



Joint Communications Release

JSF Program Office & Lockheed Martin

Subject: F-35 Acoustics Based on Edwards AFB Acoustics Test

Date: April 2009





F-35 Acoustics Testing: Modern and Comprehensive



- **A comprehensive set of fighter aircraft acoustics data**
 - *Designed to produce the most modern and accurate acoustic profile ever generated for a military aircraft*
- **Preliminary conclusions based on extensive analysis of acoustics test data collected October 2008 at Edwards AFB on F-35A**
- **Over 170 microphones used to obtain acoustic data**
 - *Maintenance and operations personnel acoustics (Near Field)*
 - *Community acoustics (Far Field)*
 - *Large array of measurements*
 - From 0 to 300 ft above ground
 - From 25 ft to 7 miles laterally
- **Multi-national cooperative test**
 - *Directed by AFRL – a recognized authority in acoustics*
 - *Test data used in U.S. and internationally for environmental analysis*
- **Additional data still to be analyzed, but initial analysis & validation shows F-35A comparable to current aircraft**



F-35 Acoustics Testing: Results



- **Maintenance and Operations Personnel Acoustics (Near Field)**
 - *Marginally less than or comparable to the F-22, F-18 E/F, and F-16 with an F-100-PW-229 engine at military and afterburner power.*
 - *Comparable to an F-15C with F-100-PW-100 engines at military and afterburner power.*
- **Community Acoustics (Far Field)**
 - *The F-35 community acoustics are comparable to the acoustics of other current generation aircraft*
 - Examples include F-22A and F-18 E/F
 - *Acoustic levels experienced by the public depend on a number of conditions*
 - Observer location in relation to aircraft
 - Flight profiles (Aircraft configuration, aerodynamics, power settings, approach & departure profiles, and air speed)
 - Weather: Temperature, Humidity, Wind
 - Airfield acoustics: Reflective structures, vegetation and terrain in and around airfield
 - Time of day
 - Total number of flight operations per year



F-35 Acoustics Testing: Acoustics Background Questions



- **Why does the Maintenance and Operations Personnel Acoustics (Near Field) chart use a different set of units than the Community Acoustics (Far Field) chart?**
 - *The Maintenance and Operations Personnel Acoustics (near field) chart relates sound level (in dB) because this is the most appropriate measure of the steady, continuous sound received by personnel who work in close proximity to aircraft with running engines*
 - *The Community Acoustics (far field) chart relates Sound Exposure Level (SEL, in dBA) because this measure takes the time dependent nature of in-flight noise into account.*
 - SEL is a weighted metric to account for the amount of time a listener is exposed to sound.
 - “A-weighting” of sound (dBA) filters the measured sound to replicate human hearing response. Mid and high frequencies are given more weighting because the ear is more sensitive to them.



F-35 Acoustics Testing: Acoustics Background Questions



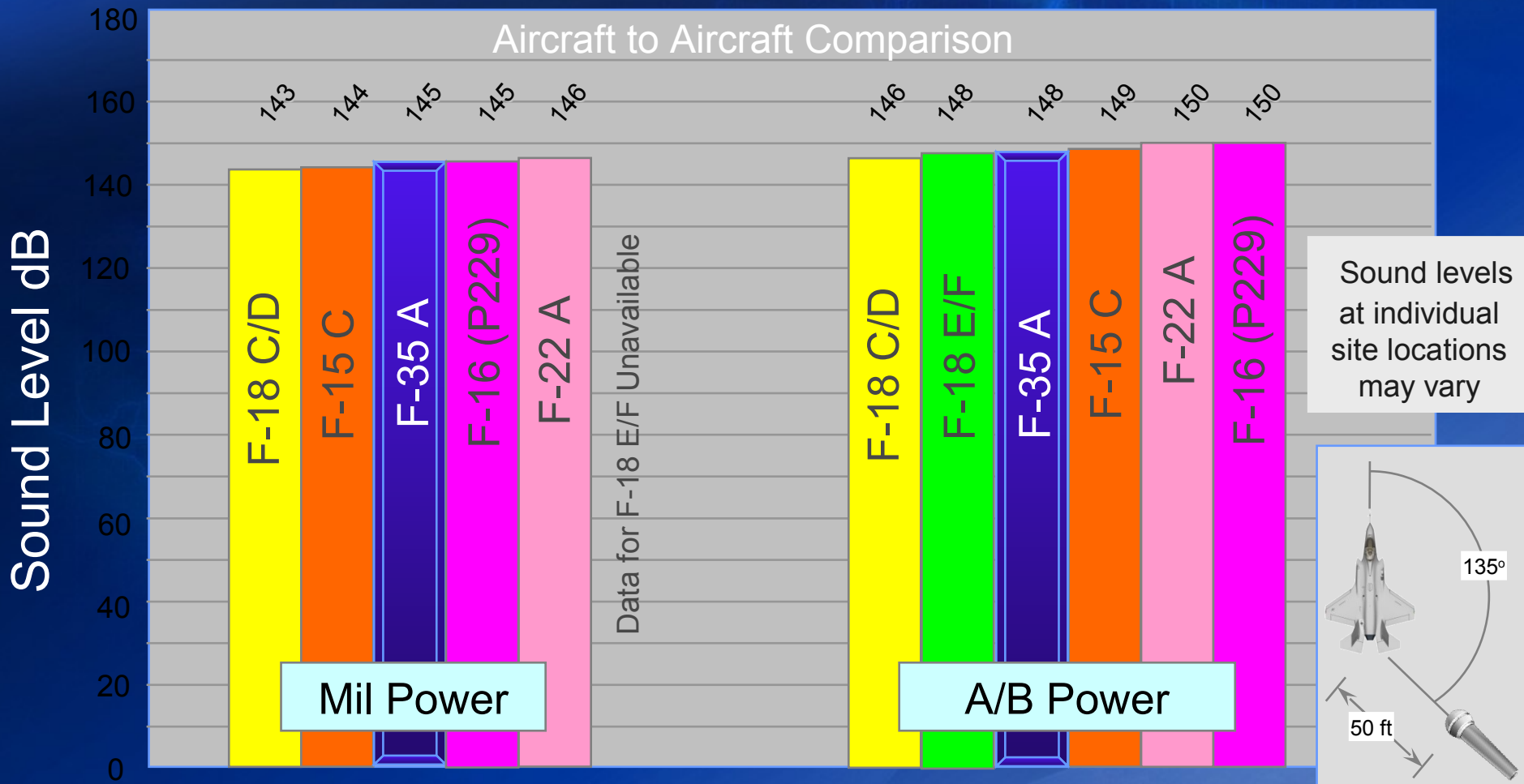
- **What is the difference between military (MIL) and afterburner (A/B) power?**
 - *Military power is the maximum power of the engine without going into afterburner*
 - *Afterburner power is the maximum power the engine can produce and is used for short periods of time*

- **Can I hear the difference between different aircraft at the same conditions?**
 - *Different types aircraft will rarely fly in the same fashion and different flight profiles may cause large differences in perceived sound level*
 - *A difference of 2 dBA in sound level or sound level exposure (SEL) should be imperceptible to the unaided human ear*



Maintenance and Operations Personnel Acoustics

Measured Worst Case Aircraft Sound Levels - @ 50 ft



Near-Field F-35 Sound Levels Are Comparable to Current Fighter Aircraft



F-35 Acoustics Testing: Maintenance and Operations Personnel Acoustics



- **Technical Basis for the Maintenance and Operations Personnel Acoustics chart**
 - *Uses measured data for current fighter aircraft provided by AFRL*
 - *Uses actual ground run-up measurements for F-35 made at Edwards AFB*
 - *Represents worst-case acoustic level at 50 ft radius from nozzle*
 - Typically at 135 degrees off the nose
 - Characterizes acoustic levels at two **high-power settings**
 - *Military power*
 - *Afterburner power*
 - Stationary aircraft on the ground
 - Data presented as measured – **Atmospheric corrections are negligible at this distance**
 - *Data only for comparison between aircraft*





F-35 Acoustics Testing: Maintenance and Operations Personnel Acoustics

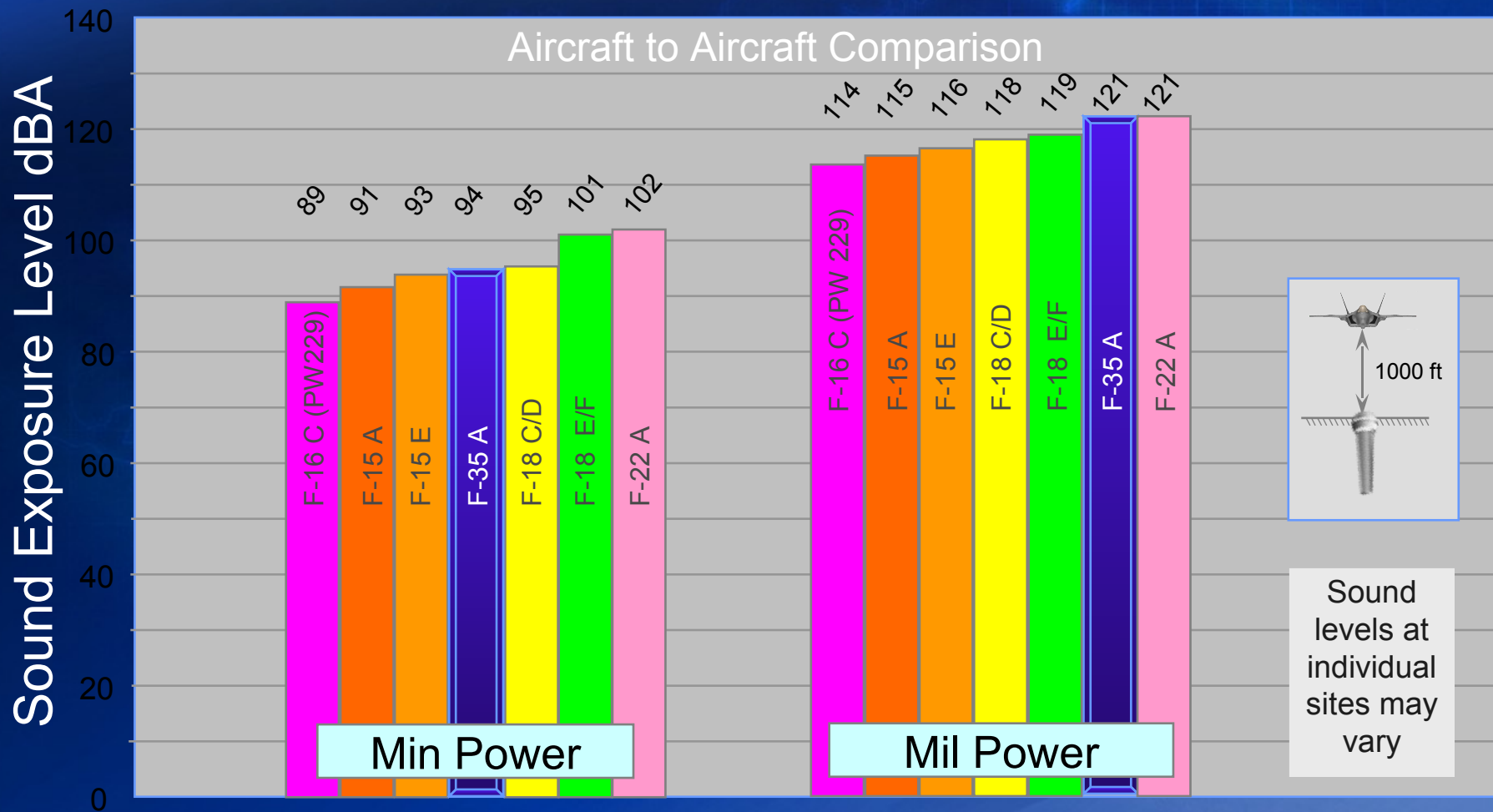


- **Summary of Maintenance and Operations Personnel Acoustics (Near Field)**
 - *Marginally less than or comparable to the F-22, F-18 E/F, and F-16 with an F-100-PW-229 engine at military and afterburner power.*
 - *Comparable to an F-15C with F-100-PW-100 engines at military and afterburner power.*
 - *The acoustics experienced by ground personnel is comparable to other fighter aircraft as perceived by the human ear*



Community Acoustics

Predicted Sound Levels @ 1000 ft Level Flight
Min & Mil Power, 59 deg. F, 70% RH, 160 knots



Far-Field In-flight Sound Levels Are Comparable to Current Fighter Aircraft



F-35 Acoustics Testing: Community Acoustics – 1000 ft. Level Flight



- **Technical Basis for the Community Acoustics chart – 1000 ft Level Flight**
 - ***Uses recognized acoustic software predictions for current fighter aircraft***
 - Inputs provided by AFRL for all aircraft
 - Atmospheric conditions set to standard acoustic day
 - 59 degrees F and 70% relative humidity
 - 160 knots True Air Speed
 - ***Predictions very close to actual fly-over measurements for the F-35 at Edwards AFB***
 - ***Characterizes Sound Exposure Level (SEL, dBA)***
 - SEL accounts for time exposed to acoustic source
 - Level flight for all aircraft at 1000 ft above ground
 - All aircraft at either min or military power setting
 - ***Data only for comparison between aircraft***





F-35 Acoustics Testing: Community Acoustics



- **Summary of Community Acoustics (Far Field)**

- *The F-35 community acoustics are comparable to the acoustics of other current generation aircraft*

- Examples include F-22A and F-18 E/F

- *Acoustic levels experienced by the public depend on a number of conditions*

- Observer location in relation to aircraft
- Flight profiles as required by future test and operational requirements (Aircraft configuration, aerodynamics, power settings, approach & departure profiles, and air speed)
- Weather: temperature, humidity, wind
- Airfield acoustics: Reflective structures, vegetation, and terrain in and around airfield
- Time of day
- Total number of flight operations per year
- Length of time listener is exposed to aircraft



F-35 Acoustics Testing: Future Results Anticipated



- **Advanced Acoustics Model in development by Strategic Environmental Research and Development Program**
 - *More accurate 3-D representation of aircraft acoustics propagation*
 - *Will be used for predicting F-35 acoustic levels in communities surrounding military airfields*
 - *Current models over-estimate F-35A acoustic footprint*
 - *New model expected to be ready Fall 2009*
- **Advanced ground crew hearing protection by JSF Program Office**
 - *Goal to reduce exposure levels for ground personnel to below current aircraft*
 - *Lockheed Martin contracted to develop new hearing protection devices to protect F-35 pilots, maintainers, and carrier deck crews*
 - *The developed devices utilize state-of-the-art active noise reduction techniques*
 - Advanced earplugs
 - Improved fit
 - Improved materials
 - Meets strict military performance and compatibility requirements
 - Additional Navy-developed carrier deck crew head protection - integrates with the new F-35 hearing protection device



F-35 Acoustics Testing: Summary



- **Results based on comprehensive set of fighter aircraft acoustics data**
 - *Designed to produce the most modern and accurate acoustic profile ever generated for a military aircraft*
- **F-35 acoustics are comparable to other aircraft**
- **A newly developed model can be used to predict each basing location's specific acoustics**
 - *Acoustical impact is highly dependent on local environmental conditions*
 - *Flight profiles can be tailored to mitigate local acoustical impacts at each basing location*



F-35 Acoustics Testing: Supplemental Information



- **JSF Fact Paper**
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- **Additional comment available**
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