

Human Performance & Limitations - Module The Cabin Environment

D — Poisons & The Cabin

Chapter 10 — The physical environment around the pilot: humidity, temperature, vibration, glare and UV, and what happens when a pilot is incapacitated in flight — from a simple faint to a fit.

BOOK

Human Performance & Limitations

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EXAM

DGCA CPL / ATPL — HPL

CHAPTER

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Plate 10.0 — The pilot's physical world: the heat, glare, dryness and vibration that quietly wear performance down.

§ 23 Humidity

23.1 Why Humidity Matters Up High

DGCA-QUOTED

Humidity may become an issue with high-altitude jet transport aircraft because of the low relative humidity at their operational altitudes. The discomfort arising from low relative humidity may not imply physical indisposition.

DGCA-QUOTED HUMIDITY RANGES

- **40 – 60 %** relative humidity is **NORMAL**.
- **< 20 %** may create **minor discomfort**, such as **skin, eye, nose, throat dryness**.

40–60% Normal relative humidity

< 20% Minor discomfort — skin, eye, nose, throat dryness

3–8% → 22% Modern humidifiers raise cabin RH from 3–8% to ~22%

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PREVENTION & MANAGEMENT

- **Overall dehydration can be prevented with adequate fluid intake.**
- **Diuretics like coffee or tea should be avoided.** They drive fluid out of the body via increased urination — the opposite of what is needed at altitude.

23.2 Aircraft Humidifier Systems

DGCA-QUOTED

The installation of humidifiers on aircraft **raises cabin/cockpit humidity**, but there are potential problems such as:

- **Weight penalty,**
- **Condensation,** and
- **Mineral contamination** that the designer must consider.

Aircraft such as the **Airbus A350, Boeing 787, and the future Boeing 777X** are compatible with onboard humidifiers, either in **crew areas or the entire cabin**. These technologies **increase humidity from 3–8 % to 22 %** and **reduce contaminants** in the air we breathe on a flight.

§ 24

Temperature

DGCA-QUOTED

Temperature affects performance as follows:

24.1 The Three Reference Temperatures — memorise verbatim

Temperature effects on pilot performance (DGCA verbatim)

Temperature	Effect on Performance
20 °C	Comfortable temperature for most people in normal clothing.
30 °C	Increased heart rate, blood pressure, and sweating.
> 15 °C	Discomfort, loss of feeling in hands, poor control of fine muscle movement. <i>(Note: source phrasing uses "> 15 °C" — referring to deviations beyond 15 °C from a comfortable baseline, i.e. cold-stress.)</i>

COCKPIT-TEMPERATURE CONSIDERATIONS

- **At 20 °C** the pilot is comfortable — fine motor skills, judgement and reaction time are optimal.
- **At 30 °C** the body's ANS responds to heat stress by raising HR, BP and triggering sweating to cool the skin. Cognitive performance starts to degrade.
- **In cold conditions** — far below the comfort baseline — the pilot loses sensation in the fingers, struggles with fine-motor tasks like switch selection or fast checklist scanning, and may shiver involuntarily.
- For both extremes, **cabin temperature management is a flight-safety task**, not merely a comfort one. Climate control should be set to keep cockpit temperature near 20 °C for sustained operations.

TEMPERATURE & PILOT PERFORMANCE



GHOST AVIATOR

Figure 10.1 — Pilot performance peaks around 20 °C; both cold and heat degrade it in their own way.

25.1 Natural Resonance — Why Frequency Matters

DGCA-QUOTED OPENING

Different parts of the body show a natural resonance at different periods of vibration. For example:

- The natural resonance of the eyeball is 30 – 40 Hz, and
- The skull is 1 – 4 Hz.

WHAT "NATURAL RESONANCE" MEANS IN PLAIN ENGLISH

Every physical structure has a frequency at which it *wants* to vibrate — push it at that frequency and small inputs build up into huge oscillations (think of pushing a child on a swing in time with the swing's natural period). When external aircraft vibration matches a body part's resonant frequency, **that part suffers maximum disturbance**. The eyeball resonating at 30–40 Hz is precisely why **vision becomes blurred at certain helicopter or propeller-vibration frequencies**.

25.2 Effects of Vibration — Full DGCA Frequency Table

MEMORISE THIS TABLE — DIRECT EXAM TARGET

Effects of vibration include:

Vibration frequency vs body effect (DGCA verbatim)

Frequency Range	Effect on the Body
1 – 4 Hz	Interference with breathing; neck pain. <i>(Skull resonance range.)</i>
4 – 10 Hz	Chest and abdominal pain.
8 – 12 Hz	Backache.
10 – 12 Hz	Headache, eyestrain, throat pain, speech difficulty, muscle tension.
30 – 40 Hz	Interference with vision. <i>(Eyeball resonance range.)</i>

VIBRATION & THE BODY

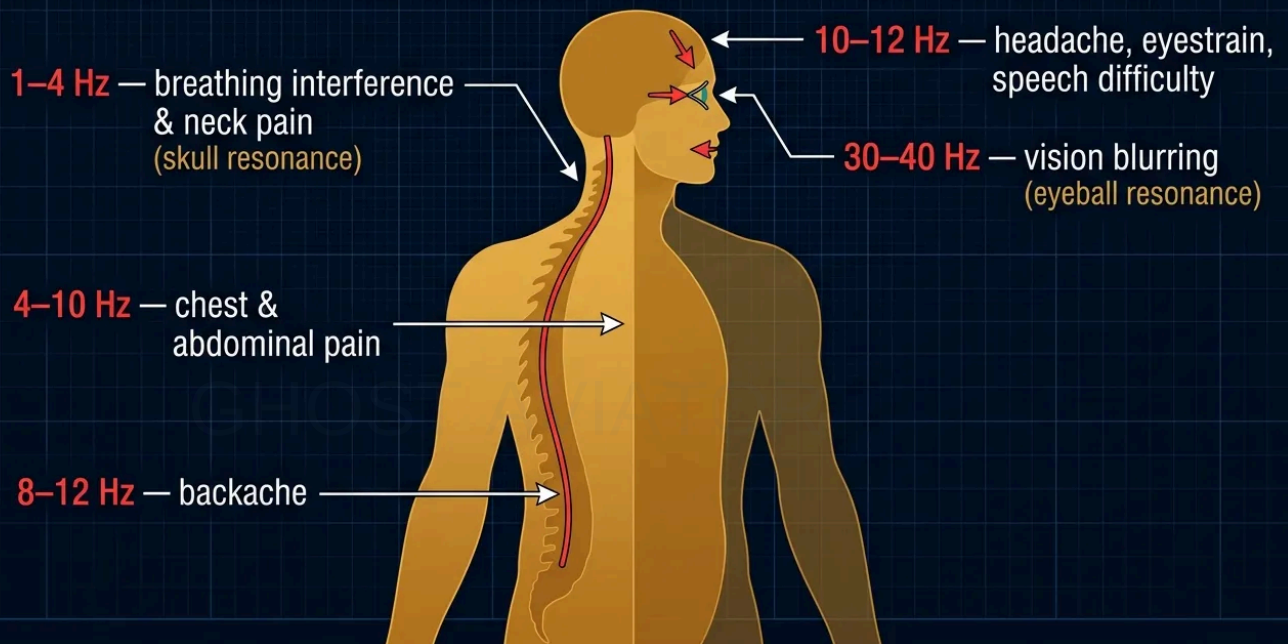


Figure 10.2 — Each vibration frequency band affects a specific body region; the natural-resonance bands are the dangerous ones.

OPERATIONAL VIBRATION SOURCES IN AVIATION

- **Helicopter rotors:** typically 4–7 Hz (main rotor) → chest/abdominal pain & backache range.
- **Piston / turboprop engines:** 10–30 Hz on the airframe → headache, eyestrain, vision interference.
- **Jet engine buffet:** higher-frequency, but resonant peaks in the seat may still strike critical body-part frequencies.
- **Turbulence:** low-frequency buffeting (1–10 Hz) → fits the skull / neck / chest range.

This is why aircraft seats incorporate **damping and isolation systems** — to keep the airframe's vibration spectrum from delivering energy at the worst body-resonance frequencies.

§ 26

Glare & UV Radiation

DGCA-QUOTED

UV radiation from sunlight can cause visual fatigue, as well as affect visual health.

WHY GLARE AND UV DESERVE THEIR OWN SECTION

At cruise altitudes (FL300+), the protective filtering of the atmosphere is reduced. Cockpit windows admit **significantly more UV-A and UV-B** than ground-level glass would. Over a long career, this contributes to:

- **Visual fatigue** — the immediate effect of glare on the working pilot. Squinting, eyestrain, reduced contrast sensitivity, headache.
- **Cumulative visual health damage** — cataract formation, macular degeneration risk, conjunctival/skin damage.

PRACTICAL PILOT PRECAUTIONS

- Use **aviation-grade polarised or non-polarised UV-blocking sunglasses** (note: certain LCD instruments may distort under polarised lenses — check before adoption).
- Use **cockpit sun-visors** appropriately — don't leave them stowed when the sun is over the nose.
- For long-haul crews, schedule **vision rest breaks** on autopilot legs.
- Periodic **aero-medical eye examinations** — already mandated by DGCA — pick up early cataract / retinal changes.

§ 27 INCAPACITATION IN FLIGHT

27.1 Why Pilot Incapacitation is a Flight-Safety Issue

DGCA-QUOTED INTRODUCTION — VERBATIM

The risk of seizure in flight is obvious. Incapacitation is in most cases:

- Sudden,
- Unpredictable,
- Unavoidable,
- Prolonged,
- Complete, and
- Potentially more frequent in the stressful flying environment,

... and constitutes a **direct threat to the health and safety**.

DGCA-QUOTED PREVENTION MEASURE

Periodical medical examinations minimize the risk of incapacitation in flight. The frequency of medical checks increases with advancing age.

CLASS-1 MEDICAL (COMMERCIAL PILOT) UNDER 40

12 months

CLASS-1 MEDICAL, 40+

6 months

CLASS-2 MEDICAL (PPL) UNDER 40

5 years (varies)

CLASS-2 MEDICAL, 40+

2 years (varies)

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(The DGCA medical-frequency periods are referenced in the syllabus generally and shown above for context; exact CAR / Schedule periods should be confirmed against the latest DGCA medical CAR / FAA Part 67 equivalent.)

27.2 Obvious Incapacitation

DGCA-QUOTED DEFINITION

Obvious incapacitation normally refers to a state in which **all of a crew member's physical or mental functions are lost**, including:

- **Loss of consciousness**, OR
- **Being unable to move while retaining consciousness**,
... **rendering them completely unable to carry out their duties.**

ONSET PATTERNS & PRESENTATION

- Obvious incapacitation can sometimes involve **convulsions**,
- OR the victim may **lapse into unconsciousness several minutes after the incapacitation occurs.**

DGCA-QUOTED CAUSES OF OBVIOUS INCAPACITATION

- **Cardiac arrest**
- **Myocardial infection** (*textual variant — "myocardial infarction" — heart attack*)
- **Interracial hemorrhage** (*intended: "intracranial haemorrhage" — bleed in the brain*)
- **Cerebral apoplexy** (*stroke*)
- **Epilepsy**

The source PDF uses the phrasings shown — students should be aware of the modern medical terminology in parentheses.

27.3 Subtle / Insidious Incapacitation

DGCA-QUOTED DEFINITION

SUBTLE (develops slowly and gradually), incapacitation refers to a state of a **partial or temporary loss of physical or mental function** which manifests itself in the form of:

- **Partial paralysis**,
- **A dulling of perception, judgment, or responses** or lack thereof,
- **A state of absence of mind, distraction of attention**,
- **Trouble with speech**,
- **Inadequate responses**,
- **Meaningless utterances**, etc.

THE HIDDEN-DANGER WARNING — DGCA VERBATIM

Particular attention must be paid to the fact that a crew member may become incapacitated **EVEN THOUGH THEIR APPEARANCE IS NO DIFFERENT FROM NORMAL.**

POSSIBLE CAUSES OF SUBTLE INCAPACITATION — DGCA LIST

- **Temporary hypoglycemia** (low blood sugar — pilot skipped meals)
- **Reduction in blood pressure**
- **Cerebroopathy or psychopathy**
- **Excessive muscular fatigue**
- **Excessive drinking** (see §14)
- **Insufficient sleep**
- **Emotional instability**
- **Toothache**
- **Stomachache**
- **Headache**

27.4 Obvious vs Subtle — Why Subtle is MORE Dangerous

DGCA-QUOTED — THE COUNTERINTUITIVE TRUTH

Since other crew members are often unable to detect subtle incapacitation quickly, from a flight safety point of view, it is possible that **SUBTLE INCAPACITATION MAY LEAD TO A SITUATION OF COMPARATIVELY GREATER DANGER THAN OBVIOUS INCAPACITATION.**

WHY THIS MATTERS IN TWO-CREW OPERATIONS

With **obvious incapacitation**, the other crew member sees the captain slumped or convulsing, declares emergency, takes control, gets the aircraft on the ground. The hand-off is instant.

With **subtle incapacitation**, the captain is still moving switches, talking on the radio, even responding to questions — but his judgement is impaired. He may set the wrong altitude, mis-tune a NAV, mishear an ATC clearance, or fail to initiate a missed approach. The other pilot may not detect this until *after* the wrong outcome unfolds. This is the rationale behind **two-crew CRM**: a healthy independent cross-check that catches subtle drift before it becomes an accident.

OBVIOUS Incapacitation

- **All functions lost** — LoC or paralysed-conscious
- May include convulsions / delayed LoC
- **Detected instantly** by the other crew
- Causes: cardiac arrest, MI, intracranial bleed, stroke, epilepsy
- **Handover happens fast**

SUBTLE Incapacitation

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- **Partial or temporary** loss of function
- Appearance may be normal
- **Often undetected for some time** by the other crew
- Causes: hypoglycemia, ↓ BP, fatigue, sleep loss, drinking, emotional/dental/stomach/headache
- **Greater overall flight-safety danger**

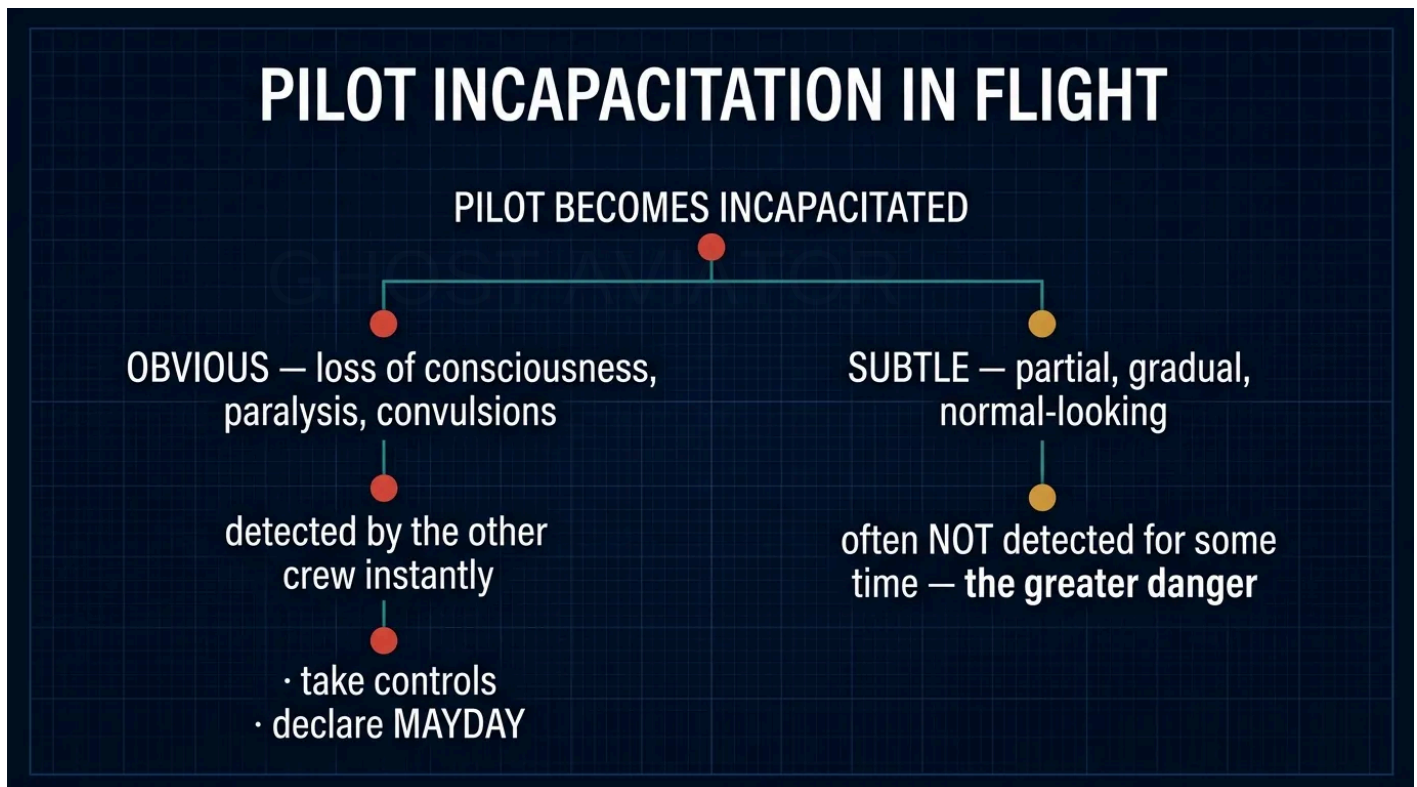


Figure 10.3 — Pilot incapacitation: recognising it and the other crew member's response.

§ 28

FITS & FAINTS

28.1 Epilepsy — Grand Mal & Petit Mal

DGCA-QUOTED DEFINITION

A **fit or seizure** is usually referred to as "**epilepsy**". A fit or a seizure is **not a specific disease** but a **set of signs or symptoms in response to a disturbance of the electrical activity in the brain**.

Grand Mal Epilepsy

- Manifests as a **generalized seizure**
- **Associated with a transient loss of consciousness**
- May be associated with a **prodromal phase** (*warning aura before the seizure*)

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- Normally accompanied by **convulsions and uncontrolled physical movement**

Petit Mal Epilepsy

- Also a **generalized seizure**
- **Not associated with a loss of consciousness**
- **Petit Mals are a MINOR attack**
- Often presents as brief "absence spells" — staring, blanking out for a few seconds

DGCA-QUOTED — THE ABSOLUTE BAR

A seizure may or may not be associated with a loss of consciousness... but **ANY FIT, MAJOR OR MINOR, IS ASSOCIATED WITH AN UNPREDICTABLE LOSS OF CONSCIOUSNESS AND IS THEREFORE AN ABSOLUTE BAR TO THE HOLDING OF A FLYING LICENCE.**

PILOT-MEDICAL IMPLICATION

This is one of the very few *absolute* medical disqualifications in aviation. Even controlled epilepsy on medication — even a single documented seizure event in adult life — is grounds for medical refusal. The reason is the word "**unpredictable**" — DGCA cannot certify the probability of an in-flight seizure as acceptably low.

28.2 Faint & Vasovagal Syncope

DGCA-QUOTED DEFINITION

Faint is a common cause of a loss of consciousness in adults. The most common causes of faints are:

Common causes of faint — DGCA verbatim list

#	Cause
1	Standing up quickly after prolonged sitting especially when hot or dehydrated
2	A sudden shock
3	Loss of blood after an accident
4	Lack of food or fluid
5	Other physiological stress

DGCA-QUOTED — SYNCOPE & VASOVAGAL SYNCOPE

Syncope is a temporary but sudden loss of consciousness when blood flow to the brain is compromised. In young individuals, **fear, anxiety, sight of blood, etc.,** can result in a temporary loss of consciousness. This is referred to as **VASOVAGAL SYNCOPE**.

Frequently, syncope is associated with symptoms like:

- **Light-headedness,**
- **Muscle weakness,** and
- **Dizziness** before the actual fainting occurs.

DGCA-QUOTED — FLIGHT-LICENCE IMPLICATION

A faint has NO SIGNIFICANCE as far as future flying is concerned, so long as the cause is clearly understood.

EPILEPSY VS FAINT — THE CRITICAL COMPARISON

This is the most frequently tested contrast in DGCA HPL papers. Memorise it:

Epilepsy vs Faint (Syncope) — side-by-side

Parameter	Epilepsy (Grand/Petit Mal)	Faint (Syncope)
Underlying cause	Disturbance of brain electrical activity	Compromised blood flow to the brain
Loss of consciousness	Often (Grand Mal) / Absent (Petit Mal)	Yes, temporary & sudden
Convulsions / uncontrolled movement	Yes (Grand Mal)	No
Predictability	Unpredictable	Cause is usually identifiable (heat, hunger, fear, blood loss)
Typical warning signs	Prodromal aura (Grand Mal)	Light-headedness, muscle weakness, dizziness
Effect on flying licence	ABSOLUTE BAR — no licence	No significance — fit to fly if cause is clear

FITS vs FAINTS

LOSS OF CONSCIOUSNESS

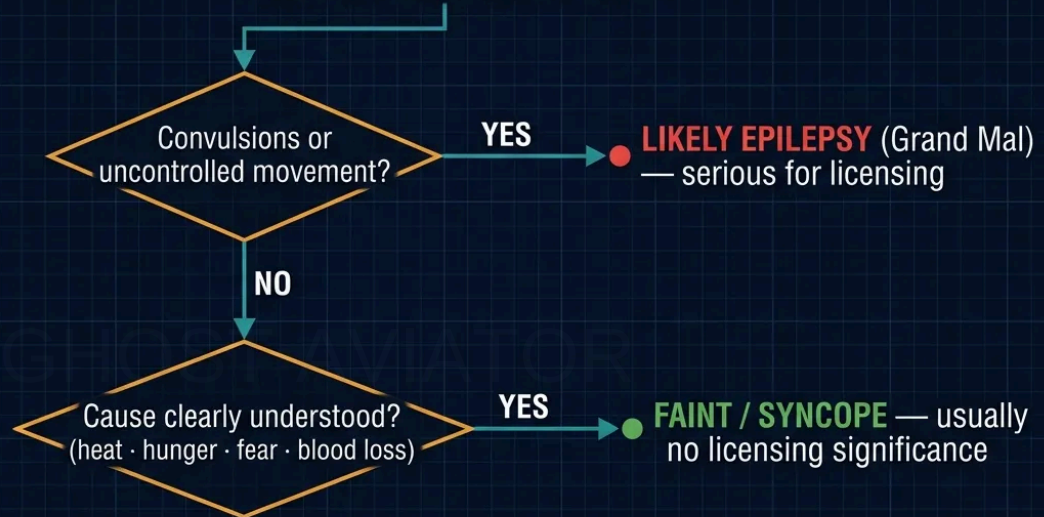


Figure 10.4 — Fits and faints: causes of syncope and how epilepsy differs from a simple faint.

✦ END OF CHAPTER 10 ✦

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