The Atlas V Aft Bulkhead
Carrier Update
Past Missions, Upcoming Launches, and Future Improvements
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Outline

• ABC Overview
• ULA’s ABC User’s Guide
• Past Missions
• Future Missions
• Lesson’s Learned
• Improvements
ABC Overview

• ABC system consists of a plate and two struts
  • Struts based on existing helium tank strut design
  • Plate is a standard ULA design used throughout the vehicle
• Standard 15” 24 bolt pattern for AP mounting
• Supports separating and non-separating APs
  • Small payloads up to 80kg (170lbs)
• Located in area separate from primary SV
  • Aft end of Centaur upper stage
• First flight in 2012
• 33 CubeSats to orbit
ABC Location and Volume

- Centaur Aft Bulkhead
- Aft Bulkhead Carrier
- Satellite Envelope
- Large Helium Tank
- RL-10 Engine
Atlas V with Aft Bulkhead Carrier

- Atlas V Booster
- RD-180 Engine
- Solid Rocket Boosters
- Centaur Interstage Adapter
- Boattail
- Payload Fairing
- RL-10 Engine
- Centaur Upper Stage
- Primary Satellite
- ABC
Summary of User’s Guide and Interface Control Document (ICD)

- Users Guide is a Public Document Issued to the AP community
- Users Guide Defines Launch Vehicle to AP interfaces
- Users Guide Defines worst case launch environments
- ICD is developed for each AP mission
- ICD Provides detailed technical requirements
  - Performance and Mission Design
  - Physical and Functional
  - Environmental
  - Ground Operations
- Each Requirement in the ICD is tracked and verified
Requirements To Be Addressed By the Secondary Payload Customer

- **Mission**
  - Orbit Insertion and Accuracy
  - Launch Window
  - Separation Control
    - Satellite Mass Properties
    - Centaur Control Capabilities
  - Separation Requirements

- **Interface**
  - Satellite to Launch Vehicle Interfaces
    - Coordinate System
    - Volume, Mechanical Interface
    - Stiffness
  - Avionics Interfaces
    - Ground Interfaces
    - Separation Indication
  - Range and System Safety Interfaces, Facilities and Processing

**Typical Requirements Closure Plan**

<table>
<thead>
<tr>
<th>Months to Launch</th>
<th># of Requirements Closed</th>
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<tbody>
<tr>
<td>10</td>
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User Guide – Key Interfaces

- AP Allowable Mass Range 145 +/- 25 lbs
- AP Stiffness: 35 Hz when mounted to rigid interface
- Acceleration Limit Load Factors: 7g’s Z, 5g’s X,Y
- Full envelope is 20x20x34 inch (Noted below)
- Typical non separating envelope shown below adjacent to the single separating payload
User Guide – Key Interfaces

- Mechanical Interface – 24 x .25 diameter Bolt on 15in diameter circle
Prelaunch Processing

- East Coast Processing at Atlas Spaceflight Operations Center (ASOC)
- West Coast Processing in Building 7525
- Temperature range approximately 50 F to 100 F
- Humidity is not controlled
- Helium environment: 3,000 Torr-hours maximum
Vibration & Acoustics Environments

Aft Bulkhead Carrier (ABC) Acoustic Requirement

Aft Bulkhead Carrier (ABC) Vibration Requirement

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Random Vibration (G²/Hz)</th>
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<tr>
<td>20</td>
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<tr>
<td>40</td>
<td>0.125</td>
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<tr>
<td>240</td>
<td>0.125</td>
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<tr>
<td>2000</td>
<td>0.003</td>
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<tr>
<td>Overall</td>
<td>7.6 Grms</td>
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<tr>
<td>Duration</td>
<td>60 sec/axis</td>
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AP and LV Shock Environments

Maximum Allowable AP Generated Shock at ASIP

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<thead>
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<th>Frequency (Hz)</th>
<th>Maximum Allowable AP Generated Shock (G's)</th>
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<tbody>
<tr>
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<td>66</td>
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<tr>
<td>220</td>
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<td>316</td>
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Maximum LV Generated Shock at ASIP

<table>
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<tr>
<th>Frequency (Hz)</th>
<th>Maximum LV Generated Shock at AP/LV Interface (G's)</th>
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<tr>
<td>5000</td>
<td>3200</td>
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<tr>
<td>10000</td>
<td>3200</td>
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Maximum LV Generated Shock at AP/LV Interface (G's)
Range and System Safety

- Auxiliary Payloads must comply with requirements of AFSPCMAN 91-710, volumes 1, 3, 6 and demonstrate compliance

- An Adequate Auxiliary Payload Safety Document:
  - Identifies the hazards
  - Describes the AP design features that preclude, prevent, these hazards not only during nominal/planned operating/operational conditions but also during credible fault/failure conditions
  - Summarizes how the effectiveness of the hazard controls or procedural precautions will be verified
  - Provides the applicable data required by AFSPCMAN 91–710, Volume 3, Attachment 1
Integration Schedule

- **Program Kickoff**
  - KO (L-23 months): Initial Target Spec, Interface Requirements Document, Intact Impact Breakup Data, Inflight Breakup Data, Preliminary Coupled Loads Model
  - KO + 1 month: Preliminary CAD Model
  - KO + 4 months: Range Safety Mission Orientation Briefing
  - KO + 6 months: Final CAD Model
  - KO + 7 months: Final Coupled Loads Model

- **Within One Year**
  - L - 12 months: Preliminary Safety Document, Thermal Models
  - L - 7 months: EMI EMC Analysis, EED Analysis
  - L - 5 months: Final Safety Document, AP Qualification Test Reports

- **Final Integration**
  - First Use - 2 months: Procedures to be used at Launch Site
  - L - 90 days: Final Target Specification
Past ABC Missions

- **NROL-36/OUTSat**
  - 11 CubeSats NRO/NASA LSP Sponsored
  - First flight = many lessons learned

- **NROL-39/GEMSat**
  - 12 CubeSats NRO/NASA LSP Sponsored
  - Proven capability = smooth process

- **AFSPC-5/ULTRASat**
  - 10 CubeSats NRO/NASA LSP Sponsored
  - First flight on Air Force mission
  - Primary SV program office actually asked us if we wanted a ride
  - Very visible due to Lightsail-A press

ABC Payloads did not affect LV or SV processing timelines!
Future ABC Missions

• **NROL-55/GRACE**
  • 13 CubeSats
  • Supports
    • Critical DoD Joint Capability Technology Demonstration
    • Government technology demonstrations
    • NASA ELaNa program

• **Insight/MarCO (No NRO Involvement)**
  • Two 6U CubeSats
  • NASA mission to Mars supporting Insight with comm relay
  • ULA demonstration of on-pad integration

• **AFSPC-7/RASCALSat**
  • Manifest and launch date TBD

• Other ABC missions in work
Lessons Learned

- Fluidity of CubeSats
  - CubeSat funding comes and goes quickly
  - Need large list of candidates

- Early coordination with range safety
  - The range is already busy with the primary missions launching
  - Deliver MSPSPs early!

- CubeSat Inhibits
  - Three independent inhibits on system power-up, RF systems
  - More work for all parties if less than three

- Primary payload expects same high standards from auxiliary payload(s)
  - Requirements
  - Management
Future ABC Improvements

- Vibration Reduction - ULA
  - Current predicted environment is conservative
  - ULA is using advanced analytical techniques and performing ground testing to better predict environments
  - ICD will be updated with new testing environments

- 6U Deployer Qualification for ABC
  - Tyvak and Planetary Systems Corp. 6U deployers are being qualified to ABC environments
  - Full flight qualification program
Information

- ULA User’s Guide
  - http://www.ulalaunch.com/Products_AtlasV.aspx