Navigating the Testing of Hypersonics in the 21st Century

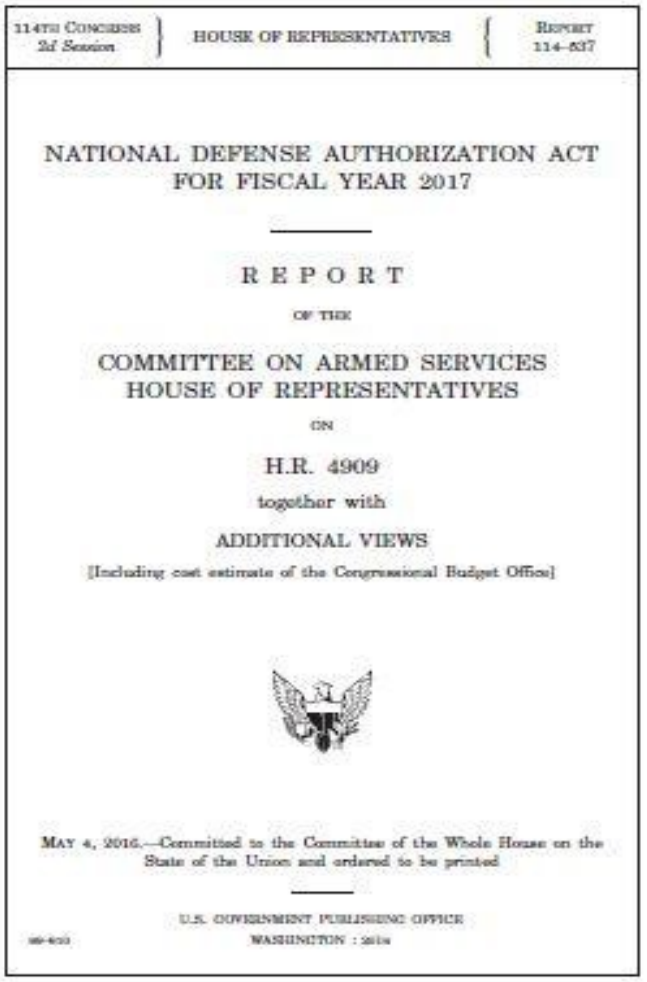
22nd ITEA Test and Training Instrumentation Workshop

Elizabeth Hill
White Sands Missile Range, NM
16 May 2018

Background

- **House of Representatives Report 114-537**
  - “The committee directs the Director of the Test Resource Management Center (TRMC) to provide a briefing to the House Committee on Armed Services by March 1, 2017*, on the results of a comprehensive assessment of Major Range and Test Facility Base (MRTFB) needs and investments to meet testing required for fifth and sixth generation aircraft and air armament, including hypersonic strike weapons.”

- **Regional Long Range Corridors:**
  - Help address gaps in existing over land capabilities to support these aircraft, air armaments, and more specifically hypersonic long range systems. Help address existing threats from ballistic, cruise missile and other hypersonic threats that currently exist.



114TH CONGRESS 2d Session | HOUSE OF REPRESENTATIVES | REPORT 114–537

NATIONAL DEFENSE AUTHORIZATION ACT FOR FISCAL YEAR 2017

REPORT

OF THE

COMMITTEE ON ARMED SERVICES
HOUSE OF REPRESENTATIVES

ON

H.R. 4909

together with

ADDITIONAL VIEWS

[Including cost estimate of the Congressional Budget Office]

MAY 4, 2016.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

U.S. GOVERNMENT PUBLISHING OFFICE
WASHINGTON : 2016

What makes Long Range Corridors possible?

- Programmatic Environmental Impact Statement (PEIS)
  - EA still needed for specific program
- Mobile instrumentation (not covered in this brief)
- Advanced FTS approach
  - Drive down risk = short distance testing first
  - Use of population models and other flight termination methods

PEIS

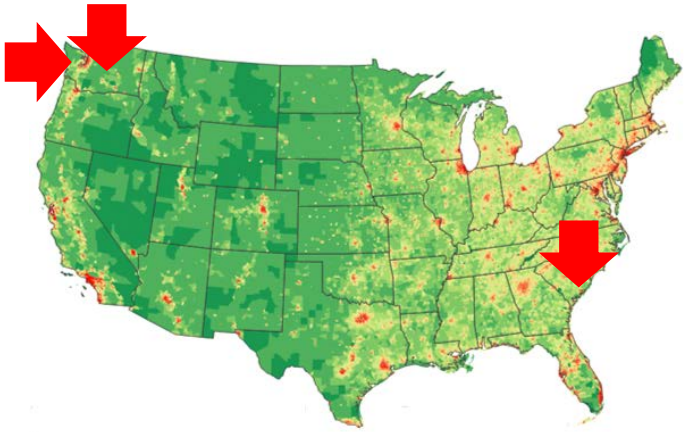
- Two types: “Programmatic” and “Project-Level”
- A PEIS is a more broad covering:
  - Wide range of individual projects
  - Implementation over a long timeframe
  - Implementation across a large geographic area
- Collaboration (Federal, State, FAA, Local Agencies, and Tribes)
- PEIS is about NEPA compliance looking at impacts to the environment, FAA requirement for temporary restricted airspace, and the need to inform the public and provide them confidence that the test can be done safely
- PEIS will have insignificant impact on the environment (FONSI)

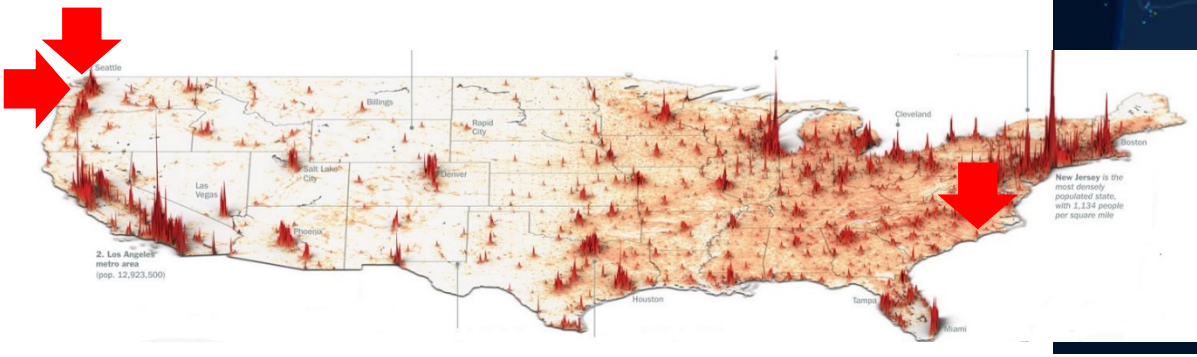
Off-Range Flight History

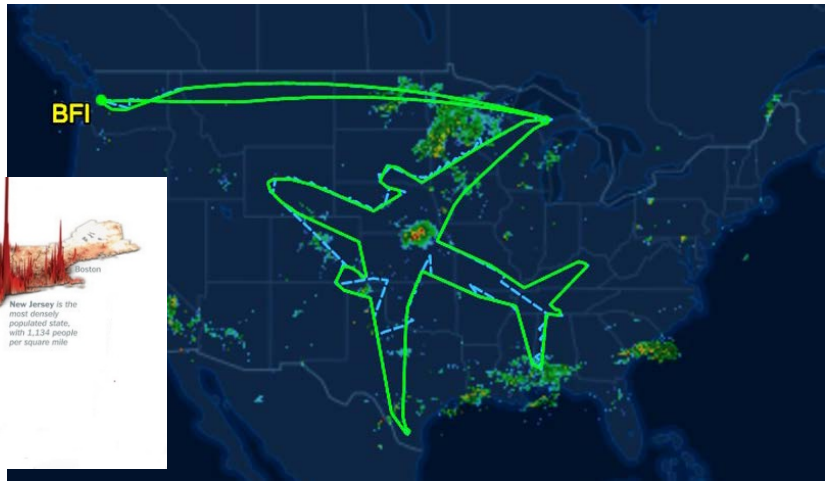
- Numerous precedents exist:
  - Ft. Wingate, NM; Green River, UT
  - HERA, Juno, Hound Dog, AQM-37, ATACMS, etc.
- Requests for off-range corridors since 1950's:
  - 100-200 nm Redstone, Talos, Nike, Crossbow
  - 925 nm ballistic missile
  - 1000 nm Hound Dog
  - 1500 nm Redstone (Canada impact)
  - 2000 nm Redstone (Alaska impact)
- Tomahawk Test corridor from the Pacific to China Lake

Large Aircraft Testing Example

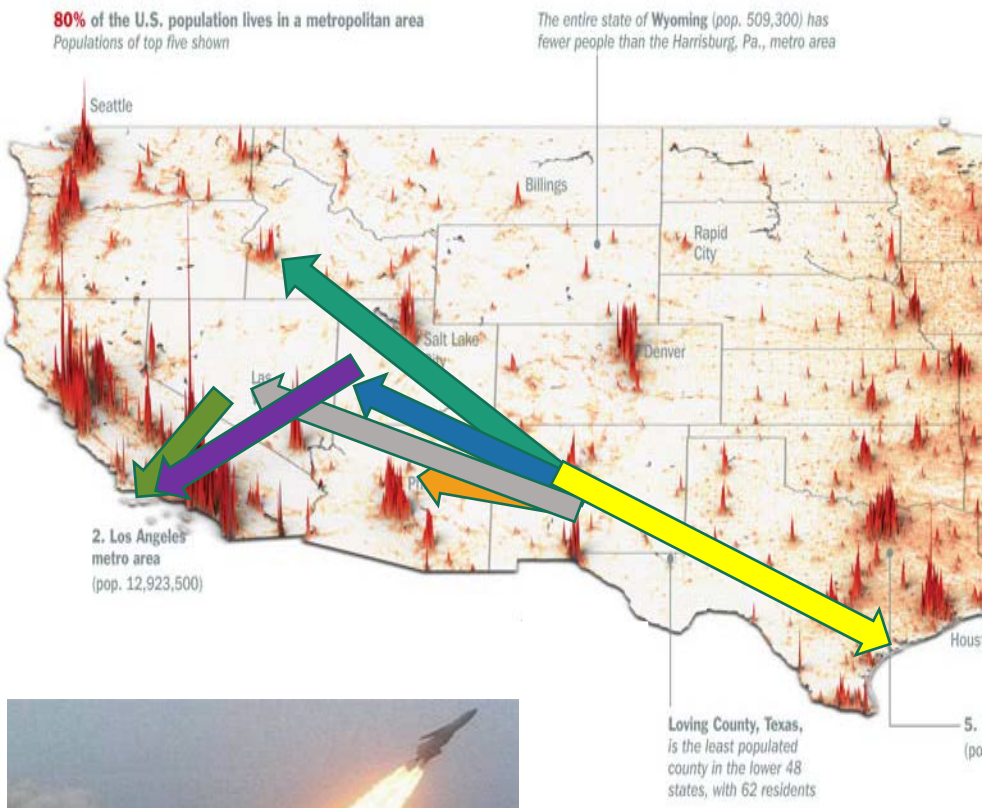
- Boeing Field, Seattle, WA
- Boeing Test Facility, Moses Lake, WA
- Boeing's Charleston International
  - Testing includes:
    - Near vertical climb
    - Hard banks
    - Water ballast tanks
    - Stalls, Etc
- 4,000 to 5,000 hours in the air, in a series roughly four-hour flights.





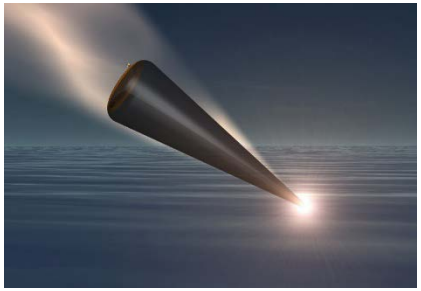


Hypervelocity/Long Range Systems



Flight Corridor	Miles	KM
Near Florence, AZ	305	490
Camp Navajo, AZ	310	500
NTTR, NV	630	1000
Gulf of Mexico	650	1046
Dugway to China Lake	400	640
Fallon to China Lake	240	390
Dugway Proving Ground	645	1038
Shoofly, ID	893	1437

Russian Zircon Hypersonic Anti- Ship Missile



Chinese Hypersonic DF-17 with Hypersonic Gliders

Autonomous Flight Termination System (AFTS)

- AFTS is an independent, self-contained system
- AFTS flight software (Developed/owned by the US Government)
- Autonomously makes flight termination / destruct decisions
- Applications
    - Primary FTS for unmanned Range Safety Operations
    - Primary FTS or Crew advisory system for human space flight
- Advantages
    - Cost Reduction (Decrease in need for ground-based assets)
    - Global coverage
    - Increased Responsiveness
    - Can support multiple vehicles simultaneously
- NASA/DoD partnership is FTS available for use by all Range Users within ITAR
- Used and supported by several NASA and DoD programs since its inception

AFTS Use Cases

Government Agencies

- NASA
- DARPA
- USAF
- US Army/SMDC
- Sandia National Laboratories

Commercial Companies

- SpaceX
- Boeing
- DARPA XS-1
- LJT
- MEI
- CCT
- ENSCO
- Blue Origin
- Tyvak
- Northrop Grumman
- SIL
- bSpace
- Garvey Spacecraft
- Miltec
- Virgin Galactic
- Coleman Aerospace
- ARCA Space
- Orbital ATK
- ULA
- Regan Designs
- Rocket Lab USA
- Excelerate
- Cimarron
- Generation Orbit
- SGT
- Vector Space
- Firefly Space Systems
- Rocket Crafters
- Aerospace
- UP Aerospace
- L-3
- Ventions

AFTS Launch Demonstrations

Flight/Launch Demos:

- Sept. 27, 2005, aircraft flight test near Kennedy Space Center
- Apr. 5, 2006, Two-stage Terrier Orion Sounding Rocket at WSMR
- Mar. 21, 2007, SpaceX Falcon 1 at Reagan Test Site, Kwajalein
- Nov. 8, 2007, F-104 aircraft at Kennedy Space Center SLF
- Sept. 21, 2010, Two-stage Terrier Orion Sounding Rocket at WFF
- Nov. 19, 2013, DoD ORS demonstrated ATK AFTS on Minotaur from WFF

F-104

Sounding Rocket at WSMR

SpaceX Launch

Sounding Rocket at WFF

AFTS Modifications

- WSMR and NASA discussing possible modifications for long range corridor support in the areas of:
  - Impact Points
  - Flight Termination Impact Points
  - Population Density Driven Cut Lines
- Correct FTS can greatly reduce the probability of casualties in the case of an anomaly

Conclusion

- Over land testing, embraced by commercial companies, needs to again be an option for testing of many long range systems
- The choice of the correct corridors, the right environmental approach, and utilization of a safer Flight Termination System are important factors for consideration