R A S C A L

“A Demonstration of Responsive Space Lift for Small Satellites”

18th Annual AIAA/USU Conference on Small Satellites
RASCAL Overview

• Distinguishing characteristics of the RASCAL air-launch system
  – 1st stage is a new aircraft design
  – Simple, low cost expendable rocket vehicle
  – Ability to operate outside of existing federal launch ranges
  – Enhanced turbojet engines are employed for high speed/high altitude flight
  – Near exo-atmospheric (alt. ~180,000 ft) staging of rocket vehicle

• RASCAL represents a new paradigm for small payload launch
  – Low recurring cost
  – Highly responsive
  – Aircraft-like operations
  – Dedicated space launch for small payloads
  – Scaleable technology
RASCAL Operations

**Responsive** 1 hour scramble with aircraft like sorties.
- Quick response to developing threats
- High flight rates

**Flexible** Covert delivery of a variety of payloads to any orbital inclination.
- Operates from any airfield with a 2500 m (8200 ft) runway
- In-flight mission planning capability

**Operable** Aircraft-like reliability, supportability, maintainability.
- Not dependent on launch ranges
- 24-hour mission turn around

**Economical** Mission cost $10,000/kg
• Currently in Phase II of a three phase demonstration program

• Phase II involves design work and significant risk mitigation testing
  ➢ Aircraft configuration selected
  ➢ Propulsion ground testing underway
  ➢ Wind tunnel testing completed
  ➢ Full scale solid rocket motor test to take place this fall

• Phase III will end with two orbital demonstration launches

• RASCAL system performance: 75 kg to 500 km 97.1°
Phase II Industry Team

- BAE Systems
  - Mojave, CA
- Acei
  - Valencia, CA
- AAE Aerospace & Commercial Technologies
  - Huntington Beach, CA
- Universal Space Lines LLC
  - Newport Beach, CA
- Space Launch Corporation
  - Irvine, CA
- Scaled Composites
  - Mojave, CA
- Intercon Airlift Services
  - Ronkonkoma, NY
- ATK Gas/L Propulsion
  - Butte, MO
- ATK Alliant TechSystems
  - Elkton, MD
  - Manassas, VA
- Athena Technologies
  - Juno Beach, FL
- Pegasus Engineering Services, Inc.
  - San Antonio, TX
- Cymetech
  - Huntsville, TX
- Pratt & Whitney
  - San Antonio, TX
Scaled’s Tier One Program

Our subcontractor for the RASCAL aircraft has space experience.
THE RASCAL Aircraft

Configuration Summary

• Four engine, low wing, supersonic configuration with internal payload bay

• Single pilot cockpit with the capability for future autonomous operation

• Capable of conventional airport take-off and landing

• Propulsion system uses liquid oxygen and water Mass Injection Pre-Compressor Cooling (MIPCC) for thrust augmentation at high Mach number and altitude
Evolution of the RASCAL Aircraft
Current Configuration

- Gross Weight \( \approx 115,200 \) lbs
  - Payload \( \approx 18,000 \) lbs
  - Consumables \( \approx 31,900 \) lbs
  - Empty Weight \( \approx 65,300 \) lbs

- 59 ft span
- 102 ft length
- 2100 ft\(^2\) wing area

Size Comparison

- F-15
- MPV
- SR-71
MIPCC Testing Underway

- Shakedown tests with a J-85 have been completed in Mojave

- Initial tests indicate an ~2X increase in thrust when using MIPCC
- MIPCC testing with an F100-PW-200 engine underway
F100 Engine At MTB
Inlet Status

10% Scale Inlet Model Designed and Fabricated
Tunnel Testing Currently Underway – No Surprises

Self Start Demonstration at Mach 2.5, alpha = 0
Expendable Rocket Vehicle

Designed to be Low Cost, Safe, Simple, and Inherently Reliable

- Large payload volume
- Smart guidance and propulsion module provides on-orbit maneuverability
- Use of hybrid motor technology reduces recurring cost
- Autonomous flight safety system
- No payload shroud required
The Path Forward

Additional Tasks to be Completed in Phase II

• Preliminary structural design and analysis
• Aircraft systems selection and layout
• MIPCC testing with Pratt & Whitney F100 engine
• Full-scale ground test of the second stage solid rocket motor