

# Hubbard Aviation Technologies

Bernie Weiss, President & COO



QS3 the science of quiet™

# Background

- Over 10 years of extensive R&D to produce and certify the QS3 hushkit:
  - STC issued 2003, reissued with integrated thrust reverser in 2005
  - Stanley Hubbard: a principle investor and product champion
  - Over \$40 million invested in development and certification
- August 2008 ----- Hubbard purchases & installs first QS3 on company GII
- September 2008 ----- Acquires hushkit intellectual property
- October 2009 ----- Initiates production of QS3 Hushkit system



# Hubbard and Aviation

- Hubbard Broadcasting is a 3<sup>rd</sup> generation private company with over 85 years of success in business and technical innovation.
- Deep roots in aviation:
  - Founder well known as barnstormer and aviation pioneer
  - Established country's first scheduled airline
- Owned & operated many aircraft, including GI, GII, GIII, GIV & GV





# The Best Business Partners

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Stanley S. Hubbard, Chairman & President of Hubbard Broadcasting & founder of Hubbard Aviation Technologies is widely recognized as a business leader of highest moral integrity.

- “When you give your word, you keep it.”
- “Do everything in such a way that people will trust you.”
- “Honesty and fair dealing make good business partners.”
- “A business will be better served if the highest possible standards of integrity are observed.”



# Problem (with Solution)

Hushkitting is the only option currently available that allows GII/GIIB/GIII aircraft to meet federal Stage 3 noise standards.

**Court of appeals upholds Stage 2 jet ban at Naples**

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**Who's making noise at Love?**

Loudest flights aren't commercial airliners, says resident

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By ERIC T  
Dallas Mo

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**The squeeze tightens on New Jersey's Teterboro**

by Jack Elliott

Rep. Steven Rothman's (D-N.J.) recent call for a 25-percent reduction in traffic at Teterboro Airport (TEB) prompted a hearing on June 20 about traffic at the airport. William Coscia, chairman of the Port Authority of New York and New Jersey, which operates the airport, presented the Senate legislative oversight committee with four proposals he said the Port Authority would initiate to curb traffic at the New Jersey business aviation airport.

The first would ban Stage 2 aircraft from the airport by September 1. He said the Port Authority was prepared to take legal action to achieve that goal. The second part of the plan would prevent the Federal Reserve Bank, which flies overnight checks into the airport, from using Teterboro at night. Coscia said the restriction would reduce nighttime operations by 50 percent. The Port Authority has already apprised the Federal Reserve Bank of this restriction.

His third proposal would reduce the mov limit of aircraft using Teterboro from 100,000 pounds to 80,000 pounds.

"The only way to reduce activity at Teterboro," he told the committee by State Sen. Paul Sarlo (D), "is to it somewhere else. Stewart Airpo miles/one hour 10 minutes' drive north] and McGuire Air Force Bas miles/one hour 20 minutes' drive south] are underutilized," he said.

Coscia also said that the Port Au had been studying the possibility fourth airport to serve New York, hundred million people want to com every year," he said, "and we want t be able to come."

"We will look for ways to adjust tion capacity to relieve some of the sure on Teterboro Airport.

"It won't happen overnight," said, "but we are concerned with th dents around Teterboro."

Commenting on Coscia's testi Sarlo said, "You've brought recod ations that go a long way. Peop close the airport. We realize th never happen."

Jack Olcott, former president of and current president of the New Aviation Association, told the con

**TETERBORO AIRPORT INDUSTRY WORKING GROUP**

**A NEW PARADIGM FOR CREATING A SAFE, SECURE, AND QUIETER AIRPORT**

**ORDINANCE NO. 181105**

An ordinance approving a Regulation proposed by Resolution No. 17154 and revised by Resolution No. 23779 of the Board of Airport Commissioners of the City of Los Angeles amending Ordinance No. 155,727, known as the Van Nuys Noise Abatement and Curfew Regulation, to add Sections 5.2 and 5.3, thereby adopting maximum noise levels for aircraft operations at Van Nuys Airport.

**THE PEOPLE OF THE CITY OF LOS ANGELES DO ORDAIN AS FOLLOWS:**

Section 1. The Regulation, proposed by Resolution No. 17154 of the Board of Airport Commissioners on June 13,1990, and revised by Resolution No. 23779, is hereby approved. The Regulation contained in Resolution No. 23779 provides an additional noise abatement regulation for aircraft at Van Nuys Airport (VNY).

Sec. 2. Ordinance No. 155,727 of the City of Los Angeles is amended by adding two new sections to read as follows:

**SEC. 5.2. Aircraft Operations - Maximum Noise Levels. No person shall pilot, operate, or permit to be operated any aircraft in violation of the following:**

(a) **On or after January 1, 2009: No aircraft may arrive or depart the Airport whose Advisory Circular 36-3A, as amended (AC-36-3), takeoff noise level equals or exceeds 85 dBA.**

(b) **On or after January 1, 2011: No aircraft may arrive or depart the Airport whose AC 36-3 takeoff noise level equals or exceeds 83 dBA.**

- Local airports restrict or ban Stage 2 aircraft.
- Senate & House approve ban on Stage 2 aircraft in FAA Reauthorization Act.

# Measurement of Sound

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Noise level, frequency distribution, and time variation are used to describe aircraft noise. Common units include:

**dBA (Decibels Adjusted)** - The instantaneous sound level adjusted to the sensitivity of the human ear.

**EPNdB (Effective Perceived Noise (Level) in dB)** - Federal noise standards are defined in units of EPNdB, which applies correction factors to measured values to account for tone spectrum, duration and environmental conditions.

**Ldn (Level, day-night)** - The average noise exposure over a 24-hour period is often presented as a day-night average sound level. Ldn values are calculated from hourly values, with a 10 dB penalty for nighttime.

**Perceived Loudness** - A non-logarithmic value used for relative loudness as a percentage of a reference sound level.

# Putting Noise Into Perspective

## Levels of Sound:

Level in dB	Description	Perceived Loudness
125	Jet Engine @ 100 meters	100%
100	Discotheque	18%
85	Auto Traffic @ 10 meters	6%
50	Normal Conversation	1%

## Variations in Sound Levels:

Sound Level Change	Relative Loudness	Acoustic Energy Loss
0 dB	Reference	0%
-3 dB	Barely Perceptible Change	50%
-5 dB	Readily Perceptible Change	67%
-10 dB	Half as Loud	90%
-20 dB	One Fourth as Loud	99%

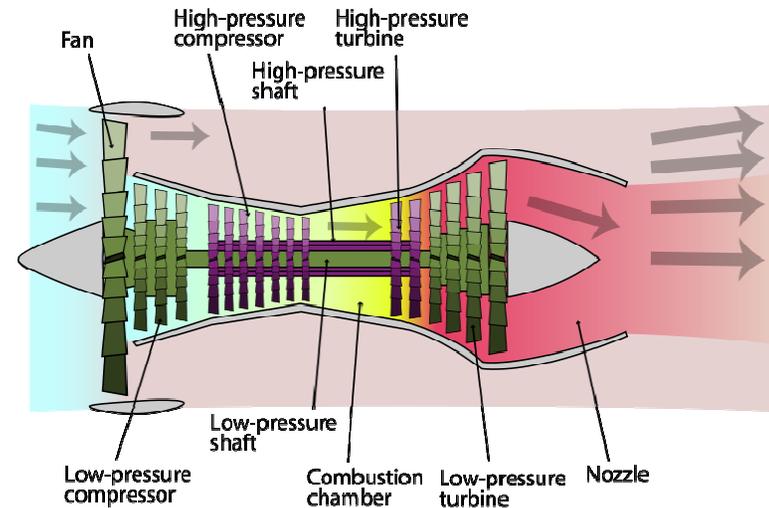
# Noise-Sensitive Airport Examples

Location	Comments	QS3 Ops
Teterboro, NJ	RW24 80 dBA Day, 90 dBA Night. Other RWs 95 dB. Aircraft banned if 3 violations in 2 years.	Yes
Van Nuys, CA	Night 74 dBA limit; 3-strikes rule. 7-yr plan to lower limits to 77 dBA max on takeoff (per AC 36-3 values).	Yes
Long Beach, CA	Ops limited by “noise budget”; Night 79 dBA SENEL, Day 86 dBA. Fines & civil charges for violations.	Yes
Naples, FL	Stage 2 aircraft banned.	Yes
San Jose, CA	Night limit 89 EPNdB (per AC 36-1).	Yes
Frankfurt, Germany	Bans Chapter 2. “Chapter 3-minus-5” banned nights.	Yes
Paris LeBourget	Chapter 3 compliance required 2330 – 0600 hours.	Yes
London Stansted	Aircraft below 84 EPNdB exempt from night restrictions.	Yes
Narita, Tokyo	Significant landing cost if louder than Chapter 3.	Yes
All, Australia	Chapter 2 aircraft prohibited.	Yes

# How the QS3 Hushkit Works

Reduction of exhaust noise:

- Generating less sound energy
- Changing frequency spectrum
- Attenuating resultant noises.



Turbulent mixing of exhaust with ambient air creates noise:

- Proportional to 8<sup>th</sup> power of velocity difference
- Mass flow must be increased to offset decrease in velocity
- Requires engine-matched, mixing exhaust nozzle.

# How the QS3 Hushkit Works



Patented, alternating-lobe mixer:

- Offers maximum mixing efficiency
- Exit area same as Spey original, ensuring engine performance is not affected
- Light weight, durable titanium material.

Bypass airflow is accelerated during the mixing:

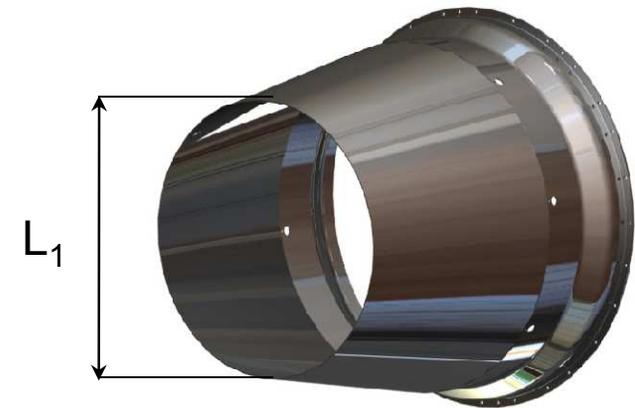
- Absorbs portion of the core exhaust's kinetic energy.
- Average velocity of the combined exhaust stream is reduced.

A 12% reduction in exhaust velocity yields a 5 dB reduction in the amount of sound generated, representing an acoustic energy decrease of 67%.

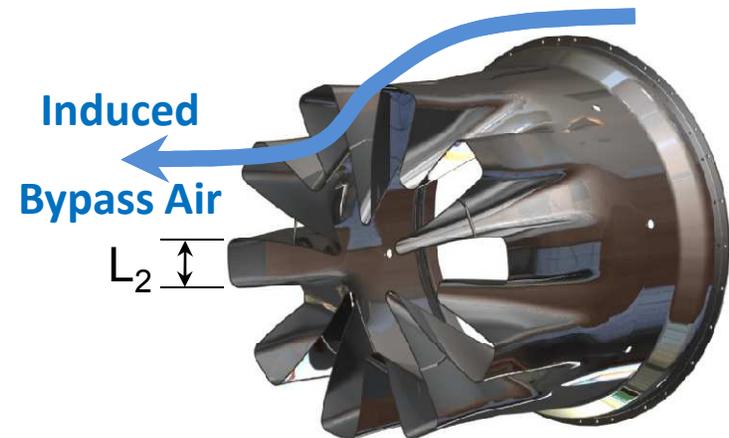
# How the QS3 Hushkit Works

Jet exhaust creates sound patterns of many frequencies and intensities.

- Dominant frequencies related to a characteristic length. For circular (Stage 1) nozzle, length is exit diameter ( $L_1$ ).
- Characteristic length of lobed design is the width of the lobes ( $L_2$ ).
- Lobed nozzle design:
  - ✓ Induces mixing airflow
  - ✓ Generates more high-frequency tones; easier to attenuate.



Stage 1 – Lower Frequencies

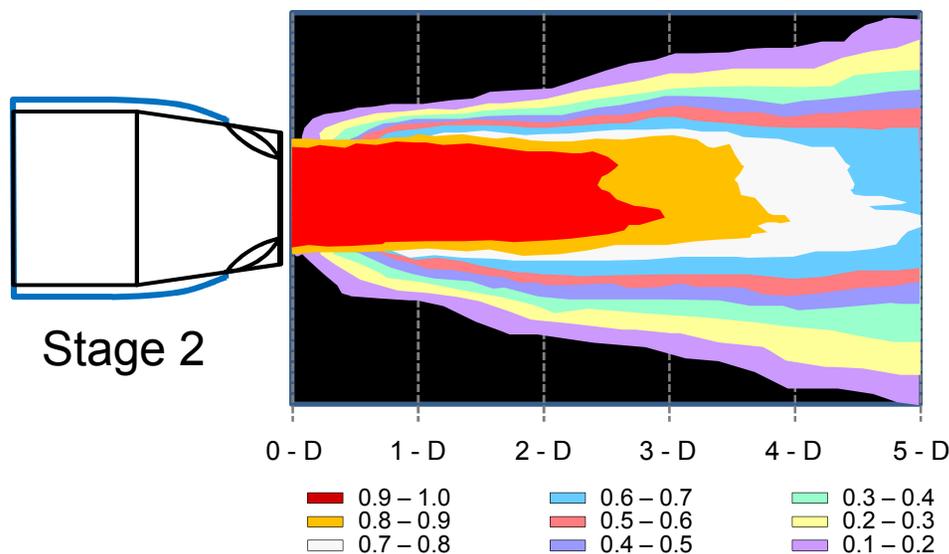


Stage 3 – Higher Frequencies

# How the QS3 Hushkit Works

After the exhaust exits the nozzle, noise reduction can only be achieved by attenuating the sound energy of the exhaust jet.

- Sound waves radiate outward from the exhaust plume
- Highest velocities<sup>3</sup> occur between the nozzle exit and 3 - 4 diameters downstream.

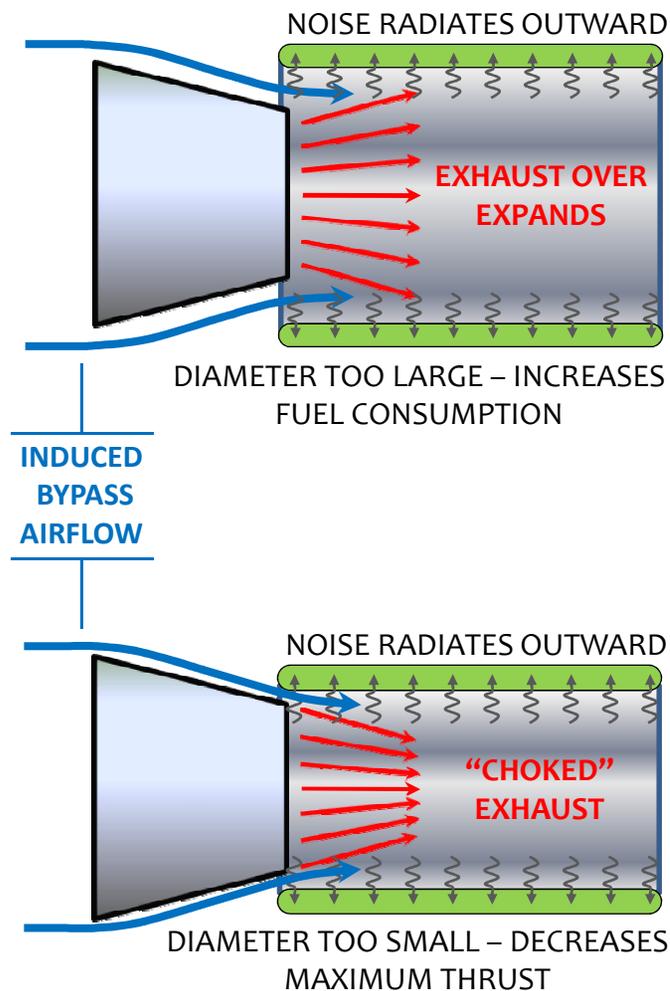


EXHAUST GAS MACH NO. vs. DISTANCE FROM NOZZLE (IN DIAMETERS)

Attenuating ejector must:

- Surround the nozzle exit
- Extend downstream far enough to capture the most-intense noises. The length of the QS3 ejector is 3.4 diameters.

# How the QS3 Hushkit Works



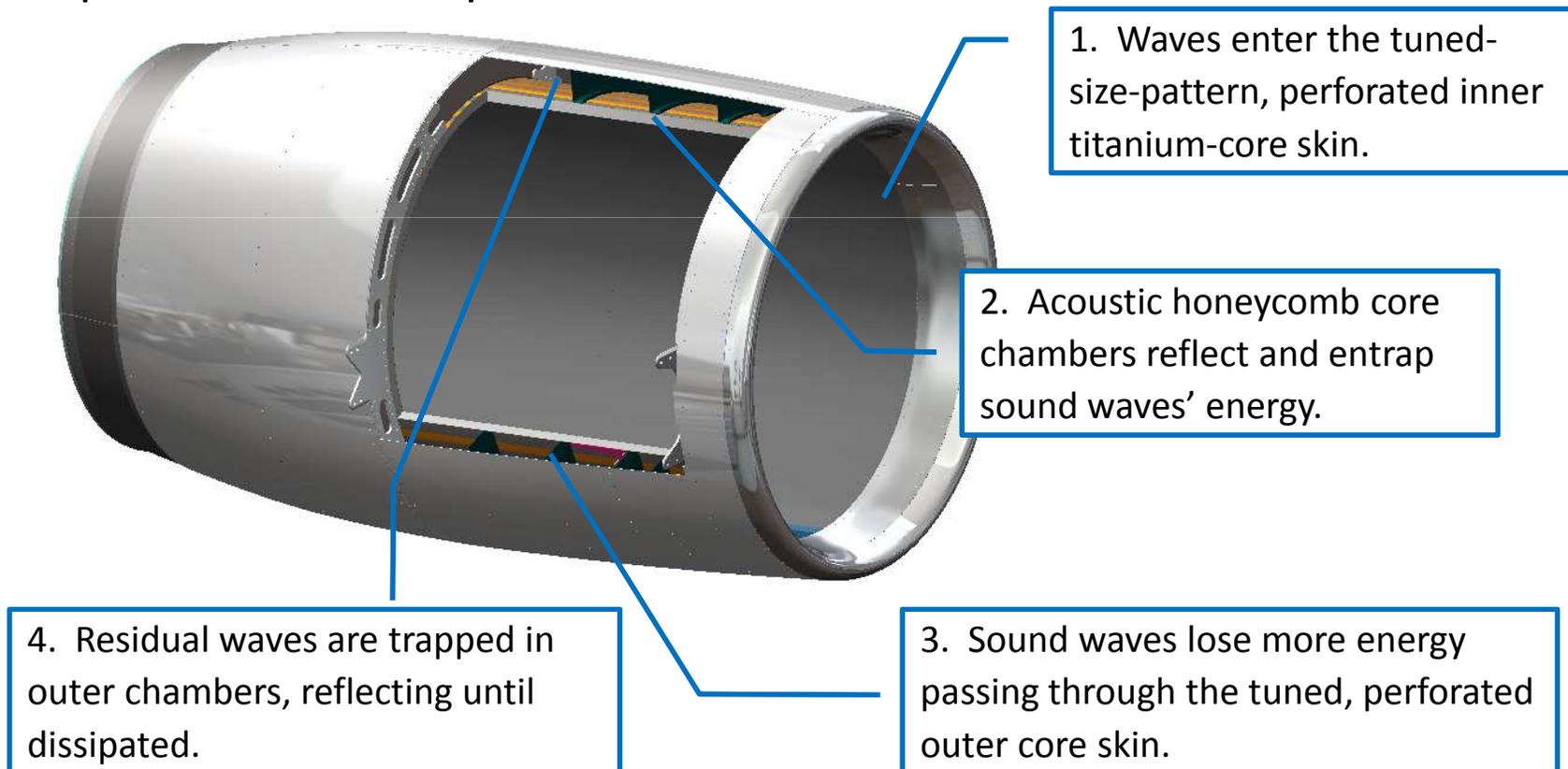
Diameter of the ejector is critical:

- Exhaust over-expands at cruise power settings if too large, requiring higher fuel consumption to maintain thrust.
- Exhaust will “choke” at high power if too small, with significant reduction in available thrust.
- Other design & sizing factors include:
  - ✓ Weight
  - ✓ Durability
  - ✓ Tolerance to high temperatures.

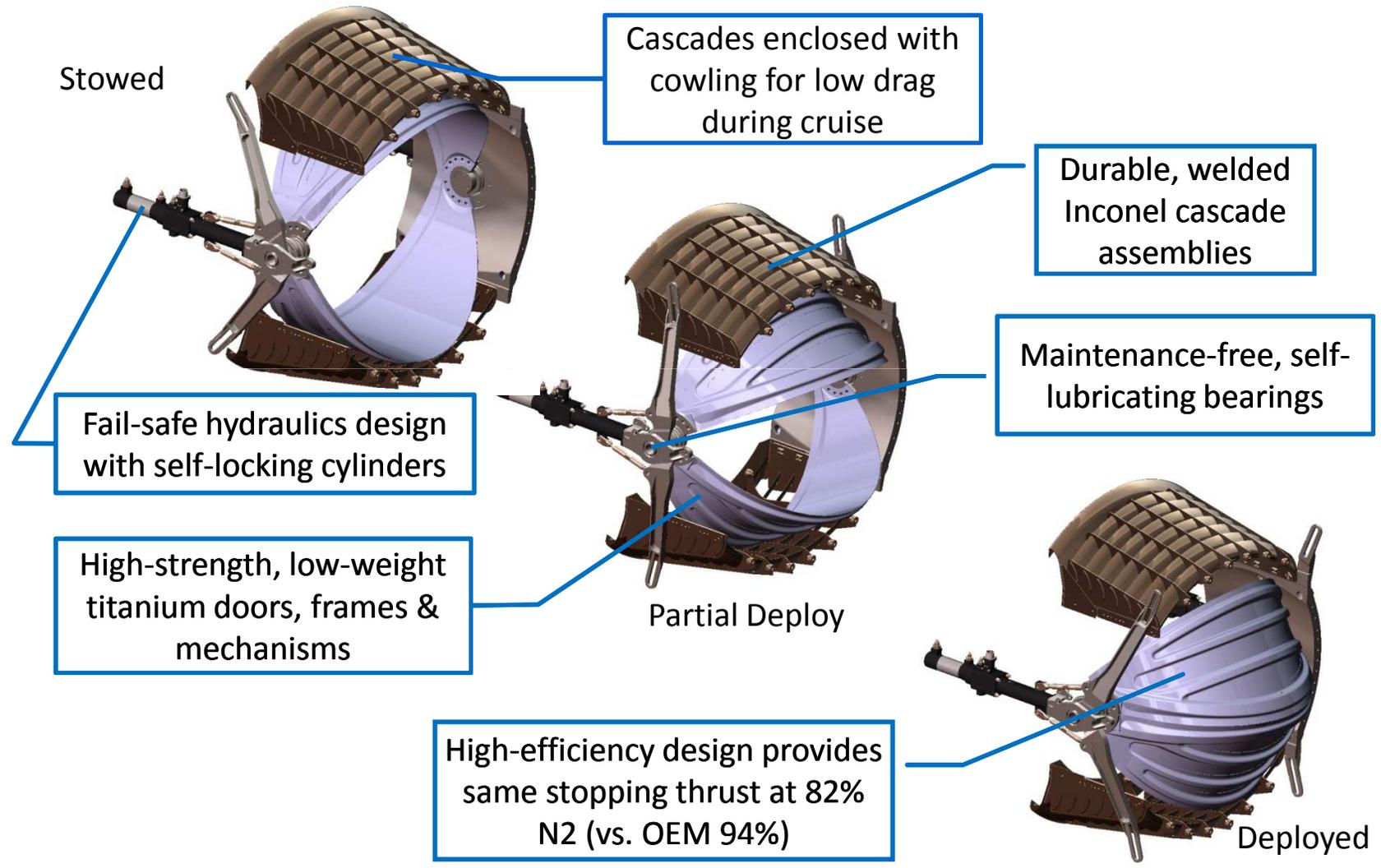
Ultimately, sizing must be validated by laboratory, ground and flight testing.

# How the QS3 Hushkit Works

Over 80% of QS3 noise reduction occurs in the sound-absorbing ejector. In each of the steps illustrated below, sound energy is attenuated and dissipated as minute quantities of heat.

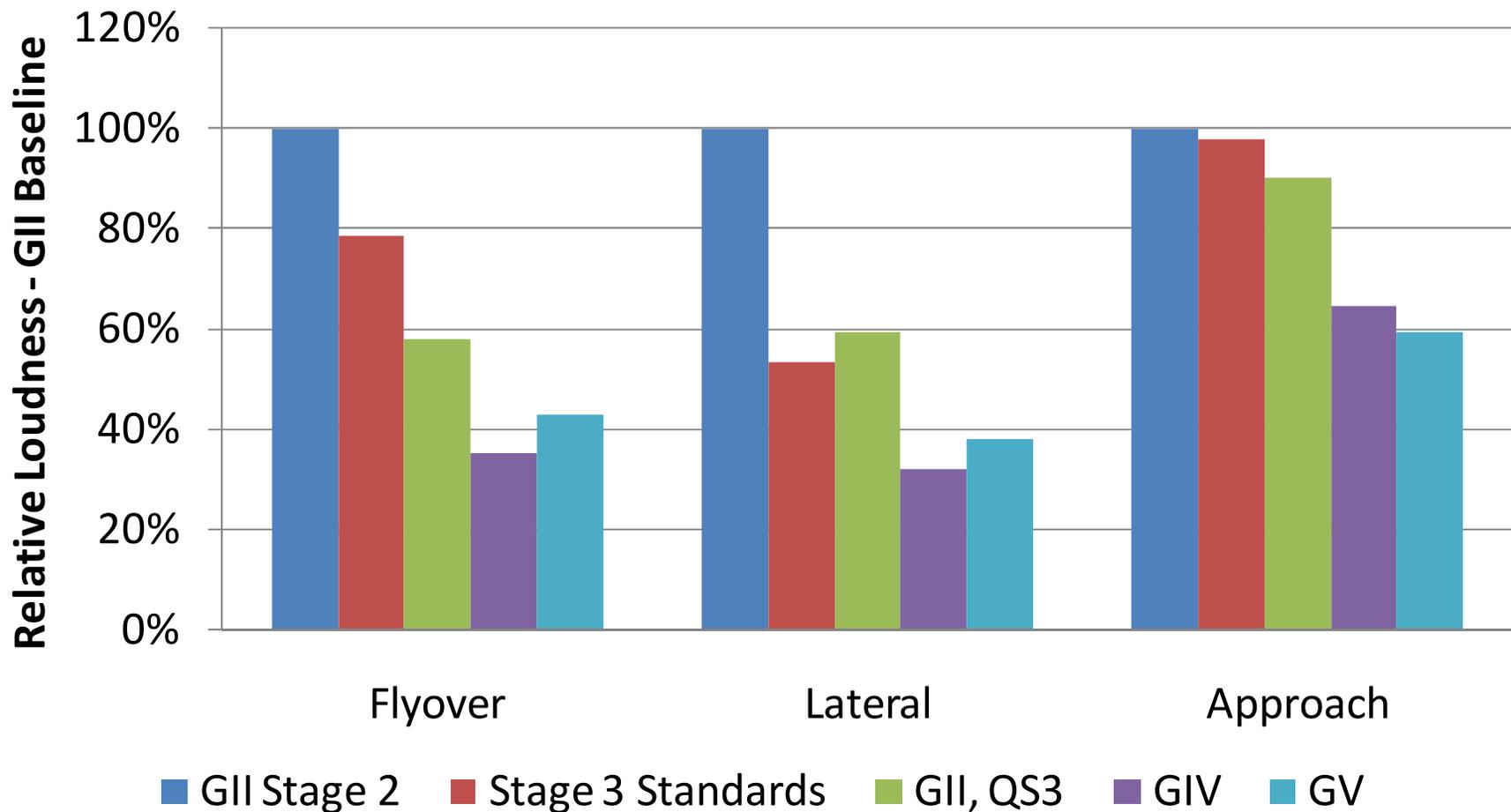


# Cascade-Style Thrust Reverser



# How Well the QS3 Hushkit Works

## Perceived Loudness Comparison Gulfstream Series Aircraft



# Economic Benefits of the QS3<sup>1</sup>

<b>PAYBACK ANALYSIS<sup>1</sup></b>	<b>G-II</b>	<b>G-III</b>	<b>G-IV</b>	<b>Falcon 900</b>	<b>CL601-3R</b>
Retail Price (Vref) – All Yrs Avg Fleet Prices	\$0.8m	\$2.4m	\$8.4m	\$10.5m	\$6.6m
Upgrades: Paint, Hushkit, Avionics & Interior	\$3m	\$2.5m	-	-	-
Total Investment	\$3.8m	\$4.9m	\$8.4m	\$10.5m	\$6.6m
Total Variable Cost/Hr. (1,000 nm)	\$3,990	\$4,067	\$3,184	\$2,665	\$2,908
Hours Flown Per Year	400	400	400	400	400
Total Variable Cost/Yr.	\$1.6m	\$1.6m	\$1.3m	\$1.1m	\$1.2m
Factoring 'Total Years of Operation Investment' and the above 'Variable Cost' before 'Payback' (equal investment) is reached.					
Payback vs G-IV	14 yrs	12 yrs			
Payback vs 900	13 yrs	12 yrs			
Payback vs CL601-3R	6 yrs	6 yrs			
Sources: Vref Vol. 4 2009/10; Conklin & de Decker; August 2009 B&CA					

1. Chart from WORLD AIRCRAFT SALES MAGAZINE – March 2010: *Aircraft Comparative Analysis* by Michael Chase.

# Summary: The QS3 System

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- Certified as Stage 3 compliant: STC No. ST01567LA
- Kits available beginning August, 2010; four weeks to install
- Full reverse thrust at 82% N2; reduced engine & aircraft loads
- Weight: +420 pounds vs. OEM
- Maintenance: No scheduled requirements; on-condition only
- No operational limitations or restrictions:
  - ✓ Same as OEM for EPR, Flaps, MTOW/MLW



Thank you. Please visit our website at:

[www/.hubavtech.com](http://www.hubavtech.com)

Questions?