Joint Strike Fighter
Program Update

CAPT John “Snooze” Martins
Director, Air Vehicle

F-35 Lightning II Program Office

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.
Key Messages

- **Vision**: Deliver and sustain the most advanced, affordable strike fighter aircraft to protect future generations worldwide.
- **Mission Statement**: Be the model acquisition program for joint service and international cooperation.
- **Program Priorities**:
  - Finish Development and Deliver Essential Warfighting Capability on Schedule
  - Maintain Affordability as Key Tenant of the Program
  - Implement Sustainment Via Performance Based Outcomes
  - Preserving the Partnership

Agenda

- Background
  - Program
  - Variants
- Air Vehicle
  - Air Frame
  - Sensors
  - Data Links
  - Displays
  - Weapons

*Lethal, Survivable, Supportable, Affordable and Connected Node on the Joint Coalition Battlefield*
Security Guidelines

• Slides and Discussions are UNCLASSIFIED
Service & International Needs

- **USAF:** Multi-role (primary air-to-ground) fighter to replace F-16 & A-10 & to complement F/A-22
- **USMC:** Multi-role, short takeoff, vertical landing strike fighter to replace AV-8B & F/A-18C/D
- **USN:** Multi-role strike fighter to complement the F/A-18E/F
- **UK (RN and RAF):** Supersonic replacement for Sea Harrier and GR-7

2,593 US/UK JSFs > 2,000 International JSFs
Lockheed Martin JSF Team

A Highly Integrated Best Value Team
F-35 Global Supply Sources

The Netherlands
- PHM Consortium
- Fokker - Elmo
- SP Aerospace
- Teknik Corena
- Flextronics
- DNV
- Rolls Royce
-齁

United Kingdom
- Smiths Aerospace
- Microfiltrex
- Beaufort

Canada
- Ben Marine
- Mindready
- Cyclone
- Honeywell Eng Sys
- DRS Technologies
- Avcorp

Australia
- GKN
- Micro LTD
- Cabelx
- Ferras Engr.
- Lovitt
- Marand
- Hawker de Havilland

Italy
- Cusinetti
- Mecear
- Datamat
- Marconi Sirio Panel
- Piaggio
- Umbra
- UoP
- Logic
- Magnaghi

Turkey
- Kalekalg
- Milsoft
- Havelsan
- TAI
- ALP Aviation
- Gate Elektronik
- Mikes
- Vestel

The Netherlands
- Dutch Space
- Aeronamic
- DAP
- TNO
- NLR
- Sun Electric
- Dutch Aero
- Eurocast
- Thales Cryogenics

Denmark
- Systematic Software Engineering
- Terma
- Maersk Logistics
- Corena
- Danish Aerotech

Norway
- Kongsberg
- EPM Technology
- Goodrich
- BAE SYSTEMS

United Kingdom
- BAE SYSTEMS
- Goodrich
- Hamble Structures

Canada
- Ben Marine
- Mindready
- Cyclone
- Honeywell Eng Sys
- DRS Technologies
- Avcorp

Australia
- GKN
- Micro LTD
- Cabelx
- Ferras Engr.
- Lovitt
- Marand
- Hawker de Havilland

Italy
- Cusinetti
- Mecear
- Datamat
- Marconi Sirio Panel
- Piaggio
- Umbra
- UoP
- Logic
- Magnaghi

Turkey
- Kalekalg
- Milsoft
- Havelsan
- TAI
- ALP Aviation
- Gate Elektronik
- Mikes
- Vestel
JSF System Development and Demonstration Phase

DEFENSE ACQUISITION MANAGEMENT FRAMEWORK

PRE-SYSTEMS ACQUISITION
- Concept & Technology Development
  - Decision Review
- Component Advanced Development

SYSTEMS ACQUISITION
- System Development & Demonstration
  - Interim Progress Review
- System Integration
- System Demonstration
- Production & Deployment
  - FRP Decision Review
- Low-Rate Initial Production
- Full-Rate Production & Deployment

SUSTAINMENT
- Operations and Support
  - Sustainment
- Disposal
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|

### Major Program Events
- **USAF / USMC**
  - Critical Design Reviews
  - USN CDR
  - First Flights
  - USN
  - USAF
  - USMC

### Low-Rate Initial Production (LRIP)
- **AA-1 (15 Dec)**
- **CATB (23 Jan)**

### Production and Sustainment
- **LRIP 1 (2)**
- **LRIP 2 (12)**
- **LRIP 3 (19)**
- **LRIP 4 (32)**
- **LRIP 5 (47)**
- **LRIP 6 (118)**
- **LRIP 7 (132)**

### Planned U.S. Production and Sustainment
- **Air Force** 1,763 A/C
- **Dept of Navy** 680 A/C

Planned International Production > 500

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**EOQ** = Economic Order Quantity  
**MYP** = Multi-Year Procurement
LRIP Deliveries by Variant

- LRIP 1: 2, 12, 21, 37, 61, 124, 134
- LRIP 2: 12, 21, 37, 61, 124, 134
- LRIP 3: 21, 37, 61, 124, 134
- LRIP 4: 37, 61, 124, 134
- LRIP 5: 61, 124, 134
- LRIP 6: 124, 134
- LRIP 7: 134

Aircraft Deliveries / Month

Delivery Year (CY)


1/day Achieved

MY1 2017

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.
Major Accomplishments

Flight Test
- AA-1: 62 Total Flights, 99.9 flight hrs
  - Significant risk reduction (Fuel Dump, Flight Controls, Electrical System, PTMS)
  - Successful Edwards Deployment (Air Starts, High Fidelity Noise Data, High Sortie Completion Rate)
- CATB: First Flight: 23 Jan 07
  - 37 Total Flights /105.7 Total hours/13.5 Mission Systems hours (INS/GPS integration flights)
- BF-1: First Flight 11 Jun 2008
  - 14 Flights, 13.3 flight hrs (Initial Hover Pit, STOVL Doors Open in Flight, Electrical System, IPP Test)
- BF-2: First Flight 25 Feb 09

Production
- All 19 SDD and 2 LRIP Aircraft in production

Development
- Autonomic Logistics Information System Operational and Supporting AA-1
- 61% of all JSF software complete and in test
- All three variants tracking to NTE weight growth forecasts and meeting KPPs

Subsystems
- All mission Sensors Flown on Test Beds (Radar, DAS, EOTS, EW/CM)
- Radar Blk 0.5 software tracked open air targets over Fort Worth from the lab and displayed on PCD
- Electro-Optical Targeting System Planar Array Sensor re-designed and delivered to LM

F135
- 10,281 total hours on 13 engines (as of 6 Oct 08)
- Supporting AA-1 and BF-1 flight test
- STOVL retrofit engine on track for Jan 09 Delivery

F136
- 712 total hours on 2 engines (002 and 003) (as of 6 Oct 08)
- First Engine to Test (FETT) Engine 004 successful light off
Multi-Service Design

Carrier Variant (CV)
- Probe and Drogue Refueling (Basket)
- Strengthened Landing Gear and Tailhook
- Wingfold and Ailerons Added

Conventional Take-Off and Landing (CTOL)
- Larger Wing and Horizontal Tail Area
- In-Flight Refueling Door (Boom)
- Internal 25mm 4-Barrel Gatling Gun

Short Take-Off and Vertical Landing (STOVL)
- Centerline Gun Pod with 25mm Gun
- 3-Bearing Swivel Nozzle
- STOVL Doors Inflight

AA-1 First Flt 15 Dec 06
BF-1 First Flt 11 Jun 08
IBIT

STOVL Doors
CTOL Comparison

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<tr>
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<th>Length</th>
<th>Span</th>
<th>Wing Area</th>
<th>Internal Fuel</th>
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<tbody>
<tr>
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<td>31 ft</td>
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<tr>
<td>Second</td>
<td>50.5 ft</td>
<td>35 ft</td>
<td>460 ft²</td>
<td>18,307 lb</td>
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<tr>
<td>Third</td>
<td>62.1 ft</td>
<td>44.5 ft</td>
<td>840 ft²</td>
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STOVL Comparisons

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<tr>
<td>Span</td>
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<tr>
<td>Wing Area</td>
<td>400 ft²</td>
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<tr>
<td>Internal Fuel</td>
<td>10,800 lb</td>
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<tr>
<td>Spot factor</td>
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<tr>
<td>Wing Area</td>
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<tr>
<td>Internal Fuel</td>
<td>13,400 lb</td>
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<td>Spot Factor</td>
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<tr>
<td>Wing Area</td>
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<tr>
<td>Internal Fuel</td>
<td>7915 lb</td>
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<td>Spot Factor</td>
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### Carrier Comparison

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<tr>
<td><strong>First Aircraft</strong></td>
<td>56 ft</td>
<td>37.4 ft</td>
<td>400 ft²</td>
<td>10,800 lb</td>
<td>1.0</td>
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<td><strong>Second Aircraft</strong></td>
<td>50.8 ft</td>
<td>43 ft</td>
<td>620 ft²</td>
<td>19,145 lb</td>
<td>1.11</td>
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<td><strong>Third Aircraft</strong></td>
<td>60.38 ft</td>
<td>42 ft</td>
<td>500 ft²</td>
<td>14,708 lb</td>
<td>1.24</td>
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</table>
VLO Stealth Design

- Internal Fuel Tanks
- Fixed Array Radar
- Engine Inlets
- Full Line-of-Sight Blockage
- Aligned Edges
- Embedded Antennas
- Reduced Signature Nozzles
- Internal Stores Carriage

**Fundamental 5TH Design Features Can Not Be Retrofitted**
JSF Engine Interchangeability

- Physically and Functionally Interchangeable
- Any Aircraft Able to Use Any Engine
- Common JSF Autonomic Logistics System Interfaces
F-35 Integrated Avionics

Electro-Optical Targeting System (EOTS)
- Saberliner

Electronic Support Measures
- BAC-111

Emitter Locating
- Sphyraena ESM Flight

All Aspect Stealth – Low Observable

Full Spherical Coverage by RWR & Distributed Aperture System (DAS)

360° Coverage

Mission Systems Test
- CATB 1st Flight Dec 07
- BF-4 1st Flight Mar 09

Network Connectivity
- Link-16, VMF, MDL
- SINCGARS
- Wide Band Tactical (TTNT/WNW)
- NEW
- SATCOM (Voice/Data/IBS)
## Validating Mission Systems in Flight

<table>
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<tr>
<th>Systems in Test</th>
<th>Flight Hrs</th>
<th>Lab Hrs</th>
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<tr>
<td>HMD (AA-1/BF-1)</td>
<td>97.6 Hrs</td>
<td>14456</td>
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<tr>
<td>Radar (BAC-111)</td>
<td>227 Hrs</td>
<td>18000</td>
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<tr>
<td>EO DAS (F-16, BAC-111, QF-4) (CATB – 1Q ’10)</td>
<td>245 Hrs</td>
<td>25282</td>
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<tr>
<td>EO DAS (Sabreliner) (CATB – 4Q ’09)</td>
<td>152 Hrs</td>
<td>10680</td>
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<tr>
<td>Integrated CNI (AA-1/BF-1)</td>
<td>109 Hrs INS/GPS: 126 Hrs INS/GPS: BAC-111 35 Hrs RALT 20 Hrs CATB</td>
<td>12000 (Supplier ) 8155 (MSIL)</td>
</tr>
<tr>
<td>EW/CM (CATB –1Q ’09)</td>
<td>101 Hrs</td>
<td>28842</td>
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**Systems**
- QF-4: EO DAS
- Sabreliner: EOTS
- BAC-111: Radar, EO DAS, INS, GPS

**DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited**
APG-81 Advanced Electronically Scanned Array (AESA) Radar

APG-81 Ultra High Resolution SAR Imagery

Targets
Decoys
Taxiway Cracks

Radar Reflectors
Mower Patterns
The Advanced EOTS Provides Passive Multi-Spectral A/A and A/G Capabilities As Well as Enhanced A/G Target ID Capability
Distributed Aperture System (DAS)

- Total Situational Awareness Around Aircraft
- Track Wingmen & Threat Aircraft
- Missile Launch Detection
- NAVFLIR Functions
- Integrated with HMD

Short Range AA Missile Targeting

Defensive IRST VS Threat Fighters

Passive Tracking of Flight Members

Detection of Threat A/A & SA Missiles
EO Distributed Apertures Flight Demonstration

**JSF Generates 6 Continuous Images...**

**...Seamlessly Stitched Together For Full 360 Degree Imaging Capability**
Aircraft Communications Capability

- **Funded**
- **Planned**

**Voice Communications**
- UHF/VHF Clear/Secure
- HAVEQUICK
- Survival Radio Comm
- Link 16
- MADL
- SATCOM (DAMA/MUOS)

**Navigation/Landing Aids**
- INS
- GPS
- ILS
- TACAN
- ICLS
- JPALS (partial)
- JPALS (full)

**Data Communications**
- Link 16 (J-Series)
- VMF (K-Series)
- MADL (intra-flight data link)
- P5 CTS
- IBS (TIBS/TDDS)
- Streaming Video (Rover format)
- Tactical Wide Band IP based DL
- SATCOM (DAMA/MUOS)

**Weapons**
- X-band (AIM-120, AIM-9X)
- NEW (Link-16 network enabled weapons: JSOW, SDB-II)

**Identification/Surveillance**
- Mark XII Transponder and Interrogator
  - Modes 1, 2, 3/A, C, 4, 5
- Mode S (transponder only)
- Mode S (interrogator)
Enhanced Sensor Fusion & Information Displays
Total Situational Awareness

Radar
Ground Moving Target
Electro-Optical
Missile Warning

Fused Tactical Information Managed & Displayed To The Pilot

Day
Night
JSF Crew Station

8 by 20-inch Contiguous Display

3-D Audio and Voice Control
(Software Test Report: 98% accuracy for US, UK, Canadian, Dutch, and Danish speakers. Italy, Turkey, Australia less accurate)

3-D Audio and Voice Control

Integrated Life Support System Provides Interface to Any Customer Pilot Flight Equipment

Next-Generation Escape System With Vectoring Thrust and Auto-Ejection (600kts/103lbs)

Wide FOV HMD With Virtual HUD and All-View DAS Imagery

Innovative STOVL Controls

New COTS Technologies and an Innovative Approach to Pilot-Vehicle Integration Produce a Capable and Flexible Cockpit
HMDS

**DESCRIPTION**

- Provides head protection, virtual HUD, video stream and night camera for F-35 pilots
- HMDS components include
  - Display Management Computer (DMC/H)
  - Headtracker Transmitter Unit (HTU) – on seat
  - Fixed Camera – above glare shield
  - Helmet Assembly Unit (HAU) – helmet, ANR ear cups, HVI and modified MBU-23/P
  - Helmet Display Unit (HDU) – display source, optics, visors (2), headtracker receiver unit (HRU)
Panoramic Cockpit Display

- 8 x 20 AMLCD Head Down Display
- Single Piece of Glass
- 12 operator selectable portals, or two 7x10 portals
- Touch Screen Interface
- Provides virtual Keypad for system control
- Function Action Bar (FAB) for time critical system controls
**Weapons Stations**

- Over 18,000 Lbs Ordnance Capacity
- Non-pyrotechnic Suspension and Release

* STOVL Stations 2/10 & 4/8 Reduced to 1,500 (SWAT)
CTOL Loading

Day 1 Stealth
~ 5,200 lbs internal

Day 2
~ 18,000 lbs total
STOVL Loading

Day 1 Stealth
~ 3,500 lbs internal

Day 2
~ 15,000 lbs total

Shipboard Bringback
~ 5,000 lbs
High Threat (Stealth)  
~ 5,200 lbs internal

Post-SEAD/DEAD  
~ 18,000 lbs total

Shipboard Bringback  
~ 10,000 lbs
CTOL & CV Weapons Carriage Requirements

EXTERNAL WEAPONS

- 426-Gallon Wing Tank
- Stormshadow
- GBU-38 JDAM 500-lb (MK-82 Warhead)
- MXU-648/CNU-88 Baggage Pod
- AGM-158 JASSM
- AGM-154/A/C JSOW Glide Bomb
- AIM-120B/C AMRAAM
- GBU-31 JDAM 2,000-lb (MK-84 Warhead)
- AIM-9X Sidewinder
- BDU-57/58/60 Laser-Guided Training Round
- GBU-32 JDAM 2,000-lb (BLU-109 Warhead)
- Brimstone/Joint Common Missile
- Missionized Gun
- MK-76/MK-58/BDU-48

INTERNAL

- GBU-10 Paveway II 2,000-lb LGB (MK-84 Warhead)
- GBU-12 Paveway II 500-lb LGB (MK-82 Warhead)
- GBU-31 JDAM 2,000-lb (MK-84 Warhead)
- GBU-32 JDAM 500-lb (MK-82 Warhead)
- AIM-120C AMRAAM
- GBU-31 JDAM 2,000-lb (BLU-109 Warhead)
- AIM-132 ASRAAM
- CBU-103/105 WCMD
- GBU-38 JDAM 500-lb (MK-82 Warhead)
- AGM-158A/C JSOW Glide Bomb
- CBU-103/105 WDMD
- GBU-32 JDAM 1,000-lb (MK-84 Warhead)
- GBU-38 JDAM 1,000-lb (MK-84/BLU-109 Warhead)
- AIM-132 ASRAAM
- CBU-99/100 Rockeye II Cluster Munition
- CBU-103/105 WCMD
- AIM-132 ASRAAM
- MK-82 500-lb LD & HDGP

EXTERNAL WEAPONS

- GBU-24A/B Paveway III 2,000-lb LGB (MK-84 / BLU-109 Warhead)
- GBU-16 Paveway II 1,000-lb LGB (MK-83 Warhead)
- MK-83 BLU-110 LDGP 1,000-lb LDGP
- MK-83 BSU-85 HDGP
- MK-84 2,000-lb LD/HDGP
- MK-84 BSU-50 Ballute 2,000-lb HDGP
- GBU-12 Paveway II 500-lb LGB (MK-82 Warhead)
- CBU-103/105 WCMD
- CBU-99/100 Rockeye II Cluster Munition
- CBU-103/105 WCMD
- AIM-132 ASRAAM

Weapons Currently Under Development

- AGM-154A/C JSOW Glide Bomb
- GBU-31 JDAM 2,000-lb (MK-82 Warhead)
- GBU-31 JDAM 2,000-lb (BLU-109 Warhead)
- MK-82 500-lb LD & HDGP
- UK 500# PGB
- Phase I SDB
STOVL Weapons Carriage Requirements

Store Fully Certified During SDD

**EXTERNAL WEAPONS**

- Stormshadow
- GBU-38 JDAM 500-lb (MK-82 Warhead)
- MXU-648/CNU-88 Baggage Pod
- AGM-154 JASSM
- AIM-120AM AMRAAM
- GBU-31 JDAM 2,000-lb (MK-84 Warhead)
- AGM-158 JASSM

**INTERNAL**

- GBU-12 Paveway II 500-lb LGB (MK-82 Warhead)
- AIM-120C AMRAAM
- GBU-32 JDAM 1,000-lb (MK-83/BLU-110 Warhead)
- AIM-132 ASRAAM

**EXTERNAL WEAPONS**

- GBU-10 Paveway II 2,000-lb LGB (MK-84 Warhead)
- GBU-24A/B Paveway III 2,000-lb LGB (MK-84 / BLU-109 Warhead)
- GBU-16 Paveway II 1,000-lb LGB (MK-83 Warhead)
- MK-83 BLU-110 LDGP, 1,000-lb LDGP
- MK-83 BSU-85 HDGP
- MK-84 2,000-lb LD/HDGP
- MK-84 BSU-50 Ballute 2,000-lb HDGP
- MK-82 500-lb LD & HD
- CBU-99/100 Rockeye II Cluster Munition
- CBU-103/105 WCMD

**PROJECTED WEAPONS**

- GBU-31 JDAM 2,000-lb (BLU-109 Warhead)
- GBU-32 JDAM 1,000-lb (MK-83/BLU-110 Warhead)
- AIM-132 ASRAAM
- MK-76/MK-58/BDU-48
- Missionized Gun

**WEAPONS CURRENTLY UNDER DEVELOPMENT**

- AGM-154A/C JSOW Glide Bomb
- GBU-31 JDAM 2,000-lb (BLU-109 Warhead)
- GBU-38 JDAM 500-lb (MK-82 Warhead)
- CBU-103/105 WCMD
- GBU-32 JDAM 1,000-lb (MK-83/BLU-110 Warhead)
- GBU-38 JDAM 500-lb (MK-82 Warhead)
- GBU-31 JDAM 2,000-lb (MK-84 Warhead)
- GBU-12 Paveway II 500-lb LGB (MK-82 Warhead)
- Brimstone/Joint Common Missile
- AIM-132 ASRAAM
- UK 500# PGB
- Phase I SDB
- CBU-103/105 WCMD
- AIM-132 ASRAAM
Weapons Integration Progress

**Design Integration**
- Completed 3200+ Stores WT Testing
- AMRAAM, JDAM and JSOW Simulators
- Delivered for SW Integration & Testing

**CTOL Gun System Testing**
- Fired 60,000+ Total Rnds on CTOL
- 36K Qual Test Complete
- 5000 Rnds fired on STOVL gun pod

**S&RES Testing**
- S&RES Qual Testing Complete
- Rack Compatibility Tests Complete for all SDD Stores

**SMS Testing**
- Fuselage Remote Interface Unit Qual Testing Complete, Installed on BF-1

**AME Hardware**
- BF-1 AME Complete - SCT/GVT With AMRAAM, GBU-32 & Ext AIM-9X Completed

**Flight Clearance**
- AA-1 Cleared for Captive Weapon Carriage
Weapons Installed/Flown on AA-1

Loaded Inert AMRAAM & GBU-31/32
BF-1 Fit Check: 1000lb JDAM, AMRAAM
CTOL Gun System Installation
General Dynamics GAU-22 25mm Gun

- 4 Barrel 25mm Gatling gun
- 3000 SPM firing Rate
- 182 Rounds PGU-20 (DU)
- Hydraulic Drive
GAU-22;  30 Round Burst
Edwards Noise Testing
Ground Run-Up Photos
Edwards Noise Testing
Flyover Photos