Flex/Derate, Engine Bump and Derated climb
Related issues
• FLEX TAKEOFF / DERATED TAKEOFF
• BUMP
• DERATED CLIMB
Flexible Thrust Takeoff

Conditions of application:
• $T_{REF} < T_{flex}$,
• Today’s OAT < $T_{flex}$
• $T_{flex} < T_{flex max}$

Flexible Thrust Takeoff

- Max TOW
  - Available Thrust
  - Flat rated Thrust
- Actual TOW
  - Needed Thrust

OAT $\rightarrow$ Tref $\rightarrow$ Flex Temp $\rightarrow$ T Flex max

OQAT

- MAXIMUM THRUST REDUCTION

© AIRBUS S.A.S. All rights reserved. Confidential and proprietary document.
Flexible Thrust Takeoff

Flexible Takeoff procedure: at any moment, pilot can recover TOGA

Thrust

VMC certified for TOGA thrust

Flat rated Thrust

TOGA Thrust

Flexible Thrust

OAT

Tref

Flex Temp

Temperature
Derated Thrust Takeoff

Each derate level is certified and is associated to a new set of performance data

Let’s have a look to the charts ...
For the A340-500/600, two new derate levels have been added: 32% and 40%.
Derated Thrust Take-off on short and contaminated runways

A340-642 TREN T556
OPT CONF
ISA - S/L
WATER 1/4 inch

3900 m
+32.9 tons

3500 m
+83.2 tons

EXAMPLE
Derated Thrust Takeoff

Derated Takeoff procedure: pilot cannot recover TOGA.

Thrust for VMC computation at DERATED TO rating

Derated Thrust

TOGA Rating

Derated Rating

OAT

OAT

Flex/Derate comparison, Engine Bump and Derated climb
TOGA : VMCG = 105 kts
DERATE : VMCG = 100 kts
<table>
<thead>
<tr>
<th>OAT °C</th>
<th>WIND 0 KT</th>
<th>HEADWIND 10 KT</th>
<th>HEADWIND 20 KT</th>
</tr>
</thead>
<tbody>
<tr>
<td>336.3</td>
<td>39</td>
<td>381.5</td>
<td>397.8</td>
</tr>
</tbody>
</table>

**TOGA**

- VMCG = 105 kts

**DERATE**

- VMCG = 100 kts

---

**TOULOUSE(BLAG)**

- 33L
- 2 obstacles
- SLUSH 1/4''
- CONF 3
- D24

---

**A340642 - JAA RR TRENT 566 engines**

- QNH 1013.25 HPA
- Air cond. Off
- Anti-icing Off
- All reversers inoperative

---

**Note:** DO NOT USE THESE FIGURES AS A REFERENCE.
Therefore the use of TOGA together with a set of V1/Vr/V2 for DERATE takeoff must be prevented.

The aircraft protects the crew against MCDU typing errors during cockpit preparation.
ECAM Message

• Let’s assume that **no** FLEX/DERATE level has been entered into the FMS

• The thrust level is set to FLX/MCT at takeoff…

**IMPORTANT:**
This message depends on whether the DERATED TAKEOFF option is installed and available on the aircraft

**IMPORTANT:**
This message depends on whether the DERATED TAKEOFF option is installed and available on the aircraft

But…

A warning message appears on the ECAM
ECAM Message

• For aircraft **without** the DERATED TAKOFF option on board:

The message request the pilot to set TOGA

Even if FLEX takeoff was envisaged by the pilot, TOGA is proposed when the FLEX information is missing in the FMS.
ECAM Message

• For aircraft with the DERATED TAKOFF option on board:

The message requests that the pilot sets IDLE

In this case, the risk of performing a TOGA takeoff with DERATE takeoff speeds exists, the takeoff must be aborted
Reduced Thrust Level

Conditions of application:
- $T_{REF} < T_{flex}$,
- Today’s OAT < $T_{flex}$
- $T_{flex} < T_{flex \ max}$

Let’s have a look at these reduction levels more in detail...
Reduced Thrust Level

**ACTUAL SITUATION:**

- A318/319/320/321 25% (Flex only)
- A330-200/300 25%
- A340-200/300 25%
- A340-500/600 40%

**PLANNED EVOLUTIONS**

- A319-200/300 25% (24% Derate)
- A320-200/300 25% (24% Derate)
- A321-200/300 25% (24% Derate)
- A330-200/300 40%

**AVAILABILITY DATE**

- Upon Request from MID 2004
- Upon Request from MID 2004
- Upon Request from MID 2004
- Under evaluation
Transition to CLIMB THRUST

• At high levels of DERATE, the TAKEOFF THRUST may fall below the CLB THRUST

• An increase of thrust must be avoided when pulling the lever to the CLB detent

• An automatic transition sequence to MAX CLB has been implemented for the different engine models

LET’S SEE HOW THIS WORKS....
Transition to CLIMB THRUST

TRENT 500: CLIMB ADJUSTEMENT

EPR

CLIMB

FLEX/DERATE

Thrust Lever Position

FLX/MCT

CLB

THRST RED ALT

Time

- 20 s
- 40 s

• No unexpected thrust increase
• Climb performance unchanged
• No unexpected thrust increase
• Climb performance unchanged
On A320 and A321, the current Max Climb rating provides sufficient room for 25% thrust reduction.

For future evolutions, similar solutions will be applied (25% → 40% for A330).
MAIN

• FLEX TAKEOFF / DERATED TAKEOFF
• BUMP
• DERATED CLIMB
Bump

• The bump is an increased takeoff thrust.

• The bump can be occasionally used when the basic maximum takeoff thrust does not provide the required performance.

• There is no possibility to set an intermediate thrust between the basic maximum takeoff thrust and the bump.
Bump

• Various bumps were defined for the early A320 models, as a function of the customers requirements.

• For the latest A320 family models, the bump can be made available on the following models:
  - A321-211
  - A321-231
  - A320-214
  - A320-233
Bump

• These bumps provide between 6 and 10% more thrust than the basic one.

• They are available only with specific FADEC standards:
  ‣ IAE engines: SCN18
  ‣ CFM engines: 5BL

• These bumps are available, but not yet certified as no customer has ordered this option yet.

• A lead time of about 9 months will be necessary once we get a customer order
Bump

• Long range aircraft:
  ▶ A340:
    Presently, a bump is available only for the A340-313 gross weight.
  ▶ A330:
    A bump will be certified mid-2004 on the A330-202. It will provide the thrust of the CF6-80E1A3.
• Bump activation:

The bump is activated by two guarded pushbuttons, placed on the thrust levers on the A320 Family and on the external thrust levers on the A340.

It can be used with all engines operating and remains active in case of one engine failure.
• FLEX TAKEOFF / DERATED TAKEOFF
• BUMP
• DERATED CLIMB
**Principle of thrust reduction**

When the MAX CLB thrust is not necessary during the CLIMB phase, it can be performed with less thrust.

- It applies to the climb phase, so its use is completely independent of that of the DERATED TO
- Benefits of thrust reduction
  - save the engine life (↘ engine stress)
  - reduce maintenance costs
Derated Climb concept

• Two levels of derated climb available through MCDU
• Implementation: EPR/N1 decrement applied on MCL EPR/N1
• Decrement is function of pressure altitude, delta ISA and engine bleed configuration.
• Result:
  ‣ less severe engine operations and resulting lower engine DMC,
  ‣ slightly increased climb fuel/time to reach the same flight level.
• The DERATED CLIMB is basic in the LR family since 1997
• This option is not available in the SA family
Engine strain reduction

In order to maintain the same climb capabilities, the Derated Climb features a Washout function:

A340-600 RR Trent 500 Derated climb / Max climb washout function

Climb thrust derate

Max climb

ISA+10°C and below

ISA+20°C

ISA+30°C

ISA+40°C

ISA+40°C

ISA+30°C

ISA+20°C

ISA+10°C and below
Derated climb operational effect

**Example:**
- A340-642 / Trent 556
- Initial weight 372t
- ISA climb law 250kt/320kt/.82

**MTOW Derated climb operational effect**

<table>
<thead>
<tr>
<th>Time to TOC</th>
<th>DCL1: +6min</th>
<th>DCL2: +10min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to TOC</td>
<td>DCL1: +40nm</td>
<td>DCL2: +64nm</td>
</tr>
<tr>
<td>Fuel (const dist)</td>
<td>DCL1: +89kg</td>
<td>DCL2: +184kg</td>
</tr>
</tbody>
</table>
AIRBUS Derated Climb Recommendations

**EXAMPLE: TOC = FL330**

- Identically TOW = 330.3 tons at DCL1 provides the same climb time to TOC as Max Structural Weight at MAX CLB.
- The TOW = 320.5 tons at **DCL2** provides the same climb time to TOC as Max Structural Weight at MAX CLB.
This document and all information contained herein is the sole property of AIRBUS S.A.S. No intellectual property rights are granted by the delivery of this document or the disclosure of its content. This document shall not be reproduced or disclosed to a third party without the express written consent of AIRBUS S.A.S. This document and its content shall not be used for any purpose other than that for which it is supplied.

The statements made herein do not constitute an offer. They are based on the mentioned assumptions and are expressed in good faith. Where the supporting grounds for these statements are not shown, AIRBUS S.A.S. will be pleased to explain the basis thereof.