





Boeing CLEEN Phase III Program Update

FAA CLEEN Consortium – Industry Day Jennifer Kolden May 3, 2023

SUSTAINABLE AEROSPACE 2050



PEOPLE, PARTNERSHIPS, POLICIES

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SUSTAINABILITY IS BUILT IN





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Program Team – "Best of Boeing"





Projects & Benefits



	Quiet Landing Gear	Quiet High-Lift	Next Generation Inlet	Intelligent Operations	Sustainable Aviation Fuels
Technology	Accustically Tracted Main	Vortex Generators Vortex Generators	Arrs	Noise Optimized Flight	Hisker Defemine David
	 Acoustically Treated Main Gear Door Perforated Strut Shield 	 Outboard Flap Trailing Edge Fairings Flap Trailing Edge Vortex Generators 	 New Structural Architecture New Ice Protection System Maximize Acoustic Treated Area 	 Noise-Optimized Flight Paths Leverages Existing Capabilities 	 Higher Performing Biends Drop-in Compatibility Support Scale-up
Impact	Reduce Community Noise	Reduce Community Noise	Enable New Engines, Reduce Community Noise, Fuel Burn	Reduce Community Noise, Fuel Burn	Reduce Fuel Burn, Emissions
Airframe Benefits / Metrics	Up to 0.5 EPNdB	Up to 0.5 EPNdB	1.5 EPNdB 2.0% Block Fuel	3-5 peak dBA 2% Take-off Block Fuel 5% Approach Block Fuel	2%-3% Block Fuel
Projected Fleet Impact	Reduce 65 dB community noise contours	Reduce 65 dB community noise contours	Community Noise, 82M Metric ton, CO2 reduction	Community Noise, 28M Metric ton, CO2 reduction	2950M Metric ton, CO2 reduction
Transition	2030,2035 Retrofit	2030 , 2035	2030 (partial),2035	2030,2035 Retrofit	2030,2035 Retrofit

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Technology Transition



- Boeing Product Development leveraging CLEEN III technologies
 - New Products and Retrofit
 - Acoustic lining designs
 - Low speed / high lift configuration
 - Nacelle acoustics and ice protection
 - Structural configuration of wing flaps and landing gear door
- Refine/Validate noise prediction tools and design practices
- Provide near-term capabilities/services aligned with FAA NextGen and DataComm
- Address long term compatibility of fuel systems components exposed to low aromatic fuels

CLEEN Phase 3 Technologies aligned with Product Strategies and Sustainability Vision

Program Timeline





Quiet Landing Gear (QLG)





Lookahead:

Fabrication & Assembly - 4Q23

Flight Testing – 2Q24

Quiet High Lift (QHL)



Objective:

Develop outboard trailing edge flap (airframe) noise reduction technology to reduce aircraft noise at approach

Accomplishments: Detailed Fabrication Flight **Outboard Flap Assembly** Preliminar Conceptua Reporting Design Design Assembly Testing Design Vortex Generators **Design Requirements Met** CoDR, PDR, DDR Complete Vortex Generators Fairing & Vortex Generators (VGs) Designs Frozen Fairing Configuration Optimized w/CFD/CAA for Aero/Noise Generators Structural Analysis Complete - Positive Margins on all Hardware 19% CL 13% CL 19% CL 22% CL 39% CL 49% CL 59% CL 59% CL MBD Engineering Releases Nearing Completion Tooling & Materials Purchase Orders out to Suppliers weak fairing vortex further weakened main vorte: Fabrication Planning Complete and Fabrication Started 737 ecoDemonstrator Gates A and B complete for Safe-to-Fly **Prototype Testing** Fairing and VG Design / Analysis

Lookahead:

Fabrication & Assembly – 4Q23

Flight Testing – 2Q24

Next Generation Inlet (NGI)





Develop inlet (engine) noise reduction technology with reduced weight & drag to reduce aircraft noise at take-off & approach and address reduced-length inlet integration challenges of UHB engines



Lookahead:

DDR & MRL5 – 3Q23 Final Planning & Start of Fabrication – 3Q23

Flight Testing – 3Q24

Intelligent Operations (IO)



Objective:

Develop aircraft operational noise reduction technology to reduce aircraft noise at take-off & approach

Accomplishments:

SRR, SDR Complete



Noise & Population Impact Assessment

Integration of Nav/Flight/Radar/Weather Databases

Simulator/Bench Testing and 787 Cab Demos

737 ecoDemonstrator Gates A and B complete for Safe-to-Fly



Simulations Based Validations



Impact Assessment

Lookahead:

CDR – Jun 23

Flight Testing – 2Q24 / 3Q24

Sustainable Aviation Fuels (SAF)





Lookahead:

UDRI Phase 1 & 2 Lab Testing – ECD Jun / Oct 2023

Flight Testing – 2Q24

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Project	Conceptual Design	Preliminary Design	Detailed Design	Fabrication & Assembly	Flight Testing	Reporting
QLG	\checkmark	\checkmark	\checkmark	Q423	2Q24	2Q25
QHL	\checkmark	\checkmark	\checkmark	Q423	2Q24	2Q25
NGI	\checkmark	\checkmark	3Q23	2Q24	3Q24	3Q25
ΙΟ	\checkmark	\checkmark	Jun 23	NA	2Q24, 3Q24	3Q25
SAF	UDRI Phas	e 1 & Phase 2 Te	est– ECD Jun	& Oct 2023	2Q24	1Q25

All projects on-track to meet TPMs that address FAA goals and are aligned with Boeing vision for Sustainable Aerospace





Acronyms



ATP	Authority to Proceed
CAA	Computational Aero-Acoustics
CDR	Critical Design Review
CFD	Computational Fluid Dynamics
CoDR	Conceptual Design Review
dBA	Decibels, A-weighted
DDR	Detailed Design Review
EPNdB	Effective Perceived Noise, Decibels
MBD	Model Based Definition
MBSE	Model Based System Engineering
MRL	Manufacturing Readiness Level
PDR	Preliminary Design Review
SAF	Sustainable Aviation Fuel
SDR	Software Design Review
SRR	System Requirements Review
UDRI	University of Dayton Research Institute
UHB	Ultra High Bypass
VG	Vortex Generators