

## ARES I-X FLIGHT TEST PHILOSOPHY

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### ABSTRACT

In response to the Vision for Space Exploration, the National Aeronautics and Space Administration (NASA) has defined a new space exploration architecture to return humans to the Moon and prepare for human exploration of Mars. One of the first new developments will be the Ares I Crew Launch Vehicle (CLV), which will carry the Orion Crew Exploration Vehicle (CEV), into Low Earth Orbit (LEO) to support International Space Station (ISS) missions and, later, support lunar missions.

As part of Ares I development, NASA will perform a series of Ares I flight tests. The tests will provide data that will inform the engineering and design process and verify the flight hardware and software. The data gained from the flight tests will be used to certify the new Ares/Orion vehicle for human space flight.

The primary objectives of this first flight test (Ares I-X) are the following:

- Demonstrate control of a dynamically similar integrated Ares CLV/Orion CEV using Ares CLV ascent control algorithms.
- Perform an in-flight separation/staging event between an Ares I-similar First Stage and a representative Upper Stage.
- Demonstrate assembly and recovery of a new Ares CLV-like First Stage element at Kennedy Space Center (KSC).
- Demonstrate First Stage separation sequencing, and quantify First Stage atmospheric entry dynamics, and parachute performance.
- Characterize the magnitude of the integrated vehicle roll torque throughout the First Stage (powered) flight.

This paper will provide an overview of the Ares I-X flight test process and details of the individual flight tests.

### INTRODUCTION

The U.S. Vision for Space Exploration commits our nation to returning humans to the Moon and establishing an outpost there to prepare for an eventual human mission to Mars. The Ares I Crew Launch Vehicle and Ares V Cargo Launch Vehicles will be the mainstays of the fleet that will achieve this goal. In addition to supporting exploration missions, Ares I will launch up to six crew members to the International Space Station (ISS), replacing the Space Shuttle. The first new human-rated launch vehicle in over 35 years, Ares I will undergo a series of ground, development, flight, and orbital tests before lifting people to ISS in 2014. Those tests will be managed by the Flight and Integrated Test Office (FITO) at Marshall Space Flight Center (MSFC). The tests will also integrate with Ground Operations (GO) at KSC. In addition to developing new ground support equipment and procedures, the GO team will need to continue Space Shuttle operations during Ares I-X test flight; close down Shuttle operations; and make the final operational transition to supporting Ares operations.

The operational version of Ares I has a "single-stick" configuration, with the First Stage consisting of a Space Shuttle –derived 5-segment Reusable Solid Rocket Booster (RSRB). The

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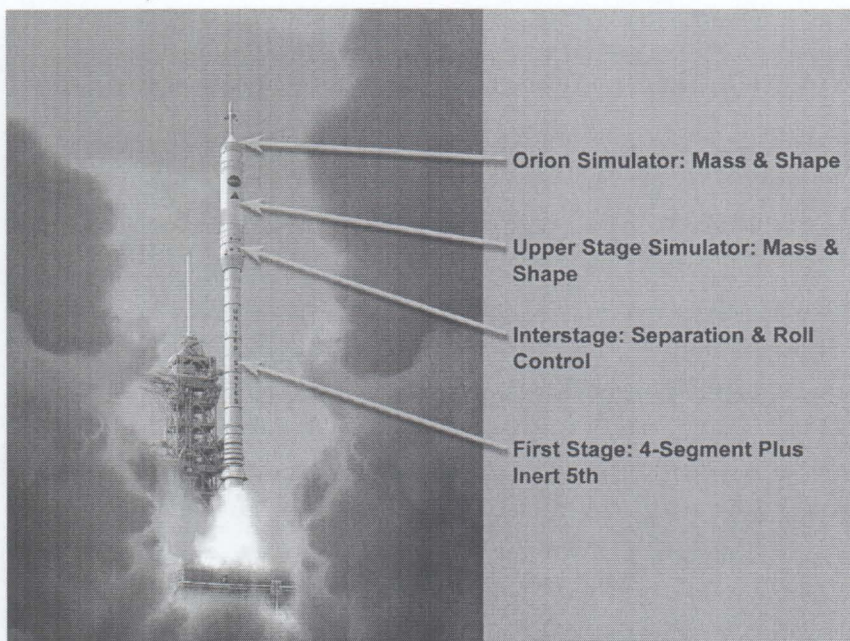
Upper Stage will use an Apollo-derived J-2X liquid oxygen-liquid hydrogen engine to boost the Orion CEV into orbit. The vehicle also will feature a Launch Abort System (LAS) atop Orion, which quickly flies the Command Module (CM) away from the launcher in the event of an emergency.

The first suborbital ascent development flight test, designated Ares I-X, is scheduled for April 2009. The primary purpose of Ares I-X will be to demonstrate flight control of a vehicle that is dynamically similar to the Ares I. This paper will describe the purposes of the Ares I-X flight test, progress toward a preliminary design, and the status of work under way for each of the vehicle's primary elements.

## RESULTS AND DISCUSSION

### A. ARES I-X: FIRST STEP TO THE STARS

The Ares I-X suborbital development flight test will encompass designing and developing a complete system, including a full-scale Flight Test Vehicle (FTV) and associated launch operations. The FTV comprises multiple elements (Figure 1), which will be developed at different NASA centers and contractor locations. The elements and components will be delivered to KSC for assembly into an integrated, flight-ready FTV. Once the FTV is integrated and final checks are completed in the Vehicle Assembly Building (VAB) and at the launch pad, the FTV will be launched.



**Figure 1. The Ares I-X flight test is planned for April 2009.**

The Ares I-X suborbital flight test will be conducted using a mix of flight and mockup hardware, resulting in a flight vehicle that is similar in mass, center of gravity, and length to the final, operational system. Ares I-X will be powered by a 4-segment Reusable Solid Rocket Booster (RSRB), which is currently in the Shuttle Program inventory, with an added inert fifth segment that approximates the size and weight of the five-segment RSRB, currently under development.

The FTV Upper Stage Simulator (USS), which includes the Orion Service Module, and the Orion CM/LAS simulator are non-functional representations of the Ares I Upper Stage, built with simple and robust construction and have only active systems for data collection and stage separation. The FTV Roll Control System (RoCS) is a modified "off the shelf" system that will not

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fly on the operational Ares I. A Jacobs/Lockheed Martin contractor team is providing Avionics hardware and flight software based on the Atlas launch system avionics.

The flight profile will closely mimic the flight conditions the Ares I will experience through Mach 4.5, at an altitude of approximately 120,000 feet through the maximum dynamic pressure quotient (Max Q), nearly 800 pounds per square foot. The flight elapsed time for first-stage burnout and upper stage separation will closely match an operational mission, at approximately 130 seconds into flight. The upper-stage simulator and the Orion CM/LAS simulator hardware will separate from the first stage and will fall into the Atlantic Ocean, not to be retrieved. The First Stage booster will "fly" through a complete recovery sequence, and the hardware will be retrieved and analyzed. After recovery, the First Stage hardware will be returned to KSC for inspections and analysis. The data generated will provide a basis for hardware and software design decisions, as well as help fine-tune operations processes and products.

In addition to simply determining the flight characteristics of the Ares I stack, other objectives of the test are:

- Demonstrating the ascent flight control system.
- Characterizing and mitigating the roll torque due to first stage motor performance for a vehicle dynamically similar to the operational vehicle.
- Demonstrating nominal first and upper stage separation and clearances.
- Testing the First Stage parachute recovery system and separation/entry dynamics.
- Validating assembly and processing flow, as well as launch and recovery operations.
- Understanding the flight dynamics of the integrated stack.
- Quantifying the effectiveness of the First Stage separation motors.
- Characterizing the induced environments on the vehicle through all flight stages.
- Demonstrating a procedure for determining the vehicle's orientation vector for the flight control system.
- Demonstrating day-of-launch flight operations.
- Characterizing the induced loads on the vehicle on the launch pad.
- Assessing potential access locations in the VAB and on the pad.
- Validating the performance of the first stage umbilical system.

### **B. PRELIMINARY DESIGN REVIEW (PDR) APPROACH**

The FITO team concluded a successful System Requirements Review (SRR) for the Ares I-X flight in November 2006 which developed vehicle requirements derived from the Constellation Program's overall mission requirements. The work since then has been dedicated to achieving a successful Preliminary Design Review (PDR), scheduled for May 2007. The purpose of the PDR is to establish that the initial design of the FTV will meet integrated system functional and performance requirements with acceptable technical performance and schedule risks. The PDR also will ensure that the system requirements are complete and have been allocated to the vehicle elements. PDRs also will be held at the element level to validate that the individual element designs can meet functional and performance requirements with acceptable technical performance and integrated schedule risk. Individual PDRs will be conducted for the primary hardware elements, including First Stage, USS, CM/LAS, Avionics, and RoCS.

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The PDR will include design and analysis details sufficient to demonstrate the maturity of the design solution at a "preliminary" level (10 to 30 percent, depending on the specific hardware element). By its very nature, a PDR will not have completely finished designs or closed analyses, but the data will be sufficiently mature to demonstrate the requirements are met or will be met by the Critical Design Review (CDR). The Ares I-X CDR is scheduled for September 2007. The individual element designs will be summarized and presented in overviews to demonstrate maturity of the underlying parts of the integrated FTV.

### C. ARES I-X HARDWARE ELEMENTS AND PROGRESS

The following section describes the various elements of the Ares I-X FTV, current technical issues, and what progress has been made to date on their development.

#### Avionics

The Ares I-X avionics system includes the flight control systems—commanding of launch, ascent, separation, and recovery, Assent Thrust Vector Controller (ATVC), telemetry systems, data (Development Flight Instrumentation (DFI) and Operational Flight Instrumentation (OFI)) recording, sensors, power, imaging, and Electrical Ground Support Equipment (EGSE). The avionics system will be a combination of avionics components from Atlas and modified Space Shuttle systems. The Ares I-X team also will employ a Systems Integration Laboratory (SIL) located at Lockheed Martin in Denver, Colorado. The SIL embraces the industry best practice of “test as you fly.” The avionics system will employ the aircraft-qualified DFI used for the Boeing 7E7 series and the U.S. Air Force Joint Strike Fighter (JSF) to collect, transmit, and store the data vital for a successful test flight. While the avionics hardware for this flight is not required to be extensible to Ares I, the Guidance and Control algorithm will be based on the Ares I algorithm.

One of the new avionics designs has already begun testing: the ATVC. The ATVC is a subsystem component of the GN&C subsystem that provides the command and telemetry interface to the Ares I-X First Stage hydraulic thrust vector rock and tilt actuators. This provides single-fault-tolerant control of the existing hydraulic actuators from the flight control computer via a redundant data bus.

MSFC's Engineering Directorate worked with Honeywell International to complete a brassboard test of the initial ATVC design in December 2006. The Component Development Area at MSFC provided a TVC load cell using an actual Solid Rocket Booster (SRB) TVC hydraulic actuator. The test was successful and the contractor plans to return in March 2007 to complete further testing at MSFC.

The ground interfaces for the avionics have been established. The avionics team had a choice between using a Lockheed-Martin-provided multipurpose van (MVAN) or a customized Ground Command, Control, and Communication (GC3) unit, called a mini-GC3, embedded within the Main Launch Platform (MLP). The MVAN, which also services the Atlas program, is capable of commanding and monitoring avionics systems from the ground. However, location of the MVAN at the launch pad was a considerable challenge; the project also faced potential schedule conflicts with the Atlas program, reducing its availability and the team's ability to make quick changes. The recommendation to FITO was to use the mini-GC3 unit, providing easier access to the ground-based avionics systems and enabling Mobile Launch Platform (MLP) modifications to occur parallel with Space Shuttle Operations.

The avionics team is in the process of clarifying their requirements for capturing, transmitting, and storing video imagery. Because the flight will study the dynamics of stage separation, the video cameras will provide an integral part of measuring the speed at which the USS separates from the First Stage. The current baseline mounts three digital cameras at 120° positions around the vehicle interior on the forward end of the Interstage, and focuses them on a series of highly reflective targets placed on the aft portion of the USS (Figure 2). Acceleration will be measured based on the rate the targets contract in the camera's field of view.



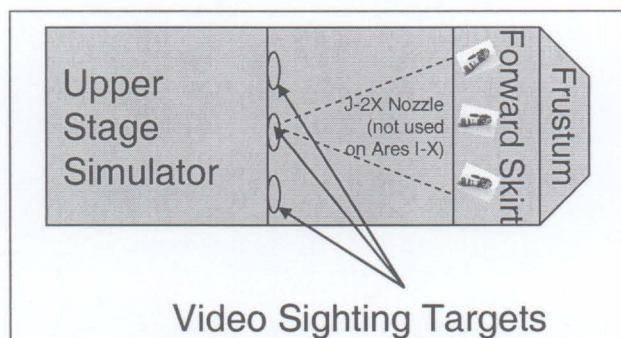


Figure 2. Video camera placement for the Ares I-X FTV.

Finally, the team is finalizing the location of the Developmental Flight Instrumentation (DFI) and Flight Test Inertial Navigation Unit (FTINU). The FTV will fly a prescribed trajectory, simulating the Ares I ascent flight to obtain data that supports the flight test objectives. Ares I-X will not be commanded or controlled from the ground during flight, except for the Flight Termination System (FTS), if required. The DFI will provide data to the operational Ares I program. The sensors are located on all elements of the test vehicle and have been specifically requested by the Ares I discipline leads. All data will be telemetered in real time as the primary method of data gathering. The data recorder, located on First Stage, will be recovered and used to fill in any drop-outs that occur during flight. This hardware, consisting of part new and part legacy Atlas hardware, will most likely be placed in the forward skirt of the First Stage. Because of bandwidth limitations, the team plans to equip the FTV with DFI, telemetry system(s), and a data recording system, which will be recovered with the First Stage after splashdown.

#### First Stage

As described earlier, the Ares I-X First Stage consists of a 4-segment RSRB, topped by an inert fifth segment, forward skirt, frustrum, and interstage. The Ares I-X First Stage, manufactured by ATK Launch Systems, will consist primarily of Shuttle SRB heritage hardware. The advantages of using heritage hardware include reduced cost, the ability to meet schedule for an early demonstration test flight, and reliability. Extensive flight and static test data for the heritage hardware minimizes safety, programmatic, and technical risks. Hardware designed and built to the Space Shuttle requirements but included in the Ares I-X First Stage design will conform to the design, processing, inspection, and test requirements imposed during the Space Shuttle program only. It will not be manufactured, processed, or inspected according to the requirements imposed on new Ares I-X hardware. Figure 3 identifies which components within the First Stage are considered heritage hardware.

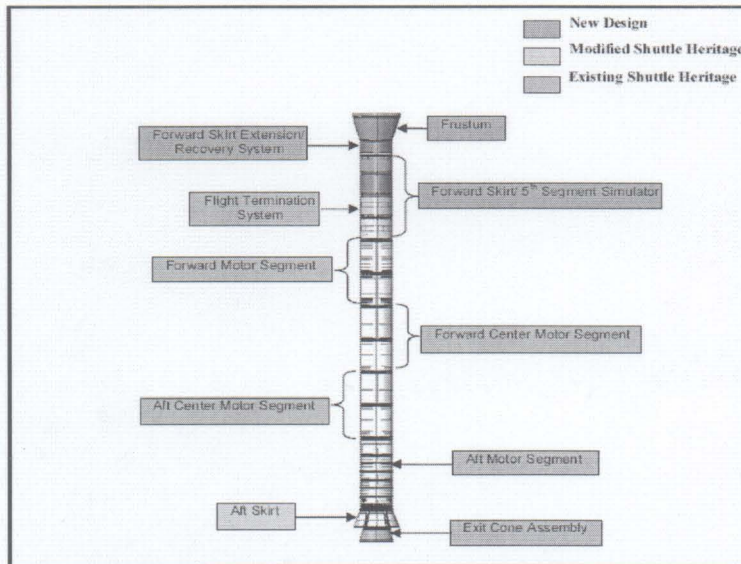


Figure 3. FTV First Stage components.

One design challenge the team will evaluate is whether the aft skirt can support the weight of the integrated vehicle. The RSRB for the Shuttle did not support loads directly on top of the structure. Another concern will be the safe recovery of the DFI and flight data from the avionics boxes in the Forward Skirt.

In November 2006, ATK Launch Systems performed a nighttime test of Flight Support Motor 13 (FSM-13) to prepare for the December night launch of Space Shuttle *Discovery*. The Ares I-X team used this opportunity to obtain critical propellant burn and roll torque data on the RSRB (Figure 4).



Figure 4. November 2006 night test of Shuttle FSM

The FITO team will use an existing motor from Space Shuttle inventory to power Ares I-X. The team is developing new forward structures to make the more closely resemble the Ares I First Stage, including:

- *Frustum* – The frustum’s primary function is to provide the physical transition from the smaller diameter of the First Stage and the larger diameter of the Upper Stage. Shortly after separation, Booster Tumble Motors (BTM) located on the frustum ignite to begin the First Stage tumbling away from the upper stage and toward Earth. The Frustum-Interstage assembly is jettisoned in a secondary separation at a separation



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plane located near the aft end of the frustum. The centrifugal force as the First Stage begins to tumble will be enough to propel the Frustum-Interstage assembly away from the First Stage without re-contact. The Frustum and Interstage are not reused. Booster Deceleration Motors (BDMs) on the Interstage ignite to help propel the Frustum away from the First Stage without re-contact. The Frustum and Interstage are not reused. The Interstage structure is considered part of the Upper Stage element for Ares I; the First Stage element will manufacture the Interstage for Ares I-X.

- *Forward Skirt Extension* – The forward skirt extension replaces the current Shuttle frustum to house the Main Parachute Support System (MPSS) and main parachutes for First Stage recovery. In addition, the drogue and pilot parachutes sit atop the forward skirt extension and are protected by the heritage nose cap used on the current SRB.
- *Forward Skirt/Fifth Segment Simulator* – This new 5<sup>th</sup> segment simulator will be added to simulate the Outer Mold Line (OML) of the Ares I First Stage 5-segment motor. It will interface at the lower end with the forward dome Y-joint of the RSRM motor and at the upper end with the forward skirt. The forward skirt and 5<sup>th</sup> segment simulator will be combined into one compartment that is water resistant.

### Upper Stage Simulator (USS)

The Ares I-X USS will consist of stacked, hollow cylindrical segments with interior ring platforms and stairs or ladders to permit internal access to the vehicle (Figure 5). These segments will house avionics wiring, DFI, ballast, and the fuel tanks for the Roll Control System (RoCS). Because the flight is primarily a test of the First Stage propulsion system, the USS will not include an analog of the Upper Stage J-2X engine.



**Figure 5. Pathfinder segment for Ares I-X Upper Stage Simulator.**

The mass simulator will be shaped like the regular flight vehicle and weighted with ballast to help capture dynamic vehicle behavior at particular points in the flight (e.g. stage separation). It is not a perfect mass simulator because it is not carrying a full-up engine or cryogenic propellants. Ballast will consist of 2-inch-thick circular steel plates. The plates are 130 in. across and approximately 7,500 lbs. for each. Each segment will be approximately 9.5 feet tall.

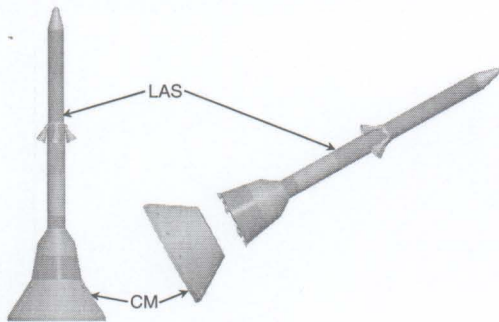
At present, Glenn Research Center has built one “pathfinder” segment for the USS, and has begun building a second unit. More definitive production-quality segments will begin after the PDR.

### Command Module/Launch Abort System (CM/LAS) Simulators

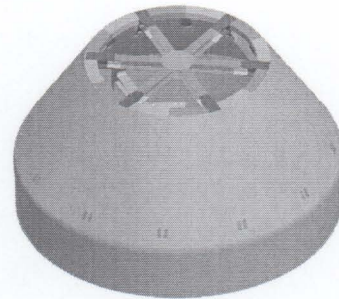
Langley Research Center (LaRC) in Virginia is building the CM/LAS simulator for Ares I-X. On the operational Ares I, the CM/LAS combination would house the crew and the means of escape in the event of an emergency. On Ares I-X, the exteriors of the CM/LAS structures will



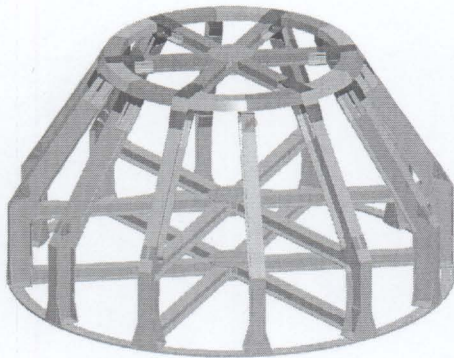
simulate the aerodynamic characteristics (outer mold line) of the current Ares I design. The simulator is expected to house DFI hardware. Figures 6 through 9 provide visual details of the simulator.



**Figure 6. Command Module/Launch Abort System (CM/LAS) Simulator**



**Figure 7. CM Support Structure and skin panels.**



**Figure 8. CM support frame, skins removed for clarity.**



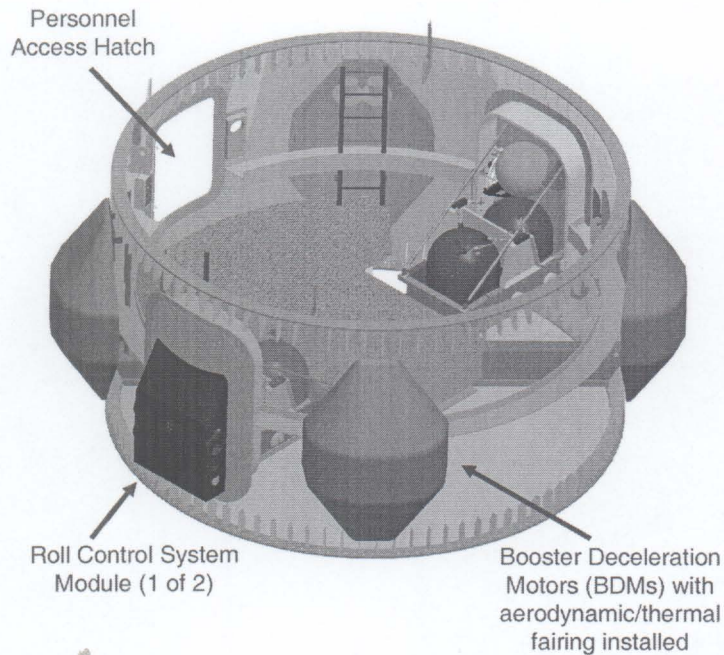
**Figure 9. Launch Abort System (LAS) mockup on Langley Research Center shop floor for servicing access testing.**

### Roll Control System (RoCS)

The Ares I-X Roll Control System is called RoCS to differentiate it from the Reaction Control System (RCS), which will be used on the operational Ares I vehicle for upper stage coast attitude and roll control during its powered flight. The RoCS is designed to provide roll control against adverse self-induced torques caused by internal hot-gas flow, nozzle misalignment, and aerodynamic-induced roll torques as the vehicle ascends under First Stage power. It also can be used to provide specific vehicle azimuth control for simulating the crew position during ascent. The RoCS will be mounted on the Interstage structure, the lowest axial segment of the Upper Stage Simulator.

The engines will have tangential thrust components in opposite directions (along the Y axis of the vehicle's forward motion), with two to four engines providing clockwise thrust and two to four engines providing counter-clockwise thrust (Figure 10).





**Figure 10. Ares I-X Interstage and RoCS Configuration (Notional)**

In a fine example of beating swords into plowshares, the RoCS engines and propellant feedsystem components are being salvaged from the decommissioned Peacekeeper (MX) nuclear missile arsenal. These components were part of the terminal guidance stage, originally designed to provide the final ballistic trajectory adjustments to the delivered nuclear warheads. Rather than totally destroying these decommissioned stages, the Air Force is allowing NASA to “harvest” selected components from the stages for use in the RoCS modules. FITO and the RoCS element will be sponsoring operational verification testing of one of the salvaged Peacekeeper axial engines (AXEs) for suitability to the anticipated Ares I-X roll control duty cycle.

As mentioned in the First Stage discussion, the Ares I-X team used test data from the FSM-13 test at ATK Launch Systems to assess the internally-induced roll torque requirements.

#### Ground Operations

The Ares I-X flight test also will be a test of new Ground Operations (GO) procedures at the launch site. Among the activities the GO team is studying, along with MSFC, are: stabilizing the vehicle during rollout from the VAB; setting up electronic ground equipment; studying the operation of the FTS; and loading the propellants for the RoCS.

To ensure that the Atlas-heritage avionics system knows where it is and can guide the FTV correctly, the vehicle must remain as stable as possible once on the Main Launch Platform (MLP). The GO team at KSC is working with MSFC to study the need for a wind damper to keep the vehicle from twisting or swaying too much. The avionics system requires a minimum of 60 minutes’ relative motionlessness to ensure proper attitude reference.

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The vehicle's First Stage includes a Flight Termination System (FTS). The Ares I-X flight test vehicle is equipped with a Linear Shaped Charge (LSC) that extends along three of the four solid rocket motor (SRM) segments of the Ares I-X FTV (Figure 12), which provides the force to crack the cases of the three SRM segments.

The 45<sup>th</sup> SW has recommended that the LSC be extended to all four segments for the Ares I-X flight and all five segments of the Ares I to meet their requirements. Based on a study conducted by the Flight and Integrated Test Office (FITO), the First Stage team is extending the LSC to meet the Air Force requirement, which will increase the safety of the new vehicles.



**Figure 11. Linear Shaped Charge Extension location.**

## SUMMARY AND CONCLUSIONS

The Ares I-X effort is developing the design, hardware, and software simultaneously in an "X-vehicle" operational mode. As the FITO team's preparations for the May Preliminary Design Review continue, the flight test is on schedule to complete its Critical Design Review in November of 2007 and launch in April 2009.

## ACKNOWLEDGMENTS

The authors wish to thank Bart Leahy, Technical Writer at Analytical Services Inc., for his contributions to this paper.





# Ares I-X Flight Test Philosophy

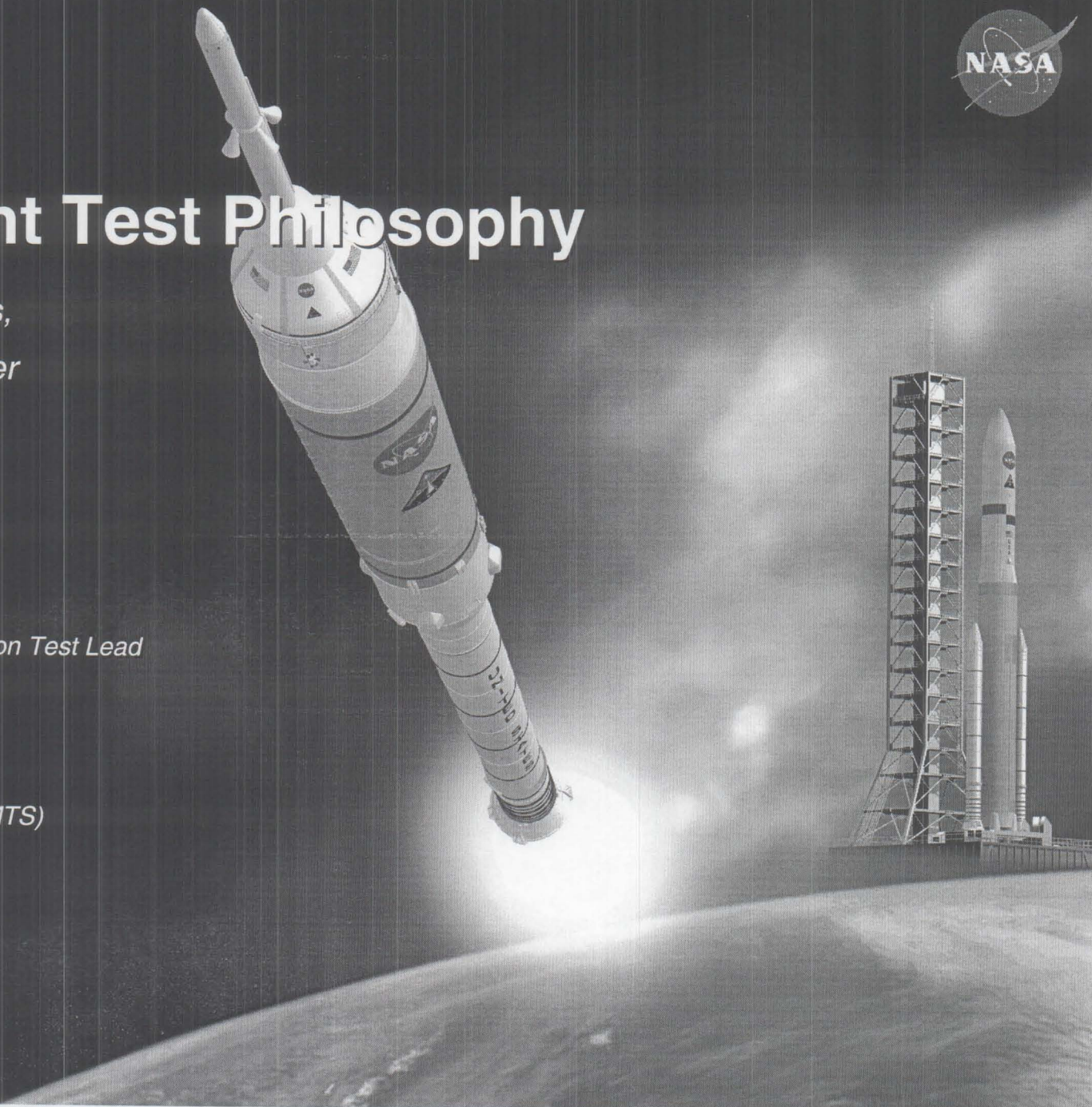
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May 2007*



# Agenda

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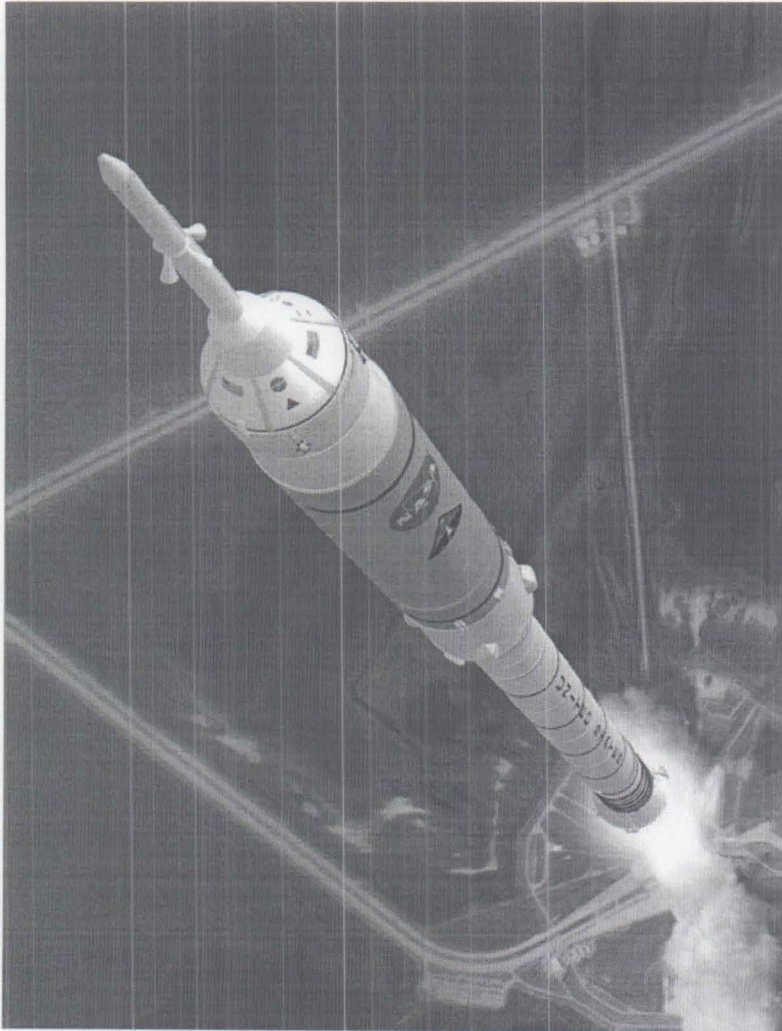


- ◆ **Overview of the Ares Launch Vehicles**
- ◆ **Overview of the Ares I-X**
- ◆ **Progress toward Preliminary Design Review (PDR)**
- ◆ **Details of individual flight test elements**



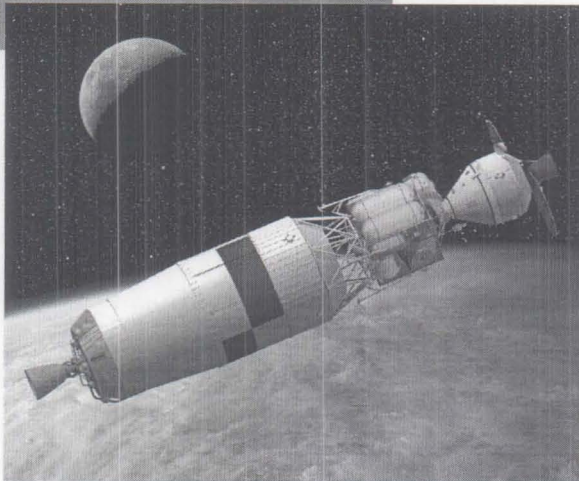
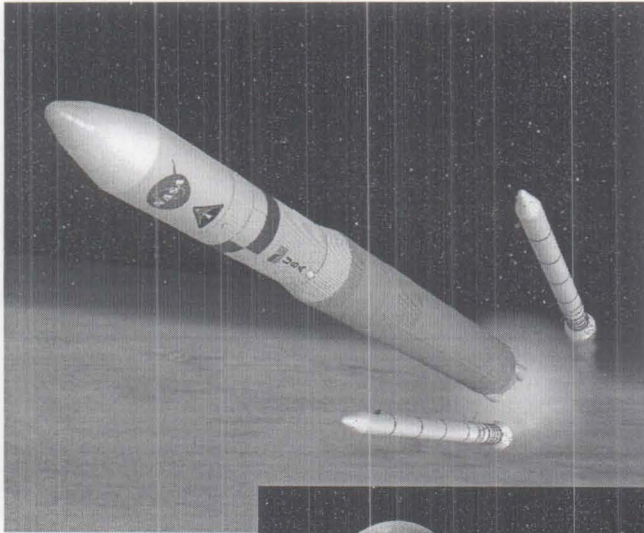
# Overview of the Exploration Launch Projects Architecture

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- ◆ **Carries Crew Exploration Vehicle (CEV) to orbit to rendezvous with International Space Station or Ares V**
  
- ◆ **Ares I propulsion:**
  - First Stage
  - 5-segment Reusable Solid Rocket Booster (RSRB)
  - Upper Stage
  - J-2X

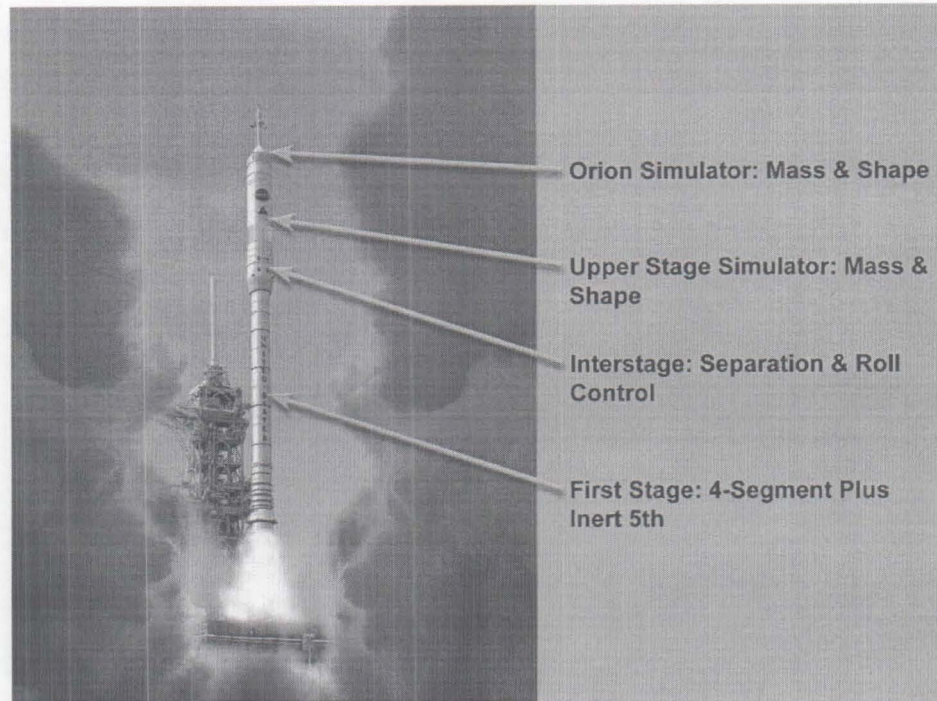
# Exploration Launch Projects Architecture (Cont'd)



- ◆ **Ares V carries cargo to ISS or Lunar Surface Access Module (LSAM) and Earth Departure Stage to orbit**
  
- ◆ **Ares V Propulsion:**
  - Core Stage
    - 2 RSRBs
    - 5 RS-68
    - 33-foot (10 meter) diameter
  - Earth Departure Stage
    - J-2X for orbit circularization and Trans-lunar injection (TLI) burn
  
- ◆ **Common hardware and procedures with Ares I to reduce development and operations costs**



# Overview of Ares I-X Test Flight



- ◆ **First suborbital ascent development flight test, scheduled for April 2009**
- ◆ **Flight test vehicle (FTV) uses mix of flight and mockup hardware:**
- ◆ **Similar in mass, center of gravity, and length to final, operational system**
- ◆ **Flight profile approximates the flight conditions of Ares I.**

# Ares I-X Primary Objectives

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- ◆ **Demonstrating the ascent flight control system**
- ◆ **Characterizing and mitigating the roll torque due to first stage motor performance for a vehicle dynamically similar to the operational vehicle**
- ◆ **Demonstrating nominal first and upper stage separation and clearances**
- ◆ **Testing the First Stage parachute recovery system and separation/entry dynamics**
- ◆ **Validating assembly and processing flow, as well as launch and recovery operations**



# PDR Approach

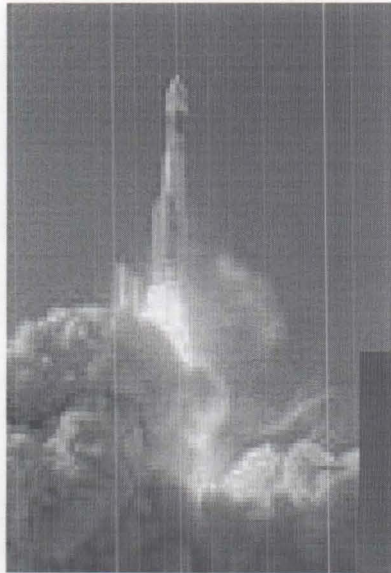
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- ◆ **Concluded successful System Requirements Review (SRR) for the Ares I-X flight in November 2006**
- ◆ **PDR scheduled for May 2007**
- ◆ **Establish initial FTV design meets functional and performance requirements with acceptable technical, performance and schedule risks**
- ◆ **Ensure that system requirements are complete and have been allocated to vehicle elements**
- ◆ **PDRs also will be held at the element level for primary hardware elements, including First Stage, Upper Stage Simulator, Command Module/Launch Abort System, Avionics, and Roll Control System**
- ◆ **Ares I-X CDR scheduled for September 2007**

# Avionics – Overview

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- ◆ **Combines components from Atlas, modified Space Shuttle systems, and new hardware**

- ◆ **Includes:**

- Flight control systems
- Ascent Thrust Vector Controller (ATVC)
- Telemetry systems
- Data recording—Development Flight Instrumentation (DFI) and Operational Flight Instrumentation (OFI)
- Sensors
- Power
- Imaging
- Electrical Ground Support Equipment (EGSE)



# Avionics Progress

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- ◆ **Completed brassboard test of ATVC**
- ◆ **Selected customized Ground Command, Control, and Communication (GC3) unit, called a mini-GC3, embedded within the Main Launch Platform (MLP), for ground interfaces**
- ◆ **Clarifying requirements for capturing, transmitting, and storing video imagery**
- ◆ **Finalizing location of the Developmental Flight Instrumentation (DFI) and Flight Test Inertial Navigation Unit (FTINU)**

# First Stage

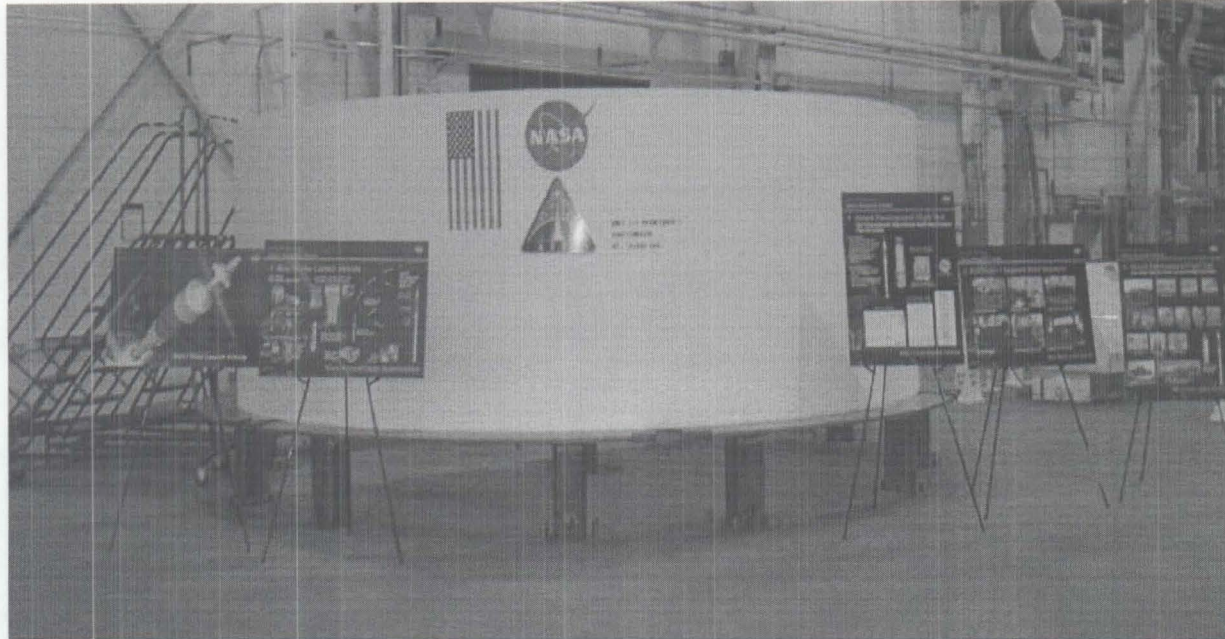
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- ◆ **Obtained internal roll torque data from Flight Support Motor test at ATK in December 2006**
  
- ◆ **Developing new forward structures**
  - Frustum
  - Forward Skirt
  - Forward Skirt Extension

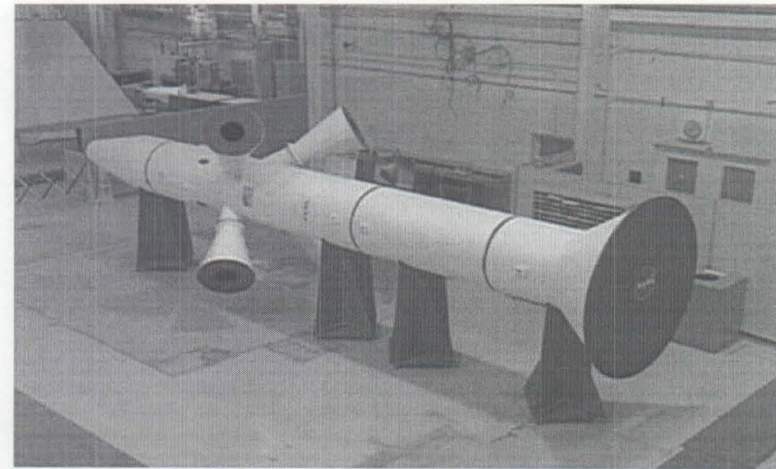
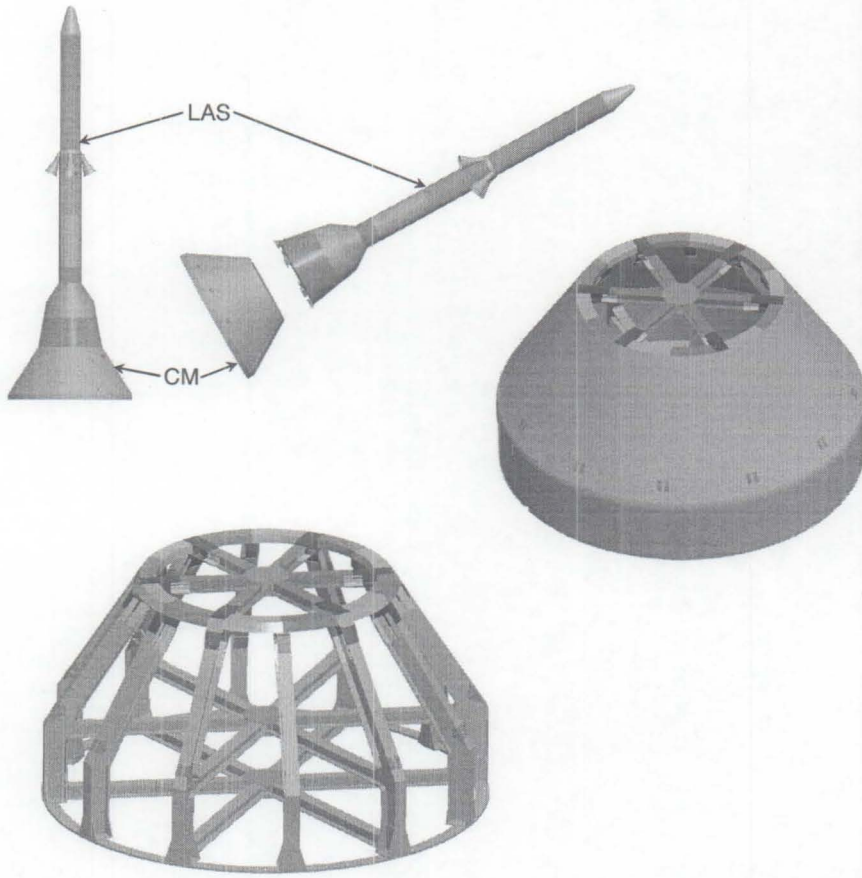


# Upper Stage Simulator (USS)



- ◆ **USS comprises stacked segments with internal access**
- ◆ **Built two “pathfinder” segments at Glenn Research Center—production-quality segments will begin after PDR**
- ◆ **USS includes ballast to ensure Ares I-X approximates the mass properties of Ares I**

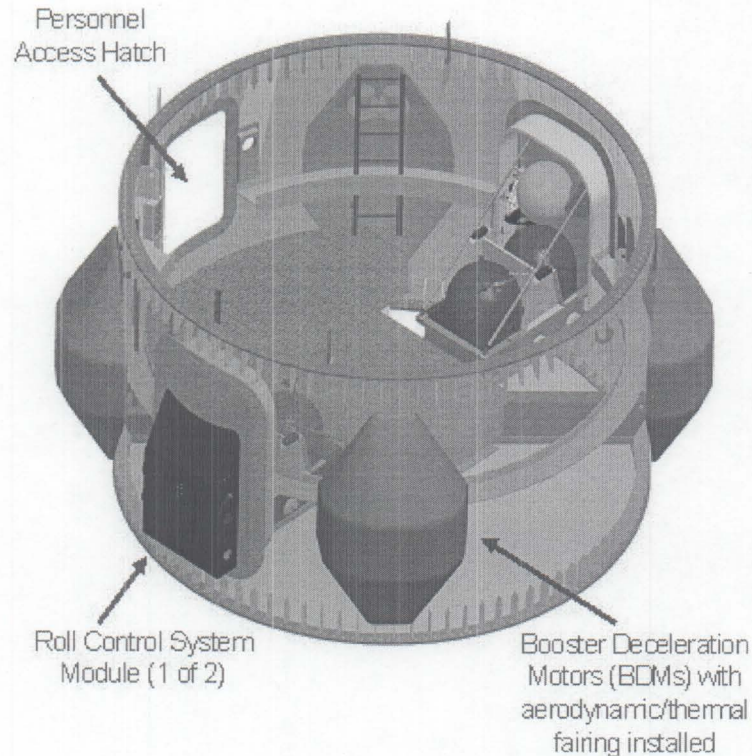
# Command Module / Launch Abort System (CM/LAS) Simulator



- ◆ Langley Research Center developing
- ◆ Simulates outer mold line of Ares I.



# Roll Control System (RoCS)



- ◆ Counters torque around x-axis
- ◆ Bi-propellant engine originally used for Peacekeeper (MX) missile
- ◆ Five engine sets obtained from Hill AFB
- ◆ Testing to begin soon

# Ground Operations (GO)

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## ◆ Ares I-X GO activities under review, including:

- Stabilizing the vehicle during rollout from the VAB
- Setting up electronic ground equipment
- Studying operation of Flight Termination System
- Loading the propellants for the RoCS



# Summary

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- ◆ **The Ares I-X effort is developing the design, hardware, and software simultaneously in an “X-vehicle” operational mode.**
  
- ◆ **The flight test is on schedule:**
  - PDR in May 2007
  - Critical Design Review in November 2007
  - Launch in April 2009

# Contact Information

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