Airbus – Aircraft Energy management in descent phase using FMS

Airbus fleet performance

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Introduction to descent operations:
FMS full managed mode

In Airbus A/C, the FMS provides a **theoretical descent profile (TDP)** based on a Performance model (PDB) along the **lateral path** defined by a sequence of Waypoints provided by the Navigation Database (NDB), taking into account ALT and SPD constraints. This flight path is used for:

- Top of Descent (ToD) display
- Altitude and speed predictions
- Guidance during descent phase

FMS full managed mode (lateral, vertical & speed)

The use of FMS full managed mode is strongly recommended when ATC does not use radar vectoring

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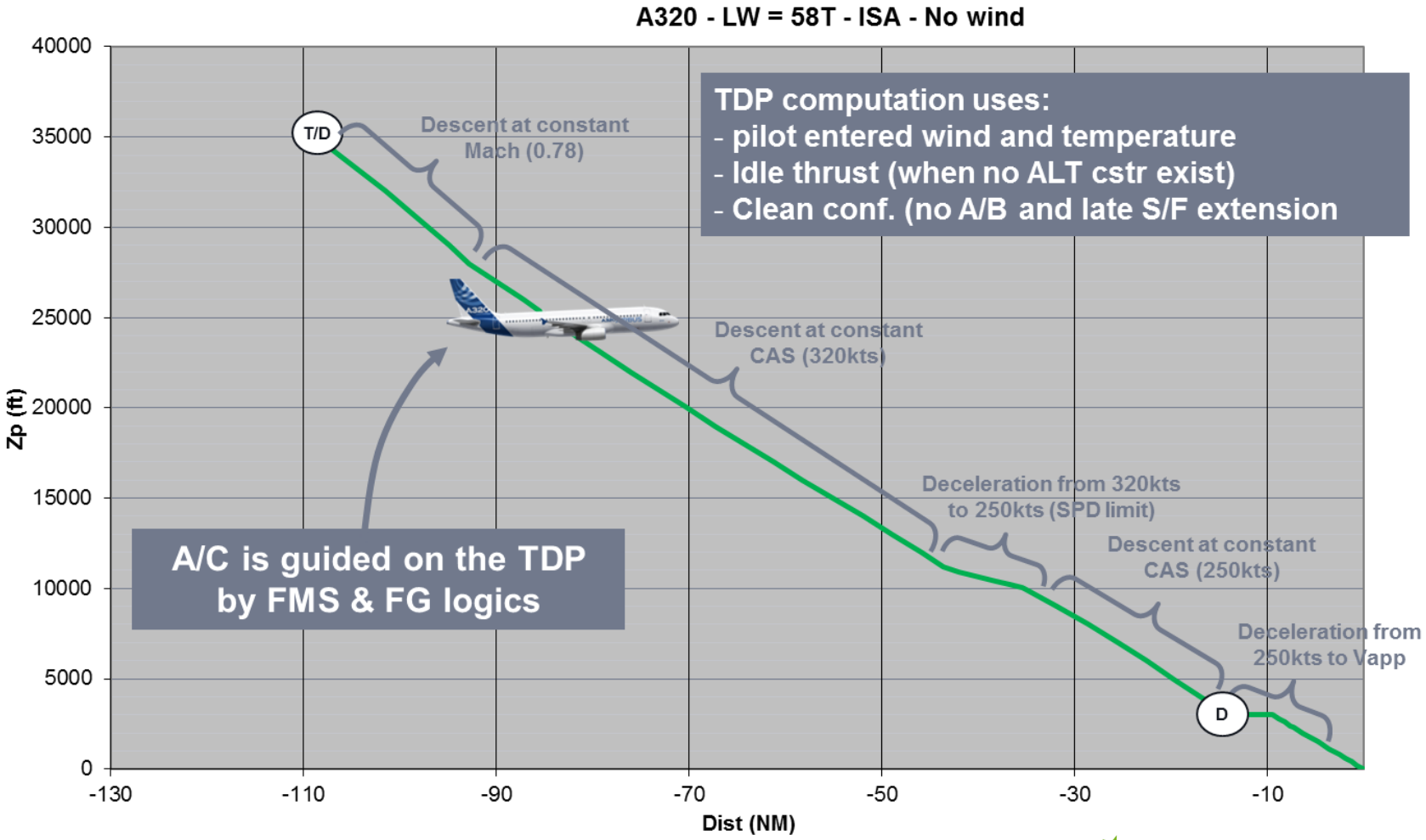
Introduction to descent operations:

TDP example without constraint (Idle Path)



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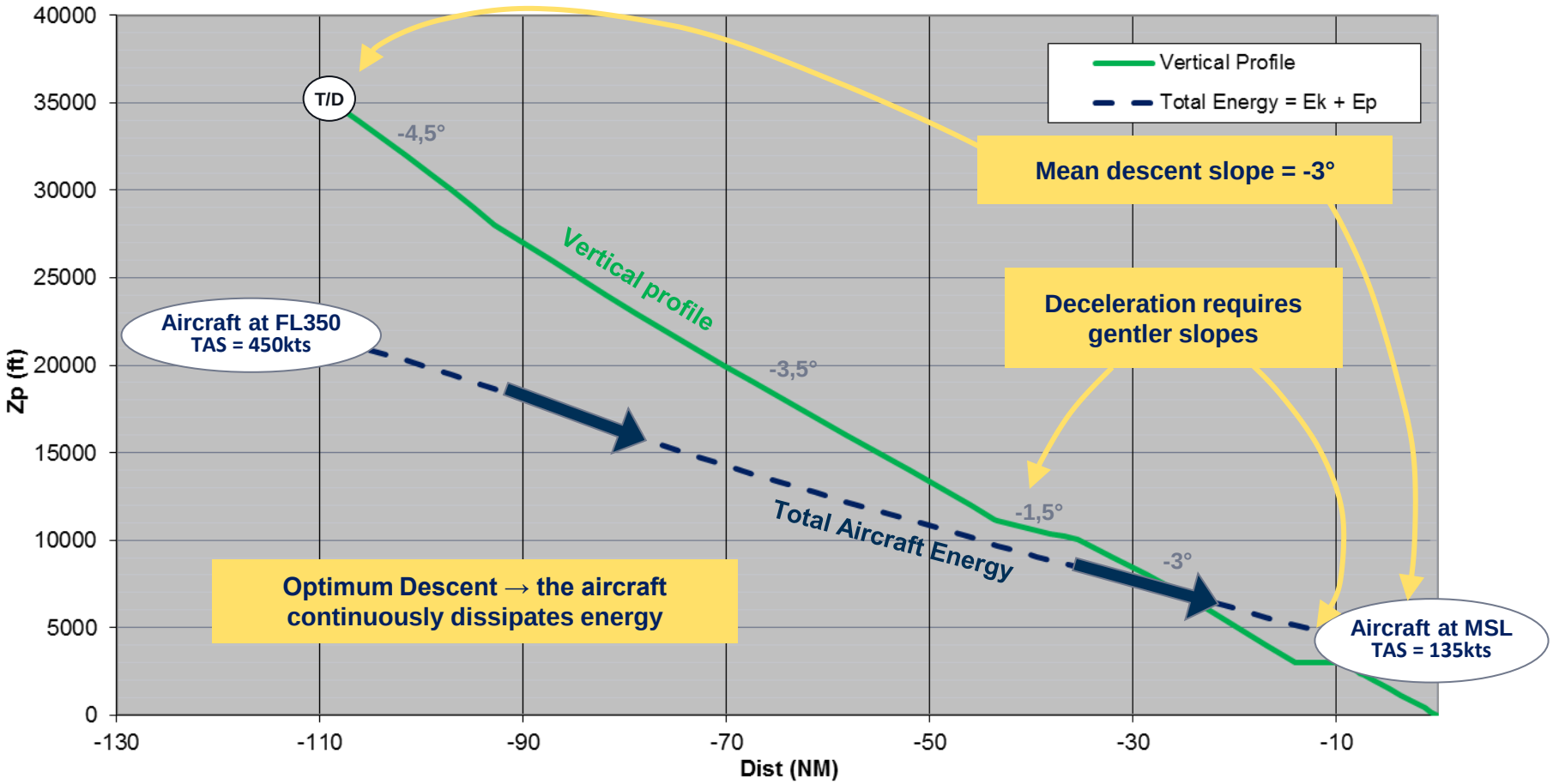
Introduction to descent operations:

TDP example without constrains (Idle Path)



Descent slope strongly depends on flying objective (hold constant speed or decelerate)

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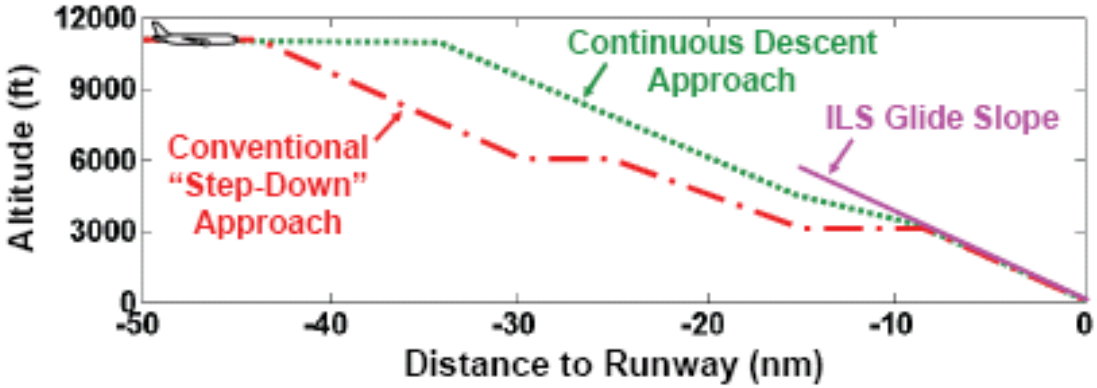
Introduction to descent operations: CDO definition

- **ICAO Definition** (CDO manual released in 2010):

  "Continuous descent is an **aircraft operating technique**, enabled by airspace design, Procedure/Profile and ATC facilitation, in which an arriving aircraft **descends continuously** to the greatest possible extent, by employing **minimum thrust**, ideally in a **low drag** configuration, prior to the final approach fix (FAF)"



- **Consequences** on descent operations:

  The best way to fulfill CDO objectives consists in using the FMS vertical profile computed without ALT constraint (ALT constraints lead to adapted thrust or use of Airbrakes).

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Optimum Descent profile sensitivity

- Descent profile computation mainly depends on:
  - Aircraft type & Engine type
  - Landing weight
  - Descent speed law
  - Wind

- These parameters are taken into account by the FMS before descent phase and will impact the ToD position

- Procedure design should allow the aircraft to adapt its descent to the various flight conditions

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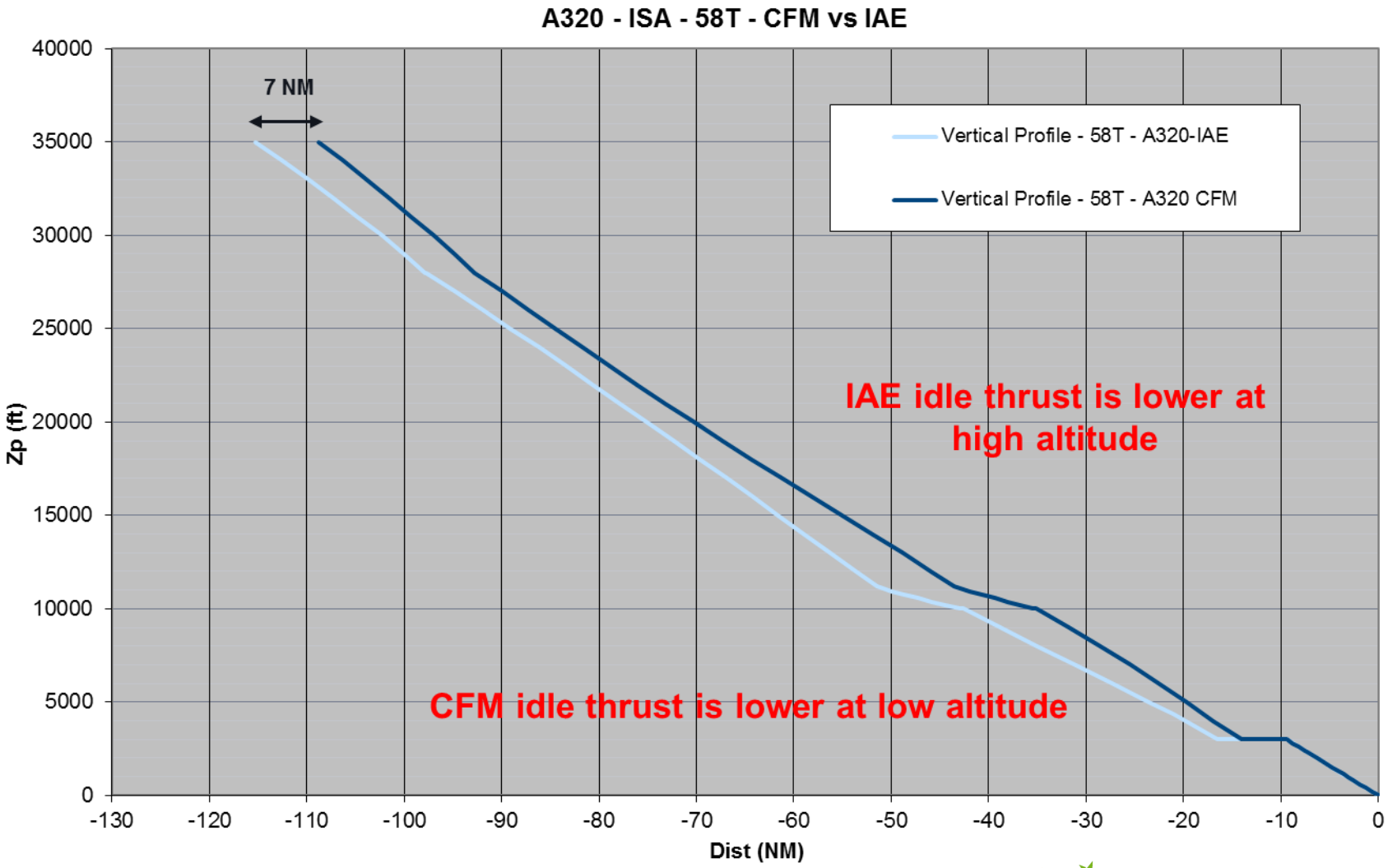
Optimum Descent profile sensitivity: Engine type



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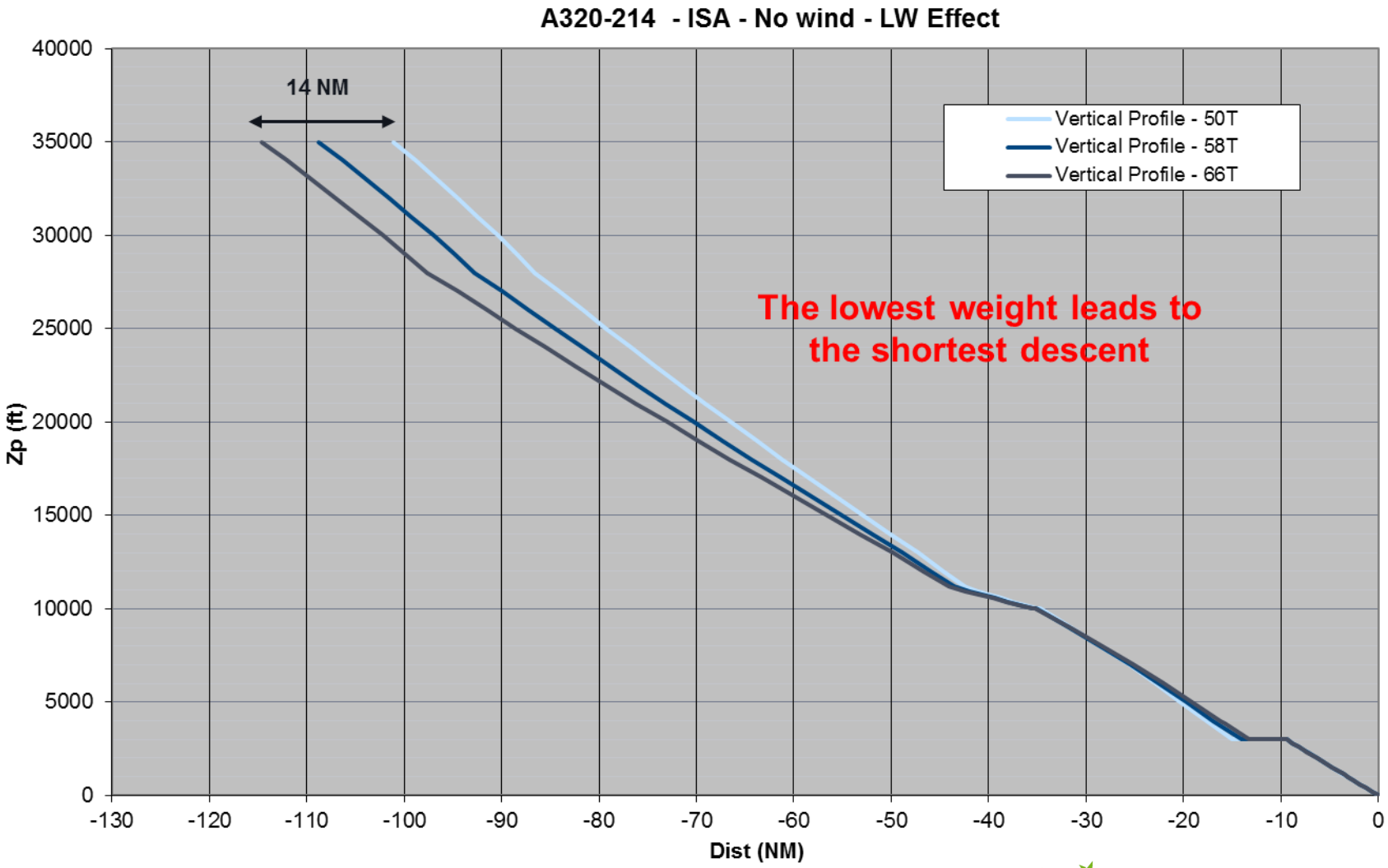
Optimum Descent profile sensitivity: weight effect



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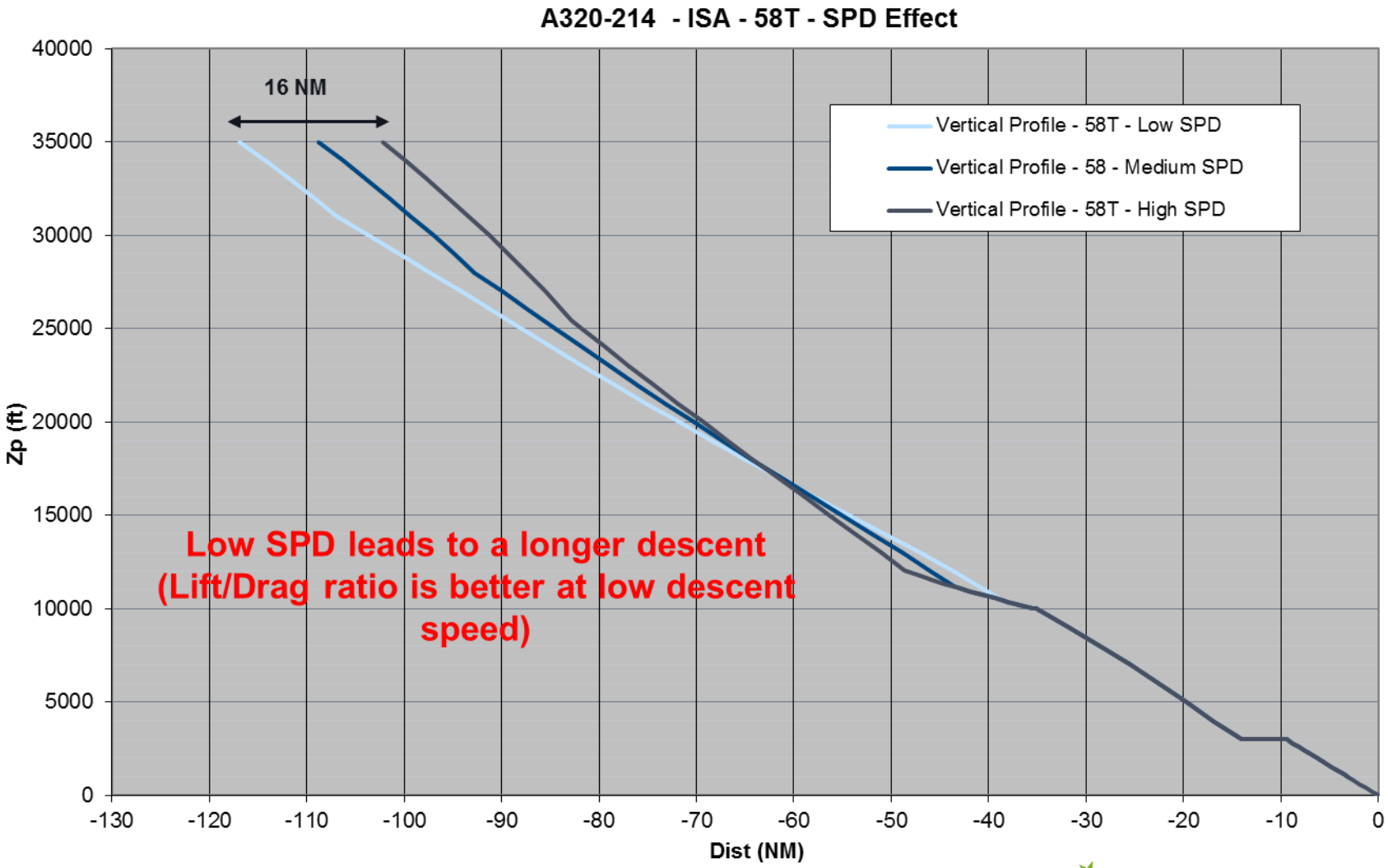
Optimum Descent profile sensitivity: descent SPD



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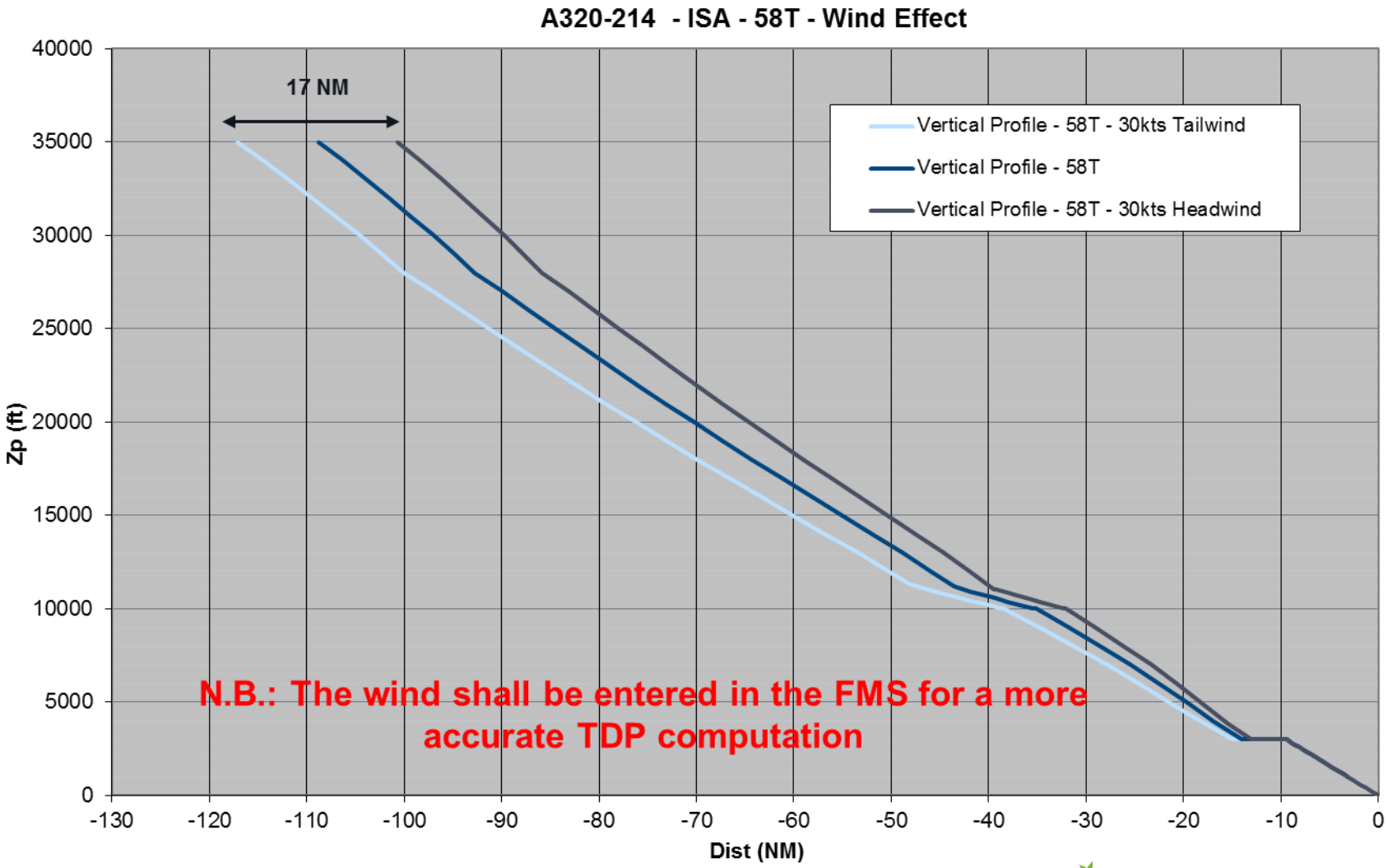
Optimum Descent profile sensitivity: wind effect



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Recommendations for CDO procedure design

In the frame of SESAR project, the following recommendations to optimize CDO have been identified:

- **"Window" ALT constraints** should be preferred compared to "AT" (AT constraints lead to geometric path in adapted thrust)
- Altitude constraints **should not impose a "too steep"** flight path angle to the aircraft (a too steep path requires the use of Airbrake) => refer to next slides
- **The average local wind shall be considered** (10kts of tailwind shall decrease the limit slope by 0,1°)
- **A gentle slope (between -1° to -1,5°) should be allowed for deceleration** (e.g. before glide slope interception) => refer to next slides
- The transition altitude should be preferably **above FL100**
- Speed restrictions **below 230kts** and far from the FAF shall be avoided (they lead to early S/F extension and early DECEL point)
- The noise level can be reduced by using a **reduced SPD Limit** (below 250kts)

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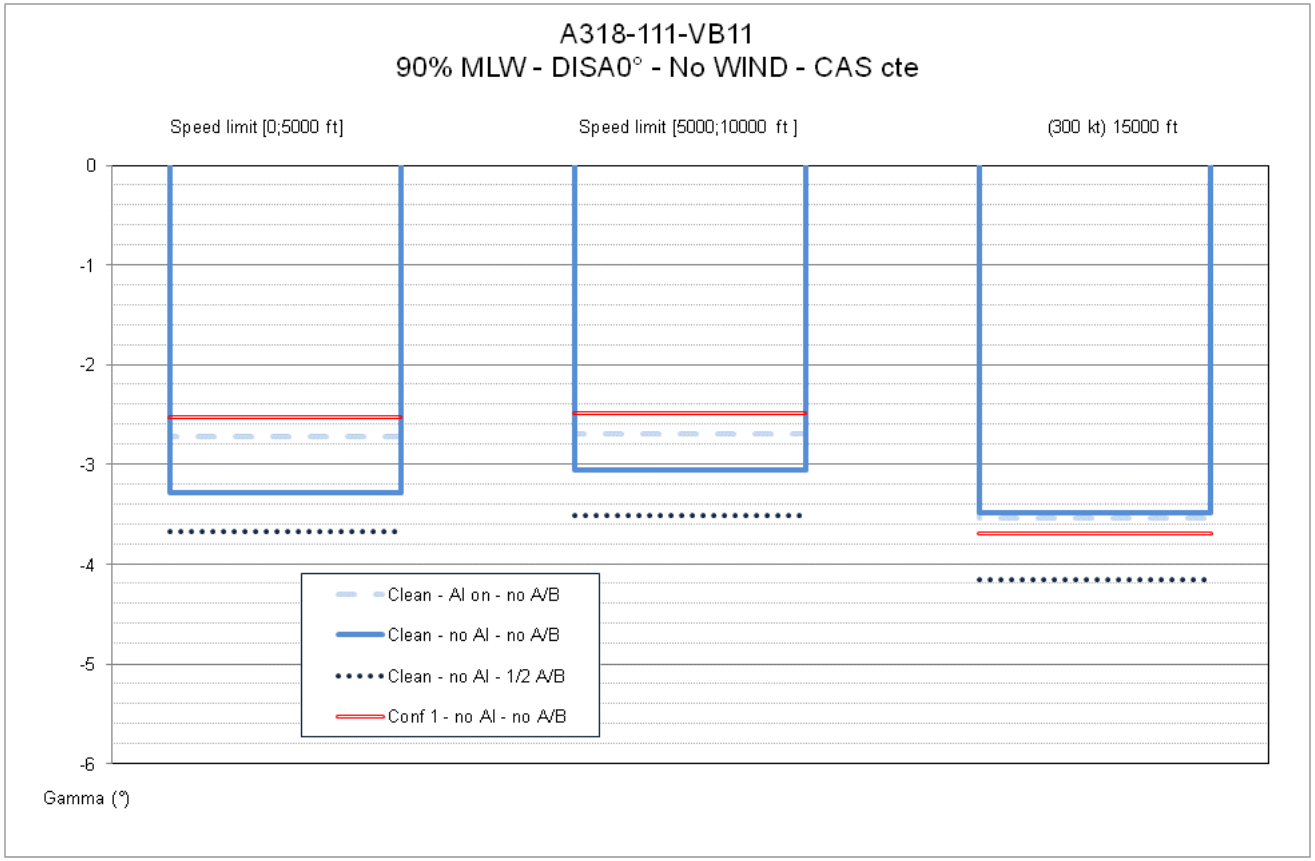
Recommendations for CDO procedure design: limit slopes at constant CAS for the whole Airbus fleet

Example of the steepest slope allowing a constant CAS descent



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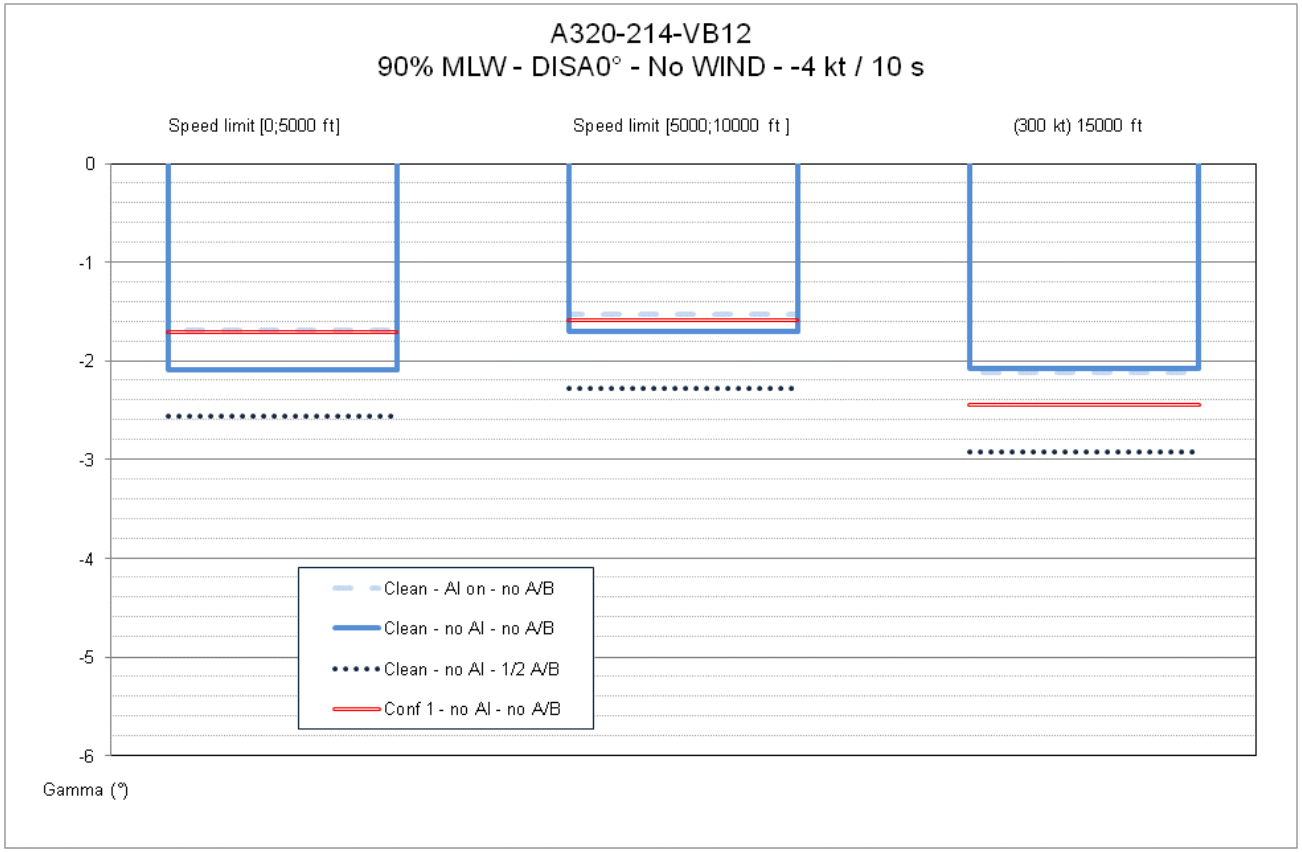
Recommendations for CDO procedure design: limit slopes allowing deceleration for the whole Airbus fleet

Example of the steepest slope allowing a deceleration rate of 4kts/10s



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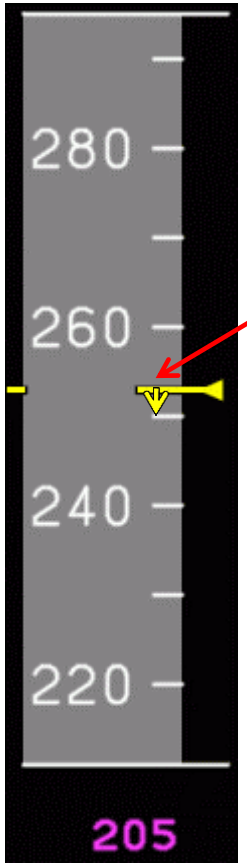
Operational issues with steep slopes: pilots need a minimum deceleration rate of 4kts/10s

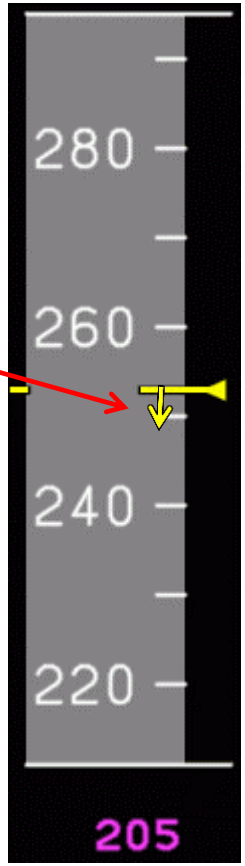


On Primary Flight Display, a speed trend is displayed for deceleration indication to the crew

Speed trend for deceleration rate = 2 Kts/10s

Speed trend for deceleration rate = 4 Kts/10s

When deceleration rate becomes lower than 2 Kts/10s, no arrow is displayed anymore



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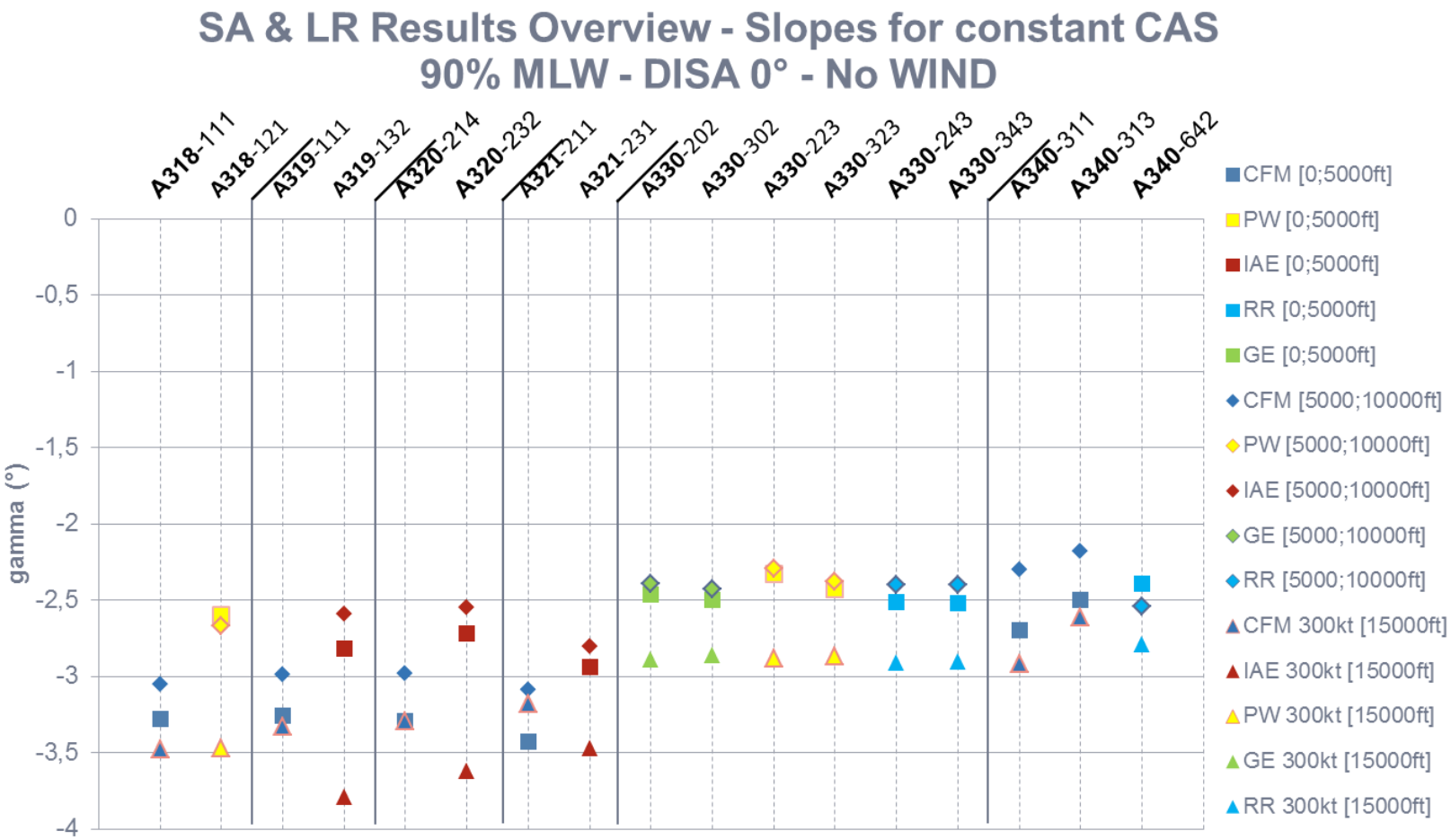
Recommendations for CDO procedure design: Descent capability of Airbus fleet (constant CAS)



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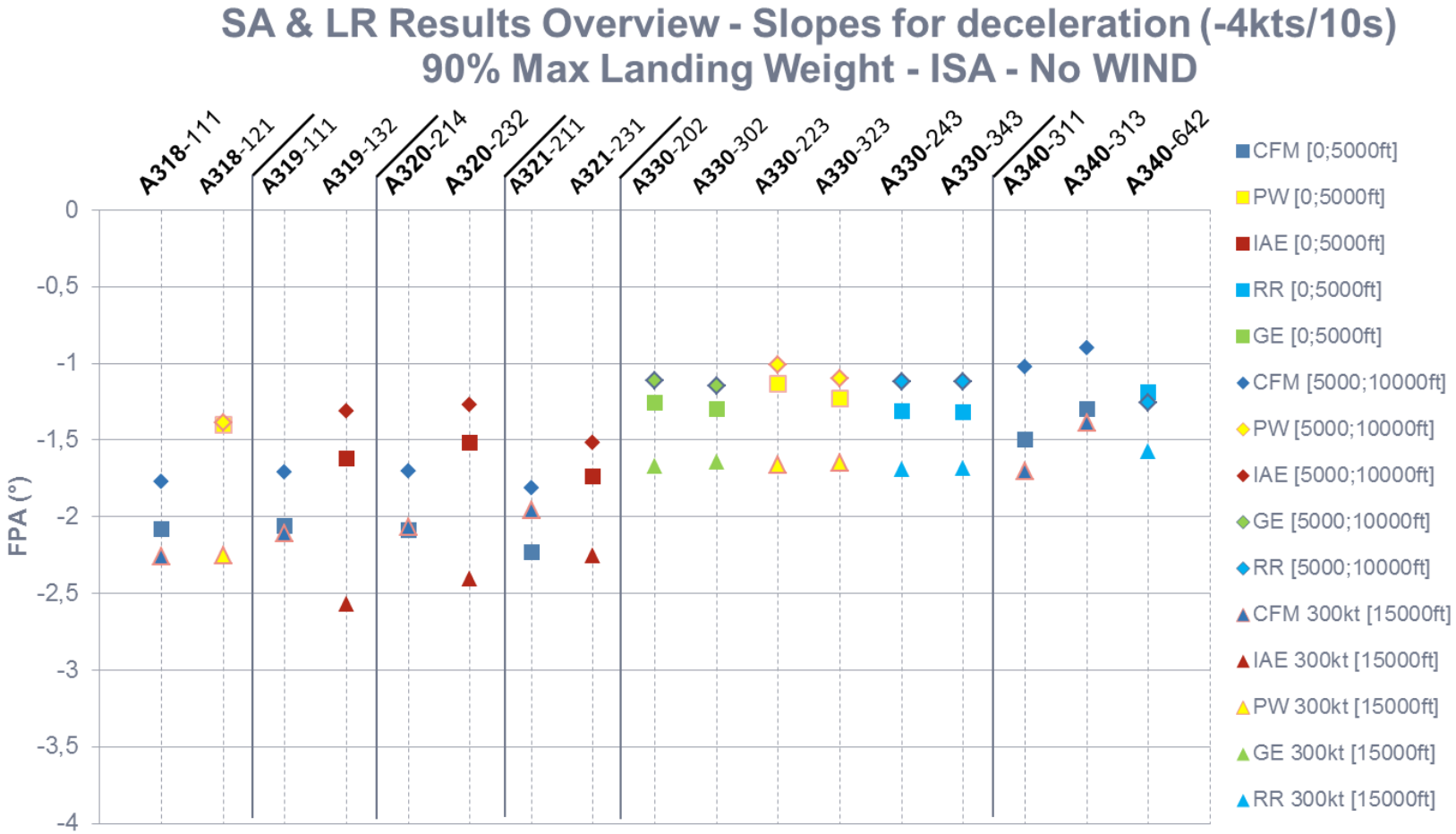
Recommendations for CDO procedure design: Descent capability of Airbus fleet (deceleration)



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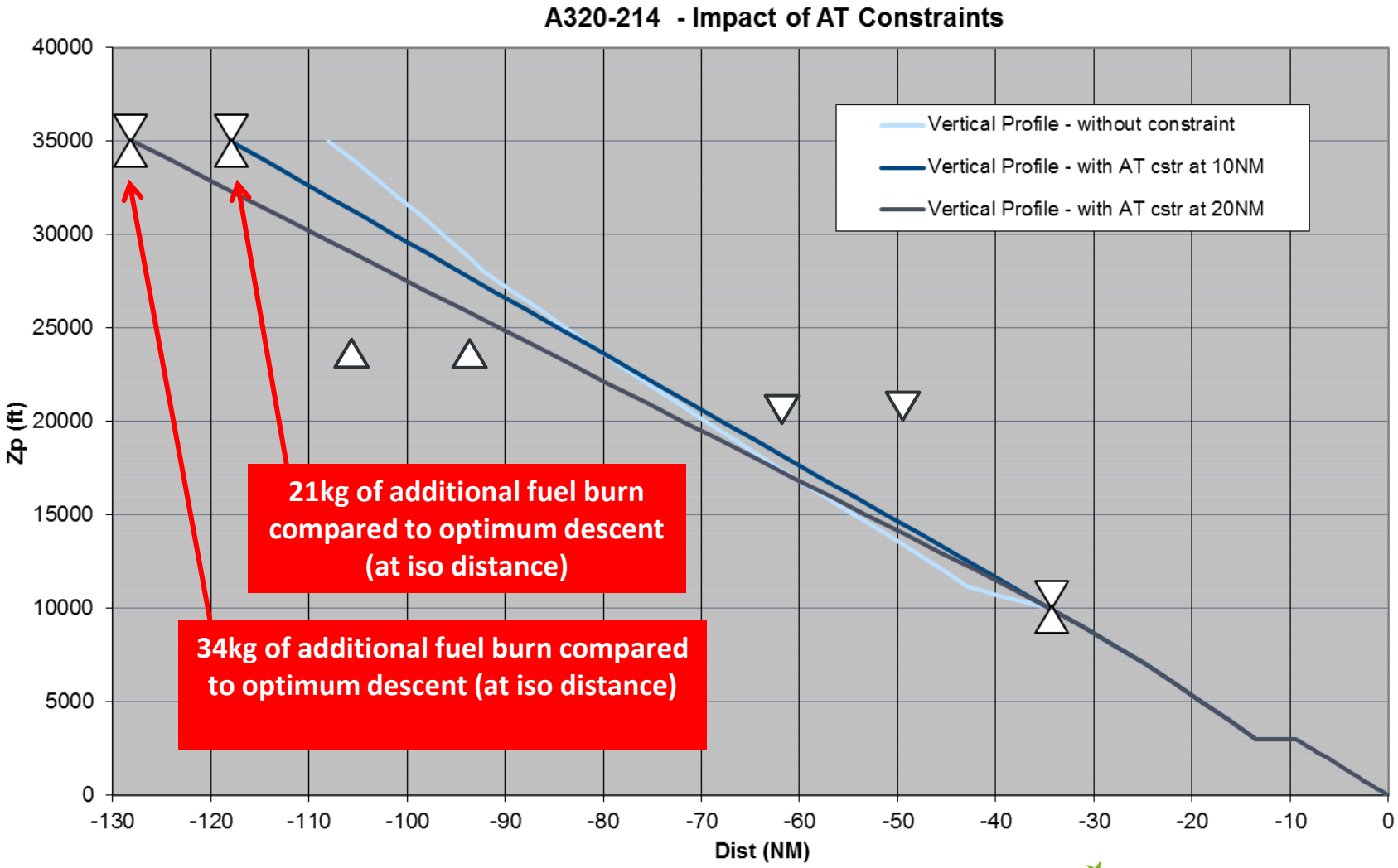
Fuel burn impact due to AT constraints



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Conclusion

- An **efficient descent** (regarding fuel & noise) consists in flying at **Idle thrust**, in **low drag configuration** → The FMS idle path (TDP without ALT constraint) meets this objective

- Approach procedures should allow (as far as possible) aircraft to fly **appropriate slopes** along the whole descent:

Appropriate slopes for	A320/A319/ A321	A330	A340
constant CAS above FL100	-3,2°	-2,9°	-2,6°
constant CAS below FL100	-2,5°	-2,3°	-2,2°
deceleration before final approach below 5000ft	-1,5°	-1,2°	-1,2°
deceleration before final approach above 5000ft	-1,3°	-1°	-0,9°

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Thank You

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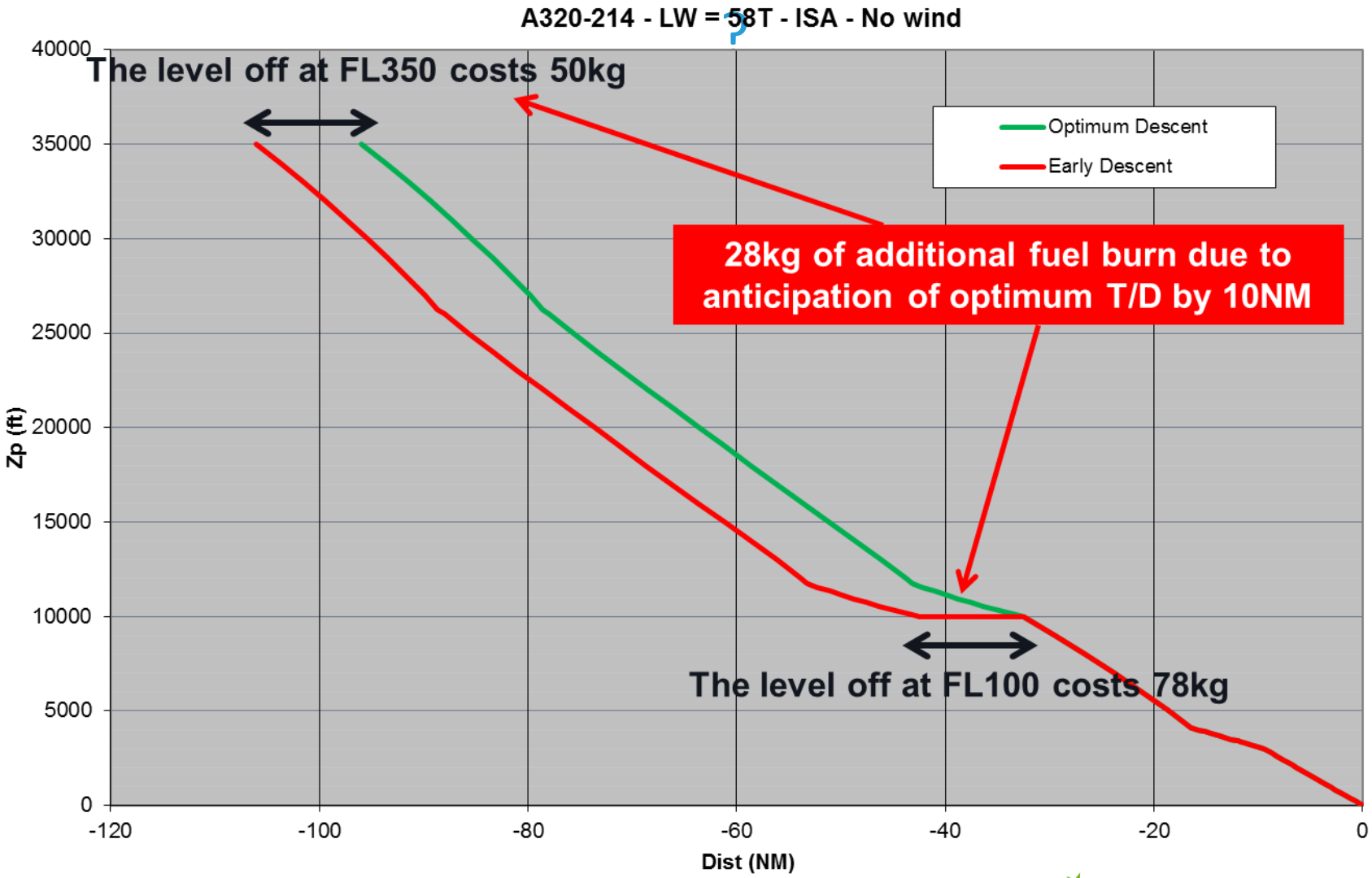
Back-up slide: What if the T/D is anticipated (on A320)



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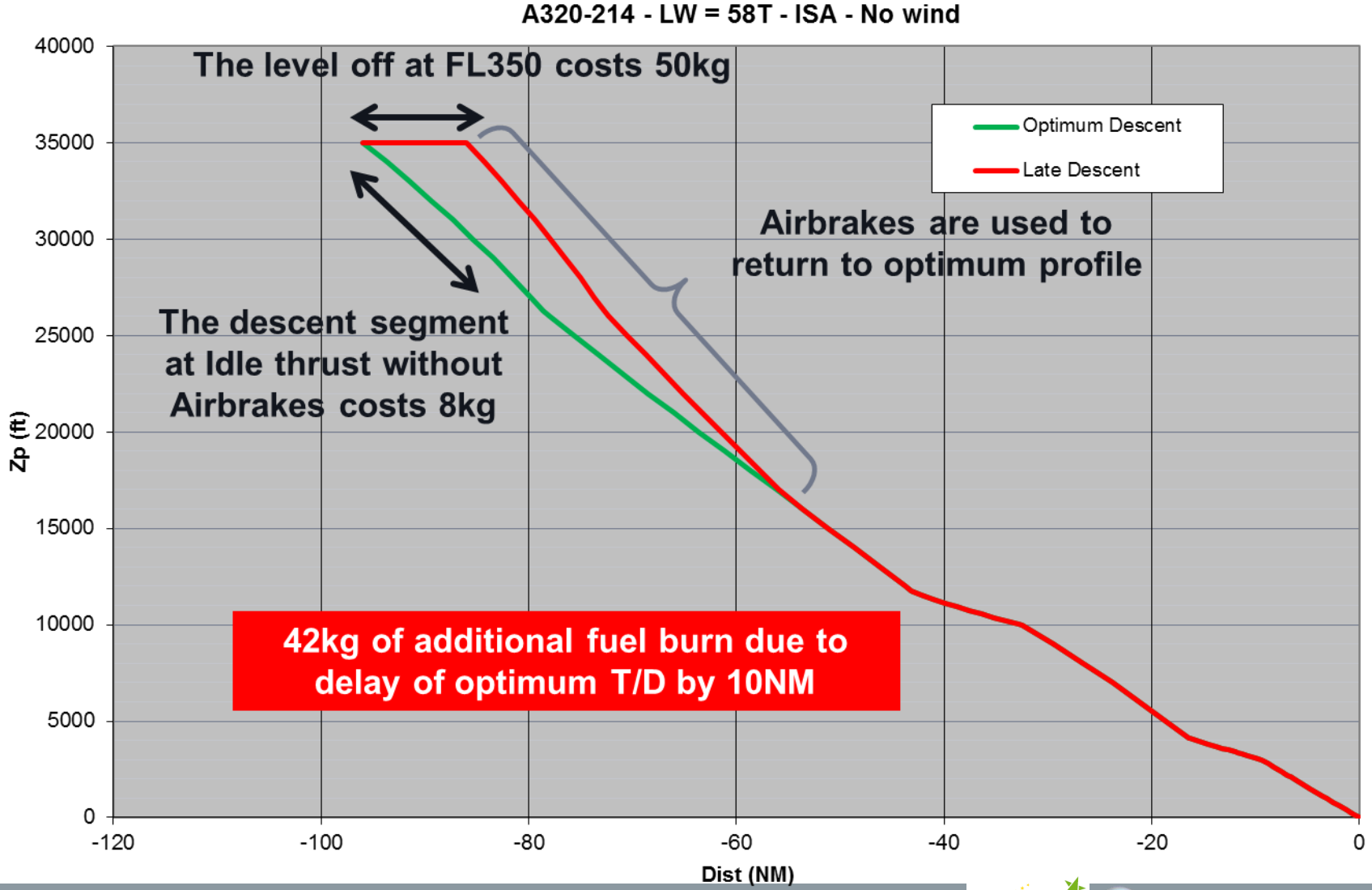
Back-up slide: What if the T/D is delayed (on A320) ?



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