



Robins Air Force Base NDIA Brief

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Agenda

- Introduction
- U.S. Army Redstone Test Center (RTC) Proximity to Air Force Bases
- Redstone Arsenal Tenants
- RTC Overview
- Recent USAF Tests at RTC
- RTC Capabilities and Test Flows

RTC Proximity to Air Force Bases





Redstone Arsenal Tenants



U. S. Army Redstone Test Center (RTC)

Mission Statement

Provide technical expertise, state of the art facilities, and innovative solutions to expand capabilities in research and testing for aviation, aviation systems, missiles, and sensors at all levels (component, subsystem, system, and system of systems).



How RTC Fits



RTC

35/27

Military

• UAS

• CMWS/ATIRCM

• CIRCM

Mission Statement

Provide Technical Expertise, State-of-the-Art Facilities, and Capabilities to Plan, Execute, and Report the Test Results on Aviation, Aviation Systems, Missiles, and Sensors at all levels.

- Component
- Subsystem
- System
- System of Systems

The "Income Statement"

- Only Army test center that is not a Major Range and Test Facility Base.
- No centralized funding for civilian pay, operations and support.
- 100% reimbursable for each test directorate.

RTC Must Execute Its Mission and Provide Value to Ensure **Fiscal Solvency**

Resources



Missile

Testing

Key Programs



- HELLFIRE
 - Test Sets
 - SRP
- Joint Air-to-Ground Missile
- Javelin
- Precision Fire Missiles
- Integrated Base Defense
- Tactical Signals Intel Payload
- Counter UAS Risk Reduction
- Active Protection Systems

RTC Assigned Mission Areas

Aircraft Test

Assigned Mission Areas



- Manned/Unmanned
- Integration & Technical Performance
- Airworthiness & Safety
- Systems/Subsystems/Components
- Aircrew Soldier Systems

Environmental Test

Supporting Mission Areas



- Full MIL-STD-810
- Inert & Explosive Dynamics
- Inert & Explosive Climatics
- Full MIL-STD-461/464
- Inert & Explosive Electromagnetics
- Explosive Rail and Projectile Impact
- Insensitive Munitions

LOS Missile Systems Test



- Aircraft, Ground Vehicle & Soldier Fired
- Technical Performance & Safety
- Vulnerability, Lethality, Survivability
- Systems/Subsystems/Components
- Propulsion

Instrumentation



- Full Aircraft Instrumentation Suites
- SWaP Appropriate Missile Instrumentation
- Highly Miniaturized Instr for sUAS
- Fixed and Mobile Telemetry Suites
- Flight Termination Systems
- Expeditionary Capabilities
- Radar and Optical Trackers

Sensor



- Aircraft, Ground Vehicle & Missile
- Lab & Field Sensor Test Capabilities
- Technical Performance & Safety
- ISR Subsystems
- Laser Performance (HE, Designator, Range Finder, etc)
- Realistic Targets

Modeling & Simulation



- HWIL Facilities for Aircraft & Missile
- Cutting Edge Distributed Testing
- Component and Subsystem Test in Mission Relevant Environments
- Physics Based Models

RTC Aviation, Missile and Sensor Life-Cycle Test Capabilities



RTC Range Footprint



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Recent Air Force Tests



ON-GOING

JATM Basic Safety Series

- 28-Day Temperature & Humidity
- Transportation / Shipboard Vibration & Captive Carriage Vibration
- 40 ft Drop Testing

JATM Natural & Induced Environmental

- Rapid Pressure Change NASA MSFC Partnership
- Blowing Rain, High Humidity, and Extreme Low Humidity

Hypersonic Attack Cruise Missile (HACM)

ON-GOING
Pre-Flight Readiness Testing (PFRT)
& Qualification Testing

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- Pre-Testing Trials
- Hot / Cold Radiographic
 Inspection
- Transportation Vibration & Shock
- Captive Carriage Vibration
 (Lateral, Long & Vertical Axis)
- Eject Shock



HACM

Hellfire / JAGM / Maverick / 2.75

ON-GOING

Telemetry (TM) Kit & Mission Support

- Telemetry Kit Design & Development
- Mission Support
- Weapon System Eval. Program (WESP)

Missile & Launcher Conversions

- Hellfire Launcher Conversions to make compatible with various AF platforms
- Missile conversions as needed to support
 AF Flight Testing



2.75" TM Kit Variants



Hellfire & JAGM Variant TM Kits

Recent Air Force Tests

- RTC has tested both Navy and Air Force assets to qualify AARGM-ER for both F-18 and F-35.
- Assets were fully instrumented and calibrated before missile body, joints, and strakes underwent structural qualification at RTC.
- Completed dynamic fatigue testing on joints and fasteners to simulate aerodynamic loads.
- Completed environmental testing such as salt/fog, humidity, altitude, and other conditions.



AARGM-ER Dynamic Fatigue Testing



Instrumentation Calibration on AARGM-ER



AARGM-ER Strake Failure Test

Telemetry and Flight Termination System Capabilities

TM/FTS Capability

Telemetry (TM) / Flight Termination System (FTS) components are designed and developed by experts with years of experience in the world of high dynamic missile flight testing. This Army owned, RCC-319 qualified TM/FTS has completed 40+ successful flight test missions on multiple missile platforms.

Adaptable Form Factors

Initially designed for the Army GMLRS 9-inch diameter missile, the RTC TM/FTS kit has been integrated into multiple missile platforms of varying diameters and sizes.

Mission Support

Team RTC provides a full range of TM/FTS support spanning mission planning to post test analysis. This includes RTC-designed ancillary test support equipment for real-time FTS control and health/status.

FUTURE UPGRADES

- Miniaturization using Multi-Chip Module Design
- Hypersonic Capable Autonomous FTS
- NSA TYPE 1 Encryption
- Dual High-Dynamic GPS Tracking
- Lossless Compression



Custom TM / FTS for Army GLMRS



Maverick Missile TM Kit



TM Trailer with Auto Trackers

Explosive Atmosphere, Rapid Decompression, and Altitude Test Capabilities

- Able to achieve 150,000 ft vacuum in 5 Large Accumulator Tanks. This can be used in support of rapid decompression (RD) testing and static testing.
- Large Chamber and Small Chamber can reach 120,000 ft.
- RD testing and altitude can be done with either chamber. 8- 40k ft or 8-100kft per MIL-STD.
- Static Fire motors both vertically and horizontally.
- Explosive Atmosphere Chamber can reach 40,000 ft and can condition components up to 160F.





Explosive Atmosphere Chamber



Motor/Warhead Dissection Capabilities







- Used for any solid rocket motor and warhead dissection.
- Grit-blast technique employed for cutting through motor cases and then a wire pull technique to slice the solid propellant.
- Propellant samples used for further testing and analysis in support of Shelf Life Extensions and Failure Analysis.
- Current and past motors dissected have included both domestic (Army, Navy, and Air Force) and foreign.

Motor Static Fire at Test Stand C

- Monolithic concrete and steel structure.
- Used for large tactical and ballistic missile propulsion testing for both foreign and domestic motors.
- Low side designed thrust limit of 10,000,000 lbf.
- High side designed thrust limit of 250,000 lbf.
- Sensor firing position designed for thrust limit of 20,000 lbf.
- A 6-DOF test fixture is available for use on this stand designed for testing motors up to 30K lbs of thrust with vectoring nozzle.
- At the sensor firing position a test fixture (as shown) is used to allow for nose on signature collection of both foreign and domestic motors.
- Portable temperature conditioning is available to condition rocket motors on the stand to extreme temperatures.



6DOF and Tandem Shaker Capabilities

Large Capacity Six Degree-of-Freedom (6DOF) Vibration Exciter

- Allows for independent control of 3 linear and 3 rotational degrees of freedom, simultaneously.
- 8x8 ft base table with 4x12 ft extensions
 Payload Capacity*: 5,000 lbs (810H Vibration), 20,000 lbs (static/lower level vibration)
- •Force Rating: 225 klbf Vertical, 120 klbf Lateral
- •Acceleration (bare table): 18 g-pk Vertical, 10 g-pk Lateral
- •Velocity: 30 inches/sec
- •Stroke: 3 inches (pk-pk)
- •Rotation: +/- 3 deg



Large Capacity Six Degree-of-Freedom (LCDOF)

Vibration Exciter



Captive Carriage Repetitive Shock (LC6DOF)

* Payload is dependent on vibration amplitudes. Typically 5000 lbs for MIL-STD-810H Transportation Vibration, but loads up to 20,000 lbs may be tested to lower level vibration.

Tandem Shakers T-5500

- Twin, Matched Unholtz-Dickie T5500
- Force Ratings up to 55,000-lbf with displacements up to 3in Pk-Pk



Tandem Shaker Captive Carriage Vertical Axis



Component Test and Analysis Capabilities

Aviation Component Structural Testing (ACST)		Materials Analysis and Advanced Materials	
<image/>	 Fatigue/Lifecycle Testing Remediation Testing New Source Fatigue Qualification Testing Structural Load Testing 	 Failure Analysis Materials Analysis Metallic Additive Manufacturing Programs supported Product Quality Deficiency Reporting (PQDR) Production Lot Verification (PLT) on Aviation Critical Safety Items Engineering Investigations 	
Mechanical Design, Modeling, Metrology,		Electro-Mechanical Component Testing	
Machine	 Mechanical Design Metrology Lab Programs supported Product Quality Deficiency Reporting (PQDR) Production Lot Verification (PLT) Repair Parts Program ACST 	 Technical Data Package (TDP) Performance and Conformance Testing Production Lot Sample Testing/1st Article Testing UAV Launcher Modification Programs supported Repair Parts Program Missile Stockpile 	

Reliability Program

Additive Manufacturing (AM) Capabilities

UH-60 Bell Crank







- RTC is performing mechanical testing and material characterization on AM components.
- Mechanical behavior of AM components is relatively unknown. RTC AM Test Capability:
 - Finite Element Analysis (FEA)
 - Assembly level mechanical testing
 - Coupon level mechanical testing
 - Full material characterization lab
- Working with ASTM board group members and the Army Air-Worthiness Authority on AM Components.





UH-60 Fuel Elbow





RTC completed testing from concept to flight test for the AM fuel elbow.

Open Air Test Range Capabilities

Sensor Test Ranges

- Sensor Test Ranges (3.7km & 5km)
- Laser Test Range
- Performance against Countermeasures
- Dirty Battlefield
- Real and Pseudo Targets
- High Fidelity TSPI Collection









View Up Test Area 3





Typical Test Flow for Missile Sustainment Component Test



Test Flow for Missile Lot Acceptance

- 1. Visual Inspection
- 2. Launch Tube Assembly Leak Test
- 3. X-Ray
- 4. Metrology
- 5. Baseline Functional Test
- 6. Temperature Cycling
- 7. Visual Inspection
- 8. Transportation Storage Vibration
- 9. Visual Inspection
- 10. X-Ray
- 11. Handling Drop
- 12. Visual Inspection
- 13. X-Ray
- 14. Field Handling
- 15. Visual Inspection
- 16. X-Ray
- 17. Launch Tube Assembly Leak Test
- 18. Functional Test
- 19. Temperature Condition
- 20. Manual Battery Coolant Unit Squib Continuity
- 21. Visual Inspection
- 22. Flight Test













Aviation Flight Test Capabilities















Aviation Flight Test

- Flight Performance
- Handling Qualities
- Engine/Drivetrain Assessment
- Flight Load Surveys
- Sensors/DVE
- ASE and Hostile Fire Testing
- Aircraft lcing
- Human Factors Engineering
- UAS Flight Testing
- Experimental Test Pilots (XP)



Flight Test Support Capabilities

- Flight Test Control Center for Real-time Telemetry
- Flight Test Instrumentation
- Safety Assessments
- Captive Flight Test (FW & RW)
- Chase Aircraft for Flight Test
- Video Recording and Playback
- Pace Aircraft for Airspeed Calibration
- Voice Communications
- Limited Authority for Flight Releases for Aircraft Modifications



Examples of Aviation Flight Tests



(ASE)

Examples of RTC Innovation



Dual CMWS Test Aircraft

Live-Virtual-Constructive Environments

RATH Hostile Fire Testing



Redstone Test Center's Value Proposition

- Close Proximity to Robins AFB allows test witness and daily situational awareness of test results
- Agile Test Schedule
- History of Support to critical Air Force programs
- Engineering expertise in focus areas within Robins mission
- Financial Agreements already in place to support Robins
- Mission areas between RTC and Robins have similarities
- RTC can provide a wide variety of test result products

Redstone Test Center POCs

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U.S. ARMY

Truth in Testing!

Laboratory Sensor Testing





UAS Test Operations Center (UTOC)

- The UTOC provides a location for DoD Customers to fly new UAS systems, sensors, and payloads (kinetic & non-kinetic)
- Designed to support prototyping of new ideas and flight test them in hours/days not weeks/months
- Located on RTC range within restricted airspace up to 30k ft
- Test Operations Center
 - Test operations support for UAS Groups 1-3
 - Two GCS operation rooms & briefing areas
 - Test network access to send/receive data/video to/from on-range or other DREN-equipped DoD Ranges
- UAS Hangar (33'x54')
 - Designed to fit up to two Group 3 UAS aircraft
 - > Modular and expandable to support additional aircraft
 - ➢ Footprint is currently 54 ft x 33 ft



Climatic Testing

Radiographic Inspection

MIL-STD-810 / Climatic Testing

Altitude

- Extreme Temperature
- Temperature Shock
- Solar Radiation
- Humidity
- Temperature/Altitude/Humidity
- Corrosion: Salt Fog / SO₂
- Icing/Freezing Rain
- Blowing Rain, Sand, & Dust
- Dripping Rain
- Immersion/Leak
- Contamination by Fluids
- Field Temperature Conditioning
- Wind
- Snow



Metrology



Missile Modification

- Disassembly of items down
- to the component level. Modification of fielded items to a new configuration, or
- for experimental or developmental testing.
- Foreign Items.





Center of Gravity Measurement



Dye Penetrate Inspection



Coordinate

Measuring Machine

Borescopic Inspection of

Internal Components



Dynamic Balancing

System

UNCLASSIFIED

Dynamic Testing

Mission

• Ensure Army Modernization Programs will perform and be safe for the Warfighter by conducting the highest quality Dynamic Testing for the DOD.

• Accomplished by Subject Matter Experts and Professional Workforce working together to create the MIL-STD-810 representative dynamic environments in order to investigate a system's transportation, supply, deployment, and engagement lifecycle.

Large Capacity Six Degree of Freedom Vib (LC 6-DOF)



• Supports MIL-STD-810 Transportation Vibration for large (+5k lbs.) payloads while under temperature conditions.



Drop, Shock, and Vibration Test

• Numerous vibration tables and shock machines located throughout numerous test bays at TA-2 that are also approved for hazardous testing.

• Conduct Life Cycle Environment Test for large to small systems and components supporting DOD Modernization Programs.

Other Testing

Safe and Arm and Fuze Testing

 Replicate arming sequence to measure reliability Field Test
 Rail Impact and Road Course Testing

 Signal Analysis Modal Test and Spec Development



Electromagnetic Environmental Effects (E3)







Electromagnetic **Interference (EMI)** MIL-STD-461(A-F)

- Radiated Emissions Radiated
 - Susceptibility Conducted
 - Emissions
 - Conducted Susceptibility

Electromagnetic Compatibility (EMC)

MIL-STD-464D/ADS-37A-PRF

- Source / Victim Noise Floor
- Power Quality • EEDs

Transients

MIL-STD-464D

- Personnel ESD
- Helicopter ESD Near Strike
 - Lightning
- Direct Strike Lightning



Vulnerability (EMV) MIL-STD-464D / ADS-37A-PRF • External RF EME • EMRO • HERO

Radiation Hazards (RADHAZ) • HERP • HERF • HERO



Systems

tic Test

Electromagne

Investments/ Future Capabilities Military



Improved Landing Zone and Towway



Modeling & Simulation

Distributed Test and M&S

RTC is providing a means to safely execute large-scale, All-Domain, System of Systems tests which would not otherwise be achievable due to cost and resource constraints. Provide:

- Operational Realism
- LVC Integration Process
- Cross Domain Solutions
- Data Acquisition
- Multiple Persistent Networks
- Distributed Prototyping Experiments



Surveillance Testing

<u>All Up Round (AUR) Level</u> • HELLFIRE/Longbow/ future JAGM

Javelin

Stinger9 total vans



Hardware-in-the-Loop (HWIL) Testing Synthetic Flight Environments for Aviation and Missile Systems



capability to cyber assess components at SIL or Live Events, while safely isolated from safety critical systems" – Dr. Crosswait DOTE

Cyber Test Support <u>Subject Matter Expertise</u> – "RTC has developed a foundational

> Cyber Test Instrumentation, Cyber Data Collection, & Cyber Threat Visualization