Noise Certification Workshop

Session 2: Aircraft Noise Certification

Annex 16, Volume I and equivalent procedures

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Documents

- ICAO Annex 16, Volume I, Third Edition, Amendment 7, applicable since 21 March 2002
  - regulation
  - contains reference conditions and initial demonstration procedures
- ICAO Doc 9501-AN/929 Environmental Technical Manual on the Use of Procedures in the Noise Certification of Aircraft (ETM), Third Edition - 2004
  - guidance material
  - mainly contains equivalent procedures

ICAO Annex 16

- Relevant Chapters for Small Propeller-driven Aircraft and Helicopters -

Chapter	aircraft	application accepted
6	small* propeller-driven	from 1975 to 1988
10	small* propeller-driven	from 1988
8	helicopters	from 1985
11	small** helicopters	from 1993

* MTOM ≤ 8618 kg

** MTOM ≤ 3175 kg

ICAO Annex 16
- Relevant Chapters for Jet and Large Propeller-driven Aircraft (1) -

Chapter	aircraft	application accepted
2	subsonic jet	until 1977
3	subsonic jet	from 1977 to 2005
3	large* propeller-driven	from 1985 to 2005
4	subsonic jet	from 2006
4	large* propeller-driven	from 2006
5	large* propeller-driven	from 1977 to 1985
12	supersonic	——

* MTOM > 8618 kg or 5700 kg

ICAO Annex 16
- Relevant Chapters for Subsonic Jet and Large Propeller-driven Aircraft (2) -

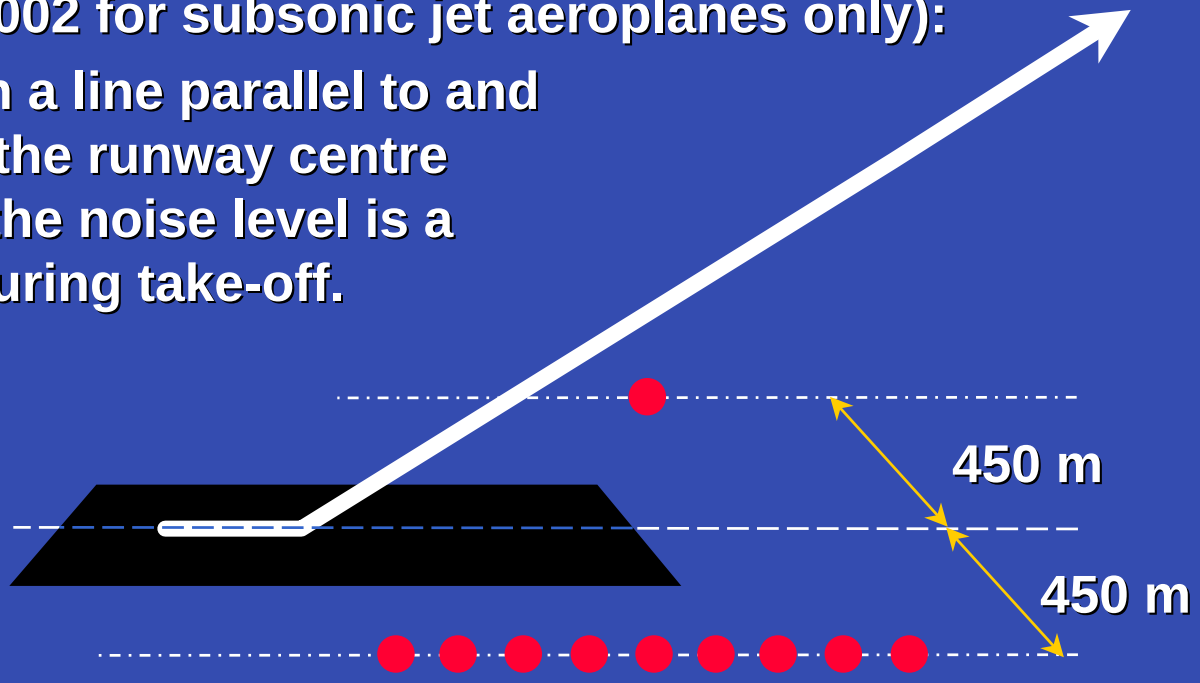
Reference during this presentation are Chapters 3 and 4

- **Chapter 4 vs. Chapter 3**
  - **maximum noise levels for Chapter 4 are more stringent**
- **Chapter 2 vs. Chapter 3**
  - **maximum noise levels for Chapter 2 ("older" subsonic jet aeroplanes) are less stringent**
  - **different procedures (sideline microphone position)**
- **Chapter 5 vs. Chapter 3**
  - **maximum noise levels for Chapter 5 ("older" large propeller-driven aeroplanes) are less stringent**

Chapters 3 and 4
- Reference Noise Measurement Points (1) -

Lateral full-power reference noise measurement point (since March 2002 for subsonic jet aeroplanes only):

- **The point on a line parallel to and 450 m from the runway centre line, where the noise level is a maximum during take-off.**

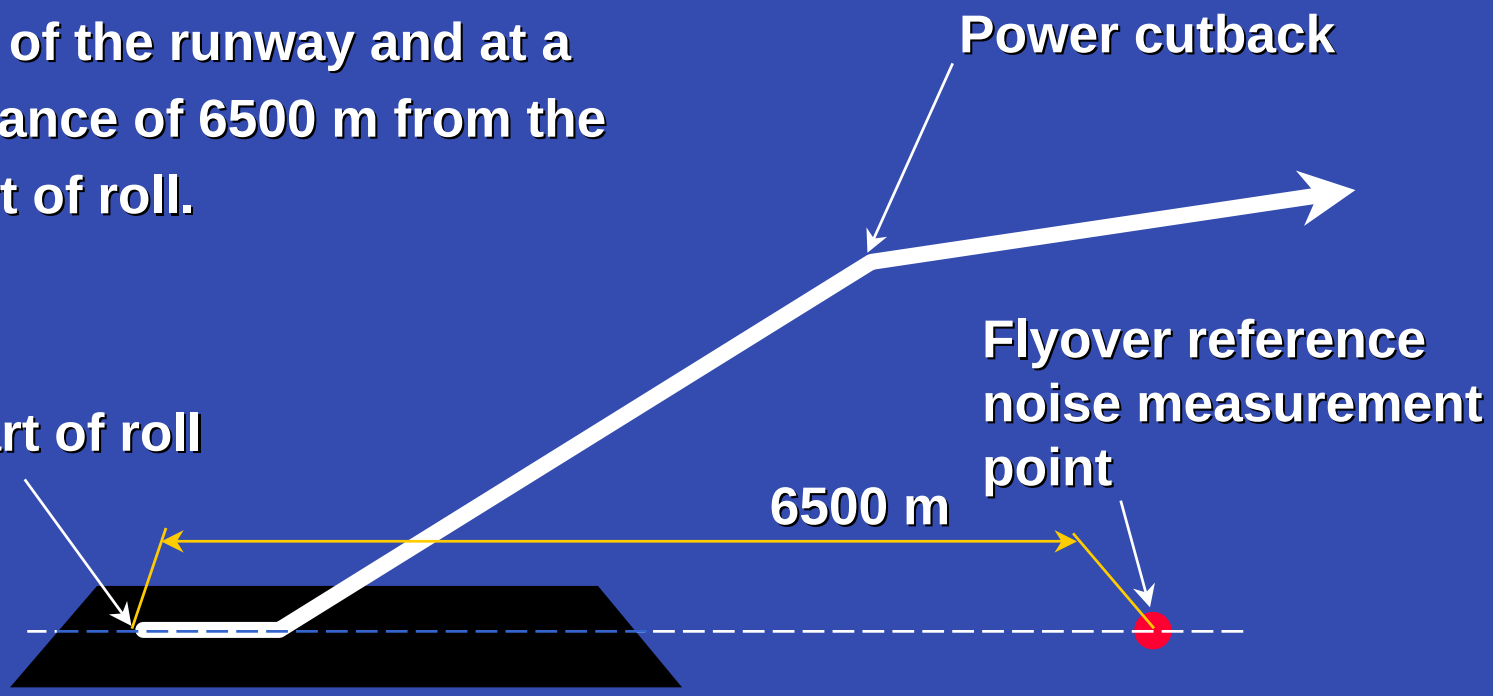


Lateral full-power reference noise measurement point

Chapters 3 and 4
- Reference Noise Measurement Points (2) -

Flyover reference noise measurement point:

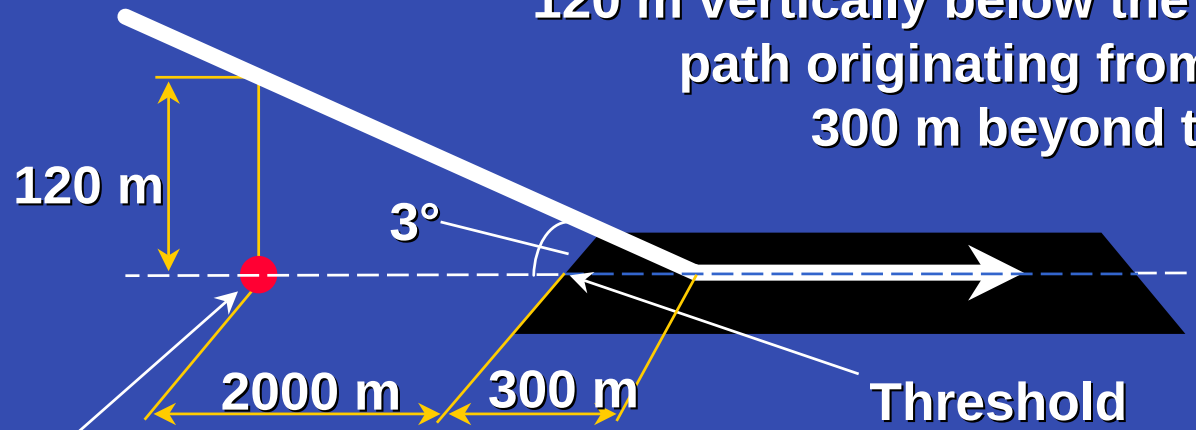
- **The point on the extended centre line of the runway and at a distance of 6500 m from the start of roll.**



Chapters 3 and 4
- Reference Noise Measurement Points (3) -

Approach reference noise measurement point:

- **The point on the ground, on the extended centre line of the runway 2000 m from the threshold. On level ground this corresponds to a position 120 m vertically below the 3° descent path originating from a point 300 m beyond the threshold.**



Approach reference noise measurement point

Noise Evaluation Measure

- The noise evaluation measure is the Effective Perceived Noise Level (EPNL) in EPNdB.
- The EPNL "is a single number evaluator of the subjective effects of aircraft noise on human beings".
- The EPNL is the perceived noise level
  - adjusted for spectral irregularities,
  - adjusted for the duration of noise.

Note: For details see ICAO Annex 16, Volume I, Appendix 2

Chapter 3 - Maximum Noise Levels

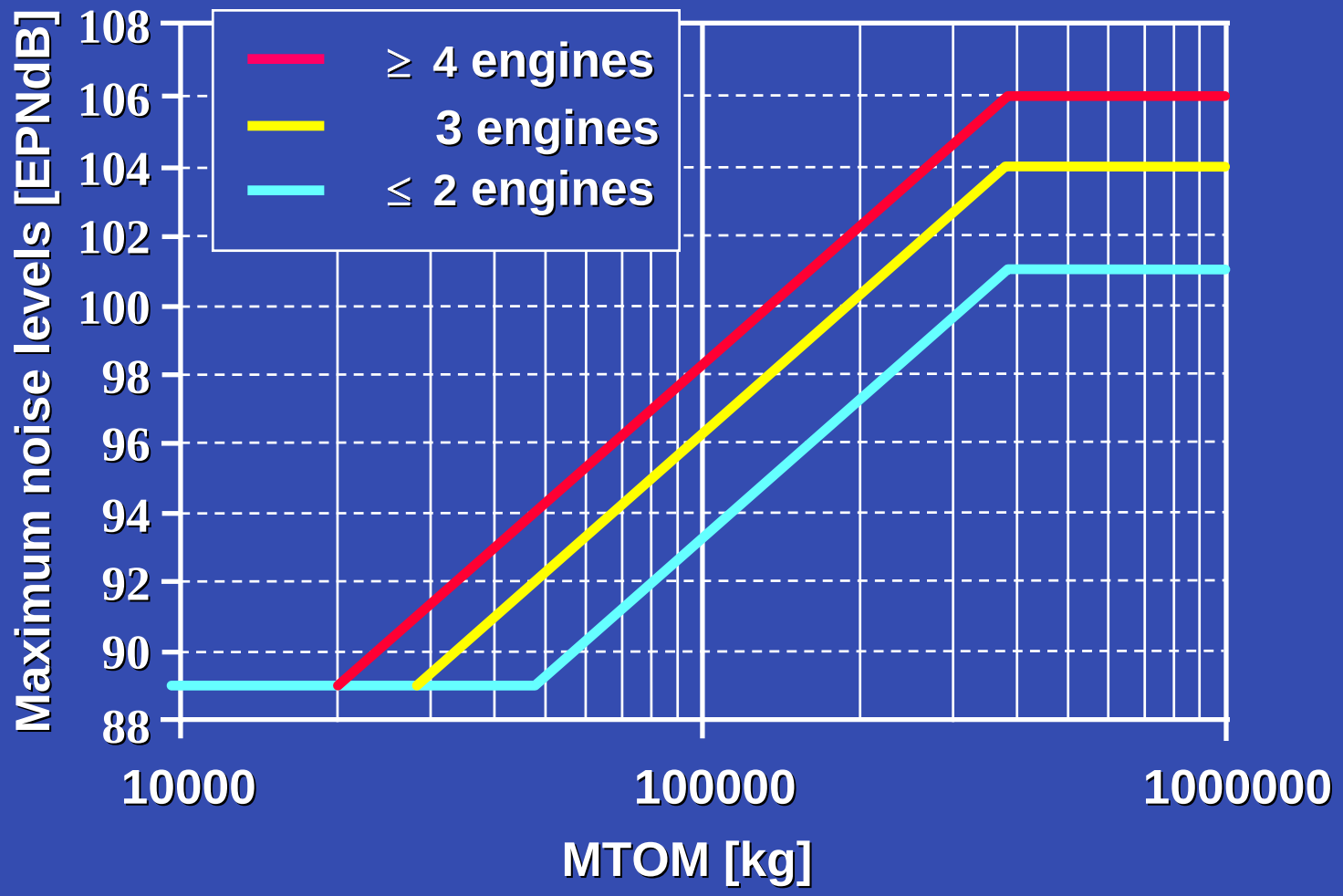
All noise levels are in EPNdB

*MTOM***		*0*	*20.2*	*28.6*	*35*	*48.1*	*280*	*385*	*400*
Lateral		94				80.87 + 8.51 log M			103
Fly-over	≤ 2*	89				66.65 + 13.29 log M			101
	3 *	89				69.65 + 13.29 log M			104
	≥ 4 *	89				69.65 + 13.29 log M			106
Approach		98				86.03 + 7.75 log M			105

* number of engines

** MTOM in 1000 kg

Chapter 3 - Maximum Noise Levels at Flyover Reference Noise Measurement Point



Chapter 3 - Trade-offs

If the maximum noise levels are exceeded at one or two measurement points:

- **The sum of excesses shall not be greater than 3 EPNdB.**
- **Any excess at any single point shall not be greater than 2 EPNdB.**
- **Any excess shall be offset by corresponding reductions at the other point or points.**

Chapter 4 - Maximum Noise Levels

- **The maximum permitted noise levels are defined in Chapter 3 and shall not be exceeded at any of the measurement points.**

- **The sum of the differences at all three measurement points between the maximum noise levels and the Chapter 3 maximum noise levels shall not be less than 10 EPNdB ("cumulative margin").**

- **The sum of the differences at any two measurement points between the maximum noise levels and the Chapter 3 maximum noise levels shall not be less than 2 EPNdB.**

Chapter 3 and 4
- Noise Certification Reference Procedures -

- Take-off reference procedure
  - for the determination of the lateral full-power noise level
  - for the determination of the flyover noise level
- Approach reference procedure
  - for the determination of the approach noise level

Chapters 3 and 4
- Take-off Reference Procedure (1) -

Take-off reference flight path shall be calculated as follows:

- **Mass: The mass of the aeroplane at brake release shall be the maximum take-off mass at which the noise certification is requested.**

- **Engine thrust 1: Average engine take-off thrust or power shall be used from the start of take-off to the point where at least the following height above runway level is reached:**
  - **aeroplanes with two engines or less: 300 m,**
  - **aeroplanes with three engines: 260 m,**
  - **aeroplanes with four engines or more: 210 m.**

Chapters 3 and 4
- Take-off Reference Procedure (2) -

- **Engine thrust 2 (cutback):** Upon reaching the height specified above, the thrust or power shall not be reduced below that required to maintain:

  - a climb gradient of 4 per cent,
  - in the case of multi-engined aeroplanes, level flight with one engine inoperative,

  whichever thrust or power per engine is greater.

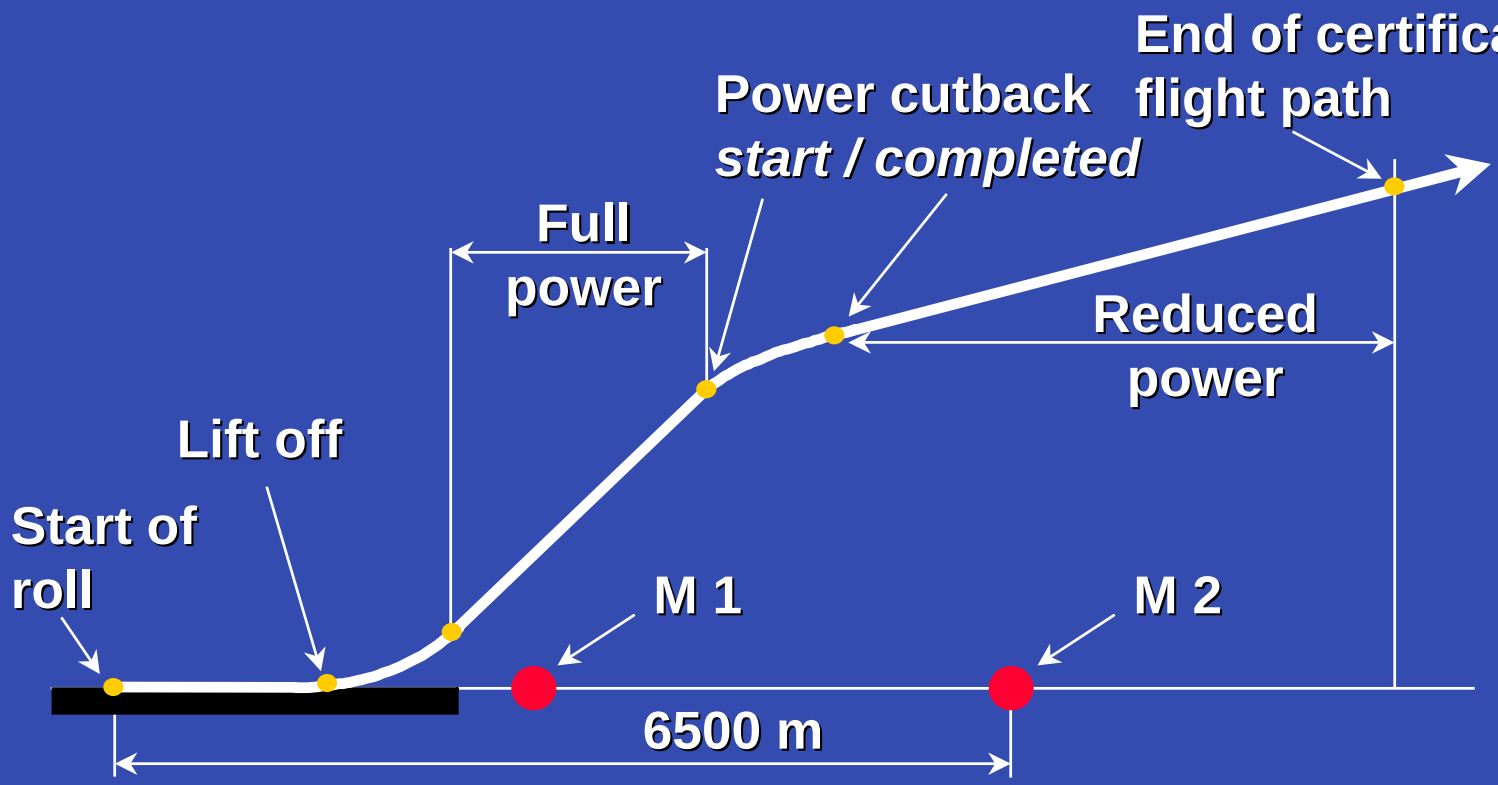
Chapters 3 and 4
- Take-off Reference Procedure (3) -

- **Engine thrust 3:** For the purpose of determining the lateral full-power noise level, the reference flight path shall be calculated on the basis of using full take-off power throughout without a thrust or power reduction.

- **Speed:** The speed shall be the all engines operating take-off climb speed and shall be at least V_2 + 10 kt but not greater than V_2 + 20 kt.

- Etc.

Chapters 3 and 4
- Take-off Reference Procedure (4) -



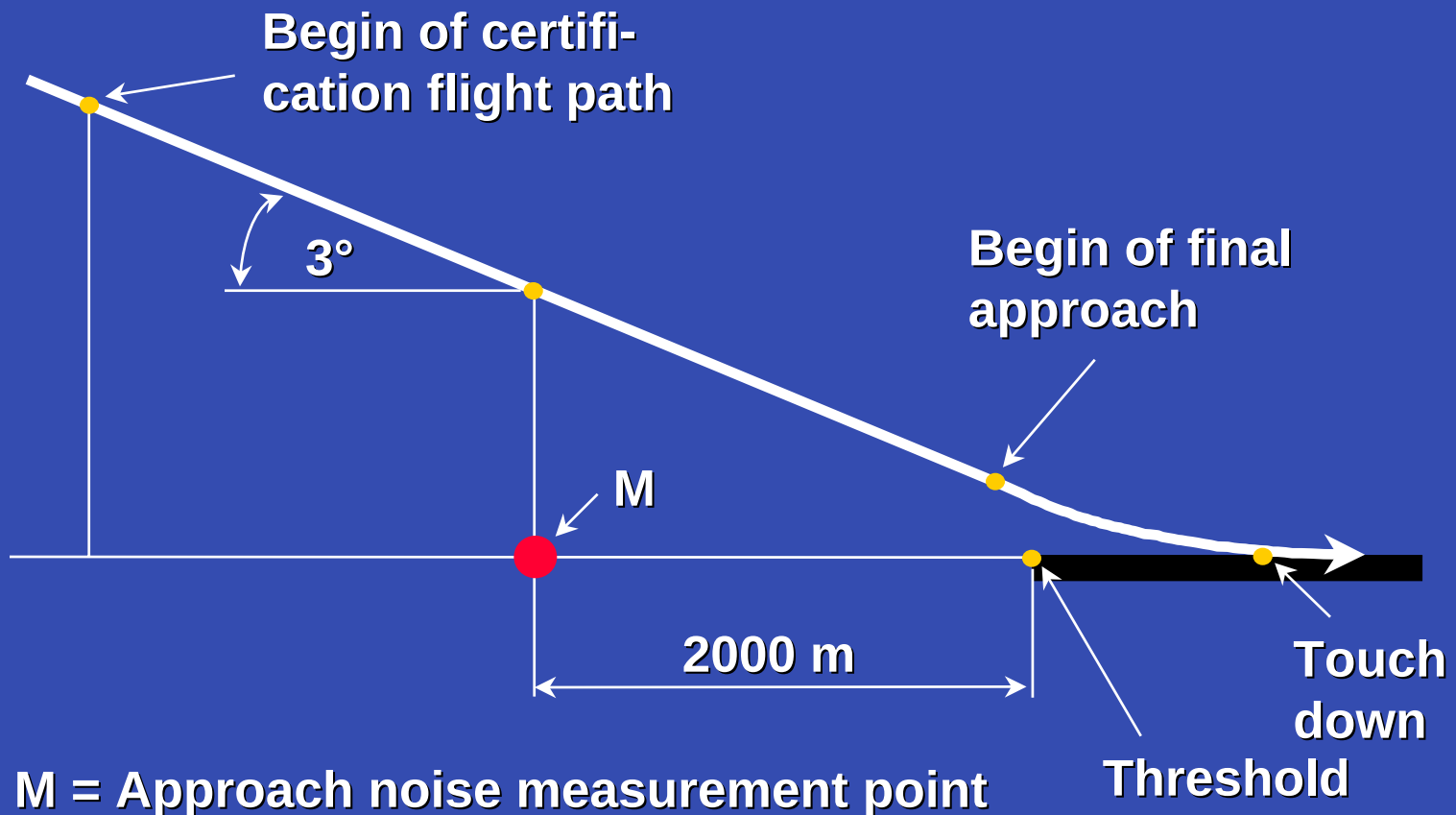
M 1 = Lateral full-power noise measurement point
M 2 = Flyover noise measurement point

Chapters 3 and 4
- Approach Reference Procedure (1) -

Approach reference flight path shall be calculated as follows:

- **Glide path: The aeroplane shall be stabilized and following a 3° glide path.**
- **Speed: A steady approach speed of V_{REF} + 10 kt, with thrust and power stabilized, shall be maintained.**
- **Mass: The mass of the aeroplane at the touchdown shall be the maximum landing mass at which noise certification is requested.**
- **Configuration: The most critical configuration (that which produces the highest noise level) shall be used.**
- **Etc.**

Chapters 3 and 4
- Approach Reference Procedure (2) -



M = Approach noise measurement point

Chapters 3 and 4
- Atmospheric Conditions (1) -

The reference procedures shall be calculated under the following reference atmospheric conditions:

- **Sea level atmospheric pressure of 1013.25 hPA**
- **Ambient air temperature of 25°C, i.e. ISA + 10°C**
- **Relative humidity of 70 per cent**
- **Zero wind**

Chapters 3 and 4
- Atmospheric Conditions (2) -

The tests shall be carried out under the following atmospheric conditions:

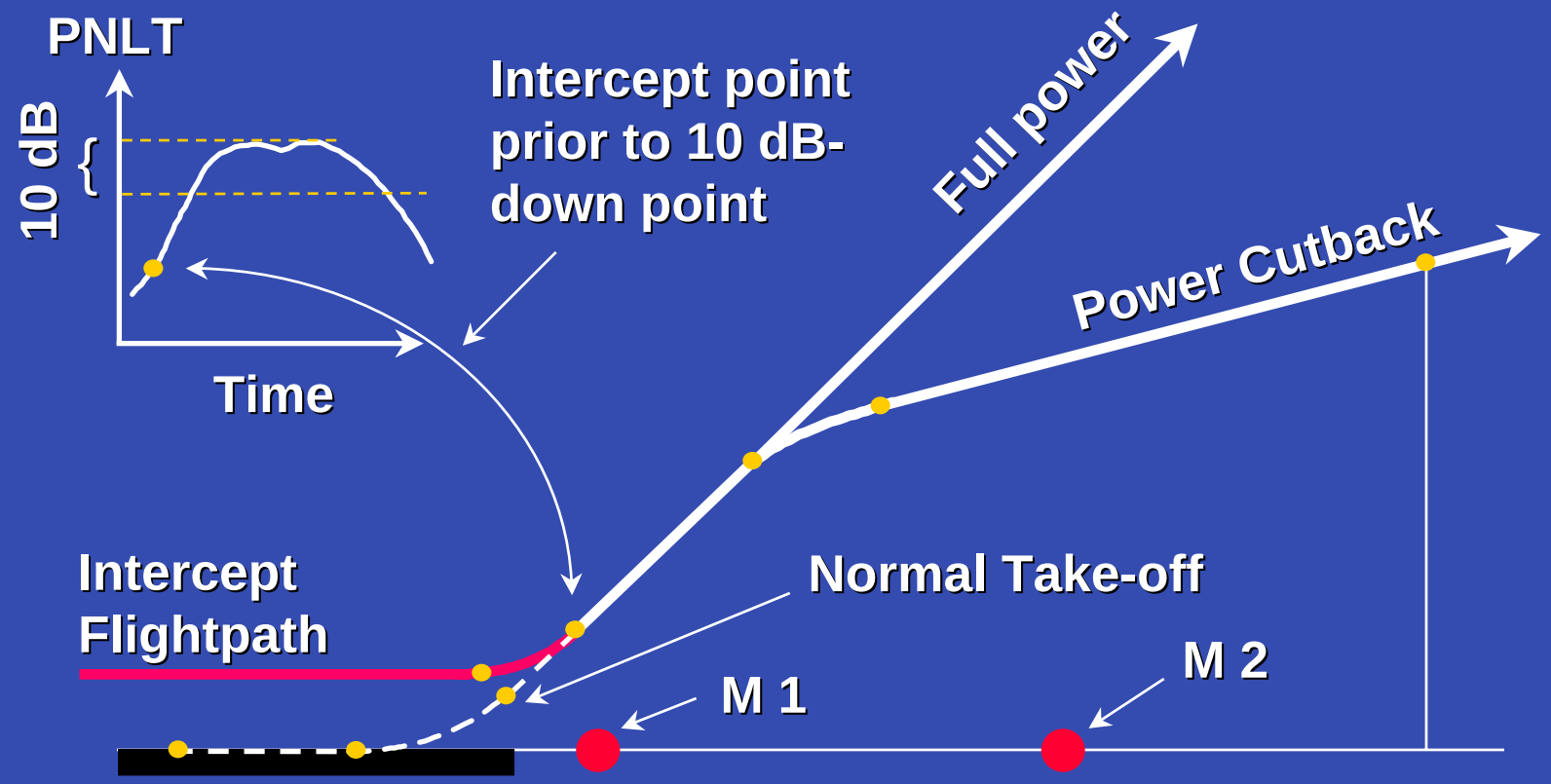
- **No precipitation**
- **Ambient air temperature between -10°C and 35°C**
- **Relative humidity between 20% and 95%**
- **Wind speed not above 12 kt and crosswind speed not above 7 kt at 10 m above ground**
- **No anomalous atmospheric conditions that would significantly affect the measured noise levels**

Equivalent Procedures - Questions

- What is an equivalent procedure?
  - An equivalent procedure is a test or analysis procedure which, while differing from one specified in Annex 16, Volume I, in the technical judgement of the certificating authority, yields effectively the same noise levels as the procedure specified in Annex 16.
- Why are equivalent procedures used?
  - To reduce cost and time
  - To obtain more information than just the “basic” noise data for a single configuration
- Where are equivalent procedures described?
  - In the ICAO Environmental Technical Manual (ETM)

Equivalent Procedures - Examples (1)

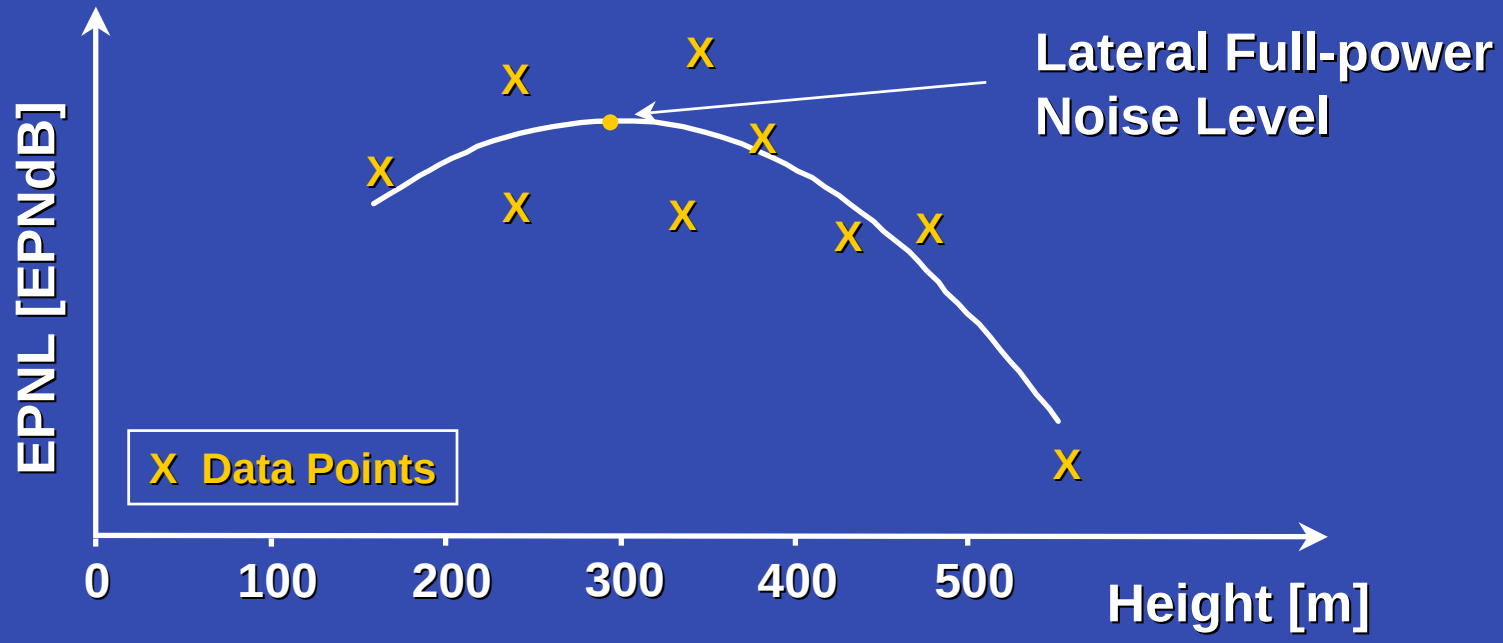
- Take-Off Intercept -



M 1 = Lateral full-power noise measurement point
M 2 = Flyover noise measurement point

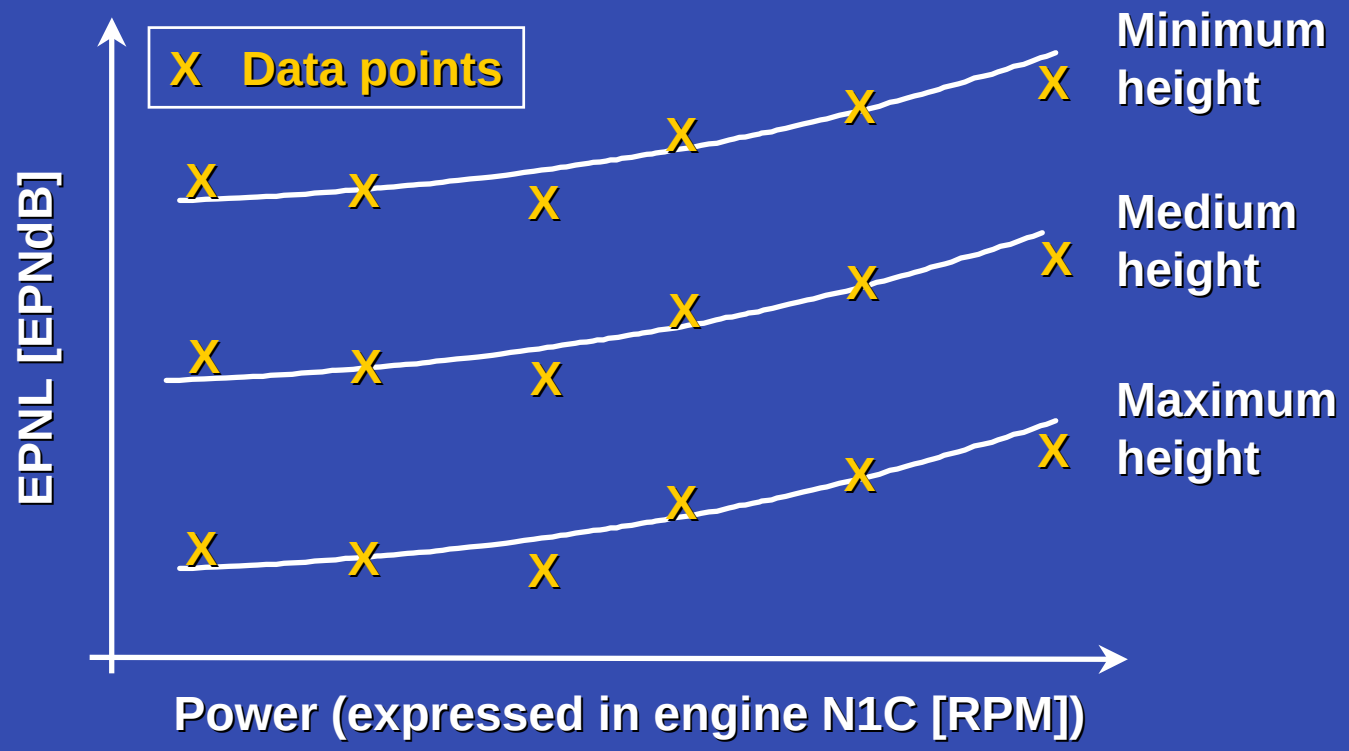
Equivalent Procedures - Examples (2)
- Measurement of Lateral Full-power Noise Level -

- Two microphones are located symmetrically on either side of the take-off reference track.
- Flights are carried out at full take-off power at different heights midway between the microphones.



Equivalent Procedures - Examples (3)
- Noise Power Distance (NPD) Curves -

NPD curves enable determination of noise levels when engine power/thrust has changed. No new noise test is necessary.



Equivalent Procedures - Examples (4)
- “Family Plan” Noise Certification Process -

- The “family plan” process typically is used for noise certification of an aircraft with a derivative engine.
- Main prerequisite is the development of a static-to-flight projection prediction scheme.

Typical Steps:

- Noise flight test with the aircraft with “parent” engine
- Static noise test with “parent” engine
- Static noise test with derivative engine
- “Parent” / derivative engine correlation
- Derivative engine static data projected to flight
- Estimate noise levels of the aircraft with derivative engine

ICAO Annex 16

- Certification of Small* Propeller-driven Aircraft -

Chapter 6

- Application accepted from 1975 to 1988
- One measurement point - flyover at 300 m at the highest power in the normal operating range
- Noise measured in dB(A)

Chapter 10

- Application accepted from 1988 onwards
- One measurement point - take-off flight path with max. take-off power
- Noise measured in dB(A)

*** MTOM ≤ 8618 kg**

ICAO Annex 16

- Certification of Helicopters -

Chapter 8

- Application accepted from 1985 onwards
- Three measurement points
  - Take-off with max. take-off power at best rate of climb speed Vy
  - Overflight at a height of 150 m
  - Approach following a 6.0° approach path
- Noise measured in EPNdB

Chapter 11 - for helicopters with MTOM ≤ 3175 kg

- Application accepted from 1993 onwards
- One measurement point - overflight at a height of 150 m
- Noise measured in dB SEL

Summary
- Annex 16, Volume I and Equivalent Procedures -

1. Introduction

- documents, chapters of Annex 16

2. Noise certification of subsonic jet and large propeller-driven aircraft

2.1 Reference conditions and initial demonstration procedures

- reference noise measurement points, noise evaluation measure, maximum noise levels, trade-offs, noise certification reference procedures, atmospheric conditions

2.2. Equivalent procedures

- definition, reasons for use, examples

3. Noise certification of small propeller-driven aircraft and helicopters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Thank you