

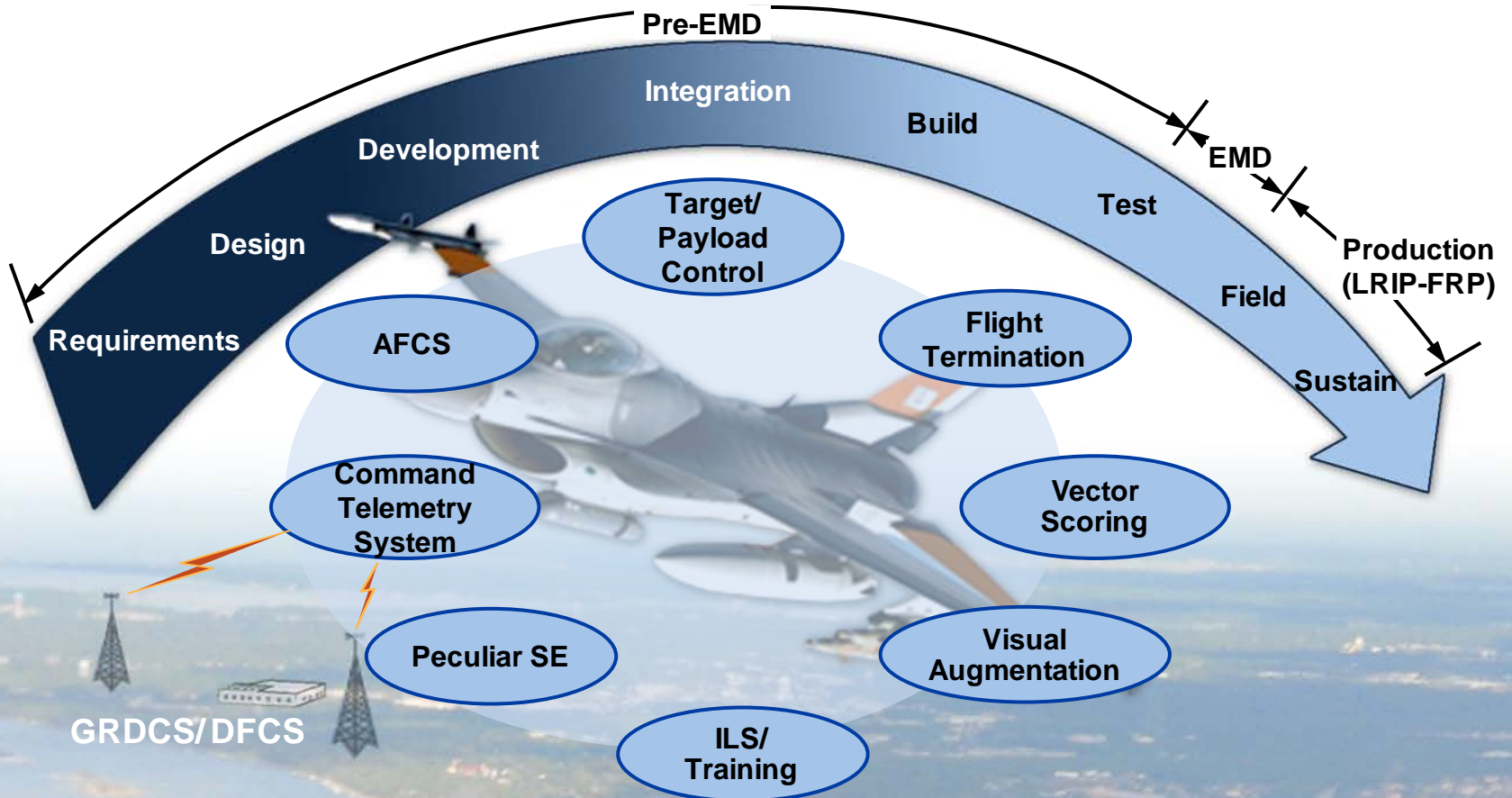
50th Annual NDIA Conference Targets, UAVs & Range Operations Symposium & Exhibition Boeing QF-16 Program – Test Results



QF-16 Full Scale Aerial Target
Boeing Global Services and Support
Maintenance, Modifications, & Upgrades

Mr. Paul Cejas
QF-16 Chief Engineer
October 4, 2012

QF-16 Overview

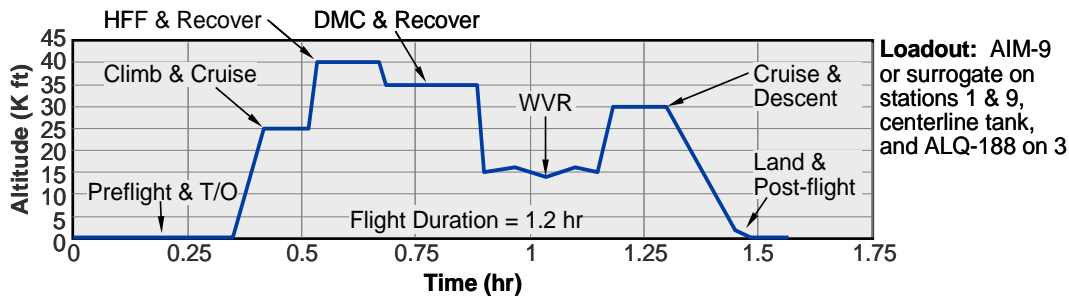


QF-16 Mission Requirements



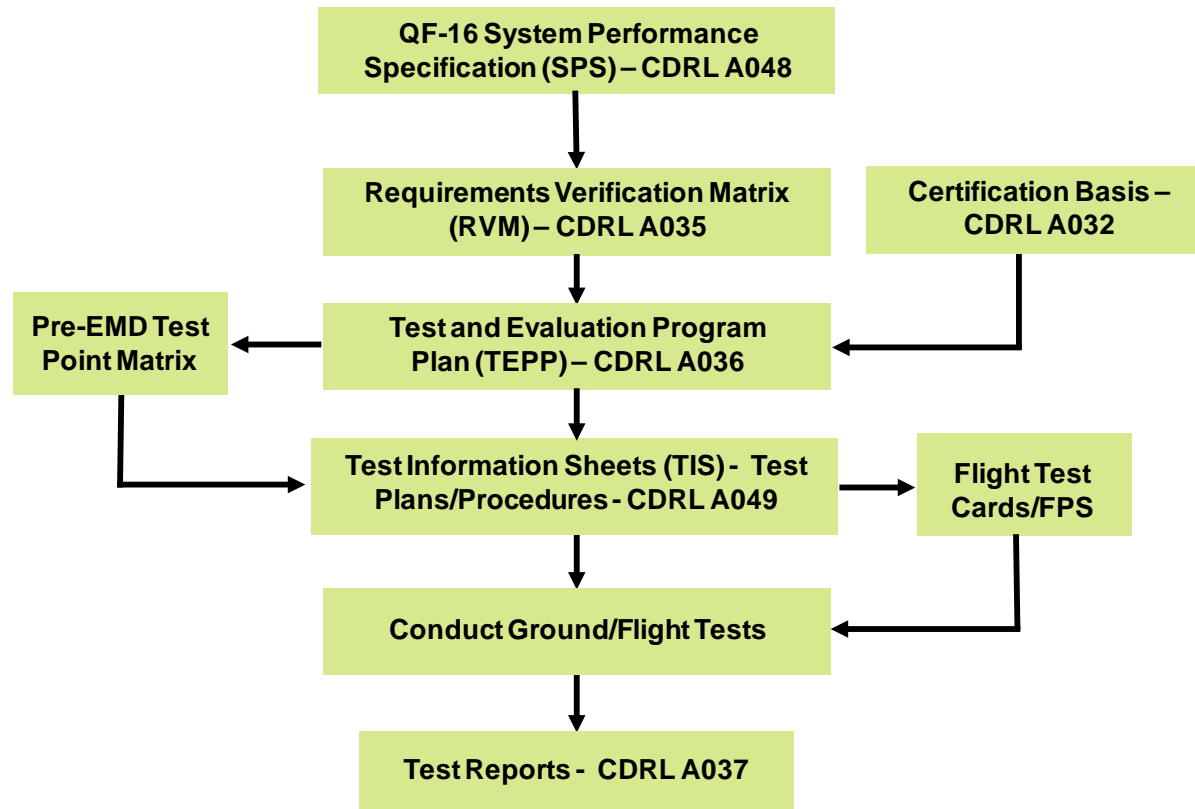
QF-16 Design meets Mission Requirements

- 4th Gen Threat
- F-16 Maneuverability
- Low RCS
- Countermeasures
- 120nm GRDCS datalink
- Weapon accuracy scoring
- Range Safety – Flt Termination
- Optionally Piloted
- Reliable
- Supportable – Test Equipment
- Growth – Phase II Air Superiority Target (AST)



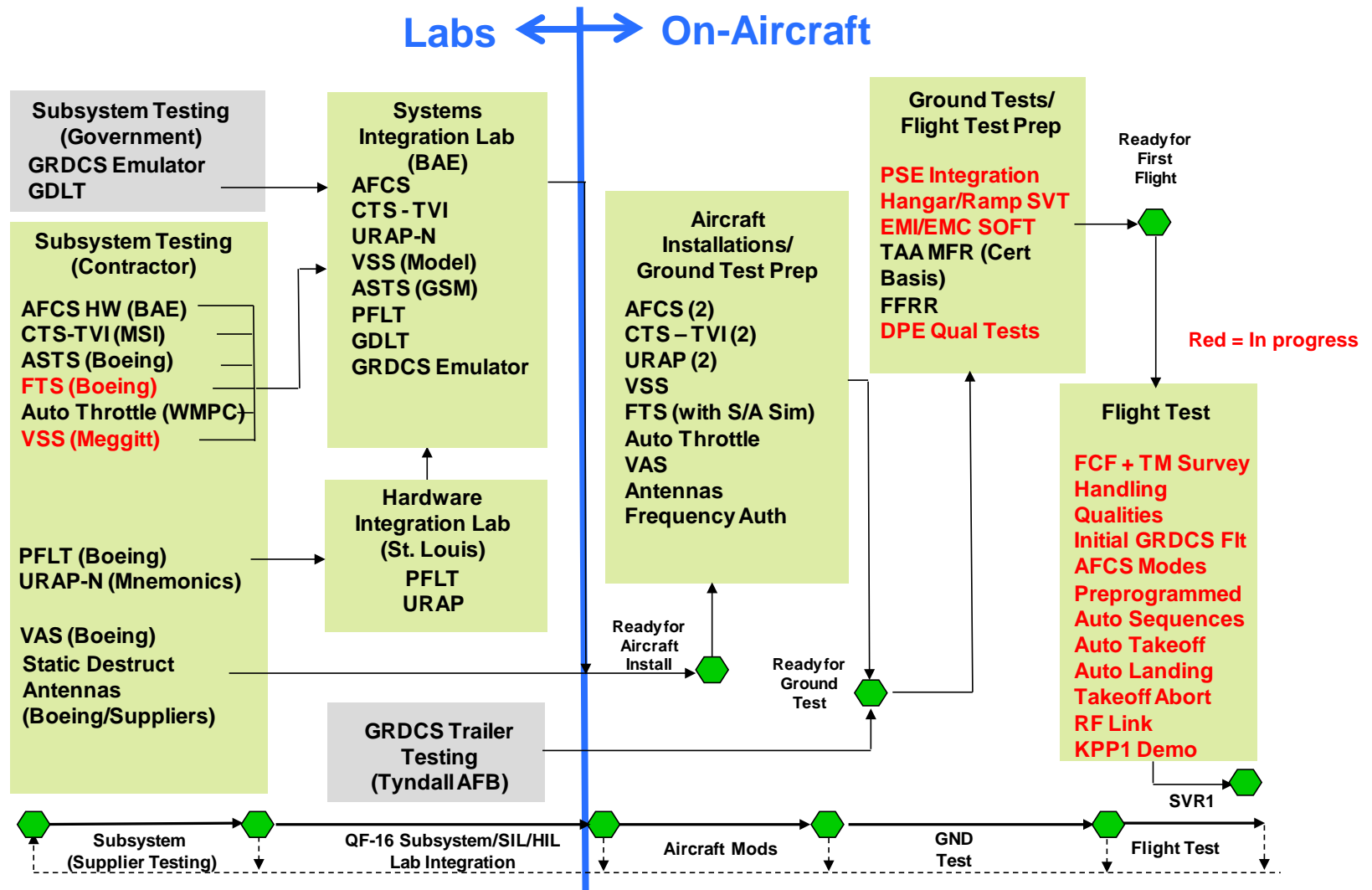
The QF-16 is designed for Mission Success

QF-16 Ground/Flight Test Definition Process



- Disciplined Systems Engineering approach to ensure all requirements are verified
- “Two-way” verification to ensure all test points trace back to requirements
- Consistent basis used for Manned Flight Release

System Verification Flow



Have progressed from labs to aircraft testing and verified installed functionality of all subsystems

QF-16 Test Status

- System Integration Lab (SIL)
 - All subsystem interfaces integrated and AFCC software verified
- Subsystem Qualification Tests
 - All subsystems completed environmental qualification and EMC except flight termination system and VSS– planned November completion
 - Flight termination system (FTS) being tested to RCC-319-07 tailored for QF-16
- On Aircraft Ground Testing
 - 6 test aircraft – 2 Block 30, 2 Block 25 (C-model), & 2 Block 15 (A-model)
 - All Drone Peculiar Equipment (DPE) installations completed within a week
 - Peculiar Support Equipment (PSE) in place and in use
- Flight Testing
 - In progress at Cecil Field, Jacksonville, FL



QF-16 System Test Plan

System Verification plan broken up into segments

- All 6 test aircraft to be subjected to hangar system verification test (SVT), ramp SVT, functional check flight (FCF) and GRDCS initial flight
- At least one A-model and one C-model to conduct all tests

Hangar SVT

EMI/EMC

Ramp SVT

VSS Performance Test
(Meggitt provided procedure)

FCF/Handling Qualities/TM
Survey

GRDCS Initial Up and Away

Up and Away Flight (AFCS
Modes, Preprogrammed
Maneuvers, Loss of Carrier,
Auto Escapes)

Takeoff Abort/Auto Takeoffs
and Landings



QF-16 Ground Testing - SVT (Hangar)

QF-16 System Verification Test (SVT) - Initially run in Hangar, then Ramp

- Started on Schedule - 25 Jan 2012 (Hangar SVT)
- Hangar SVT Philosophy:
 - Verify existing F-16 systems that were affected by the mod were not degraded/damaged in any way
 - Verify newly added systems can be controlled in Manned (Normal and Remote) and NULLO Modes
 - Sequential Build up in complexity culminating in full up flight controls testing
 - Perform Critical (AFCS) Testing first, then checkout Ancillary Equipment
 - Peculiar Support Equipment verified in parallel - software FQT & ATP demo completed
 - Maintenance Demo completed
 - 6 aircraft planned for October completion



QF-16 Ground Testing - SVT (Ramp)

- Ramp Testing
 - ✓ Initial GRDCS Comm Checks
 - ✓ EMI/EMC Testing (A model in work)
 - ✓ URAP GPS live-sky testing
 - ✓ GRDCS Comm Checks (Engine ON)
 - ✓ High Power Testing
 - ✓ Taxi Testing
 - Vector Scoring System (VSS) low speed projectile testing
 - ✓ NULLO startup demo
 - ✓ 200D engine install and demo
 - PSE PMT testing
- Tests successfully completed
- Scoring system seeing target beyond 100 ft requirement



QF-16 Ground Testing – Taxi Tests

- Low speed tests conducted in two phases:
 - Pilot Controlled taxiing of aircraft on ramps/taxiways/runway
 - GRDCS Communications checks in chocks – Engine ON
 - Pilot performs low speed taxi on predetermined route Verify Normal F-16 Braking and Steering (35 knots max)
 - Verify GRDCS Tracks Drone location accurately during taxi
 - GRDCS controlled low speed taxi tests
 - Conducted on 12,500' runway
 - Start at Centerline
 - Start at Offset
- Hi/Low Speed Automatic Takeoff Aborts (TOA)
 - Conducted after Low Speed Taxi Tests
 - Verify GRDCS/Aircraft interface acceptable
 - Evaluate remote steering/braking in preparation for auto takeoff/ landings
 - Verify pilot can disengage and control steering/braking during TOA sequence



QF-16 Pre-EMD Flight Testing

- Functional Check Flight (FCF)
- Performance and Flying Qualities
- Initial GRDCS Up and Away
- GRDCS Up and Away (AFCS Modes, Preprogrammed Maneuvers, Auto Escape, LOC)
- Takeoff Abort, Automatic Takeoff and Landing



- Testing requires portable GRDCS trailer and antenna setup at Cecil Field
- Provide close-in navigation capability
- Long distance GRDCS controller commands only
- Portable system has created connectivity challenges for the test team

QF-16 Aircraft/GRDCS Instrumentation

- GRDCS Telemetry Data (Displayed and recorded in GRDCS trailer)
- Onboard Instrumentation System (Recording 1553 from DPE—Ampex Recorder)
- Data Transfer Cartridge (DTC) – Standard F-16 GFE recording maintenance data
- HUD Video/ Pilot Audio (8mm tape recorder)
- Data Scribe (FTE) in control station will keep running log of test events during flight
- Pilot Observations



QF-16 Flight Test Results

- ✓ Post-Mod FCF – completed
- ✓ Performance/Flying Qualities - completed
- ✓ TM Survey Flight – completed
- ✓ GRDCS Up and Away Flights - Completed
 - Altitude, Mach and Speed Hold modes
 - Verified ADR modes at selected altitudes/airspeeds
 - Airspeed Inc/Dec
 - Pitch Attitude Hold with Roll
 - Auto Escape from S/L flight
 - Pitch, Roll Attitude Commands (Up and Away)
 - Mach Hold Ramp Maneuver
 - Pitch, Roll Step - Landing Mode
 - Speed Hold Ramp, Altitude Hold – Landing Mode
 - Speed/Mach Hold on Pitch
 - G Disconnect Maneuvers (4-7 gs)
 - AOA/G Limiters
- Visual Augmentation System and Vector Scoring System in-flight verification
- Takeoff Abort, Auto takeoff and auto landing test buildups in progress



All systems meeting performance requirements

Ground Testing

- Payloads EMC testing
- Repeat Ramp SVT & taxi tests

Flight Testing

- AFCS modes verification
- Canned & sequenced maneuvers verification
- GRDCS navigation & formation flying
- VAS, VSS and Payloads verification
- TOA, auto takeoffs & auto landings – manned
- OT testing to include:
 - NULLO missions
 - Live-fire shot and potential FTS



QF-16 Growth Potential

Enhanced Flight Termination System

- Architecture enables incorporation of RCC-319-07 compliant receiver

GPS Navigation & Autonomous System Operation

- Accurate aircraft state estimation available during all flight phases
- Mature navigator used on X-45, Phantom Eye, JDAM, SDB, others

Integration with Navy Common Datalink

- Communication interface built in

4.5 Gen Performance Enhancements

- Enhanced maneuvering capabilities
- Enhanced RCS
- Enhanced ground station



QF-16 Video



QF-16 Test Summary

- The Boeing QF-16 Program is in the last stages of completing the pre-EMD phase of the program
- Six aircraft have been modified and tested extensively, and all systems are performing as planned
- The pre-EMD program has been a success at mitigating program and design risks, and we are ready to move into a successful DT/OT test program during the EMD phase
- QF-16 has a great team and a bright future!



