

Ares I-X: Getting Constellation off the ground



MORE THAN 30 YEARS AGO I JOINED A planeload of Air Force Academy cadets on a tour of Cape Canaveral AFS and NASA's Kennedy Space Center. In February 1977, KSC seemed dormant, resting on the hard-won laurels of the Moon race. The last Apollo (Apollo Soyuz Test Project) had launched in July 1975, and the new space shuttle's debut was still four years away. Inside the cavernous Vehicle Assembly Building (VAB), an Apollo-Saturn mobile launcher still shouldered the gray lattice "milk stool" platform used to launch the Saturn IBs for Skylab and ASTP. Outside, the Saturn V's 399-ft-tall launch umbilical towers were being dismantled to clear the way for the space shuttle.

The inactivity at the cape saddened me: Apollo's glories had passed. But out at Complex 39's twin "Moonport" pads, there were signs of life. Gray steel was rising next to the flame trenches to prepare for the era of routine, once-a-week shuttle launches.

You can sense something of that atmosphere at KSC today. The shuttle still flies, but a well-deserved retirement looms. March saw the successful delivery on STS-119 of the fourth and last set of solar arrays to the ISS. That mission kicked off the final series of station assembly and supply missions. Eight such flights remain, although NASA may fly one more to deliver the Alpha Magnetic Spectrometer to ISS.

The shuttle era is ending, but the first material signs of its coming replacement are visible: Three 600-ft lightning protection towers have risen around Pad 39B. The catenary wires suspended from their fiberglass masts will shield the Ares I booster and Orion spacecraft from the cape's frequent thunderstorms.

Shifting gears

Those towers will be in place late this summer as NASA shifts gears from shut-

tle and mounts the first test flight of its new human-rated booster. That test, Ares I-X, is also caught up in the swirl of questions about NASA's future. At press time, President Barack Obama had yet to nominate a new administrator, although he promised in late March to do so "soon." Amid rumors about who the new boss might be, the agency is being buffeted by congressional pressure to stretch the shuttle's remaining flight

manifest beyond 2010, ostensibly to protect workers at KSC and narrow "the gap," meaning NASA's reliance on the Russian Soyuz vehicle for U.S. access to the station.

Even more worrisome, commercial launch advocates have been lobbying Congress to defer Ares I and Orion, promising instead to deliver astronauts to the station in evolved versions of the commercial cargo ships being developed



Ares I-X stands on Launch Pad 39B for a late summer 2009 launch. The test will use the existing shuttle service structure and mobile launch platform, as in this artist's depiction.

for NASA's Commercial Orbital Transportation System. Those vehicles have yet to fly a single cargo mission, let alone demonstrate the safety and reliability needed for carrying crews, but the energetic marketing campaign on Capitol Hill during the stimulus frenzy heightens worries about NASA's shuttle-to-Orion transition. As NASA tries to get Constellation on the road, it's not clear who will be in the driver's seat, and for how long.

Flying real hardware

NASA is eager to fly Ares I-X, the most visible sign that the Constellation program is not just buying mockups and CAD models, but is building real flight hardware. In addition, launch abort system components for Orion are heading for White Sands testing this fall, and the Ares I-X hardware at KSC is now being stacked for launch.

The I-X flight will be the first test of a booster configuration designed to get U.S. astronauts to LEO, there to head for either the ISS or a deep-space departure. Ares I, conceived after the Columbia accident, is an in-line, two-stage launcher, 325 ft tall and weighing just over 2 million lb. Its first stage is a five-segment derivative of the shuttle's reusable solid rocket motor (RSRM). The 18-ft-wide upper stage weighs 302,000 lb and is powered by a single LH₂/LOX J-2X cryogenic engine derived from the Saturn V program. Ares I is designed to put 25 metric tons into LEO. (See "Shake, rattles, and roll: The evolving Ares I," July 2008, page 38.)

Scheduled for late this summer, the Ares I-X test is meant to provide an early sanity check on the design of the new booster. For I-X, the first stage will be a four-segment RSRM (91-A) transferred from the shuttle program, topped by a dummy fifth segment. The upper stage is an inert mass simulator, largely steel, built by NASA Glenn. Atop the stack will be an Orion vehicle simulator and inert launch abort system manufactured at NASA Langley. Only the first stage is live, although the upper stage simulator does carry an active roll-control system.

The Ares I-X test objectives are



Ares I-X upper stage and launch abort system components are in place for stacking at Kennedy Space Center. Note the technicians working inside the 18-ft-wide upper stage section at left.

straightforward: demonstrate flight control of the Ares I/Orion vehicle, characterize vehicle roll torque during first-stage flight, conduct in-flight staging, quantify first-stage entry dynamics and parachute performance, and demonstrate first-stage recovery. After liftoff from Pad 39B with 3.3 million lb of thrust, Ares I-X will reach a speed of Mach 4.7 at motor burnout, about 2 min after launch. At an altitude of 130,000 ft, separation motors will fire to drop the RSRM away from the upper stage, which will coast



The "boilerplate" crew module and launch abort system for Ares I-X are stacked at Langley before transport to Kennedy.

upward and then follow a ballistic trajectory to impact.

The spent first stage will coast to a peak altitude of 153,000 ft, go into a drag-enhancing tumble, and finally deploy pilot and main parachutes for an Atlantic splashdown, just over 7 min after launch. A shuttle booster recovery ship will retrieve the stage for postflight inspection.

During powered flight, telemetry will yield data on first-stage thrust oscillation, flight loads and vibration, and the bending modes of the integrated vehicle. More generally, the flight will give many NASA and contractor engineers their first experience with flight testing a new vehicle. The agency's field centers will benefit from the close coordination required for I-X, relationships that will be constantly tested while developing Constellation's Ares I, Orion, Ares V, and Altair vehicles. At the Cape, Ares I-X will serve as a facilities pathfinder for assembly, checkout, test, and launch of a vehicle configuration that may fly from Pad 39B for three decades or more.

Ares I-X draws on 30 years of shuttle experience with the RSRMs, 200 of which have flown successfully since Challenger's loss in 1986. Ares I-X will also benefit from the long history of operations staged out of the VAB and Launch Complex 39. Pad 39B will be used in a backup role for May's STS-125 Hubble servicing mission, supporting launch preparations for Endeavour, the launch-on-need rescue vehicle. Once Atlantis is safely on its way home from Hubble, the shuttle program will release Pad 39B for Ares I-X modifications.



With the VAB as a backdrop, construction began in March at KSC on the new mobile launch platform for the Ares I booster.



For Ares I upper stage separation, after RSRM thrust tail-off, a set of linear-shaped charges between the upper stage and first stage will fire, separating the metal between the first stage and the interstage. At the same time, 10 booster deceleration motors fire to pull the first stage directly backward, while eight ullage settling motors fire to push the upper stage forward. (NASA)

For launch, the I-X will be stacked in the VAB on a shuttle mobile launch platform, then rolled out to 39B, where the fixed service structure will be adapted to support the slim booster, 140 ft taller than the shuttle stack.

Following the test, demolition of Pad 39B's fixed and rotating service structures will begin; Ares will use a new launch umbilical tower carried on a new mobile launcher. That platform will deliver the Ares vehicle and tower to a "clean pad," much as in the days of the old Saturn V.

Is this flight necessary?

Although cosmetically similar to the later operational configuration, Ares I-X has significant functional differences from "the Stick," the nickname for the slen-



On March 10, 2009, ATK completed the successful test firing of the igniter that will be used to start Ares I's 5-segment, first-stage motor. The test, conducted at ATK facilities near Promontory, Utah, generated a flame almost 200 ft in length. ATK Launch Systems is the first stage prime contractor.



A February 2009 dawn reveals the newly erected lightning towers on Launch Pad 39B at KSC. The two towers at left contain the lightning mast on top; the one at right does not. At center are the fixed and rotating service structures that have served the space shuttle program. Each of the towers is 500 ft tall with an additional 100-ft fiberglass mast atop supporting a wire catenary system. (NASA)

der Ares I. With just a stock four-segment space shuttle RSRM, an inert upper stage, and boilerplate Orion, will we learn enough from the Ares I-X test to justify the \$388-million cost?

Flying I-X with only a live first stage echoes the early 1960s test approach used successfully by the von Braun team for the Saturn booster family. The Saturn I's first three flights in 1961-1963 used dummy second stages, with live S-IV and S-IVB stages added only after first-stage reliability was proven. Given the nearly three decades since STS-1 and this new vehicle configuration, the Ares I-X approach seems a prudent first step for NASA's new team of rocketeers.

Beyond the flight test data returned, Ares I-X will pay some intangible but undeniable political dividends. Flying a real rocket will have greater impact than just the weight of the stacked hardware: Constellation will emerge as a real flight program, not just CAD designs and slick PowerPoint pitches. Pulling off a successful test will showcase a NASA serious about its future and credibly capable of getting Constellation off the ground.

NASA cannot build further support in Congress and the White House for Constellation without setting, and meet-

ing, highly visible milestones toward its stated goals. To get beyond LEO, NASA must do more than say it is going; it must show it can design, produce, and fly real hardware. Ares I-X, then, will



NASA tested the first three Saturn I boosters with live first and inert second stages. Here, the inaugural Saturn SA-1 lifts off from Pad 34 on Oct. 27, 1961. This first Saturn I was 162 ft high and weighed 460 tons at liftoff. Its eight H-1 engines generated 1.3 million lb of thrust. (NASA)

provide NASA's supporters with powerful proof of progress, while quieting critics who think the fastest way to the Moon and deep space is to go back to the drawing board and start over.

Flight and risk: Inseparable

Flying Ares I-X inevitably entails risk. A failure would be costly—roughly \$300 million, according to NASA's Exploration Systems Mission Directorate. Of course, nearly all of the hardware has been built and paid for (the RSRM, for example, is shuttle surplus). Canceling Ares I-X, as some have suggested, would save only the launch operations cost. And although the differences with Ares I are real, NASA must start flying its new vehicle sometime. The longer NASA waits to demonstrate even this early version of Ares and Orion hardware, the greater the likelihood that it may never fly at all.

Fear of failure is natural, but NASA has an opportunity to demonstrate that no worthwhile advance comes without risk. A test failure, while discouraging, can often teach invaluable lessons. The second unmanned flight of the Saturn V in April 1968 was a near-disaster, with destructive pogo vibrations causing multiple engine failures; the S-IVB third stage staggered into a compromised orbit and refused to reignite. But the test led to effective fixes for the problems, and the next Saturn V carried the Apollo 8 crew to lunar orbit.

First in a string

Ares I-X is currently targeted for launch no earlier than late July. Following up, Constellation plans a series of test flights leading to piloted missions to the ISS, no earlier than early 2015. Ares I-Y will test the five-segment SRB, Ares avionics and flight control, and J-2X-powered upper stage. Orion 1 and 2, both unmanned, will test the orbital performance of the Orion spacecraft. Budget woes have forced delays in the entire test sequence; the earliest date for Ares I-Y will likely be 2014, with Orion 2 not earlier than 2015.

Moving in parallel with Ares will be a series of launch abort system tests. The first, Pad Abort 1, will occur late this summer at White Sands Test Facil-

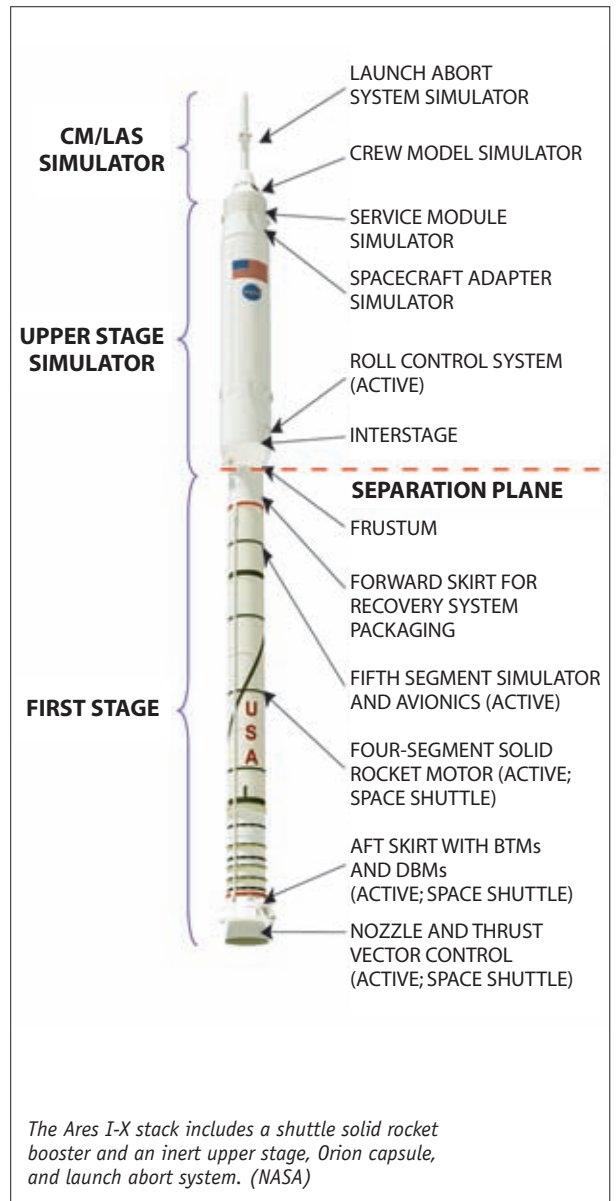
ity. ATK's launch abort motor, with half a million pounds of thrust, will rocket a boilerplate Orion capsule from ground level to more than 7,000 ft to test flight control and parachute recovery. Later tests will prove abort system performance at progressively higher speeds and altitudes.

Making the leap

As NASA approaches Ares I-X, the agency finds itself trying to wring the most value from the remaining shuttle missions, operate an ambitious orbiting laboratory, develop a new booster and spacecraft, and marshal public and political support for returning Americans to deep space. Looming over these technical challenges are fiscal storm clouds: Beyond FY10's \$18.3-billion budget (with an extra billion from the stimulus bill added), the president's out-year projections for NASA show zero real growth. In the near term, that will end any hopes for fielding Orion before 2015, and may signal administration plans to defer deep space missions.

Anemic funding has been a chronic drag on NASA's Constellation plans since President Bush's "Vision" rollout in 2004. More of that slow starvation—where NASA's budget slips below 0.5% of federal spending, even as the president's budget swells to \$3.6 trillion—may guarantee an even longer dependence on the Russians' Soyuz and a true eclipse of U.S. leadership in human spaceflight.

NASA's leaders and people have a long record of mastering the toughest technical challenges, but prospects for solving the funding problem have seldom seemed shakier. An Ares I-X suc-



cess this summer could mark the start of a successful transition from shuttle to a new era in U.S. human spaceflight. Validating five years of Ares design work, a success might help NASA out of the blocks on the long technical and political road to human deep space exploration. But unless the test also helps persuade the Obama administration to fund Constellation adequately, even a successful flight may prove to be a false start.

Tom Jones

skywalking1@gmail.com
www.AstronautTomJones.com