonial drink from their water bags. Padalka squeezed out a blob of water and then drank it out of mid air.

"The taste is great and as Gennady is showing you, it's perfectly clear and worth chasing in zero G here," Barratt said.

"It looks really, really good from down here," said space station Flight Director Courtenay McMillan. "I'm glad yours is only a couple of day old. Our vintage here is about four years old from ground testing at Marshall (Space Flight Center), but it still tastes just fine."

The station's \$250 million U.S.-built water recycling system was installed during a shuttle assembly flight late last year. But problems with a centrifuge in the unit's vacuum distillation assembly forced the astronauts to extend testing until a replacement unit could be launched on a shuttle mission in March. The new unit worked well and samples were returned to Earth for detailed laboratory analysis. Those tests cleared the way for today's ceremony.

The water recycling system is critical to NASA's plans to boost the station's crew size from three to six later this month. It will be especially crucial after the space shuttle is retired next year because Russian, European and Japanese supply ships cannot carry enough water to support six full-time crew members.

4:30 PM, 5/8/09, Update: NASA braces for manned space flight review

Reeling from projected budget cuts totaling more than \$3 billion through 2013, NASA managers and engineers working to build a post-shuttle rocket system for an eventual return to the moon are bracing for a critical review ordered by the Obama administration that could set the agency on a different course.

The chairman of an independent review panel charged with evaluating NASA's post-shuttle manned space program said Friday he will bring an open mind and "go where the facts lead" in assessing the technical and economic feasibility of the space agency's

current manned space program.

Norman Augustine, former chief executive officer of Lockheed Martin Corp., said the Review of United States Human Space Flight Plans Committee also will assess alternatives, including different rocket systems and alternative targets for exploration. The team's report is expected by August.

"We are planning to spend billions of dollars on the human space flight program and it's wise to be sure we're spending that the way we should," he told reporters in a teleconference. "New information becomes available all the time. And similarly, we have a new administration and it would probably be imprudent on their part not to examine this major of a program to be sure such a long term undertaking is still on a course that makes sense to them."

The cost of NASA's manned space program - and ongoing efforts by the Office of Management and Budget to cut spending - is at the heart of the review, announced Thursday when the Obama administration's fiscal 2010 budget request was unveiled.

"I think what it boils down to is we're being told there's no sense in being unrealistic and putting together a program that can't possibly be afforded, and we've been given some guidance," Augustine said. "I think one of the chronic problems NASA's encountered over the years has been that it usually had more programs than it had money. That can be dangerous when you're doing something as difficult as NASA does.

"So as we go through this evaluation, if we were to find there were reasons the budget didn't make sense in any way, I can assure you we would not be bashful about pointing that out, and I suspect the administration would want to know that anyway."

The Obama administration is asking Congress for \$18.7 billion in funding for NASA in 2010, a watershed year for the civilian space agency as it tries to complete assembly of the International Space Station and retire the space shuttle fleet after just nine more flights.

NASA is designing a new rocket, called the Ares 1, and an Apollo-style Orion capsule to replace the shuttle, but the new system will not be ready for routine use until 2015. During the five years between the shuttle's retirement next year and the debut of Ares 1/Orion, NASA will be forced to buy seats on Russian Soyuz rockets to get U.S. astronauts to and from the space station.

NASA's long-range goal, set by the Bush administration, is to return to the moon by 2020, using Ares 1/Orion spacecraft to carry astronauts to orbit and then new heavy-lift Ares 5 rockets to boost the astronauts and lunar landers to the moon. The new rocket systems are the central elements of what NASA calls the Constellation program.

But funding has been a critical issue from the beginning. Congress and the Bush administration, which put NASA on its current course, did not provide the funding necessary to significantly reduce the gap between shuttle retirement and first flight of Ares 1/Orion.

The Obama administration's 2010 budget includes a near-term funding boost of \$630 million for Constellation, thanks in part to about \$1 billion routed to NASA as part of the economic Recovery Act.

But the administration's predicted budgets through 2013 show an overall cut of \$3.1 billion for the exploration systems directorate in charge of Constellation, cuts that have sent shock waves through the NASA community.

"That's the real story," a senior space manager, who asked not to be named, said of NASA's Thursday budget briefing. "It's like that Sherlock Holmes thing, the real story is the dog that didn't bark in the night. ... If the three-plus billion dollars in the out years, if that cut stands, then there's no moon by 2020 and maybe none at all."

NASA officials said Thursday the budget numbers may change depending on the results of the Augustine review. But the agency turned down a request for an interview with Jeff Hanley, Constellation program manager at the Johnson Space Center in Houston, to discuss the potential impacts of the projected cuts.

Against this backdrop, the Obama administration ordered the Augustine review of NASA's ongoing Constellation program, prompting speculation that budget pressures could lead to a major change of course. It's not yet known how any such a change might affect the gap between shuttle and any follow-on spacecraft, or whether the moon will even remain NASA's primary target.

"I must confess, as an individual I'm not thrilled with the fact that we have a gap," Augustine said. "But we have what we have. ... There are things that could be done, probably, that would shorten the gap, there are some things one might do that would lengthen the gap. But certainly, an objective, I think, of anybody would be to balance the various pros and cons of whatever is proposed against the impact on the gap, among other things, and recognizing that extending the gap is probably not a desirable thing. On the other hand, and I'm not making predictions here because I don't know the outcome, it's not something that's written in stone, either."

John Holdren, director of the White House Office of Science and Technology Policy, said the administration's objective "is to

ensure that these programs remain on a strong and stable footing well into the 21st Century, and this review will be crucial to meeting that goal."

An OSTP statement said Augustine's panel will "assess a number of architecture options, taking into account such objectives as: 1) expediting a new U.S. capability to support use of the International Space Station; 2) supporting missions to the Moon and other destinations beyond low Earth orbit; 3) stimulating commercial space flight capabilities; and 4) fitting within the current budget profile for NASA exploration activities."

Augustine said he planned to assemble a team of experts with a broad range of space experience to evaluate the Constellation program and alternative architectures "both from an economic and a technical standpoint."

"We have a rather short time period to conduct our review, to be completed in August, and because of that we're drawing heavily on prior work and on our own experience as well as analyses ... from NASA and possibly others."

He said the panel's instructions are "to take a fresh, independent look at the human spaceflight program and go where the facts lead. And that's what we'll try to do. Obviously, the U.S. has excelled in the exploration and utilization of space for a long time. It's a source of great pride to our nation as well as, I might say, to myself."

"I also have long believed it should be a balanced program that includes both robotics and human involvement. Our focus will be on the human spaceflight aspect. The president has made rather clear he's very supportive of human spaceflight, he believes it's important from an economic and technical and scientific leadership standpoint. I certainly share that view and I believe this is an important task and I look forward to leading it."

6:30 PM, 5/7/09, Update: Obama orders independent review of manned space operations; NASA 2010 budget unveiled

The Obama administration's fiscal 2010 NASA budget request includes \$630 million in additional near-term funding for development of follow-on rockets and spacecraft needed for the agency's post-shuttle moon program, officials said Thursday. But most of the increase is from the administration's economic stimulus package and projections through 2013 show a \$3.1 billion reduction in overall funding for the program compared with 2009 projections.

Unveiling NASA's \$18.7 billion 2010 budget today, acting Administrator Chris Scolese said the Obama administration had ordered an independent review of NASA's plans to replace the space shuttle with a combination of manned and unmanned Ares rockets, Apollo-style Orion capsules and lunar landers needed to establish research stations on the moon by the early 2020s. The new rockets are the central elements of what NASA calls the Constellation program.

"You can expect a new administration coming in wants to understand where we're at and is this the best way to go forward," Scolese said. "That's the purpose of the review, to understand that. Clearly if we're on the wrong path we should change. If you're asking me do I think we're on the wrong path, no, I don't. We need to go off and demonstrate that. The review team needs to look at it and understand what we're doing and offer suggestions on how we could do it better."

The review is expected to be completed by August. In the meantime, NASA will continue work on the Ares 1 rocket and Orion capsules the agency hopes to begin flying in March 2015. But contracts needed for initial development of the unmanned Ares 5 heavy lift booster needed for NASA's planned return to the moon are on hold pending the results of the review.

NASA's \$18.7 billion budget request includes \$1 billion in Recovery Act money and funds the addition of one shuttle flight to deliver an already-built physics experiment to the International Space Station.

Including next week's launch of the shuttle Atlantis on a fifth and final mission to service the Hubble Space Telescope, NASA plans nine more shuttle flights through Sept. 30, 2010, the end of the fiscal year. If one or two flights slip beyond that target, NASA will need additional funding but the Obama administration has indicated it would support such a request if needed.

"What does this budget represent? I was surprised, in the last month I've seen the president three times," Scolese told reporters Thursday. "And I think that's an indication that NASA is something that this administration really cares about. The fact that we were highlighted in the budget discussions today with the (president's) science advisor is another indication of that. And I think you see it in this first bullet here, a \$630 million increase to exploration, a \$456 million increase to science and a \$264 million increase to aeronautics. Those are significant increases."

Even so, the picture is much less rosy in the out years. Projections through 2013 in the fiscal 2010 budget package feature an asterisk after totals for the Exploration Systems Mission Directorate responsible for space station operations and development of the Constellation program.

The asterisks mean those numbers may change based on the results of the upcoming manned spaceflight review. But as of this writing, exploration faces \$3.1 billion in cuts through 2013.

"We're up this year and next by about \$630 million," said Douglas Cooke, associate administrator for the Exploration Systems Mission Directorate at NASA headquarters. "Over that time period, it's down about \$3.1 (billion)."

Former NASA Administrator Mike Griffin said in a recent speech the projected funding shortfalls threaten America's leadership in manned space flight.

"In the last five years two presidents and two Congresses have provided the top-level direction necessary to ensure that the root cause of Columbia's loss - the lack of a guiding strategic vision for NASA - never happens again," Griffin said. "But apparently something more is needed. We're not matching the words with the necessary actions at the staff level. How soon we forget.

"Let me be clear. In a democracy, the proper purpose of the OMB (Office of Management and Budget) is not to find a way to create a Potemkin Village at NASA. It is not to create the appearance of having a real space program without having to pay for it. It is not to specify to NASA how much money shall be allocated for human lunar return by 2020. The proper purpose of the OMB is to work with NASA, as a partner in good government, to craft carefully vetted estimates of what is required to achieve national policy goals. The judgment as to whether the stated goals are too costly, or not, is one to be made by the nation's elected leadership, not career civil service staff."

Griffin said "no one can wrest leadership in space from the United States. We're that good. But we can certainly cede it, and that is the path we are on."

Sen. Bill Nelson, D-FL, said he believes Obama understands the value of space exploration and "I believe that's why the president has committed to finishing all nine space shuttle missions, regardless of how long it takes; and, to make full use of the International Space Station."

"This is a step in the right direction," he said. "But down the road the administration's budget does not match what candidate Obama said about the future of our space program. Still, he's assured me these numbers are subject to change, pending a review he has ordered of NASA."

The Constellation program was born in the wake of the 2003 Columbia disaster. The Bush administration decided in January 2004 to finish the international space station and to retire the shuttle in 2010. At the same time, NASA was told to begin development of a replacement system that could ferry astronauts to and from the space station and eventually, on to the moon, a system that would be safer and less expensive to operate than the shuttle. The long-range goal was establishment of Antarctica-type lunar research stations where astronauts can live and work for months at a time.

The Constellation program marked a radical departure from the world of shuttle operations. Instead of one rocket designed to carry astronauts and heavy payloads, two rockets were envisioned: the manned Ares 1, designed to boost Orion crew capsules to low-Earth orbit; and the unmanned Ares 5, a huge heavy lift rocket that would carry a four-person lunar lander into space.

For a moon shot, the Ares 5 would be launched from pad 39A at the Kennedy Space Center, followed a few hours later by launch of the crew in an Orion capsule atop an Ares 1.

After linking up in Earth orbit, the Ares 5 upper stage would propel the Altair lunar lander and astronauts in the attached Orion capsule to the moon. The entire crew then would descend to the lunar surface in the lander and, when its mission was complete, blast off, rendezvous with the orbiting Orion capsule and return to Earth for an ocean splashdown.

The Bush administration did not give NASA much in the way of additional funding to pay for initial Constellation development and the agency has been forced to cut back in other areas to kick start the new program. After station assembly is complete and the shuttle is retired in 2010, NASA plans to divert more than \$4 billion a year into Constellation that currently goes into shuttle and station operations.

But given the lack of funding up front, technical problems and changing requirements, NASA will not be ready to begin initial operations with Ares 1 until March 2015. During the five-year gap between the end of shuttle operations and the debut of Ares 1/Orion, NASA will be forced to buy seats on Russian Soyuz spacecraft to ferry U.S. and international astronauts to and from the space station.

Almost from the beginning, critics have complained about the Constellation architecture. Some believe NASA should look into modifying heavy lift Atlas or Delta rockets - evolved expendable launch vehicles, or EELVs - for manned flights. Others believe it makes more sense to eliminate the Ares 1, which requires development of a new five-segment solid-fuel booster, and instead rely on a modified version of the Ares 5, using four-segment boosters, to launch crew and cargo.

The independent review announced Thursday will look into all aspects of the Constellation architecture.

"We were requested to conduct a more detailed study of human spaceflight capabilities," Scolese said. "We want to fully utilize the

international space station, that's a decision that needs to be factored into this review, we need to consider the workforce and the transition requirements as we retire the shuttle and move on to the next system and we need to look at what the gap means and how to best utilize the commercial and international capabilities that are out there.

"So the president's science advisor has asked us, and we're forming a review team, a blue ribbon team, that will be headed by Norm Augustine, which we anticipate being done in the next 60 to 90 days. So by August we're prepared to make any budget adjustments that may need to be made."

Cooke said he does not believe a switch to another rocket system would narrow the gap between the end of the shuttle program and the debut of a new system.

"I don't personally see one," he told CBS News. "We have looked at other possibilities in anticipation of questions. I think we've got a plan that gets there as quickly as we know how. If we could come up with one that's better, we'd do it."

He said the biggest single reason he has favored Ares 1 over competing designs is crew safety.

"The biggest difference is in the risk," he said. "We can argue numbers all day long in terms of cost and schedule and that sort of thing and they have different levels of maturity so you're never actually comparing equivalent numbers. But in terms of the risk numbers we've seen and calculated - and I usually look closest at loss of crew numbers - the Ares 1 approach has always been at least two times better than these other approaches comparing EELVs and the Direct 2.0."

That's in part due to the Ares 1 first stage, an extended five-segment shuttle booster. Two four-segment boosters are used for every shuttle flight and in 125 missions to date - 250 booster flights - only one booster has ever failed, the one that doomed Challenger.

"I personally believe the risk is lower for the crew on this vehicle and that to me is the bigger of the discriminators," Cooke said.

While NASA will proceed with work on the Ares 1 program while the external review is underway - an unmanned test flight is planned for later this year - contracts for initial work on the heavy lift Ares 5 have been put on hold.

"I've been inclined to hold off on them because I don't want to presume an answer out of this review," Cooke said. "I think we really need to see where we end up in terms of recommendations there before we start new contracted activity. We're going to continue on our current contracted activities, but to start a new one right now, I'm not sure we've fully developed that thought process. I'm inclined to hold off."

12:45 PM, 4/15/09, Update: Station crew says lab ready for six full-time crew members

The International Space Station's power, life support and emergency systems are in good condition and ready for the arrival of three additional crew members in late May, the commander said Wednesday. Michael Barratt, a NASA astronaut and flight surgeon making his first flight, said the crew has been cleared to use processed urine and condensate for personal hygiene and expects permission to begin drinking the recycled water in the next few weeks.

Barratt also told CBS News he looked forward to "running on Colbert" when a new treadmill, named after comedian Stephen Colbert, is delivered to the station later this year.

Colbert recently urged viewers to vote for him in a NASA competition to name a new space station module. His choice - the Colbert module - came in first, but NASA announced on his show Tuesday that the module would instead be named Tranquility. Astronaut Sunita Williams, a space station veteran, told the comedian a new treadmill would be known as the Combined Operational Load Bearing External Resistance Treadmill, or COLBERT.

Asked today what he thought of the gesture, Barratt said "I think the more people we reach, the better, and Mr. Colbert does a great job. I'm just looking forward to running on Colbert and living in Tranquility."

Exercise is a critical element of life aboard the space station and keeping six people fit will be an ongoing challenge. NASA and its international partners hope to boost the lab's crew size to six in late May when cosmonaut Roman Romanenko, European Space Agency astronaut Frank De Winne and Canadian Space Agency astronaut Robert Thirsk join Barratt, Expedition 19 Commander Gennady Padalka and Japanese astronaut Koichi Wakata.

"Space station is really in a good operational condition," Padalka told CBS News. "All ECLSS (environmental control and life support) systems in the Russian segment are operational and in great condition. ... We're ready to get six-person crew on board."

Barratt said he did not anticipate any major problems, primarily because "the station is huge, and it really needs six people to man it and get as much work out of it as it was designed to provide."

"This is a huge station, and it's more than big enough to accommodate six people and their productive work," he said. "We worry a

little bit about the consumables and the resources to support six people continually - the food, water, the communications resources and everything to make the people who live up here as productive as possible. But no, there's plenty of room for six people. During shuttle dockings, by the way, we'll be up to 13 for a period of 10 to 12 days. So we're big enough, I think, to accommodate the full crew of six."

To support six people, the station's life support system must be able to recycle condensate and urine for drinking, crew hygiene, food preparation and oxygen generation. The water recycling system initially had problems with a vacuum distillation unit centrifuge that was installed late last year. But the crew of the most recent shuttle assembly mission delivered a replacement and the system appears to be operating normally. Samples returned aboard the shuttle currently are undergoing laboratory analysis to make sure the water is safe to use.

"We have already been given a go to use the water for hygiene and we do a little bit of that," Barratt said. "We're expecting an answer, probably within the next couple of weeks, on using it for potable water. So far, everything has been looking fairly positive, but we're waiting for the definitive answer."

As a flight surgeon, Barratt brings a unique perspective to monitoring his own body's adaptation to weightlessness.

"It is an adaptation over time," he said today. "You're definitely not at your best the first couple of days of space flight, especially as a first-time flier. Every system adapts at a slightly different rate. Some of it you feel, and some of it you don't feel. Some of it is just very difficult to quantify. Fluids tend to shift to your face and you feel a little bit flushed and puffy and over a period of a week to two weeks, that starts to go down.

"Other things, like just learning to fly through the station gracefully and keep kind of a three-D image in your head while you're doing it and not bump into anything that is really expensive or might hurt you if you bump it back. In general, everything gets better as the days go on and right now, after a little over two weeks on orbit, I feel great. From what I understand from reading and talking to other people, people go on from this and several weeks later they say they even feel better. So I think it's a continual process."

NASA and its international partners are making the jump to six-person crew as the space station nears completion and the shuttle program enters its final stages. It is a critical period for NASA, but the Obama administration has not yet named an administrator to replace Mike Griffin, whose tenure ended on inauguration day.

Barratt said "it may be critical that we get an administrator as soon as possible, but I would say it's a wonderful time for NASA because we do have this facility up here, we've almost finished building it and we're starting to realize the productivity out of it we had always planned."

"We have new ships on the drawing board and a lot of smart people that design the station, that operate it day to day and really make the daily process of NASA work. They are still in place and are not going anywhere anytime soon. So I feel very confident in the infrastructure, that we'll be able to continue operating.

"We'd like an administrator soon - sooner is better, certainly - but I think we're on a course and I think we'll stay that course right now with station and hopefully the new vehicle will come in its allotted time."

5:55 PM, 4/13/09, Update: NASA plans to stop work protecting option for shuttle extension past 2010 deadline; will focus on nine flights between now and end of calendar 2010

Facing a tight budget, a 2010 deadline to end space shuttle operations and a lack of concrete political support to fund additional flights or stretch out the current manifest, NASA managers are meeting this week to discuss the impact of ending efforts that have been keeping open the possibility of extending the shuttle program past the current deadline.

In a note to shuttle managers and engineers last week that was obtained by CBS News, shuttle Program Manager John Shannon outlined the issues in stark terms, reflecting the lack of any political action to fund shuttle flights past the end of 2010.

"You have heard me say that 'hope is not an effective management tool' on many occasions," he wrote. "It is my position that we cannot continue to spend money to retain the capability to fly additional space shuttle missions, hoping that someone will recognize the national assets we are giving up.

"We have to take our destiny in our own hands and manage within the limited budget we have been given and ensure that we will fly the full manifest and leave the International Space Station in the best configuration possible."

NASA's most recent authorization act included language that directed the space agency to take no action that "would preclude the continued safe and effective flight of the space shuttle after fiscal year 2010" if the next president - Barack Obama, as it turned out - decided to delay the orbiter's planned retirement. Depending on how one does the accounting, that directive had the potential to cost the agency nearly \$90 million.

The Obama administration has expressed support for the addition of one shuttle flight to carry the Alpha Magnetic Spectrometer, an already-built, high-priority physics experiment, to the International Space Station.

But the Office of Management and Budget said the administration is sticking with the 2010 shuttle retirement date. The Bush administration's deadline was the end of fiscal 2010, or Sept. 30, 2010. The Obama administration has since told the space agency the deadline is the end of calendar 2010. Between now and then, NASA has nine shuttle flights planned, including the AMS mission. But only eight missions are currently funded. Money for the AMS flight has not yet been appropriated.

"If we're going to make this thing work, we've got to focus 100 percent on those nine flights and make sure we get them done," said a senior NASA manager who spoke on background and asked not to be identified. "We can no longer continue to split our attention both ways. We're going to have to have a hard discussion with our folks ... we're going to have to make those nine flights real. And that's what we're going to go do."

The Obama administration has offered little visible guidance beyond support for the AMS flight and the shuttle deadline clarification. The president has yet to name a replacement for former NASA Administrator Mike Griffin, the Bush-administration appointee whose tenure ended with Obama's inauguration.

Griffin inherited the job of overseeing the post-Columbia decision to complete the space station and retire the shuttle by the end of 2010 and to develop a new spacecraft to replace the shuttle. That vehicle, the Apollo-like Orion capsule and its Ares 1 rocket, is intended to ferry astronauts to and from the space station and, eventually, on to the moon.

But the Orion/Ares system will not be ready for use until 2015. During the five-year gap between the shuttle's retirement and the debut of the new rocket, NASA and its international partners will have to hitch rides to the space station aboard Russian Soyuz spacecraft.

Concern about reliance on the Russians has prompted several key lawmakers to lobby for additional funding to extend shuttle operations, stretching out the current manifest to close or narrow the gap. Rep. Bill Posey (R-FL), whose district includes the Kennedy Space Center, and Rep. Debbie Wasserman Schultz (D-FL) introduced legislation earlier this month to extend shuttle operations beyond 2010 and to accelerate development of the Ares/Orion spacecraft.

But so far, no such funding has been approved or even money to cover the costs of simply keeping the extension option open.

Complicating the picture for NASA planners, there is a very real possibility that one or two of the final shuttle missions currently envisioned will slip into the October-December 2010 timeframe, i.e., the first quarter of fiscal 2011. There is no money in NASA's projected 2011 budget for any shuttle operations beyond \$300 million or so intended for retirement activities.

As a result, NASA now plans to terminate work that kept open the option of a shuttle extension when the current legislation expires at the end of the month.

"We don't have enough money to keep carrying various options to extend and add additional flights," said the NASA manager who spoke on condition of anonymity. "We don't have funding right now for that first quarter of 2011. So we've got to save money out of '10 to roll into that first quarter of fiscal year 2011.

"So that's what John's kind of saying in his note to the troops, that we can no longer carry options, we've got to make some hard decisions if we want to try to get these nine remaining flights flown. Where we were kind of slowing things down and we were buying some extra spare parts and kept some subs (subcontractors) around and stuff, it's now time we've got to start making those hard decisions to really start trying to save money so we ... can support all the way to the end of calendar year 2010."

Shuttle program managers were scheduled to meet Tuesday and Wednesday at the Kennedy Space Center for a quarterly budget review. The final missions on NASA's shuttle manifest are critical flights to deliver spare parts and supplies to the International Space Station and NASA managers don't want to risk losing one because money that could have helped cope with technical problems or launch delays had been diverted to building hardware for flights that are not expected to be approved.

"It's not cut and dried," said the NASA manager. "Even though we're going to start ramping back down again, we still haven't really lost capability. I've still got this hardware sitting around and if someone has some great idea this summer that we want to goÂ do this and they give us a ton of money, we could probably figure out a way to get the thing flying again. But we can't protect for that option."

In his email last week, Shannon said "here is our dilemma: Do we keep up the 'do not preclude' strategy, spending at a level that is inconsistent with our current budget line, in the hopes that someone will come along with additional funding to allow us to fly the full manifest? Or do we make the difficult decisions to cut core future capability in order to fly the current manifest within our current budget marks?"

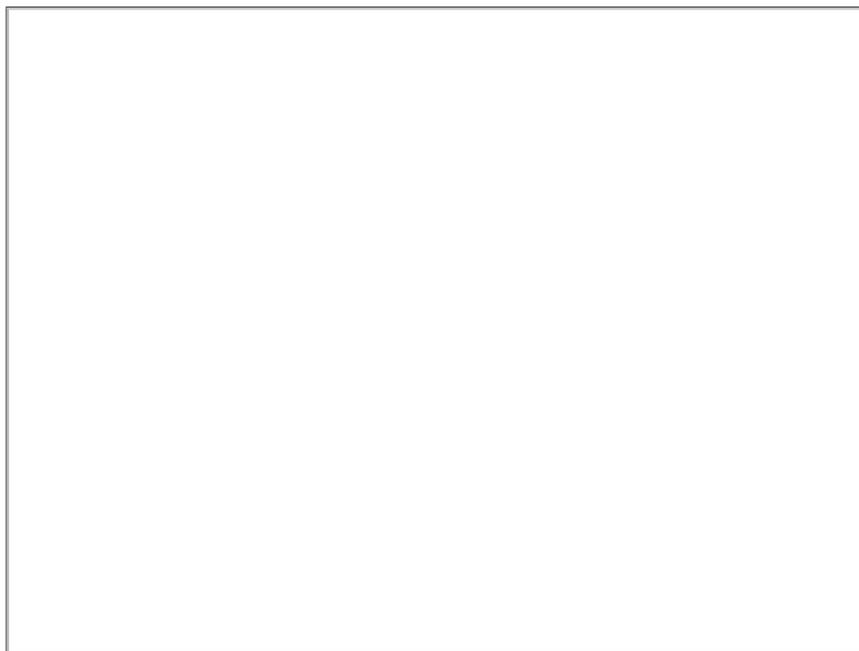
After stating his position that NASA must protect the existing manifest in the absence of any concrete political support and funding for extending shuttle operations, he said "unfortunately, it will be extraordinarily painful to let go of the team members that have ensured our success for 28 years - the testing teams, the manufacturing teams, the teams that integrate, ship and assemble the most complex and capable rocket in history.

"I ask that you put aside the emotions, and concentrate on what is known," Shannon concluded. "We have a limited budget and a clear mission - fly through STS-134 (the final shuttle mission) safely and successfully."

3:40 AM, 4/8/09, Update: Soyuz TMA-13 lands in Kazakhstan

Dropping to Earth under a huge parachute, a Russian Soyuz spacecraft carrying outgoing space station commander Mike Fincke, flight engineer Yury Lonchakov and space tourist Charles Simonyi settled to a jarring landing in Kazakhstan today after a descent from the International Space Station.

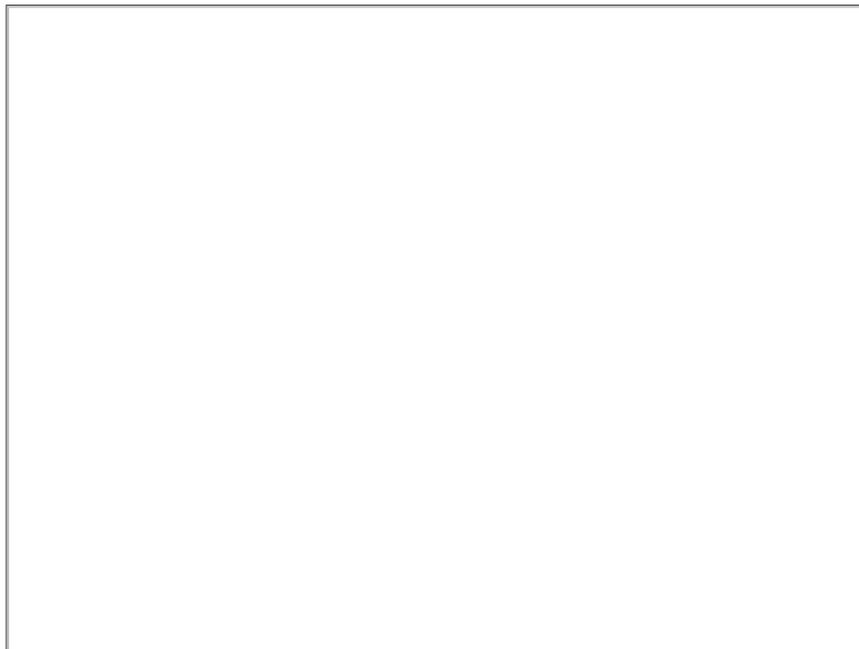
With Lonchakov at the controls, the central descent module of the Soyuz TMA-13 spacecraft touched down at 3:16 a.m. EDT northeast of Dzhezkazgan, coming to rest on its side. A few minutes later, Lonchakov was out, reporting the crew was in good condition.



Soyuz TMA-13 at the moment of touchdown in Kazakhstan

Russian recovery forces were staged nearby to assist the returning space fliers as required and by 3:30 a.m., all three were resting comfortably in reclining chairs near the descent module, smiling and chatting with flight surgeons and technicians.

"It landed just a few kilometers long of its intended site, but essentially a dead-on, spot-on, bullseye landing for Mike Fincke, Yury Lonchakov and Charles Simonyi," said NASA commentator Rob Navias from the landing site. "The Soyuz landed on its side, that is very typical for a Soyuz landing, it is breezy out here today, the wind caught the chutes, pulled the capsule over. But it was a very quick extraction out of the top hatch for the three crew members. They all look to be in excellent shape."



**The Soyuz TMA-13 crew (left to right): Charles Simonyi,
Yury Lonchakov, Mike Fincke**

Landing came one day later than originally planned because of soggy conditions at the normal landing zone north of Arkalyk.

The Soyuz TMA-13 spacecraft undocked from the international Space Station at 11:55 p.m. Tuesday. Lonchakov carried out a four-and-a-half-minute deorbit rocket firing at 2:24 a.m., slowing the ship by about 258 mph and putting it on the proper trajectory for landing.

Just before atmospheric entry, Russian flight controllers lost contact with the spacecraft, but the three modules making up the Soyuz TMA-13 spacecraft apparently separated as planned and the central descent module carrying the crew made a normal re-entry. Communications were restored a few minutes before the craft's braking parachute was deployed and Lonchakov reported "nominal" conditions on board.

"We're happy to say one more space flight mission is now in the history books," an unidentified Russian observed.

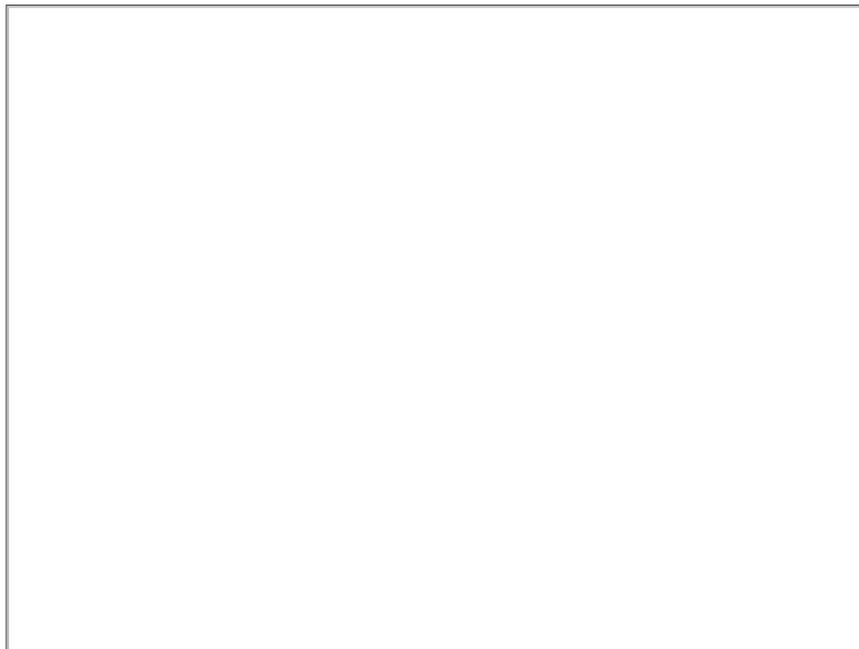
U.S. flight controllers then called the space station, informing Expedition 19 commander Gennady Padalka, flight engineer Michael Barratt and Koichi Wakata that their crewmates had made a safe landing.

"Hey guys, just in case you didn't have good video and audio during that, the Soyuz landed safely, the crew reported they feel fine. SAR forces are on the scene," called the spacecraft communicator.

"We did get that and thanks so much for the video. We saw it and hurrah for the 18 crew and Charles Simonyi and welcome them back to Earth," replied Barratt.

Touchdown ended a 178-day voyage for Fincke and Lonchakov, who were launched to the station last Oct. 12 as the core members of the lab's 18th full-time crew. Fincke's time in space through two space station expeditions now stands at 366 days, putting him third on the list of most experienced U.S. astronauts behind Peggy Whitson with 377 days and Mike Foale with 374 days.

Lonchakov's total for three space missions stands at 201 days while Simonyi's 13-day station visit boosted his two-flight total to 27 days. Simonyi, a Hungarian-born U.S. software developer, is the first space tourist to make two privately financed trips to the space station. His wife, Lisa, was standing by at the recovery zone to welcome him back to Earth with a kiss.



Lisa Simonyi welcomes husband Charles back to Earth

"It was a difficult decision for me to fly for the second time and now, looking back, I'm so glad that I've done it," Simonyi said Tuesday during a brief farewell ceremony aboard the station. "It was a great trip, thank you everyone. I'm looking forward to get home, to my wife, but it was a fantastic trip. Thank you."

An inflatable tent was set up at the landing site for initial medical checks before helicopter flights back to Karaganda and then a three-hour flight to the Gagarin Cosmonaut Training Center in Star City near Moscow where friends and family members will be waiting.

Fincke will be welcomed home in Kazakhstan by NASA space station Program Manager Mike Suffredini, chief astronaut Steve Lindsey and a NASA flight surgeon, Steve Hart. Fincke's family will be waiting in Star City.

2:30 AM, 4/8/09, Update: Soyuz braking rockets fired

Braking rockets on the Soyuz TMA-13 spacecraft fired as planned early today to drop the ship out of orbit for a landing in Kazakhstan. The four-and-a-half-minute deorbit burn began on time at 2:24 a.m., slowing the ship by about 258 mph and putting it on the desired trajectory for atmospheric entry.

After falling to an altitude of about 87 miles, the three modules making up the Soyuz TMA-13 spacecraft will separate and the central descent module will enter the discernible atmosphere at an altitude of about 62 miles at 2:52 a.m. If all goes well, the module's main parachute will deploy shortly after 3 a.m. for a rocket-assisted touchdown at 3:16:29 a.m.

12:15 AM, 4/8/09, Update: Soyuz TMA-13 undocks from space station

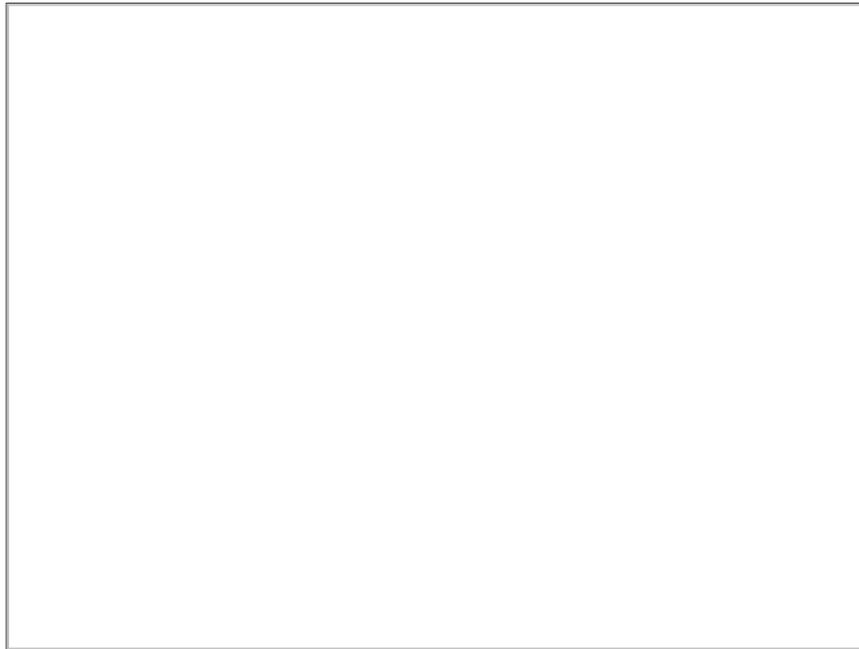
With cosmonaut Yury Lonchakov at the controls, Russia's Soyuz TMA-13 spacecraft undocked from the International Space Station late Tuesday, pulling away from a port on the Zarya module to set up for a Wednesday landing in Kazakhstan.

Lonchakov, Expedition 18 commander Mike Fincke and space tourist Charles Simonyi bid farewell to the Expedition 19 crew Tuesday evening and floated aboard the Soyuz around 8:45 p.m. With Fincke seated to Lonchakov's left and Simonyi to his right, the TMA-13 spacecraft undocked at 11:55 p.m. as the space station sailed 223 miles above Mongolia.

"All the best, Gennady, all the best to you, we are already missing you," one of the departing crew members radioed Expedition 19 commander Gennady Padalka as the Soyuz pulled away.

"Very, very smooth backout," someone said.

"All the best, guys. Good luck."



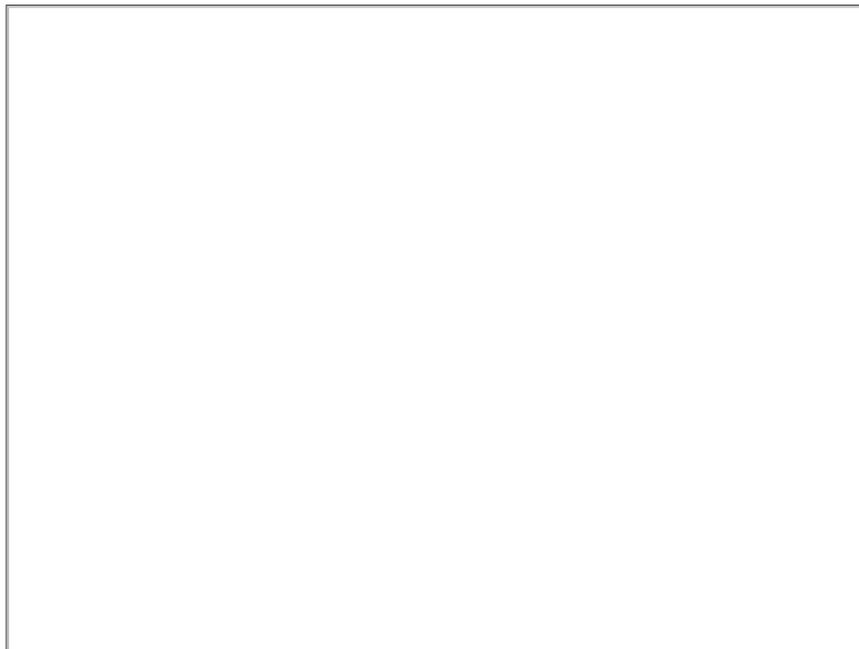
**View of the International Space Station from the
departing Soyuz TMA-13 spacecraft**

If all goes well, Lonchakov will fire the Soyuz ferry craft's braking rockets at 2:24 a.m. to put the ship on a trajectory to touchdown in Kazakhstan around 3:16 a.m. Here is the remainder of today's re-entry timeline (in EDT and mission elapsed time; dV: change in velocity):

EDT.....DDD...HH...MM...EVENT

04/07/09
 11:52 PM...177...20...51...Undocking command
 11:55 PM...177...20...54...Physical separation (11:55:30 PM; dV: 0.3 mph)
 11:58 PM...177...20...57...Soyuz separation burn 1 (15 sec; dV: 1.2 mph)

04/08/09
 12:00 AM...177...20...59...ISS maneuver to duty attitude
 12:08 AM...177...21...07...Russian ground station loss of signal
 12:23 AM...177...21...22...Sunset
 01:24 AM...177...22...23...Russian-to-U.S. attitude control handover
 02:24 AM...177...23...23...Soyuz deorbit burn start (2:24:26 AM; dV: 257.7 mph)
 02:27 AM...177...23...26...Sunrise
 02:29 AM...177...23...27...Deorbit burn complete (2:28:47 AM)
 02:49 AM...177...23...48...Separation of modules (87 miles)
 02:52 AM...177...23...51...Atmospheric entry (62.5 miles)
 02:54 AM...177...23...53...Entry guidance start (50.1 miles)
 02:59 AM...177...23...58...Maximum G-load (23.8 miles)
 03:01 AM...177...23...60...Command to open parachute (6.6 miles)
 03:16 AM...178...00...15...Landing (3:16:29 AM; 1:16 PM local)
 10:03 AM...178...07...02...Sunset at landing site



**View of the departing Soyuz TMA-13 spacecraft
from inside the International Space Station**

1:30 PM, 4/7/09, Update: ISS-18 crew, space tourist prepare for landing (UPDATED at 9:15 p.m. with farewell ceremony; hatch closure)

Outgoing space station commander Mike Fincke, flight engineer Yury Lonchakov and space tourist Charles Simonyi bid farewell to the Expedition 19 crew Tuesday and boarded a Soyuz ferry craft for re-entry and landing Wednesday in Kazakhstan.

Fincke and Lonchakov, launched to the International Space Station last Oct. 12, are wrapping up a 178-day stay off planet as the core members of the lab's 18th full-time crew. Simonyi, a wealthy software developer making his second paid trip to the station, took off March 26 with Expedition 19 commander Gennady Padalka and flight engineer Michael Barratt.

After a busy day of packing and readying the Soyuz TMA-13 spacecraft for re-entry, Fincke, Lonchakov and Simonyi shared hugs and handshakes with Padalka, Barratt and Japanese astronaut Koichi Wakata before floating into the ferry craft around 8:45 p.m. EDT. Hatches were closed a few moments later to set the stage for undocking just before midnight. Landing is expected around 3:16 a.m. Wednesday.

In a brief farewell ceremony earlier Tuesday, Fincke thanked his crewmates for a successful mission and said he looked forward to re-entry in the Russian Soyuz, "a great, reliable transport vehicle, up and down. ... It's going to be an interesting and fun ride back."

"I think the coolest thing in my life, outside of being married to a beautiful woman and having three kids, is to work with the international partners, all of us, the United States, Canada, the European Space Agency, Japan and of course, Russia," he said. "We do everything together, we're humanity's bright hope for the future.

"So we're handing you over a station with all that," he told Padalka, Barratt and Wakata. "The pressure's on, guys! ... Good luck to you."

"Well, from where I stand, I think humanity got a wonderful space station in the International Space Station," said Simonyi, the only space tourist to make two trips to the lab complex. "Maybe the only thing that is more remarkable than the size and the effectiveness of this space vehicle is the people serving on board. ... It was a difficult decision for me to fly for the second time and now, looking back, I'm so glad that I've done it. ... It was a great trip, thank you everyone. I'm looking forward to get home, to my wife, but it was a fantastic trip. Thank you."

Padalka then took the microphone, saying in English, "thank you very much, guys, for (leaving) a space station in great, safe condition for us. (We're) ready to accept space station command and ready to continue our research and to prepare space station for six-person crew. Honestly, we'll be missing you. You'll be always in our hearts and we'll be looking forward to seeing you again as soon as possible. But not earlier than in six months!"

Padalka, Barratt and Wakata plan to welcome three additional crew members in late May - cosmonaut Roman Romanenko, European Space Agency astronaut Frank De Winne of Belgium and Canadian Space Agency astronaut Robert Thirsk - as the station project transitions to a six-person crew for the first time.

Fincke, Lonchakov and Sandra Magnus, who returned to Earth aboard the shuttle Discovery March 28, completed final preparations for the long-awaited crew increase, hooking up and testing a complex water recycling system and accepting delivery of a fourth and final set of solar arrays.

"The can-do crew came through and we all worked together," Fincke radioed flight controllers Tuesday during his final daily planning conference. "So we're very proud of that, especially today."

The Soyuz TMA-13 re-entry originally was planned for Tuesday, but rain, snow and soggy terrain in the normal landing zone northeast of Arkalyk, Kazakhstan, prompted Russian mission managers to delay the crew's return by one day to move the landing zone about 190 miles to the southeast where conditions were more favorable.

Lonchakov will serve as commander of the Soyuz spacecraft, sitting in the center seat of the central descent module, with Fincke, serving as flight engineer, to his left and Simonyi on his right.

Undocking from the downward-facing port of the Russian Zarya module is targeted for around 11:55 p.m. Tuesday. After moving a safe distance away and reaching the proper point in their orbit, Lonchakov will oversee a planned four-minute 21-second rocket firing at 2:24 a.m. that will slow the craft by about 258 mph and put it on the proper re-entry trajectory.

After falling to an altitude of about 87 miles, the three modules making up the Soyuz TMA-13 spacecraft will separate and the central descent module will enter the discernible atmosphere at an altitude of about 62 miles at 2:52 a.m. If all goes well, the module's main parachute will deploy shortly after 3 a.m. for a rocket-assisted touchdown at 3:16:29 a.m.

Here is an updated re-entry timeline (in EDT and mission elapsed time; dV: change in velocity):

EDT.....DDD...HH...MM...EVENT

04/07/09

09:59 PM...177...18...58...U.S.-to-Russian attitude control handover
 10:16 PM...177...19...15...Russian ground station acquisition of signal
 10:28 PM...177...19...27...ISS maneuver to duty attitude
 10:33 PM...177...19...32...Russian ground station loss of signal
 11:22 PM...177...20...21...ISS maneuver to undocking attitude
 11:24 PM...177...20...23...Sunrise
 11:49 PM...177...20...48...Russian ground station acquisition of signal
 11:51 PM...177...20...50...ISS to free drift
 11:52 PM...177...20...51...Undocking command
 11:55 PM...177...20...54...Physical separation (11:55:30 PM; dV: 0.3 mph)
 11:58 PM...177...20...57...Soyuz separation burn 1 (15 sec; dV: 1.2 mph)

04/08/09

12:00 AM...177...20...59...ISS maneuver to duty attitude
 12:08 AM...177...21...07...Russian ground station loss of signal
 12:23 AM...177...21...22...Sunset
 01:24 AM...177...22...23...Russian-to-U.S. attitude control handover
 02:24 AM...177...23...23...Soyuz deorbit burn start (2:24:26 AM; dV: 257.7 mph)
 02:27 AM...177...23...26...Sunrise
 02:29 AM...177...23...27...Deorbit burn complete (2:28:47 AM)
 02:49 AM...177...23...48...Separation of modules (87 miles)
 02:52 AM...177...23...51...Atmospheric entry (62.5 miles)
 02:54 AM...177...23...53...Entry guidance start (50.1 miles)
 02:59 AM...177...23...58...Maximum G-load (23.8 miles)
 03:01 AM...177...23...60...Command to open parachute (6.6 miles)
 03:16 AM...178...00...15...Landing (3:16:29 AM; 1:16 PM local)
 10:03 AM...178...07...02...Sunset at landing site

"The Russian search and recovery forces ... are putting the final touches on their landing plans for this homecoming in the southeastern region of Kazakhstan," NASA landing commentator Rob Navias said early Tuesday. "Late tonight U.S. time, as the Soyuz undocks from the International Space Station, the recovery team will begin to make their way to the airport here in Karaganda, where seven Mi-8 helicopters and two fixed-wing aircraft will be standing by to take off for an hour-and-40-minute flight to the landing zone."

Four helicopters will fly directly to the planned landing site 134 miles northeast of Dzhezkazgan while three will be stationed midway between the planned landing site and the so-called "ballistic" landing area where the Soyuz could end up if a problem of some sort causes a steeper-than-usual re-entry.

Assuming a normal touchdown, recovery forces will be on hand within minutes to assist the returning crew.

"One of the first helicopters to land will contain medical personnel to place the crew into reclining chairs so they can begin to acclimate themselves to Earth's gravity, particularly Fincke and Lonchakov, who have been off the planet for a half year," Navias said.

Assuming an on-time landing, Fincke will have logged 178 days in space, pushing his total through two space station expeditions to 366 days, third on the list of most experienced U.S. astronauts behind Peggy Whitson (377 days) and Mike Foale (374 days).

Lonchakov will have logged 178 days in space on this flight for a total time of 201 days over three missions. Simonyi's total will be 13 days in space for this flight, 27 including his first station visit in 2007.

An inflatable tent will be set up at the landing site for initial medical checks before helicopter flights back to Karaganda and then a three-hour flight to the Gagarin Cosmonaut Training Center in Star City near Moscow where friends and family members will be waiting.

Fincke will be welcomed home in Kazakhstan by NASA space station Program Manager Mike Suffredini, chief astronaut Steve Lindsey and a NASA flight surgeon, Steve Hart. Fincke's family will be waiting in Star City.

03:35 PM, 4/3/09, Update: Soyuz TMA-13 re-entry delayed one day due to poor conditions at planned Kazakhstan landing site; Space Adventures CEO vows additional tourist flights

Snow and soggy conditions at the primary landing site in Kazakhstan have prompted Russian flight planners to order a 24-hour delay, from April 7 to 8, for the return of a Soyuz capsule carrying outgoing space station commander Mike Fincke, flight engineer Yuri Lonchakov and space tourist Charles Simonyi.

The mission had been scheduled to conclude with a touchdown on April 7 northeast of Arkalyk, Kazakhstan, but the landing zone has been moved to a backup site about 180 miles to the southeast where conditions may be more favorable. Touchdown now is targeted for 3:15 a.m. EDT on April 8.

Fincke and Lonchakov were launched to the international space station aboard the Soyuz TMA-13 spacecraft Oct. 12. Their replacements - Expedition 19 commander Gennady Padalka and flight engineer Michael Barratt, a NASA physician-astronaut, were launched March 26 aboard the Soyuz TMA-14 spacecraft. They were joined by Simonyi, a Hungarian-born U.S. software developer making his second privately funded trip to the space station.

During a change-of-command ceremony Thursday, Fincke formally handed the station over to Padalka, saying "all systems are in order and Yuri and I can now take a little bit of a rest and get ready, along with Charles, to come back to the planet."

"Thank you very much, my best friend," Padalka replied. "Expedition 19 is very happy to get space station in great operational condition. ... We're ready to work on behalf of all our space agencies and ... all human beings."

If all goes well, Fincke, Lonchakov and Simonyi will say farewell to Padalka, Barratt and Japanese astronaut Koichi Wakata the evening of April 7, sealing hatches between the Soyuz TMA-13 spacecraft and the downward-facing port of the Russian Zarya module around 8:45 p.m.

Undocking is planned for 11:55 p.m. with a 22-second deorbit rocket firing expected at 2:24 a.m. on April 8. The three modules making up the Soyuz spacecraft will separate just before atmospheric entry at 2:52 a.m. and the central crew module carrying Fincke, Lonchakov and Simonyi will descend to a parachute-and-rocket-assisted touchdown at 3:15 a.m.

Assuming an on-time landing, Fincke will have logged 178 days in space, pushing his total through two space station expeditions to 366 days, third on the list of most experienced U.S. astronauts behind Peggy Whitson (377 days) and Mike Foale (374 days).

Lonchakov will have logged 178 days in space on this flight for a total time of 201 days over three missions. Simonyi's total will be 13 days in space for this flight for a total of 27 including his first station visit in 2007.

Simonyi's visit was arranged through Space Adventures, a Vienna, Virginia-based company that has brokered seven space tourist flights using available seats on Russian Soyuz capsules beginning in 2001 with U.S. businessman Dennis Tito.

But plans to boost the station's crew size from three to six in late May could mean a hiatus in tourist flights, at least in the near term. While one seat on a Soyuz flight scheduled for launch this fall apparently has opened up, it's not yet clear whether the Russians will fill the slot with a professional cosmonaut or allow Space Adventures to book one of its clients who has gone through training as a backup.

"There is a possibility that one of Space Adventures' clients could launch on Soyuz TMA-16, which is currently scheduled for launch this Sept. 30," Eric Anderson, CEO of Space Adventures, told reporters today. "We have learned from Roskosmos (the Russian space agency) that the third seat aboard Soyuz TMA-16 may not, in fact, be used by the cosmonaut from Kazakhstan and if that seat is not used ... Roskosmos is considering both the possibility of another spaceflight participant opportunity for Space Adventures or using the seat for a professional Russian cosmonaut."

Esther Dyson, a respected high-tech journalist, entrepreneur and Space Adventures investor, trained as Simonyi's backup and attended his launch at the Baikonur Cosmodrome in Kazakhstan. But it's not clear whether she could fly on such short notice or whether she could complete required training in time. There are no other known clients who are thought to have a realistic shot at the September flight.

Even so, Anderson expressed optimism that additional seats will open up occasionally and he said the company is pressing ahead

with plans for privately funded Soyuz missions starting in 2012 that would include a Russian commander and two tourists per mission.

But it's not yet known whether the Russians can build enough Soyuz capsules and rockets to support expanded space station operations as well as tourist flights. Between the end of shuttle operations in 2010 and the debut of its replacement in 2015, the Soyuz flight rate will have to double to support six-person crew operations aboard the space station.

"I am aware of the questions that have been raised regarding the ability of the Russian space industry to supply an increased number of Soyuz missions," Anderson said. "Building rockets is a complicated business, it's certainly challenging, but ... I'm confident by 2012, for example, the prospect of adding a fifth Soyuz is something that is reasonable."

But tickets to space, assuming the seats are available, will be increasingly expensive.

Tito's ticket reportedly cost \$20 million. It has since gone up to around \$35 million, according to Simonyi. In a pre-launch telephone interview with CBS News, Simonyi said the future of commercial spaceflight is "certainly not my concern." But, he added, "my feeling is the commercial pressures will be toward resolving this and have more flights."

Even at the current list price, he said, the experience of flying in space is worth it for those who can afford the cost.

"The price is going up," Simonyi said. "Future seats that NASA has bought are even more expensive. This has to be put into perspective because other means of getting to space are even more expensive. So this one is actually quite cost effective at the current state of technology."

4:40 PM, 3/27/09, Update: Former shuttle commander recalls wing damage, communications breakdown

The exhaustive attention NASA now devotes to making sure shuttle heat shields are damage-free and safe for re-entry is a direct result of the 2003 Columbia disaster. But a blacked-out military flight 21 years ago still stands out as a warning to astronauts, engineers and managers, a frightening "close call" that had the potential to bring the shuttle program to an early end.

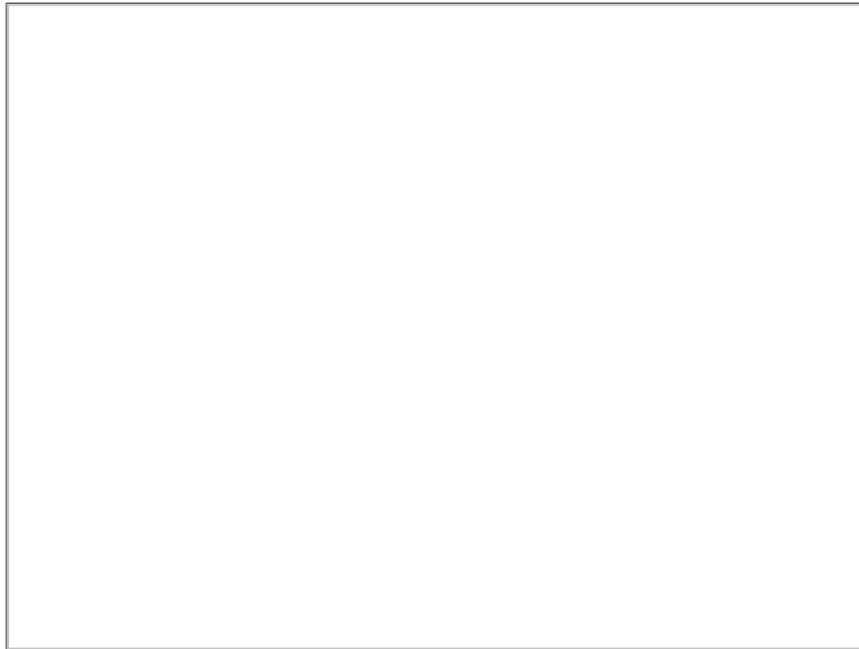
It was that close.

"I will never forget, we hung the (robot) arm over the right wing, we panned it to the (damage) location and took a look and I said to myself, 'we are going to die,'" recalled legendary shuttle commander Robert "Hoot" Gibson. "There was so much damage. I looked at that stuff and I said, 'oh, holy smokes, this looks horrible, this looks awful.'"

He was seeing the worst tile damage any shuttle had ever experienced.

But a perfect storm of poor communications, caused in part by military restrictions that prevented the crew from downlinking clear images showing scores of chipped and broken tiles, ultimately resulted in a flawed analysis on the ground that indicated the crew had nothing to worry about. Flight controllers were not convinced the shuttle was seriously damaged at all. Some engineers apparently believed the astronauts had been misled by poor lighting conditions and grainy TV images.

The crew knew better. The images were crystal clear on the shuttle, and definitely alarming. But the astronauts reluctantly accepted the judgment of mission control and went on about their business. The mission still stands out as an example of how assumptions, poor communications and an unwillingness to challenge authority can put people in danger in high-risk endeavors like spaceflight.



**Shuttle Atlantis lands at Edwards AFB, Dec. 6, 1988;
Extensive tile damage is visible on the ship's underside**

"There was a big failure to communicate," Gibson recalled in an interview this week. "When you talk about crew resource management, or cockpit resource management or any of that resource management stuff, it's real easy to be talking and not communicating. In order to be really communicating, you've got to say 'here is what's on my mind.' I think I was doing that to a major degree, but maybe I fell short by not arguing with them. But they really did not tell us what was on their minds."

Gibson, a former Navy test pilot, "Top Gun" graduate, chief astronaut and veteran of five shuttle missions, was at the controls when the shuttle Atlantis blasted off Dec. 2, 1988, on the second post-Challenger mission. Carrying a top-secret spy satellite, the mission was fully classified and all communications with the astronauts were blacked out.

But 85 seconds after launch, a piece of insulation on the tip of the shuttle's right-side solid-fuel booster broke away and struck Atlantis' right side. The impact was not noted on NASA television at the time and after landing, NASA engineers said that while the shuttle had suffered more tile damage than usual, "it isn't something that's of a major concern."

But as it turned out, the damage was, in fact, extensive. More than 700 heat shield tiles were damaged. One tile on the shuttle's belly near the nose was completely missing and the underlying metal - a thick mounting plate that helped anchor an antenna - was partially melted. In a slightly different location, the missing tile could have resulted in a catastrophic burn through.

It was the most extensive shuttle heat shield damage ever recorded until Columbia took off on its final voyage.

Years later, Gibson would be asked to brief the Columbia Accident Investigation Board about his experiences aboard Atlantis and as the tale was told, "their jaws dropped," he said.

Crewmate Mike Mullane devoted a chapter to the mission in his book "Riding Rockets: The Outrageous Tales of a Space Shuttle Astronaut," writing that as entry approached, "the anxiety was exhausting."

"I finally gave in to Hoot's solution. The day before (entry), as he floated to the windows to do some sightseeing, he said, 'no reason to die all tensed up.' I would do my best to relax and enjoy the sights."

Even so, he wrote, during Atlantis' descent "I had visions of molten aluminum being smeared backward like rain on a windshield."

Gibson, Mullane, pilot Guy Gardner, Jerry Ross and William Shepherd had no idea Atlantis had been hit during ascent. It was not until the next day that mission control called up with an unusual request. The crew was asked to use Atlantis' robot arm to inspect the shuttle's heat shield on the ship's right side.

Mullane, the arm operator, dutifully carried out a procedure to maneuver the arm into position so a black-and-white television camera on the end could "see" the tiles in question.

"As I moved the arm lower the camera picked up streaks of white," he wrote in "Riding Rockets." "There was no mistaking what

they were. ... As I continued to drop the arm lower we could see that at least one tile had been completely blasted from the fuselage. The white streaking grew thicker and faded aft beyond the view of the camera. It appeared that hundreds of tiles had been damaged and the scars extended outboard toward the carbon-composite panels on the leading edge of the wing. Had one of those been penetrated? If so, se were dead men floating."

Gibson, who flew for Southwest Airlines for years after retiring from NASA, recalled his impressions as the images snapped onto TV monitors in Atlantis' cockpit and his immediate "we are going to die" reaction.

"So I get on the mic and I call Houston and I tell them, Houston, we are seeing a whole lot of damage on the right wing, in the chine area and back on the right wing in the tiles. ... The ground comes back and says well, you know what, we need you guys to send us secure TV."

Because the mission was classified, no pictures or television were being downlinked, even to mission control. When the decision was made to send down TV images of the tile damage, the video had to be encrypted."

"So we send them secure TV," Gibson said. "The problem with secure TV is, it takes a frame, it encrypts it, it ships that frame, it takes the next frame, it encrypts it, it ships the next one, so you get a frame about every three seconds."

While the astronauts beamed down the images, Gibson was thinking the worse.

"I think the words 'we're in deep doo doo' were said in the cockpit, this could be a problem, guys, you know? This looks bad. Now you know, I didn't really think at that instant, yep, we're as good as dead, write our wills and all that stuff. But I did look at it and say 'holy smokes, we are going to die' to myself."

The astronauts anxiously waited for mission control's assessment. And they were stunned when the ground called back.

"We've looked at the images and mechanical says it's not a problem," the mission control CAPCOM said, according to Mullane. "The damage isn't that severe."

"We couldn't believe what we were hearing," Mullane wrote. "MCC was blowing us off."

Gibson then chimed in, saying "Houston, Mike is right. We're seeing a lot of damage."

But mission control repeated the engineering assessment that the damage was not that severe.

"I'm just perplexed at this point," Gibson said. "Because I'd never seen anything like this before. Never seen anything even close, and I'd been there since before day one. ... He came back and he said 'Hoot, they've looked at it and they've determined that it's not any worse than what we've seen on other flights.' And I am just perplexed. I think I was silent for maybe 30 seconds, because I didn't know what to say. And I came back and I said something to the effect that well, all right. It looks pretty bad to us, but you guys are the experts, so OK."

"And I honestly believed at that point, the rest of my crew said, 'Oh, OK, great, no problem.' I did not. I did not believe them. I didn't want to argue with them, I didn't want to have a long drawn-out argument over the air, but I suppose I was probably remiss to some degree because I didn't quiz them some more."

Of course, it's not clear what, if anything, could have been done if engineers had realized the severity of the problem. There were no tile repair tools on board the shuttle and no techniques for even getting an astronaut to the damage site. Changes to the shuttle's re-entry orientation and trajectory could have been attempted, Gibson said, but whether anything like that would have worked is an unknown.

The real issue for Gibson - and the same issue was faced Columbia's crew - was that no one took the extra step to make sure the problem was fully resolved.

"NASA does amazing things when they've got their back against the wall," he said. "Like Apollo 13. I've seen us work out some really dramatic things in some of the missions when we had on-orbit problems and we did in-flight maintenance and things like that. You never know what you could have done because you didn't try."

Hoping for the best, Gibson and Gardner fired Atlantis' twin braking rockets on Dec. 6 to begin the shuttle's fiery descent to a landing at Edwards Air Force Base, Calif. The astronauts did not discuss any fears they may have had, but as the shuttle fell into the discernible atmosphere, Gibson kept his eyes on a gauge that showed how much the elevons at the back of each wing were deflected.

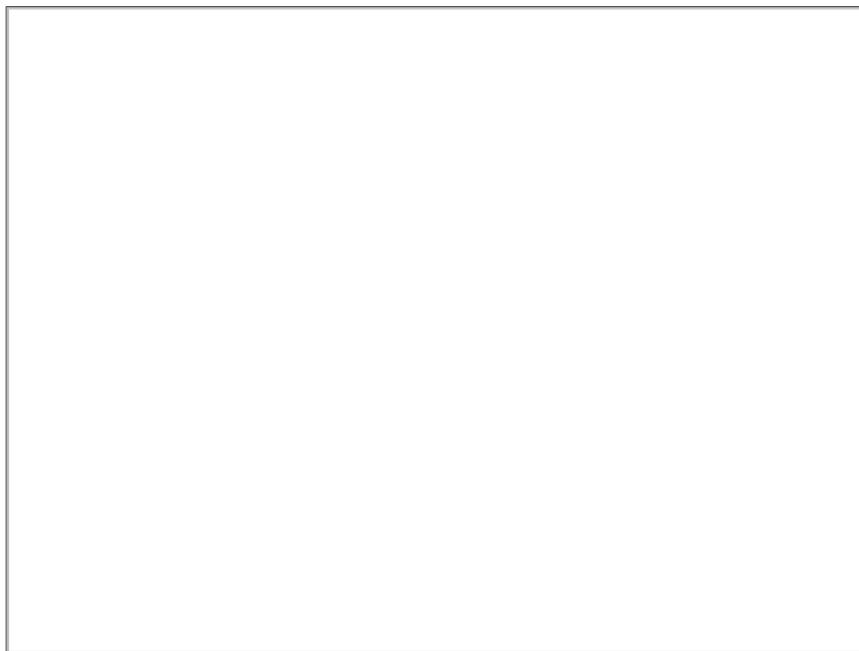
"I knew that what would happen was, if we started to burn through we would change the drag on that wing," he said, "which is exactly what happened to Columbia. We would change the drag on the right wing and what we'd see happening is, we'd start seeing

right elevon trim, you'd start seeing right aileron, if you will, trim, which means putting down the left elevon, moving the left elevon down.

"I knew we would start developing a split (between right and left wing elevon positions) if we had excessive drag over on the right side. The automatic system would try to trim it out with the elevons. That is one of the things we always watched on re-entry anyhow, because ... if you had half a degree of trim, something was wrong, you had a bunch of something going on if you had even half a degree. Normally, you wouldn't see even a quarter of a degree of difference on the thing.

"So I knew that that's what I was going to see if it started to go," Gibson said. "And therefore, that told me that I'd have at least 60 seconds to tell mission control what I thought of their analysis."

But as it turned out, Atlantis did not suffer a burn through and Gibson guided the shuttle to a smooth landing at Edwards. Gathered on the runway after touchdown, the astronauts, engineers and NASA managers were astonished at what they saw.



Astronauts and managers inspect heat shield damage on the runway

"The damage was much worse than any of us had expected," Mullane wrote. "Technicians would eventually count 700 damaged tiles extending along half of Atlantis's length. It was by far the greatest heat shield damage recorded to date."

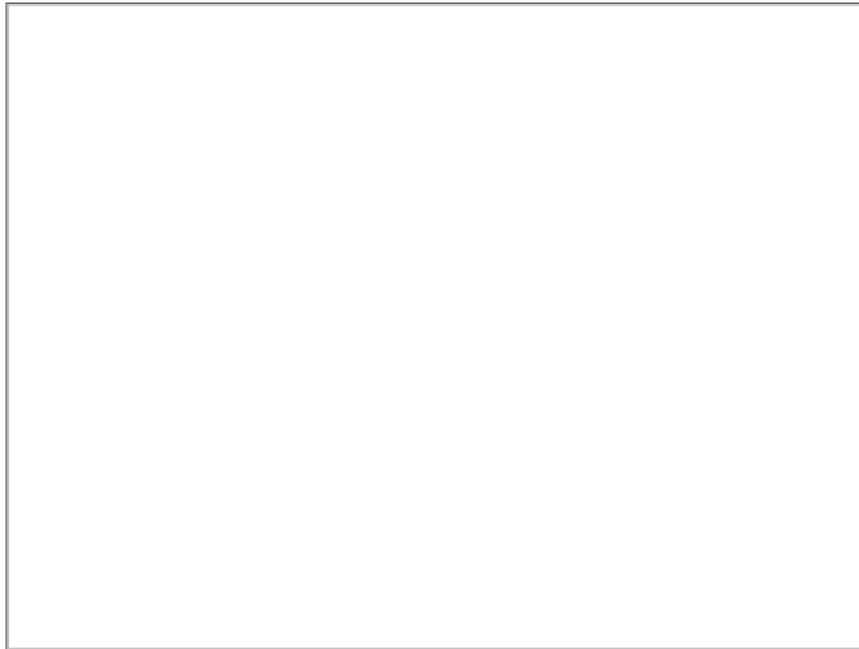
During debriefing after the mission, Gibson finally learned why the engineering community had not taken the crew's descriptions of the damage more seriously.

"Their conclusion, which they did not pass back to us, was 'oh, you know what? That's not tile damage, those are just lights and shadows we're seeing in this video.' So in other words, the resolution on the encrypted video was that bad that they based a conclusion on it that was in gross error. ... If I had said hey, I think this is important enough for us to break the encryption and send you guys clear video, oh, it would have been pandemonium down there at DOD. But in hindsight, oh man, that's what we should have done. Because they were drawing an incorrect conclusion from it and they were not telling us what their conclusion was."

Wayne Hale, a veteran ascent-entry flight director and former shuttle program manager at the Johnson Space Center, agreed engineers were caught off guard by the severity of the damage when they finally saw the shuttle on the runway.

"We were struggling in those days to try to maintain the security classification, so on and so forth," Hale said in a telephone interview. "When the crew reported they saw this stuff, we had a long negotiation as I recall with the customer to say well, can we look at the TV? Because we weren't supposed to see any TV from on orbit. (They said) absolutely not. Could we look at the bottom side of the shuttle? That was the agreement, that we could, but we used this special slow-scan TV. And it was grainy.

"People were concerned, I suppose, but not nearly at the level that we would be today. And STS-27 has always been the worst tile damage flight we ever had. It set all the reference marks. It's interesting that there is enough capability in that thermal protection system to take that kind of damage and survive."



Metal under a missing heat-shield tile is partially melted

Reflecting on what Hale agreed "was a real close call," Gibson said he believes NASA came close to losing the crew and along with it, the shuttle program. STS-27 was only the second flight after the Challenger disaster and unlike Columbia, the shuttle re-entered over the Pacific Ocean for a descent to Edwards. Had Atlantis been lost, most of the wreckage would have sunk and engineers might never have discovered the cause.

"We had spent all that money and all that time rebuilding and revamping and we launched one successful mission, we lost the very next one," Gibson said. "I think the Congress would have said OK, that's the end guys, we just don't need to do this again. I think that just would have been the end of it."

01:10 PM, 3/12/09, Update: Space debris passes station; crew told to exit Soyuz, re-enter station

Space station commander Mike Fincke, flight engineer Yury Lonchikov and Sandra Magnus evacuated to the lab's Russian Soyuz spacecraft today because of a predicted close encounter with debris from a spent upper stage booster rocket. But the space junk streaked harmlessly past the station around 12:39 p.m. and the crew was cleared to re-enter the lab complex.

"OK guys, based on all the confirmations, most likely the object passed us by," a Russian flight controller said, according to a translator. "So you are go to egress Soyuz. Yury, also please tell us are you ready to start the leak check?"

"And Houston, space-to-ground 1, can you hear us?" Fincke called over the NASA communications circuit.

"We have you loud and clear Mike, on space-to-ground 1," a controller in Houston replied.

"OK, we understand we're clear (to) ingress back to the USOS (U.S. segment of the station)," Fincke said.

"And we're all very happy the (debris) has passed with no impact," Houston replied. "That's great news."

According to a NASA statement, the station crew members evacuated to the Soyuz as a precautionary measure "due to space debris that has been determined to be within the range where a collision is possible. News of the close approach came too late for flight controllers to coordinate an avoidance maneuver. A portion of a spent satellite motor is within the distance of the station's debris avoidance maneuver requirement 'box.'

"Crew members are entering their Soyuz TMA-13 capsule and soft-locking the hatches, in case the debris should affect the space station and they are required to undock. The closure of the hatches ensures the safety of the crew and the ability to quickly depart the station in the unlikely event the debris collided with the station causing a depressurization."

Time of closest approach was 12:39 p.m. EDT. It was not immediately known just how close the debris from the spent payload assist module, or PAM-D, upper stage rocket motor came to the international space station.

But all objects in low-Earth orbit are traveling at 5 miles per second and impacts are potentially catastrophic. A 0.4 inch-wide sphere of aluminum moving at orbital speeds packs the same punch as a 400-pound safe moving at 60 mph.

There are more than 18,000 pieces of space junk in low-Earth orbit the size of a baseball and larger. U.S. Strategic Command prioritizes radar tracking to protect manned spacecraft first, followed by high-priority military and civilian payloads.

Normally, the station's rocket thrusters are used to change its orbit slightly when close encounters are predicted. Putting the crew in the station's Soyuz lifeboat with little warning is unusual and it was not immediately clear why an alert about today's close encounter was not delivered or received in time to carry out a course change.

12:20 PM, 3/12/09, Update: Station astronauts told to board Soyuz spacecraft as precaution due to possible close approach with space debris

Space station commander Mike Fincke, flight engineer Yury Lonchov and Sandra Magnus were told to board the lab's Russian Soyuz spacecraft because of a possible close approach by a piece of space debris.

At 12:15 p.m., Fincke was told to be inside the Soyuz ferry craft in the next 20 minutes. Russian flight controllers recommended leaving the Soyuz hatch open and Fincke concurred, saying the crew would make sure it could be quickly closed if necessary.

A NASA source said the debris in question was listed as "PAM-D" debris, an acronym implying it was a spent payload assist module solid-fuel motor used to boost payloads to higher orbits. It was not immediately clear if that was, in fact, what the debris might be.

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Normally, the station's rocket thrusters are used to change its orbit slightly when close encounters are predicted. Putting the crew in the station's Soyuz lifeboat is unusual. It was not immediately clear why a maneuver was not carried out today or whether the alert came in too late.

Additional details will be posted as they become available.

11:00 PM, 3/6/09, Update: Kepler launched on planet-finding mission (UPDATED at 12:30 a.m. with spacecraft separation)

Lighting up the night sky, a Delta 2 rocket roared to life and vaulted away from the Cape Canaveral Air Force Station late today, boosting a powerful space telescope into orbit around the sun for a \$591 million mission to search for Earth-like planets orbiting distant stars.

"I think people everywhere want to know whether, with all the stars out there, do they have planets that are Earth-sized?" said principal investigator William Borucki of NASA's Ames Research Center. "Are Earths frequent or are they rare? And this gives us that answer. It's the next step in mankind's exploration of the galaxy."

The Kepler spacecraft's three-and-a-half-year mission began on time at 10:49:57 p.m. with a crackling roar and a torrent of fire that briefly turned night into day along Florida's space coast. Putting on a spectacular weekend sky show, the United Launch Alliance Delta 2 rocket quickly climbed from its sea-side launch pad and arced away to the east over the Atlantic Ocean as it streaked toward space.

Just over one minute after launch, six solid-fuel strap-on boosters that were ignited at liftoff to assist the Delta's first-stage engine burned out and fell away while a final set of three ignited for another one-minute burn. The first-stage engine shut down as planned four-and-a-half minutes after launch and the ascent continued on the power of the Delta's compact second stage.

Two second-stage burns were required before Kepler and its solid-fuel third stage motor were released for a final one-and-a-half-minute firing to boost the craft out of Earth orbit. Spacecraft separation came on time at 11:52 p.m. At that point, Kepler was moving out at a blistering 6.2 miles per second.

This was the 339th Delta rocket launched since 1960, the 141st upgraded Delta 2, and the 86th successful Delta launch in a row dating back to January 1997. The Delta 2 record now stands at 139 successful missions against just two failures.

"And now we have plenty of handshakes going on here in the mission director's center because we have confirmation of spacecraft separation," said NASA launch commentator George Diller. "It did occur on time at 61 minutes 49 seconds. ... So at this point, the Kepler team now really gets to work."

Engineers will spend about two months checking out and calibrating Kepler's complex systems before the mission begins in earnest.

Trailing the Earth in its orbit around the sun, Kepler will aim a 95-megapixel camera on a patch of sky the size of an out-stretched hand that contains more than 4.5 million detectable stars. Of that total, the science team has picked some 300,000 that are of the

right age, composition and brightness to host Earth-like planets. Over the life of the mission, more than 100,000 of those will be actively monitored by Kepler.

The spacecraft's camera will not take pictures like other space telescopes. Instead, it will act as a photometer, continually monitoring the brightness of candidate stars in its wide field of view and the slight dimming that will result if planets happen to pass in front.

By studying subtle changes in brightness from such planetary transits - comparable to watching a flea creep across a car's headlight at night - and the timing of repeated cycles, scientists can ferret out potential Earth-like worlds in habitable-zone orbits.

The probability of finding sun-like stars with Earth-like planets in orbits similar to ours - and aligned so that Kepler can "see" them - is about one-half of 1 percent. Given the sample size, however, that still leaves hundreds of potential discoveries.

But it will take three-and-a-half years of around-the-clock observations to capture the repeated cycles needed to confirm detection of an Earth-like world in an Earth-like orbit.

"There's a lot of desire in the science community to understand extra-terrestrial planets, not just find them," said Ed Weiler, NASA's associate administrator for space science. "We've already found 300 or so, mostly from the ground. But now we're entering the stage of going beyond just proving that they exist. It's how many are out there, and perhaps the most important question of all, are there any Earth's out there?"

"So far, even though we've discovered (more than) 300 planets, we haven't discovered any that are the size of the Earth in the so-called habitable zone, that is, a planet close enough to the star where it's warm enough for water to be liquid, not frozen, or not too close to the sun where it would boil off. So Kepler is going to be the first mission that starts to answer that question, are there any Earth's out there?"

Named in honor of Johannes Kepler, the 17th century German astronomer who formulated the laws of planetary motion, NASA's newest science satellite weighs 2,320 pounds and measures 15.3 feet from top to bottom. It is equipped with four solar panels capable of generating 1,100 watts of power, a radiation-hardened PowerPC flight computer and a Ka-band communications link to relay science data back to Earth. The spacecraft was built by Ball Aerospace of Boulder, Colo.

Kepler will pass the moon's orbit in just two days as it heads into a 371-day orbit around the sun, separating slowly from Earth. It will aim itself at a patch of sky near the left wing of Cygnus the Swan, midway between the stars Deneb and Vega.

And then, Kepler will simply stare at the same stars for three-and-a-half years.

"An Earth-like planet passing in front of a sun-like star is going to cause the brightness of that star to dim by only 1 part per 10,000," said Natalie Batalha, a Kepler co-investigator at San Jose State University. "That's like looking at a headlight from a great distance and trying to sense the brightness change when a flea crawls across the surface. But the Kepler instrument is designed to detect such small changes in brightness."

Kepler is capable of detecting Earth-like planets around stars ranging from 600 to 3,000 light years away.

The science team is particularly interested in planets that may orbit within a star's habitable zone, the region around a star where water on a planet can exist as a liquid. Habitable zones vary in location depending on a star's size and brilliance. By timing changes in a star's light as a transit occurs, scientists can figure out the size of a presumed planet's orbit and thus whether it falls in that star's habitable zone.

"The habitable zone is where we think water will be," Borucki said. "If you can find liquid water on the surface, we think we may very well find life there. So that zone is not too close to the star, because it's too hot and the water boils. Not too far away where the water's condensed and ice-covered, a planet covered with glaciers. It's the goldilocks zone, not too hot, not too cold, just right for life."

Weiler said Kepler is a pathfinder of sorts for more sophisticated missions that may one day study the atmospheres of Earth-like planets to look for signs of biological - or even industrial - activity.

"A lot of scientists out there would like to immediately go out and build very large telescopes, not just to find Earth-like planets but to study their atmospheres, to search for clues that there might be life on those planets," Weiler said. "The trouble is, most of these proposals start at about \$5 billion and work upwards from there."

"Before we actually take the next step, looking for signs of life on Earth-like planets, we've got to be sure there are at least a few Earth-like planets out there. And that's why Kepler is so important. It's a rather small mission, a moderate mission, around (\$600 million), and it's really a pathfinder for future large space telescopes that will go after the question that we all have, are we alone in the universe?"

5:50 PM, 3/6/09, Update: Kepler set for launch

NASA's Kepler spacecraft, the centerpiece of a \$591 million mission to find out how common - or rare - Earth-like planets might be in the Milky Way, is poised for blastoff this evening atop a United Launch Alliance Delta 2 rocket. Liftoff from the Cape Canaveral Air Force Station is targeted for 10:49:57 p.m. A second three-minute window is available at 11:17:44 p.m. if needed.

As of this writing there are no technical problems of any significance at launch complex 17B, officials say, and forecasters are predicting good weather.

The Kepler spacecraft is equipped with a 95-megapixel camera attached to a Schmidt telescope with a 55-inch primary mirror. Trailing Earth in its orbit around the sun, Kepler will aim its camera at a single point in the sky for at least three-and-a-half years. By monitoring subtle changes in the brightness of more than 100,000 stars, scientists hope to identify Earth-like planets as they pass in front of their parent suns.

Based on the type of star in question, and how long it takes for an unseen planet to complete an orbit, scientists should be able to tell if any Earth-like worlds are present in a star's habitable zone where water, essential to life as we know it, can exist in liquid form.

"Kepler is designed to find hundreds of Earth-size planets, if such planets are common around stars, dozen of these planets, if they are in the habitable zone," said William Borucki, Kepler principal investigator at NASA's Ames Research Center.

"If we find that many, it certainly will mean that life may well be common throughout our galaxy because there's an opportunity for life to have a place to evolve. If, on the other hand, we don't find any, that will be another profound discovery. It will mean that Earths must be very rare, we might be the only life in our Universe."

Here is a timeline of tonight's launch through spacecraft separation (in HH:MM:SS and EST):

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EVENT.....T+H:MM:SS.....EST
Liftoff.....0:00:00.0...10:49:57 PM
Mach 1.....0:00:32.7
Maximum Dynamic Pressure.....0:00:47.6
Six Solid Motors Burnout.....0:01:03.1
Three Solid Motors Ignition.....0:01:05.5
Jettison Three Solid Motors.....0:01:06.0
Jettison Three Solid Motors.....0:01:07.0
Three Solid Motors Burnout.....0:02:08.8
Jettison Three Solid Motors.....0:02:11.5
Main Engine Cutoff (MECO).....0:04:23.3
Vernier Engine Cutoff (VECO).....0:04:29.3
First- and Second-Stage Separation.....0:04:31.3...10:54:28 PM
Second-Stage Ignition.....0:04:36.8...10:54:34 PM
Jettison Fairing.....0:04:41.0
First Cutoff - Second Stage (SECO 1).....0:09:56.0...10:59:53 PM
Begin Reorientation Maneuver.....0:12:30.0
End Reorientation Maneuver.....0:17:30.0
Begin BBQ Maneuver.....0:17:50.0
End BBQ Maneuver.....0:44:57.0
Begin Reorientation Maneuver.....0:50:02.0
End Reorientation Maneuver.....0:50:20.0
Second-Stage Restart Ignition.....0:53:10.0...11:43:07 PM
Second Cutoff - Second Stage (SECO 2).....0:54:13.8...11:44:11 PM
Begin Reorientation Maneuver.....0:54:19.8
End Reorientation Maneuver.....0:54:52.8
Third-Stage Spin-up.....0:54:53.8
Second- and Third-Stage Separation.....0:54:56.8...11:44:54 PM
Third-Stage Ignition - NCS Enable.....0:55:33.8...11:45:31 PM
Third-Stage Burnout (TECO).....0:57:00.1...11:46:57 PM
Disable NCS " Initiate Yo-Yo Despin.....1:01:43.8
Kepler Separation.....1:01:48.8...11:51:46 PM
    
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This status report will be updated after spacecraft separation, or as conditions warrant.

3:50 PM, 3/5/09, Update: Kepler camera will scan starlight for signs of Earth-like planets in pioneering mission

In a galaxy of 200 billion or more stars, one could argue planets like Earth - orbiting suitable stars in habitable "Goldilocks" zones where water exists in liquid form and the temperature is not too hot or too cold - must be common. After all, if only a tiny fraction of the Milky Way's stars harbor such planets, one could still expect untold thousands, if not millions, of potentially habitable worlds. And with numbers like that, it's not at all unreasonable to suppose life arose on at least some of them. Extending that argument to the countless galaxies populating the observable universe, one could easily assume the cosmos must be teeming with life.

But statistics alone prove nothing about how solar systems might be constructed. While more than 340 planets have been detected orbiting other stars, the limitations of Earth-based observations mean, with a few exceptions, only huge, Jupiter-class gas giants have been identified to date, many of them orbiting hellishly close to their parent stars.

Whether such seemingly strange solar system architectures are common or whether they are simply easier to detect using current methods, is not yet clear. Whether Earth-like planets are common or rare is simply unknown. But it is a question with profound implications, one at the heart of any debate about the possibility of life elsewhere in the universe.

NASA plans to take a major step toward answering that question, one way or the other, with launch of a Delta 2 rocket Friday carrying a sophisticated solar-powered satellite called Kepler that is equipped with one of the most powerful digital cameras ever built for space. The \$591 million mission is scheduled for liftoff from the Cape Canaveral Air Force Station at 10:49:57 p.m. EST.

"To this point in time, if you asked me are there other earth's out there, I'd say absolutely, there have to be, we can't be so special," said NASA science chief Ed Weiler. "But if you ask me to prove it, I can't."

The Kepler mission "very possibly could tell us that earths are very, very common, that we have lots of neighbors out there. Or, it could tell us that earth's are really, really, really rare, perhaps we're the only Earth," Weiler said. "I think that would be a very bad answer because I for one don't want to live in an empty universe where we're the best there is. That's a scary thought to many of us! But Kepler will tell us that answer, and it will tell us soon."

Trailing the Earth in its orbit around the sun, the Kepler spacecraft will aim a 95-megapixel camera on a patch of sky the size of an out-stretched hand that contains more than 4.5 million detectable stars. Of that total, the science team has picked some 300,000 that are of the right age, composition and brightness to host Earth-like planets. Over the life of the mission, more than 100,000 of those will be actively monitored by Kepler.

The spacecraft's camera will not take pictures like other space telescopes, rather it will act as a photometer and continually monitor the brightness of candidate stars in its wide field of view and the slight dimming that will result if planets happen to pass in front.

By studying subtle changes in brightness from such planetary transits - comparable to watching a flea creep across a car's headlight at night - and the timing of repeated cycles, computer analysis can ferret out potential Earth-like worlds in habitable-zone orbits.

The probability of finding sun-like stars with Earth-like planets in orbits similar to ours - and aligned so that Kepler can "see" them - is about one-half of 1 percent. Given the sample size, however, that still leaves hundreds of potential discoveries.

But it will take three-and-a-half years of around-the-clock observations to capture the repeated cycles needed to confirm detection of an Earth-like world in an Earth-like orbit.

"Kepler is designed to find hundreds of Earth-size planets, if such planets are common around stars, dozen of these planets, if they are in the habitable zone," said William Borucki, Kepler principal investigator at NASA's Ames Research Center.

"If we find that many, it certainly will mean that life may well be common throughout our galaxy because there's an opportunity for life to have a place to evolve. If, on the other hand, we don't find any, that will be another profound discovery. It will mean that Earths must be very rare, we might be the only life in our Universe. In fact, it will mean there will be no Star Trek."

But he quickly added: "We are hoping to find hundreds, of course. ... Although Kepler will not find E.T., it is hoping to find E.T.'s home."

Jon Morse, director of astrophysics at NASA headquarters in Washington, described Kepler as "our planetary census taker."

"We're going to get the full sweep of the types of planets in different types of orbits around different types of stars through a big cross-section of our galaxy," he said. "It is going to shape the way that we formulate our plans for future missions on our quest to find Earth-like planets and study their atmospheres and look for the bio-markers like the types of molecules in our atmosphere that may indicate life."

Said Michael Bicay, director of science at the Ames Research Center: "The ramifications of the results of this mission, whatever those results are, are going to be significant in our understanding of the frequency of Earth-size planets in the local galaxy and the habitable zones."

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Following launch from Complex 17B at the Cape Canaveral Air Force Station, Kepler will pass the moon's orbit in just two days as it heads into a 371-day orbit around the sun, separating slowly from Earth. It will aim itself at a patch of sky near the left wing of Cygnus the Swan, midway between the stars Deneb and Vega.

And then, Kepler will simply stare at the same stars for three-and-a-half years.

The science team will check in twice a week to check the spacecraft's health and upload commands. Once a month, Kepler will look away from its target area, point its high-gain antenna toward Earth and downlink stored data. Every three months, the spacecraft will rotate 90-degrees around its long axis to keep its fixed solar panels face on to the sun and its radiator pointed toward deep space.

Kepler's single science instrument is built around a 55-inch mirror and a 37-inch corrector plate that represents a modified Schmidt telescope design. Light from the primary mirror comes to a focus on an assembly of charge coupled devices, or CCDs, similar in operation to the chips used in commercial video and still cameras.

But unlike commercial cameras, Kepler's Focal Plane Array is made up of 42 CCDs, each one measuring 2.32 inches by 1.1 inches and containing 2,200 by 1,024 picture elements, or pixels, for a total of 95 million pixels. The focal plane will be maintained at minus 121 degrees Fahrenheit to improve sensitivity and minimize electrical "noise" in the system. Special lenses will smear out the starlight slightly to make slight changes in brightness more easily detectable.

"An Earth-like planet passing in front of a sun-like star is going to cause the brightness of that star to dim by only 1 part per 10,000," said Natalie Batalha, a Kepler co-investigator at San Jose State University. "That's like looking at a headlight from a great distance and trying to sense the brightness change when a flea crawls across the surface. But the Kepler instrument is designed to detect such small changes in brightness."

Kepler will be aimed at the same spot in the sky, measuring 10 degrees by 10 degrees, for the life of the mission, actively observing more than 100,000 candidate stars. In contrast, the moon's apparent angular diameter is 0.5 degrees. The Hubble Space Telescope focuses on areas the size of a rice grain held at arm's length. A planetary transit will cause the light from a target star to dim, or wink, on timescales of one to 12 hours, depending on the type of star and the size of the planet's orbit. For a planet like Earth passing in front of a star like the sun, the star's light would dim by just 84 parts per million, or less than 1/100th of 1 percent.

Kepler is capable of detecting Earth-like planets around stars ranging from 600 to 3,000 light years away.

The Kepler team is particularly interested in planets that may orbit within a star's habitable zone, the region around a star where water on a planet can exist as a liquid. Habitable zones vary in location depending on a star's size and brilliance. By timing changes in a star's light as a transit occurs, scientists can figure out the size of a presumed planet's orbit and thus whether it falls in that star's habitable zone.

"The habitable zone is where we think water will be," Borucki said. "If you can find liquid water on the surface, we think we may very well find life there. So that zone is not too close to the star, because it's too hot and the water boils. Not too far away where the water's condensed and ice-covered, a planet covered with glaciers. It's the goldilocks zone, not too hot, not too cold, just right for life."

Brief changes in a star's light output imply an extremely hot planet orbiting close to its parent. Longer transits imply planets at greater distances.

"We are interested in finding planets that are not too hot, not too cold, but just right," Borucki said.

In its first year of operation, Kepler is expected to discover Jupiter-class super planets orbiting close to their parent stars with periods of just a few days. The Kepler team requires multiple transits to make sure the photometer is not seeing some other phenomenon, like the passage of an unseen companion star or a major disturbance in the target star's appearance. Ground-based astronomers then will be asked to attempt confirmation and only then will results be announced.

"After several months of data processing and confirmation by ground-based telescopes, scientists hope to announce their first results approximately in December 2009 at NASA Headquarters ... about giant planets found in short-period orbits," NASA said in its Kepler press kit.

"Discovery of Earth-size planets in Earth-like orbits requires nearly the full lifetime of the 3.5-year mission, although in some cases three transits are seen in just a little more than two years. Other results that require the full 3.5 years of data are: Planets as small as Mars in short period orbits, which utilizes the addition of dozens or more transits to be detectable; and the detection of giant-inner planets that do not transit the star, but do periodically modulate the apparent brightness due to reflected light from the planet."

The first announcement of any Earth-like planets orbiting stars like the sun is not expected before December 2012.

"What I'm hoping, expecting to see as a community scientist is in the first six months to a year, the big, massive hot Jupiters are going to roll off the Kepler assembly line," said Debra Fischer, astronomy professor at San Francisco State University and a veteran exoplanet observer. "This is exciting because these are bizarre planets. We don't really understand the statistics, how they form, how they moved into their current position and just the sheer number of these objects that Kepler will find is going to help us learn a lot

about the systems.

"And then the next class of planets I think will roll out will be perhaps the hot Neptunes," she said. "Significantly smaller than Jupiter, these objects are thought to exist around something like 30 percent of stars like our sun and low-mass stars. And if that is correct, then Kepler should see quite a few of these very large, something like 17 times the mass of the Earth, orbiting." "And then the hardest detection and by far the most exciting is going to be the detection of bona fide Earths - small, rocky planets, Earth-size planets."

While such planets are often thought of as terrestrial "rocky" worlds, "I think that the science fiction writers are going to be challenged to imagine the diversity that we could expect to find, even in this type of planets," Fischer said. "They may not be rocky worlds, they may be water worlds without plate tectonics that force the landmass up above the oceans. These could be worlds that, in fact, have life like our oceans, OK? But perhaps not sending radio signals to us."

3:55 PM, 2/26/09, Update: NASA budget overview shows Obama support for one additional shuttle flight, return to moon

The Obama administration's proposed 2010 budget provides \$18.7 billion for the National Aeronautics and Space Administration. Including \$1 billion that went to NASA from the American Recovery and Reinvestment Act of 2009, the new budget proposal represents a \$2.4 billion increase over 2008 funding levels, according to the White House Office of Management and Budget.

The budget blueprint continues to support the Bush administration's directive to finish the space station and retire the shuttle in 2010 and to return astronauts to the moon around the end of the next decade.

"NASA's astronauts and robotic spacecraft have been exploring our solar system and the universe for more than 50 years," according to an OMB budget overview. "The agency will create a new chapter of this legacy as it works to return Americans to the moon by 2020 as part of a robust human and robotic space exploration program.

"NASA also will send a broad suite of robotic missions to destinations throughout the solar system and develop a bold new set of astronomical observatories to probe the mysteries of the universe, increasing investment in research, data analysis, and technology development in support of these goals."

In a short statement, acting NASA Administrator Christopher Scolese said "the \$18.7 billion budget proposal for 2010 is fiscally responsible and reflects the administration's desire for a robust and innovative agency aligned with the president's goals of advancing our nation's scientific, educational, economic and security interests."

"This budget ensures NASA maintains its global leadership in Earth and space research, and it advances global climate change studies, funds a robust program of human and robotic space exploration, allows us to realize the full potential of the international space station, advances development of new space transportation systems, and renews our commitment to aeronautics."

The budget also endorses research on global climate change, saying NASA will use National Research Council recommendations to guide development of new environmental research satellites and sensors "to ensure continuity of measurements that have long-term research applications benefits."

"I think it's a strong statement on the part of the Obama administration that they want a success-oriented space program, that they're committed to a vision of exploration," John Logsdon, professor emeritus at George Washington University and founder of the Space Policy Institute, told CBS Radio. "They are intending to retire the shuttle in 2010 and conduct a balanced program. So I think it's a very strong budget."

In the wake of the 2003 Columbia disaster, the Bush administration ordered NASA to finish the space station and retire the shuttle by 2010. At the same time, the agency was told to begin development of a new, safer manned spacecraft that could carry astronauts to and from low-Earth orbit and eventually, on to the moon.

The Constellation program that eventually was approved calls for development of a new rocket called Ares 1 that is made up of a five-segment shuttle solid-fuel booster and an advanced Apollo-era hydrogen-fueled upper stage. The Ares 1 would be used to boost new Orion crew capsules into orbit. A much more powerful, unmanned rocket called the Ares 5 would be developed later to launch lunar landers and to propel landers and Orion capsules on to the moon.

The Ares 1 will not be operational before late 2014 or early 2015. Between the retirement of the shuttle in 2010 and the debut of Ares 1/Orion, NASA astronauts will be forced to hitch rides to and from the space station aboard Russian Soyuz rockets.

Obama said during the presidential campaign that he hoped to narrow the five-year gap, but it's not clear how the new budget addresses that issue.

"That's a situation we put ourselves in by a decade or more of decision making," Logsdon said. "And there's really not a band-aid

that can fix it."

Critics have attacked the Constellation architecture on a variety of fronts, arguing other designs offer more flexibility, comparable safety and lower costs. The OMB's 2010 budget overview does not mention Ares rockets by name or indicate whether the new administration supports the current architecture beyond endorsing a return to the moon.

While few details were included in the overview released today, the new budget reflects President Obama's campaign promise to look into adding one additional shuttle flight in 2010, presumably to carry a sophisticated physics experiment called the the Alpha Magnetic Spectrometer to the space station.

"NASA will fly the space shuttle to complete the international space station and then retire the shuttle in 2010; an additional flight may be conducted if it can safely and affordably be flown by the end of 2010," the overview stated. "Funds freed from the shuttle's retirement will enable the agency to support development of systems to deliver people and cargo to the international space station and the moon."

As for the space station, "NASA will continue to assemble and utilize the international space station, the permanently crewed facility orbiting Earth that enables the agency to develop, test, and validate critical space exploration technologies and processes. NASA also will continue to coordinate with international partners to make this platform available for other government entities, commercial industry, and academic institutions to conduct research."

Said Logsdon, "President Obama has delivered, between the stimulus package and this proposed increase in the budget, on his promise to up the NASA budget by \$2 billion. It's a little disappointing that the out years don't show any additional increase above inflation. But this is a pretty substantial budget."

5:40 AM, 2/24/09, Update: NASA's Orbiting Carbon Observatory fails (UPDATED at 9:15 a.m. with news conference)

NASA's \$273 million Orbiting Carbon Observatory satellite crashed into the ocean near Antarctica shortly after launch today from Vandenberg Air Force Base, Calif., atop an Orbital Sciences Corp. Taurus XL booster. Telemetry indicated a protective nose cone fairing failed to separate early in the climb to space, weighing the rocket down and preventing the spacecraft from reaching orbit.

"It's a huge disappointment to the entire team that's worked very hard over years and years and really did their best to see it through," said NASA launch manager Chuck Dovale. "The reason not everyone is able to do this is, it's hard. And even when you do the best you can, you can still fail. It's a tough business."

Said John Brunschwyler, manager of the Taurus rocket program for Orbital Sciences: "Our whole team, at a very personal level, are disappointed in the events of this morning. It's very hard and, as I said, at a very personal level, (we're) upset with the results."

The 986-pound satellite's four-stage solid-fuel Taurus XL rocket blasted off at 4:55:30 a.m. EST and roared away from its Vandenberg launch pad about five minutes behind schedule because of a minor technical glitch. The ascent appeared normal and telemetry indicated all systems were working as planned through the first stage burn, stage separation and second stage ignition.

Seven seconds after the second stage fired up, the satellite's protective clamshell nose cone was commanded to separate. The 63-inch-wide carbon composite fairing is designed to separate in two pieces and fall away using small pyrotechnic devices that are activated by a series of electrical pulses.

"We have confirmation that the correct sequence was sent by the software," said Brunschwyler. "We had good power going into this event and we also had a healthy indications of our electronics box that sent the signal. Once that time had passed, which was about three minutes into the flight, we observed various pieces of telemetry that, of course, we then try to correlate because at first, being humans, we don't necessarily believe one piece of data."

While engineers were studying telemetry, the Taurus XL's third and fourth stage motors ignited as planned. But it soon became clear the fairing was still in place and that its weight was preventing the rocket from accelerating normally.

"The fairing has considerable weight relative to the portion of the vehicle that's flying," Brunschwyler said. "So when it separates off, you get a jump in acceleration. We did not have that jump in acceleration. As a direct result of carrying that extra weight, we could not make orbit. The initial indications are the vehicle did not have enough delta V (velocity) to reach orbit and landed just short of Antarctica in the ocean."

The Orbiting Carbon Observatory was designed to study natural and man-made carbon dioxide emission and absorption to help scientists assess how the greenhouse gas might be contributing to global warming.

"OCO was an important mission to measure critical elements of the carbon cycle," said Michael Freilich, director of NASA's Earth sciences division at agency headquarters.

"Over the next several days, weeks and months, we're going to carefully evaluate how to move forward and advance that science given our evaluation of the assets that are on orbit now, the assets of our international partners and the existence of flight spares in order to thoughtfully put together a program, as rapidly as possible, to pick up where OCO left off."

But Freilich said it was too soon to say whether a follow-on mission might be approved or how long that process might take. In the near term, NASA plans to name an investigation board to determine what went wrong with today's launching and what might be needed to ensure no similar problems happen on future flights.

A Taurus is scheduled to launch another NASA environmental research satellite - Glory - later this year. Officials said today it's too early to say how the mishap might affect those plans.

This was the eighth launch of a Taurus XL rocket and the second mission failure. It was NASA's first mission using the solid-fuel rocket after a certification process intended to ensure safety and reliability. A sticker on the ill-fated nose cone called attention to that certification, signifying what Brunschwyler described before launch as a process "to ensure it's the lowest risk possible for these valuable payloads."

4:30 PM, 2/18/09, Update: NASA plans to pursue flagship-class dual-orbiter Jupiter mission with European Space Agency

NASA and the European Space Agency hope to launch two flagship-class orbiters to Jupiter in the 2020 timeframe to study the giant planet in unprecedented detail before slipping into orbits around the icy moons Ganymede and Europa for close-up inspections. Both moons may harbor vast oceans under their frozen crusts that make them high-priority targets for extended exploration.

Representatives of both space agencies agreed last week to focus on Jupiter in the near term but to continue studies of a proposed mission to Saturn to study the ringed planet's cloudy moon Titan with a NASA orbiter, a European lander and a research balloon.

"We have determined a prioritization," said Jim Green, director of the planetary science division at NASA headquarters in Washington, told reporters today. "We believe that the Europa Jupiter System Mission is more technically ready than the Titan Saturn System Mission and therefore will be our next outer planet flagship effort."

NASA's proposed 11,000-pound Europa-Jupiter orbiter would launch aboard an unmanned Atlas 5 rocket in 2020 and reach Jupiter after a six-year voyage. With an expected price tag of \$2.5 billion to \$3 billion, the spacecraft first would orbit Jupiter for three years or so before maneuvering into orbit around Europa.

The European Space Agency's Ganymede orbiter would cost in the neighborhood of \$1 billion, Green said. The two spacecraft would be launched independently, but arrive at roughly the same time. A coordinated suite of instruments and investigations would be designed to produce complementary data.

Six previous U.S.-led missions flew past Jupiter and its moons - Pioneers 10 and 11, Voyagers 1 and 2, the Ulysses solar probe and the Saturn-bound Cassini - but only one, NASA's Galileo spacecraft, went into orbit around the huge planet, arriving in 1995 and plunging into its atmosphere in 2003.

During 12 flybys of Europa, Galileo sent back pictures showing cracked and jumbled ice rafts in a frozen surface nearly devoid of craters. By precisely measuring the moon's gravitational pull on Galileo, scientists came to believe a vast ocean of liquid water is likely hidden beneath the icy crust.

"Europa is just a tremendously exciting water world," Green said. "It has an underground ocean with probably more water in it than the Earth does. Everything that we know about Europa has really come from 12 flybys of Galileo."

The Galileo mission is considered an extraordinary success, even though its main antenna never unfolded properly and the spacecraft was only able to beam back a fraction of the data scientists originally expected. The new Europa Jupiter spacecraft would build on those results and resolve a host of unanswered questions.

"The Europa orbiter will do a lot more than Galileo did for us," said Curt Niebur, program scientist at NASA headquarters. "It will be a much more capable spacecraft with more advanced instruments and a larger instrument suite as well. But most importantly, it will be able to transmit a tremendous amount of data back to Earth, something which Galileo could not do because of its antenna problem. Because of that, we expect that this mission will increase our knowledge of Jupiter and Europa well beyond what Galileo did for us."

The proposed orbiter "will be able to monitor Jupiter for multiple years and provide movies of the cloud dynamics and the formation mechanisms of the Great Red Spot, the white ovals and how they interact, something that Galileo was able to do only in a very limited fashion. We'll be able to keep up that monitoring on a daily basis for up to three-and-a-half years."

"Orbiting Europa, we'll be able to get a global map of the surface," Niebur said. "In fact, we'll create four global maps in various colors. One of those maps will be stereo, we'll get complete topography of Europa's surface, the entire surface, something Galileo did not do. We will get compositional information on the surface so we understand what it's made of. And we'll also probe the interior of Europa. There will be a ground-penetrating radar on board that we will use to determine the ice shelf thickness and structure and we also hope to probe deeply enough to detect the ocean directly."

The Europa orbiter will use three independent techniques to study the presumed ocean, including gravity measurements.

"We all firmly believe there's an ocean under the ice at Europa," Niebur said. "This mission is going to verify that using three different lines of inquiry, three independent lines of inquiry, so that we can very well understand the nature of it."

Green said measurements of surface composition will help scientists understand how the hidden ocean affects the surface.

"It's clear that the surface of Europa is relatively new," he said, "it's not cratered, it's been resurfaced, probably much like (Saturn's moon) Enceladus where there's been major (geyser-like) plume activity and resurfacing going on. We expect that ocean to have communicated in some manner with the surface."

Asked why a lander wasn't considered for the proposed mission, Niebur said scientists simply don't know enough about the moon's surface.

"Before you're able to land on a body, you need to first understand the surface and we don't have sufficient data on what the surface of Europa is like in terms of boulders, crevices, things like that, to be able to safely design a lander that would survive landing," he said. "So the Europa orbiter mission will map the surface just as we've mapped Mars and then we will better characterize the surface so we can land at some future date."

6:10 PM, 2/15/09, Update: Fireball reported over Texas; FAA warned of possible satellite debris Saturday

The Federal Aviation Administration issued a warning to pilots and aircrews Saturday advising them to be on the lookout for possible "re-entry of satellite debris," presumably from an unprecedented satellite collision in space last week. Today, there were reports in Texas of at least one fireball and sounds of an explosion - possibly a sonic boom - but an FAA spokesman said it was not yet known whether the sightings involved satellite debris and if so, whether it came from either destroyed spacecraft.

"Late this morning, people started reporting to law enforcement there was a quote-unquote fireball and some people reported an explosion, which we suspect was probably a sonic boom," said Roland Herwig, a spokesman for the FAA's Southwest Region. "We had put out, the FAA had put out a notice to airmen, called a NOTAM, yesterday morning for pilots, for air crews to be on the lookout for space debris re-entering and and if they see anything to let the FAA know the location, the direction of travel, anything else they could about that. The notice to airmen says we suspect, we don't know, that this debris is from the two satellites that collided last week."

The actual NOTAM, however, does not mention the space collision Wednesday between a commercial Iridium telephone satellite and a defunct Russian communications station known as Cosmos 2251.

In any case, Herwig told reporters today there was no immediate "evidence of damage, no evidence of injuries, no evidence of anyone yet finding a chunk of satellite."

"We told the sheriff's departments, police departments, that people should be cautious around any debris that they do find," he said in a 5:30 p.m. EST teleconference. "But we have not gotten feedback on any debris. Nor have any aircrews reported anything."

He said until someone recovers actual debris, it may be impossible to tell whether the sightings involved wreckage from the Iridium-Cosmos crash, some other satellite or debris from a meteor. He said the Limestone County sheriff's office reported contact from someone who claimed to have a picture of the fireball and a smoke trail and a Plano, Texas, police cruiser may have capture images from a dashboard camera.

The collision between the Iridium-33 satellite and Cosmos 2251 occurred over northern Siberia at an altitude of about 490 miles around noon Wednesday. It was the first such collision in space history. An analysis of the orbits by Analytical Graphics Inc. concluded the spacecraft crashed into each other at some 15,000 mph, creating two large clouds of debris that continued along each spacecraft's orbital track.

The Cosmos ground track did not appear to cross the United States earlier today, but the Iridium's orbit did, according to widely available satellite tracking software. Whether any debris from the relatively small satellite could have re-entered from the initially high altitude and caused the sort of fireball reported in Texas was not known.

Here is the NOTAM that was posted Saturday by the FAA:

"FDC 9/5902 FDC .. SPECIAL NOTICE .. EFFECTIVE IMMEDIATELY UNTIL FURTHER NOTICE. AIRCRAFT ARE ADVISED THAT A POTENTIAL HAZARD MAY OCCUR DUE TO REENTRY OF SATELLITE DEBRIS INTO THE EARTH'S ATMOSPHERE. FURTHER NOTAMS WILL BE ISSUED IF MORE INFORMATION BECOMES AVAILABLE. IN THE INTEREST OF FLIGHT SAFETY, IT IS CRITICAL THAT ALL PILOTS/FLIGHT CREW MEMBERS REPORT ANY OBSERVED FALLING SPACE DEBRIS TO THE APPROPRIATE ATC FACILITY TO INCLUDE POSITION, ALTITUDE, TIME, AND DIRECTION OF DEBRIS OBSERVED."

Herwig said he did not know what prompted the NOTAM or whether it originated with U.S. Strategic Command, which tracks satellites and space debris, or some other organization.

"It's usually something that's passed on to us by law enforcement or some other agency to create a notice," he said. "The notice is open ended, it says 'effective immediately until further notice, a potential hazard may occur due to re-entry of satellite debris.'"

03:30 PM, 2/11/09, Update: Satellite collision assessed (UPATED at 5 p.m. with Iridium statement; UPDATED at 5:30 p.m. with Stratcom interview)

In an unprecedented space collision, a commercial Iridium communications satellite and a defunct Russian satellite ran into each other Tuesday above northern Siberia, creating a cloud of wreckage, officials said today. The international space station does not appear to be threatened by the debris, they said, but it's not yet clear whether it poses a risk to any other military or civilian satellites.

"They collided at an altitude of 790 kilometers (491 miles) over northern Siberia Tuesday about noon Washington time," said Nicholas Johnson, NASA's chief scientist for orbital debris at the Johnson Space Center in Houston. "The U.S. space surveillance network detected a large number of debris from both objects."

Air Force Brig. Gen. Michael Carey, deputy director of global operations with U.S. Strategic Command, the agency responsible for space surveillance, said initial radar tracking detected some 600 pieces of debris. He identified the Russian spacecraft as Cosmos 2251, a communications relay station launched in June 1993, and said the satellite is believed to have been non-operational for the past 10 years or so.

"As of about 12 hours ago, I think the head count was up (to around) 600 pieces," Carey told CBS News late today. "It's going to take about two days before we get a solid picture of what the debris fields look like. But you, I think, can imply that the majority of that should be probably along the same line as the original orbits."

He said U.S. STRATCOM routinely tracks about 18,000 objects in space, including satellites and debris, that are 3.9 inches across or larger. Tracking priority and "conjunction analysis" - identifying which objects may pose a threat to manned spacecraft - is the first priority.

"It's going to take a while" to get an accurate count of the debris fragments, Johnson said. "It's very, very difficult to discriminate all those objects when they're really close together. And so, over the next couple of days, we'll have a much better understanding."

Asked which satellite was at fault, Johnson said "they ran into each other. Nothing has the right of way up there. We don't have an air traffic controller in space. There is no universal way of knowing what's coming in your direction."

Iridium Satellite LLC operates a constellation of some 66 satellites, along with orbital spares, to support satellite telephone operations around the world. The spacecraft, which weigh about 1,485 pounds when fully fueled, are in orbits tilted 86.4 degrees to the equator at an altitude of about 485 miles. Ninety-five Iridium satellites were launched between 1997 and 2002 and several have failed over the years.

"Yesterday, Iridium Satellite LLC lost an operational satellite," the company said in a statement. "According to information shared with the company by various U.S. government organizations that monitor satellites and other space objects (such as debris), it appears that the satellite loss is the result of a collision with a non-operational Russian satellite."

"Although this event has minimal impact on Iridium's service, the company is taking immediate action to address the loss. The Iridium constellation is healthy, and this event is not the result of a failure on the part of Iridium or its technology. While this is an extremely unusual, very low-probability event, the Iridium constellation is uniquely designed to withstand such an event, and the company is taking the necessary steps to replace the lost satellite with one of its in-orbit spare satellites."

Johnson said the collision was unprecedented.

"Nothing to this extent (has happened before)," he said. "We've had three other accidental collisions between what we call catalog objects, but they were all much smaller than this and always a moderate sized objects and a very small object. And these are two relatively big objects. So this is a first, unfortunately."

As for the threat posed by the debris, Johnson said NASA carried out an immediate analysis to determine whether the space station faced any increased risk. The station, carrying three crew members, circles the globe at an altitude of about 220 miles in an orbit tilted 51.6 degrees to the equator.

"There are two issues: the immediate threat and a longer-term threat," he said. "It turns out, when you have a collision like this the debris is thrown very energetically both to higher orbits and to lower orbits. So there are actually debris from this event which we believe are going through the space station's altitude already. Most of it is not, most of it is still clustered up where the event took place. But a small number are going through station's altitude.

"Yesterday, we did an assessment of what the risk might be to station and we found it's going to be very, very small. As time goes on, those debris will (come down) some over months, most over years and decades and as the big ones come down they'll be tracked, we'll see them and the worst-case scenario, we'll just dodge them if we have to. It's the small things you can't see are the ones that can do you harm."

Asked if other satellites might be at risk, Johnson said "technically, yes. What we're doing now is trying to quantify that risk. That's a work in progress. It's only been 24 hours. We put first things first, which is station and preparing for the next shuttle mission."

Most, if not all, of the debris is expected to eventually burn up in Earth's atmosphere.

9:40 PM, 1/13/09, Update: Space.com reports Gration to replace Griffin as NASA administrator

[Space.com](#) reports that President-elect Barack Obama plans to name retired Air Force Maj. Gen. Scott Gration, a decorated fighter pilot, as the next administrator of NASA, replacing Mike Griffin at the helm of the U.S. space agency. The web site reports an announcement "is expected as soon as Wednesday."

Speculation about who might replace Griffin has dominated space news in recent weeks, with former shuttle commander Charles Bolden and Charles Kennel, chairman of the National Academy of Science's Space Studies Board, mentioned as possible candidates.

Gration is a virtual unknown in the space community, but not to Obama. According to [Newsweek magazine](#), Gration accompanied Obama on a tour of Africa and stumped for the presidential candidate during the campaign. His Air Force [biography](#) states he retired from active duty on Oct. 1, 2006.

As Director of Strategy, Plans and Policy with U.S. European Command, Stuttgart-Vaihingen, Germany, Gration was "responsible for formulation and staff direction of the execution of basic military and political policy, as well as planning for command activities involving relations with other U.S. Unified Commands, allied military and international military organizations and subordinate commands."

He also served as director of Capabilities and Assessments and was "responsible for the development of force structure requirements; conducting studies, analyses and assessments; and for evaluating military forces, plans, programs and strategies," the Air Force web bio said.

"The general was raised in Africa and entered the Air Force in 1974 through the Air Force ROTC program at Rutgers University. He has previously served as a White House Fellow, operations group commander and two-time wing commander. Prior to assuming his current position, the general served as Assistant Deputy Undersecretary of the Air Force for International Affairs, Office of the Under Secretary of the Air Force, Headquarters U.S. Air Force.

"General Gration is a command pilot with more than 5,000 flight hours, including more than 2,000 hours as an instructor pilot. He has extensive combat experience in the Middle East and served as the Commander of Task Force West during Operation Iraqi Freedom. General Gration's aerial combat experience includes 274 combat missions over Iraq, with 983 hours of combat time."

A NASA spokesman reached late Tuesday said he did not know whether Gration was, in fact, a candidate to replace Griffin.

11:57 AM, 1/9/09, Update: Griffin awaits word from Obama administration

NASA Administrator Mike Griffin, answering questions from Johnson Space Center workers during an all-hands meeting today, said he has not yet heard from the incoming Obama administration about whether - or when - he will be replaced as the agency's leader. But he made it clear he does not expect to be asked to stay on and barring words to the contrary from the new administration, Griffin will be out of a job Jan. 20.

"I think we all are aware we have a political transition almost upon us, and the odds are in a couple of weeks I won't be in this position," Griffin told a packed auditorium. "We don't know yet, and I certainly don't want to make presumptions about what the president elect will do. But those are the realities."

Asked what insights he could share from encounters with Obama's transition team, Griffin said there was not much to tell.

"If I knew, it would probably be inappropriate for me to share, but I can't because I don't know," he said. "I had a couple of very brief sessions with the NASA transition team and that was it. There just wasn't any discussion of goals and priorities. So I really, honestly don't know any more than you know."