Firm orders for Sharklets so far

Orders from 28 customers worldwide
Sharklets reduce fuel burn

A320 Block fuel improvement vs. current Wingtip fences

- 4% fuel burn reduction
- $150k fuel savings per year per aircraft
- 3% fuel burn reduction
- $275k fuel savings per year per aircraft
- 2% fuel burn reduction
- Attractive savings
- 1% fuel burn reduction
- $150k fuel savings per year per aircraft

3.5% fuel burn savings on long sectors
Sharklets improve take-off performance

- If facing obstacles or climb limitations, Sharklets will increase take-off weight by:
  - Improving second segment performance
  - Clearing more obstacles

**Better take-off capability**

**Improved operational efficiency around the world**
Sharklets reduce engine maintenance costs

Reduce take-off thrust for same take-off weight

Up to 2% reduction in engine maintenance costs thanks to improved take-off performance

Up to 4% additional take-off derate

Longer Time on Wing
Reduced engine maintenance cost

Lower engine DMC
Improved climb performance with Sharklets

Higher initial cruise altitude

Altitude (ft)

Sector profile

Higher optimum altitude
Sharklets benefits summary

- Fuel burn reduction
- Attractive savings
- More efficient family
- Lower CO₂ emissions
- More payload & range
- Better take-off capability
- Lower engine DMC
- Higher optimum altitude

Sharklets increase A320 Family value
Content

1. Sharklet
2. Technical & project highlights
3. Entry Into Service
4. Sharklet retrofit solutions
5. Summary
Sharklets design

→ Single piece design
→ Multi-lug and tension bolt
→ Innovative materials
→ Lightning strikes protection
→ New LED nav & strobe lights
Sharklets design: new wing-sharklet join

Simple connection: tension bolts and barrel nuts; multi-lugs and pins
Centre wing box changes

- Changes
- No changes
- Changes without assembly jigs modification

Minor design changes for adapted centre wing box reinforcement (A319/A320)
Wing changes (A320)

**Covers:**
- Skin thickness increase outboard of Rib 11.
- Topskin material 7449
- Bottomskin material 2024HDT.
- Strip milling introduced in change area.

**Stringers:**
- Increased height outboard of Rib 11.
- New btm material 2026.

**Mid and Outer Rear Spars:**
- Front spar Web thickness increase ~ 1mm outboard of Rib 9.
- Flange changes outboard of Rib 25.
- New crack stopper outboard rib 24.

**Fixed Leading Edge:**
- Bolting and rivet changes outboard of Slat 4.

**Fixed Trailing Edge:**
- Aileron Hinge bracket changes.

**Ribs 12 to 26:**
- System penetrations maintained.
- Thicker web features and taller stringer cut outs.
- Larger cleats used to fit larger fasteners.

**Rib 27:**
- New large machined rib concept
- Introduction of support straps to stringers

**Front Spar:**
- Front spar Web thickness increase ~1mm outboard of Rib 9.
- Flange changes outboard of Rib 23.

**Systems Installation:**
- New looms for Sharklet, routed outside rib 27.
- Centre Tank Vent Pipe Modified.
Computers updated for Sharklet

<table>
<thead>
<tr>
<th></th>
<th>No sharklets capability - Std &amp; P/N</th>
<th>Sharklets capability - Std &amp; P/N</th>
<th>MOD</th>
<th>Certif</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELAC</td>
<td>B L94</td>
<td>B L96</td>
<td>3945128212 or</td>
<td>160015/P121 27</td>
</tr>
<tr>
<td></td>
<td>3945129104</td>
<td></td>
<td>3945129106</td>
<td>Nov 2012</td>
</tr>
<tr>
<td>SEC</td>
<td>B’ 122</td>
<td>B’ 121</td>
<td>B372BBM0104</td>
<td>160014/P121 25</td>
</tr>
<tr>
<td></td>
<td>B372BBM0103</td>
<td></td>
<td></td>
<td>Nov 2012</td>
</tr>
<tr>
<td>FCDC</td>
<td>58</td>
<td>59</td>
<td>15370-1520</td>
<td>160051/P129 77</td>
</tr>
<tr>
<td></td>
<td>15370-1520</td>
<td></td>
<td></td>
<td>Oct 2012</td>
</tr>
<tr>
<td>FAC</td>
<td>B 620</td>
<td>B 622</td>
<td>B397BAM0622</td>
<td>160011/P121 26</td>
</tr>
<tr>
<td></td>
<td>B397BAM0620</td>
<td></td>
<td></td>
<td>Nov 2012</td>
</tr>
<tr>
<td>FWF</td>
<td>H2 F6</td>
<td>H2 F7</td>
<td>350E053021111</td>
<td>153741/P130 23</td>
</tr>
<tr>
<td></td>
<td>350E053021111</td>
<td></td>
<td></td>
<td>Dec 2012</td>
</tr>
<tr>
<td>PDB TAV</td>
<td>G2831AAB03</td>
<td>G2831AAC01</td>
<td></td>
<td>160016/P121 28</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oct 2012</td>
</tr>
<tr>
<td>PDB HWL</td>
<td>PS4087592-902 or HNP53AD06-2002</td>
<td>PS4087592-903 or HNP53AD06-2003</td>
<td></td>
<td>160017/P121 29</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oct 2012</td>
</tr>
</tbody>
</table>

Software upgrade via software upload or OBRM
The Sharklet is certified through a significant major change (classification according to EASA Part 21). The target date for the official approval is end of November 2012 for A320.

The sharklet doesn’t create any new model. For that reason, it remains as part of the existing EASA TC.

Schedule
Sharklets and provisions ramp-up

From 2014, every A320 Family delivery can benefit from Sharklets

- **Q2 2012**
  - Provisioned wings EIS
  - Start of ramp-up

- **Q4 2012**
  - 1st Sharklets certification, EIS and start of ramp-up

- **Q4 2013**
  - Provisioned Aircraft reach full production rate

- **Q1 2014**
  - Sharklets available for all deliveries

Provisions ramp-up

Sharklets ramp-up
Content

1. Sharklet benefits
2. Technical & project highlights
3. Entry Into Service
4. Sharklet retrofit solutions
5. Summary
EIS preparation with Airlines

• Dedicated communication to every Operator delivered with Sharklet

→ Provides detailed information

→ Allows tailored support to sharklet Operators

→ Very useful feedback gathered

EIS plan under deployment, reviewed with every sharklet Operator
Tech Pubs

- Minor adaptations for reinforced Aircraft and sharklet Aircraft

- AMM
  - Removal / Installation tasks (sharklet, nav and strobe lights)
    - Trial performed on Aircraft (see dedicated slide): AMM validated with minor adaptations needed.
    - Sharklet removal / installation duration: around 6 h (excluding sealant curing time)
  - Inspections for Schedule maintenance
    - No or minor update identified on Aircraft structure
    - New tasks for Rib 27 and sharklet inspections.
  - Other minor adaptations

- TSM: no impact identified to this date
- IPC: 80 items identified as modified further review on-going.
- ASM / AWM: 6 items identified (ATA 33) on-going.
GSE

- 7 specific tools considered for Sharklet Removal / installation
  - Hoist – Sharklet - 98D57356715
  - Extractor - Lower Pins - 98D57304000
  - Grid - Nut Torque - 98D57304001
  - Collar - Aileron - 98D27104005
  - Protector - Manhole - 98F57004049
  - Protector - Sharklet - 98D57304003
  - Torque Tool - TBC
    + Fuel LEL measuring device

- No specific tools needed for lights

**GSE are planned available for loan and sales stock**
AMM & GSE on Aircraft validation

- Maintenance trial performed 24-26 sept 2012 on Flight Test Aircraft
  - Sharklet Removal/Installation
  - Lights and PSU Removal/Installation

→ Final draft AMM and GSE final concept used

AMM & GSE validated with minor update needed (ongoing)
Sharklet removal / installation in less than one shift
Scheduled Maintenance

• Reinforced a/c with WTF: no maintenance program change considered.

• Sharklet Aircraft: preliminary assessment done
  • Minimum impact on existing inspection
    • update of interval / threshold
    • No new task except for sharklet
  • New inspections on sharklet and RIB27
    • RIB 27 lug inspection
    • Sharklet inspection (borescope)
    • Threshold/Interval considered: 12 YE / 12 YE

• MRBR/ALS part2 dossier under preparation for Certification

• Reviewed during A318 / A319 / A320 / A321 STRUCTURE WORKING GROUP - SAFAM SWG MEETING 27
  • 11th – 12th September 2012, Toulouse, France
SRM

• Complete revalidation of existing SRM is ongoing for both reinforced Aircraft and Sharklet Aircraft
  • Objective is to complete all SRM task revalidation by end 2013
    • Outlook today indicated 65% temporary & ADL revalidated for Sharklet Aircraft A320 EIS:
      • Nose Fwd fuselage (s11/12), Fwd fuselage (s13/14), Aft fuselage (s18), Aft Tail cone (s19.1), PAX doors, landing gear doors, belly fairings, VTP, THS, rudder, elevator, pylons

• SRM introduction includes Aircraft reinforcement and sharklet modifications into repairs / ADL effectivity list.
  • Repairs shown as not applicable would need RAS in case-by-case basis
  • Sharklet device ADL/Repairs on-going:
    • Metallic Leading Edge ADL (Scratches, Gouges, Abrasions, Corrosion and Dents)
    • Lightning Strike damage
    • Sharklet composite structure repairs
  • Sharklet SRM coverage will be maintained vs current A320.

Same level of reparability vs current A320 family
Impact Flight Ops & Training Domain

- **AFM / FCOM:**
  - To be updated to reflect Perfo improvements
  - Minor adaptation to reflect sharklet impact on systems

- **WBM:** no change for A320
  possible minor changes on Weight and CG data for A319 or A321

- **MMEL:**
  - Update of perfo charts
  - Possible update due to introduction of LAF (Load Alleviation Function)

- **Maintenance & Flight training:** Minor update (mainly on Familiarization training)
  - No impact on crew qualification – same type rating
Impact Flight Ops & Training Domain - dispatch

- Dispatch after sharklet heavy damage (out of SRM and CDL scope)
  - Ferry Flight with damaged sharklet removed and replaced by a complete wingtip (modified wingtip compatible with reinforced wing).
  - Benefit: Wingtip & fence can be transported in A320 Family. Sharklet can’t.
  - Will be managed through AFM specific instructions. Targeted at 1Q13
  - Perfo penalties under definition
    → Flight Tests to be completed by end Oct2012

- CDL: complete scope under review
  - Available at 1st EIS: static discharger.
  - Other CDL items under review: nav & strobe lights glazing’s, PSU access door
Flight Ops: performance tools update

• Impact on performance applications
  - PEP [Performance Program]
    → new version 5.2.1 with new performance Database
  - FlySmart with Airbus (former LPC NG)
    → new version L3.2 with new performance Database
    Pre-requisite: version L3.0 shall be already in service in the Airline

• Availability
  - PEP 5.2.1 and PAADMIN 7.1 20 Nov 2012
  - FlySmart with Airbus 10 Dec 2012
  - with same performance database as AFM / pending AFM approval
Spare & transportation

• Spare sharklets
  • Two sets of sharklets planned to be available at EIS in Airbus to support the fleet. One set in Singapore and one in Hamburg at EIS.

• Out of production secured
  Parts that will be out of production after Aircraft reinforcement is standard in production have been identified and secured for aftermarket (Airbus Material, Logistics and Suppliers in Hamburg).

• Sharklet transportation
  • Airworthy box defined
    → (H)1186mm X (W)1722mm x (L)4572mm
  • Fits in A330/A340 and cargo
  • Do not fit into A320 Family Aircraft
Content

1. Sharklet benefits
2. Technical & project highlights
3. Entry Into Service
4. Sharklet retrofit solutions
5. Summary
Sharklets for the A320 Family

**Production line**
- New-build aircraft delivered with:
  - Modified structure (centre wing box and wing)
  - Required flight computers functionality
  - Sharklets

**Production retrofit**
- New-build aircraft delivered with modified structure
- To be retrofitted post-delivery:
  - Flight computers functionality
  - Sharklets

**In-service retrofit**
- Retrofit:
  - Wing structure reinforcement
  - Sharklets
  - Flight computer functionality
Sharklet “production” retrofit: Airbus solution

Sharklets + Service Bulletins + Material/Kit

Sharklets: same as for new A320 family aircraft

Software upgrades

Production retrofit availability target: H1 2013
Sharklet “in-service” retrofit: Airbus solution

Sharklets + Service Bulletins + Material Kit

Sharklets:
same as for new A320 family aircraft

Wing reinforcement

Software upgrades

In-service retrofit availability target: end 2013
Sharklet in-service retrofit
Impact on the aircraft

Pre-requisites (flight computers):
- FMGC
- SEC
- ELAC
- FAC
- FCDC
- FWC

Embodiment time: 10 days
Aircraft downtime: 15 days
Content

1. Sharklet benefits
2. Technical & project highlights
3. Entry Into Service
4. Sharklet retrofit solutions
5. Summary
Key messages

- **Q2 2012**: Provisioned wings EIS, Start of ramp-up
- **Q4 2012**: 1st Sharklets certification, EIS and start of ramp-up
- **1H2013**: Retrofit solution for Provisioned Aircraft
- **1Q2014**: Retrofit solution for non-Provisioned Aircraft

**2012**
- Fuel burn reduction
- Attractive savings
- More efficient family
- Lower CO₂ emissions
- More payload & range
- Better take-off capability
- Lower engine DMC
- Higher optimum altitude

**2013**
- Provisions ramp-up
- Sharklets ramp-up
- EIS preparation with Airlines

**2014**