**Title:** Solid Rocket Testing at AFRL

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For presentation at AV SFTE Regional Symposium, Lancaster, CA, USA (21 October 2016)
Solid Rocket Testing at AFRL
21 Oct 2016

Robert Antypas
AFRL/RQRO

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Agenda

• Solid Rocket Motors
• History of Sea Level Testing
• Small Component Testing
• Full-scale Testing
• Altitude Facility
• History of Testing
• Questions
**RQ-West**

- **AFRL/RQ**
- **Aerospace Systems**
  - RQ West @ Edwards AFB
  - RQR Rocket Propulsion Division
    - Solids
    - Liquids
    - Spacecraft Propulsion
  - RQ East @ Wright-Pat AFB
  - Primarily Air Breathers

- **Mission**-
  Develop, Demonstrate and Deliver (3-D) game-changing rocket and in-space propulsion technology for US Air and Space Dominance

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Rocket Motors

- **Solid Rocket Motors**
  - Storable
  - Less moving parts
  - Lower ISP efficiency
  - Mostly non throttle-able

- **Uses**
  - ICBM’s
    - MMIII
    - Peace keeper
  - Boost assist
    - Space Shuttle SRB’s
    - Atlas SRM
  - 1st-4th Stages

**Rocket Thrust**

\[
\text{Thrust} = F = \dot{m} V_e + (p_e - p_0) A_e
\]

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History of Sea Level Testing @ AFRL

- 1947 Edwards AFB was selected for the location of the LAB
- 1959- Rocket scientists permanently move from WPAFB to “The Rock”
- 1958-1961 Thor IRBM testing
- 1960’s Atlas/ Titan I & II
- Minuteman I, II, III
- 1980s-1990s Titan IV
- Peacekeeper ICBM
- Atlas V booster
- Aging and surveillance of current fleets

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Sub Scale Testing and Component Testing

- **Components**
  - Nozzles
  - Throat materials (non-eroding and non-ablative)
  - Insulation materials
  - Propellant formulations

- **Sub Scale**
  - Pi k, 2.2-7 lbs of propellant
  - Pressure and burn rate evaluations

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Small Scale Testing BATES

- BATES: BAllistic Test Evaluation System
- Program started in 1959 and is still used today for propellant and insulation development testing
- BATES has been used in numerous tactical, strategic, and space launch propellant development programs:
  - Sparrow
  - Sidewinder
  - Peacekeeper
  - Titan 34D SRM
  - Space Shuttle SRB
- Two primary configurations
  - 15#
  - 70#

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BATES Video

8/12/2016  10:17:10.014 AM

Pad 5 Inside

8/2/2016  10:06:04.545 AM

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Full-scale Testing LEO

- Super Styrpi Launch Vehicle
- Hawaii Space Flight Laboratory
- Low cost access to space
- LEO-7 stage 2, tested at AFRL 14 August 2012
- LEO-46, stage 1, tested AFRL 8 August 2014
Full-scale Testing Atlas 5

• Full Scale Atlas V Solid Rocket Booster Test at Area 1-32 Pad 2 On 24 Feb 2014

• Verify Material Modifications are functional and Qualify Them for Production and Flight
Videos

• Atlas: Public Release # 2014-065
• Leo 7: Public Release #377ABW-2012-1393
• Leo 46: Public Release AR# 029-14
• TAM:

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Altitude Facility

- 3 Test Positions
- 110K-ft Altitude
- 50K-lbf Thrust

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Questions

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1-42 Steam Run

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History of Altitude Testing @ AFRL

- Originally built in the 1960’s for development of 2\textsuperscript{nd} & 3\textsuperscript{rd} stage ICBMs
- Portions of the stand were deactivated in the 1970’s & 1980’s
- In 1993, the stand was shutdown and left inactive
- In 1997, one ejector string was re-activated to test the Navy’s Third Stage Rocket Motor
- In Oct 2007, an 18 month refurbishment effort began to re-activate all 3 ejector strings

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Questions

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