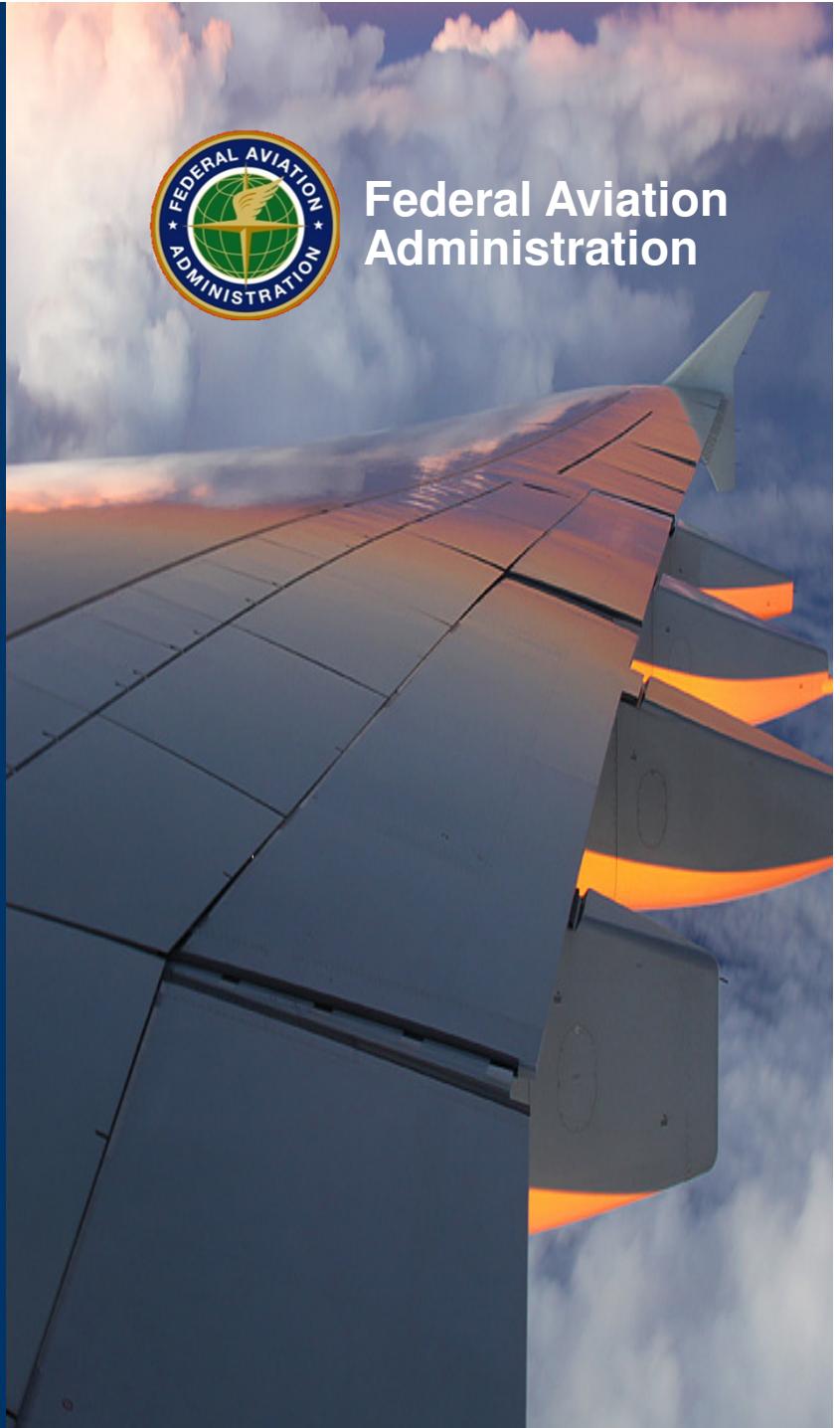


Flight Simulator Qualification

Jeffery A. Schroeder
Chief Scientific and Technical Advisor
Flight Simulation Systems

**Flight and Ground Vehicle
Simulation Course**
SUNY Binghamton

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Questions

- What does qualification mean?
- How many different qualification levels are there?
- Who qualifies simulators?
- How do the levels relate to how they are used?
- When are simulators qualified?
- How are simulators qualified?
- Is the U.S. different from the rest of the world?
- Is it all worth it?
- Do the standards change, and if so, how?
- How much do simulators vary at a given qualification level?
- What are the strengths and weakness of qualification?
- What is the future going to look like?

Take Away

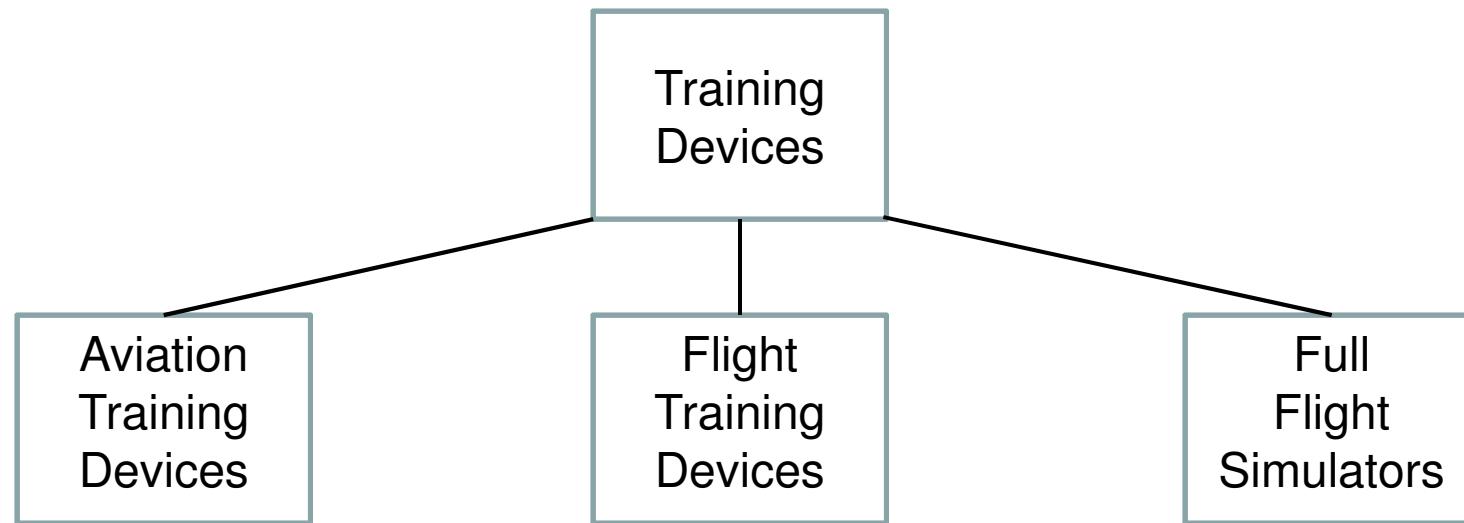
- Civil simulators have detailed qualification requirements...it's the law
- Qualification has objective and subjective parts
- Most devices in use are qualified at the highest qualification levels

What does qualification mean?

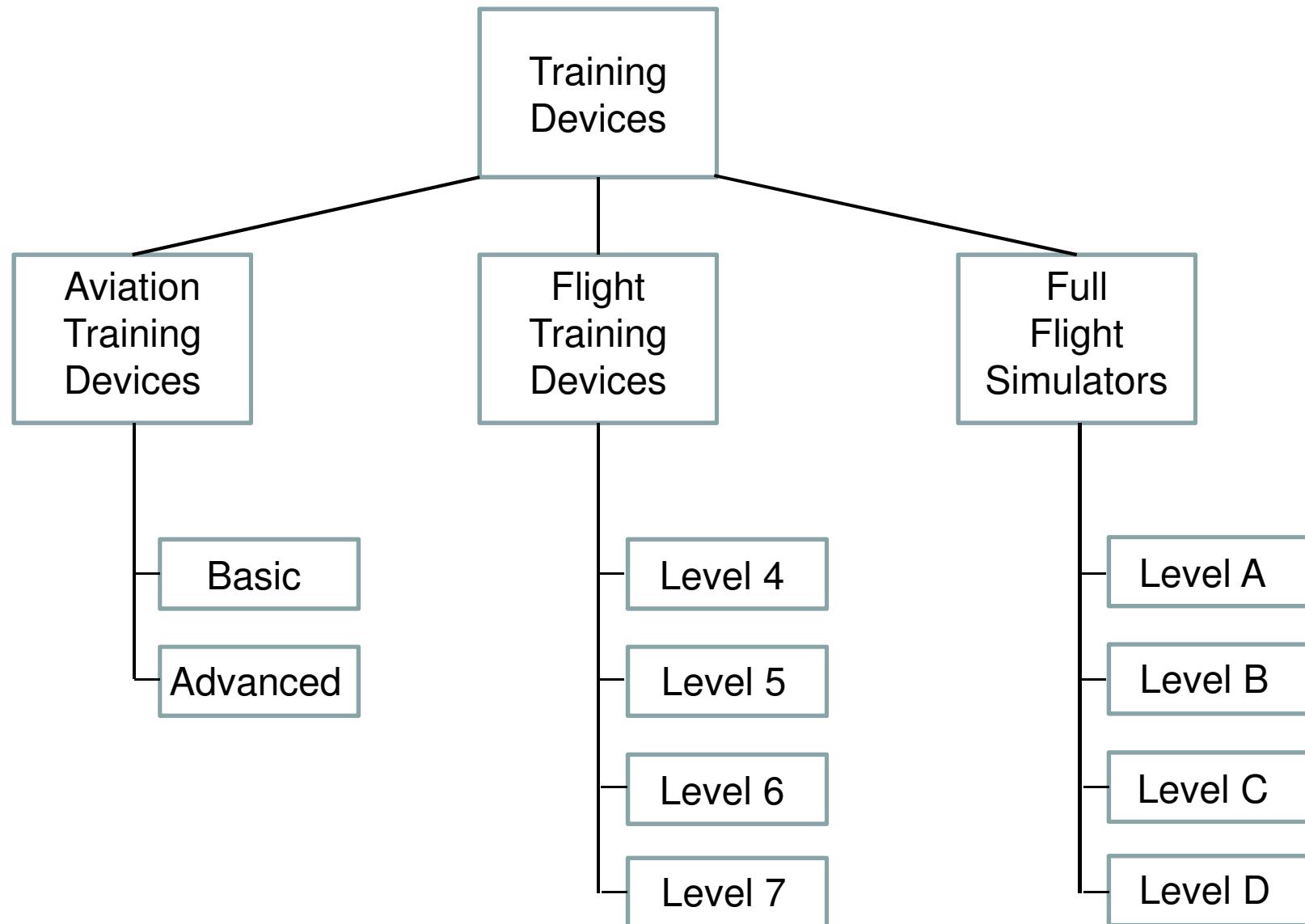
- That you have met the capabilities for a particular device category as prescribed by
 - Title 14 Code of Federal Regulations Part 60*
- Allows a device to then be used to meet training, checking, or experience requirements
- Approval of the training tasks by a principal operations inspector or training center program manager

* - or an earlier standard, if applicable

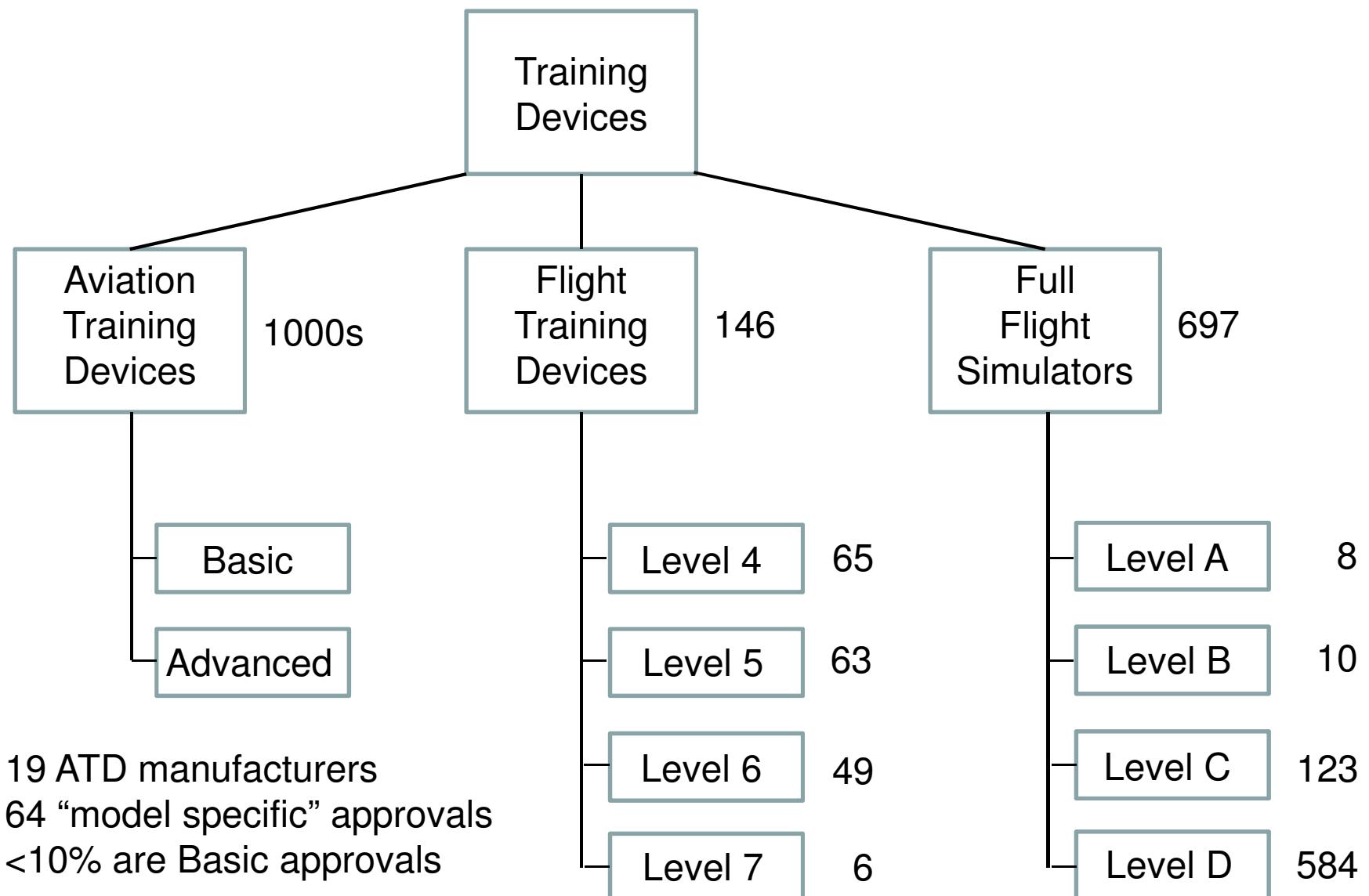
How many different qualification levels are there?



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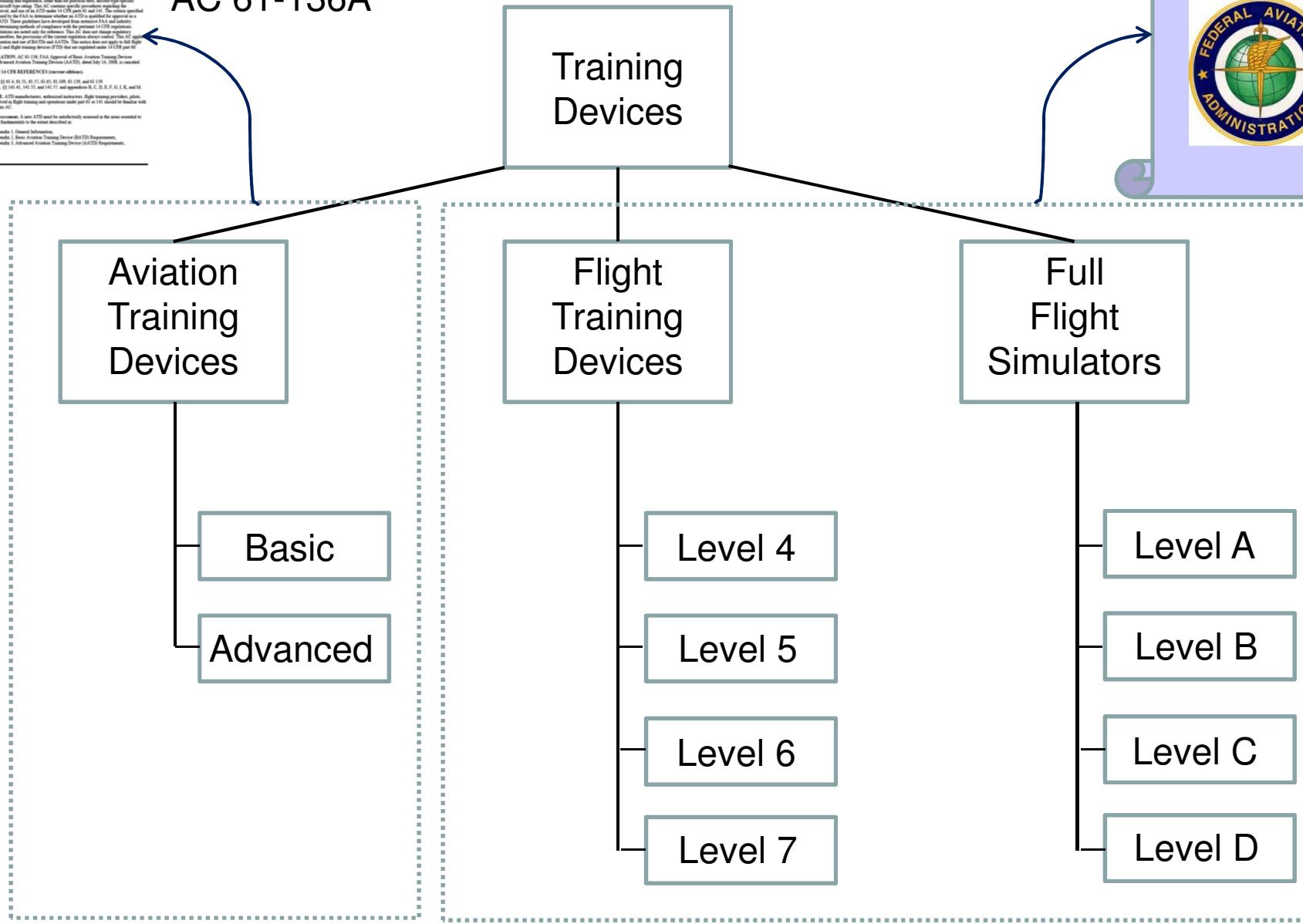


Who qualifies simulators?

Part 60



AC 61-136A



How do the levels relate to how they are used?

Basic Aviation Training Device



For a make and model, or family of aircraft
Self-centering inceptors;
Dynamics comparable for deflections
Control loading does not replicate airplane
Lift effects for turning, changes due to flap, gear

2.5 hrs towards private pilot license
10 hrs towards instrument license
Use for instrument recency
Listed at \$7500 w/o PC and monitors

Advanced Aviation Training Device



Layout to exceed above for better immersion
Instrument panel must represent specific a/c
Two-axis autopilot if applicable
Independent visual to represent IFR and VFR
Can simulate flight manual emergencies

20 hrs towards instrument, 50 hrs commercial
25 hrs airline transport pilot's license
Cessna 172 G1000

Both devices are used for training, not checking

How do the levels relate to how they are used?



A340 Level 4 Flight Training Device

Characteristics

Equip simulated enough for training
May be open or closed cockpit
No visual system required
No motion system required
No aerodynamic programming required
No objective tests

Use*

Learning procedures
Learning flight management system

- - See Table B1B (D1B) in Part 60 for complete list of airplane (helicopter) tasks allowed in Flight Training Devices

How do the levels relate to how they are used?



**Level 5 Flight Training Device
CRJ 700**

Characteristics

Cockpit and systems match an aircraft
Generic aero programming
 $\leq 300\text{ms}$ time delay
Nav allows for instrument approach
Control loading to allow instr. approach
Steep turns
Normal climb
Accels and decels
Flap, gear, trim forces
Static stability
Phugoid evaluated
Roll response evaluated
Yaw response evaluated
Spiral stability evaluated

Use

Instrument rating renewals
Precision approach w/ autopilot
Non-precision approach w/ autopilot

How do the levels relate to how they are used?

Characteristics

Enclosed flight deck replica
Effects of weight and c.g.
Comm equipment like airplane
Control loading like airplane
If motion system, $\leq 300\text{ms}$
If visual system, meets Level A simulator
Significant sounds
Approach-to-stalls
Engine failure procedures
Instrument procedures
Normal and abnormal procedures
Stick force/g
Short period
Tighter roll response and spiral stab.



**Level 6 Flight Training Device
A320**

Use

Type-specific training*
Instrument takeoff*
Flight management system procedures
In-flight powerplant failure, single engine
Emergency descents

How do the levels relate to how they are used?



Level 7 Flight Training Device
Now airplanes and helicopters

Characteristics

<= 2 arc min visual resolution^H

<= 150 msec delay^H

<= 120 msec delay^A

Hover performance checks^H

Low speed handling qualities^H

Autorotations^H

146H x 36V field-of-view^H

176H x 36V field-of-view^A

Vibration cueing system^H

Use

Instrument takeoff, wheeled gear^H

Flight control system abnormalities^H

For Airplanes, can train but not check
takeoffs and landings

How do the levels relate to how they are used?



**Level A Full Flight Simulator
Turbo Commander**

Characteristics

3-axis motion system
Static control loading
45H x 30V field-of-view
Night scene
Some cockpit noise

Use*

Recency of experience
Engine loss of takeoff*
Unusual attitude recovery
Precision approach
Missed approach
Flight control abnormalities

- - See Table A1B (C1B) in Part 60 for complete list of airplane (helicopter) tasks allowed in Full Flight Simulators

How do the levels relate to how they are used?



**Level B Full Flight Simulator
King Air**

Characteristics

3-axis motion system
Static control loading
45H x 30V field-of-view
Night scene
Some cockpit noise
Better aero, (Dutch roll)
Normal, one-eng, & x-wind landings
Envelope limits
Ground effect
Ground handling
Motion special effects
Visual cues to assess sink rates

Use

Recency of experience

How do the levels relate to how they are used?



**Level C Full Flight Simulator
A400M**

Characteristics

6-axis motion system
Static & dynamic control loading
176H x 36V field-of-view
Night, dusk, and day scenes
Significant cockpit noise
Ground handling
Windshear
Icing
Runway contaminants
Lower delays
Special weather effects

Use

Full instrument prof. check
Initial training and air-trans-pilot checks
Taxiing checks
Normal and x-wind takeoffs
Most of the ATP and type landings
CQ training and check

How do the levels relate to how they are used?



**Level D Full Flight Simulator
B787**

Characteristics

6-axis motion system
Static & dynamic control loading
180H x 40V field-of-view
Night, dusk, and day scenes
Ground handling
Runway contaminants
Operating **RADAR**
Measured buffet
High-alt Mach effects
Sideslip nonlinearities
Thrust effect on surfaces
Aeroelastics
Sounds objectively checked
Motion vibrations object. checked

Use

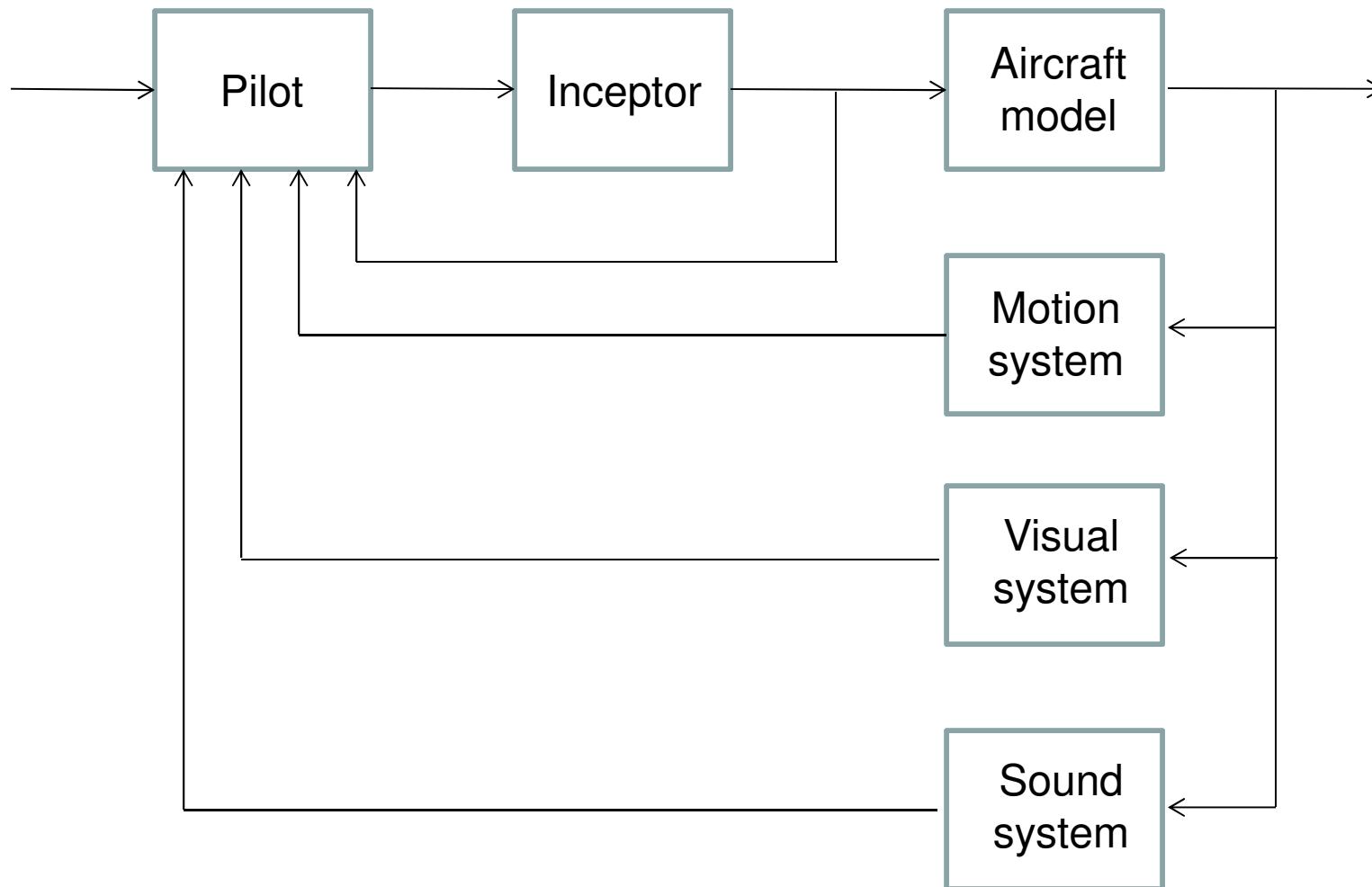
Total checking

When are simulators qualified?

- Initial
- Continuing
 - Annually: Half-day by pilot
 - When there is a change made deemed to require requalification: As much as 2-day by pilot and eng.
 - When simulator has physically moved
- Spot checks can occur unannounced
- Grandfathering

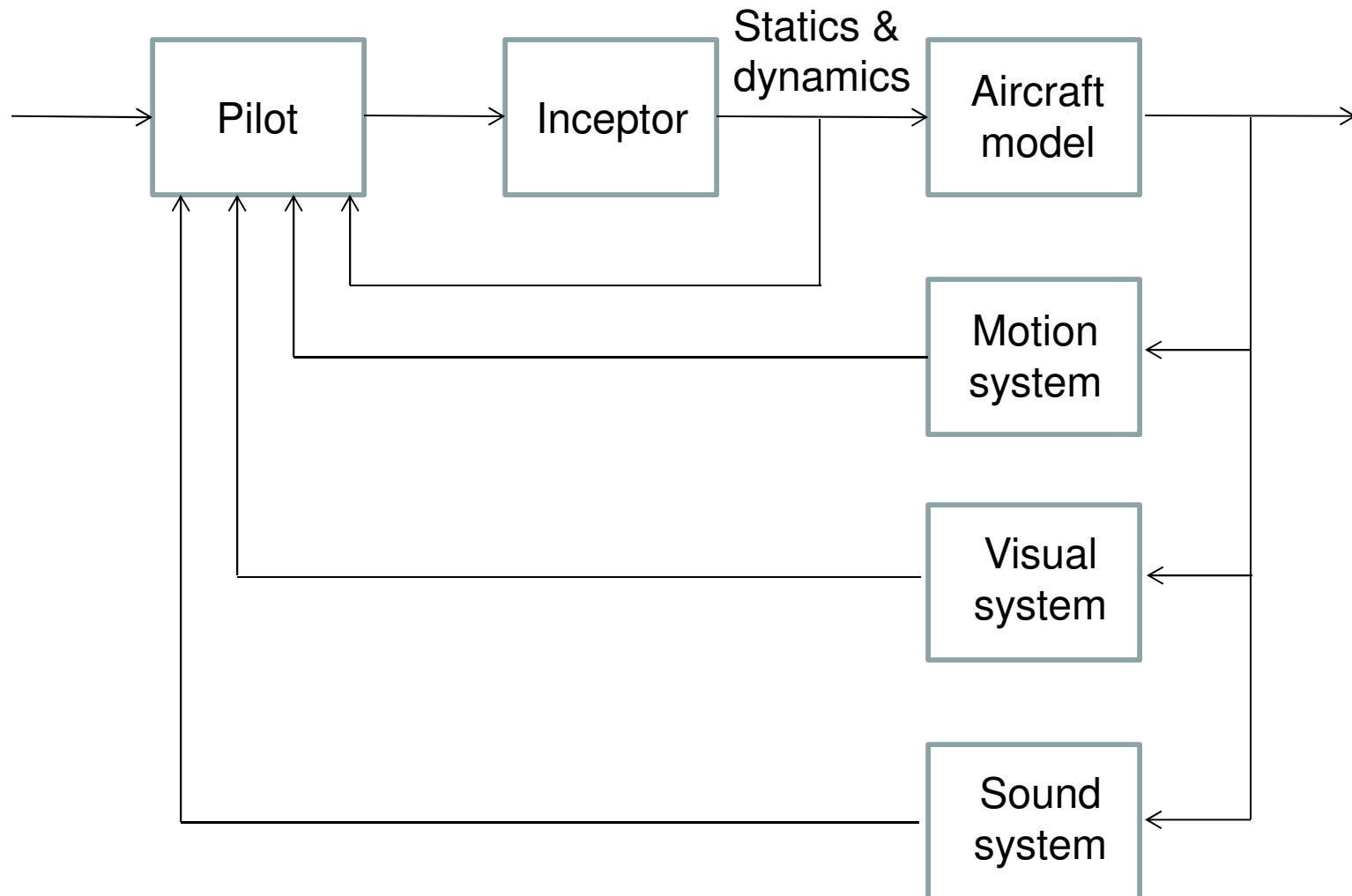
How are simulators qualified?

Objective tests



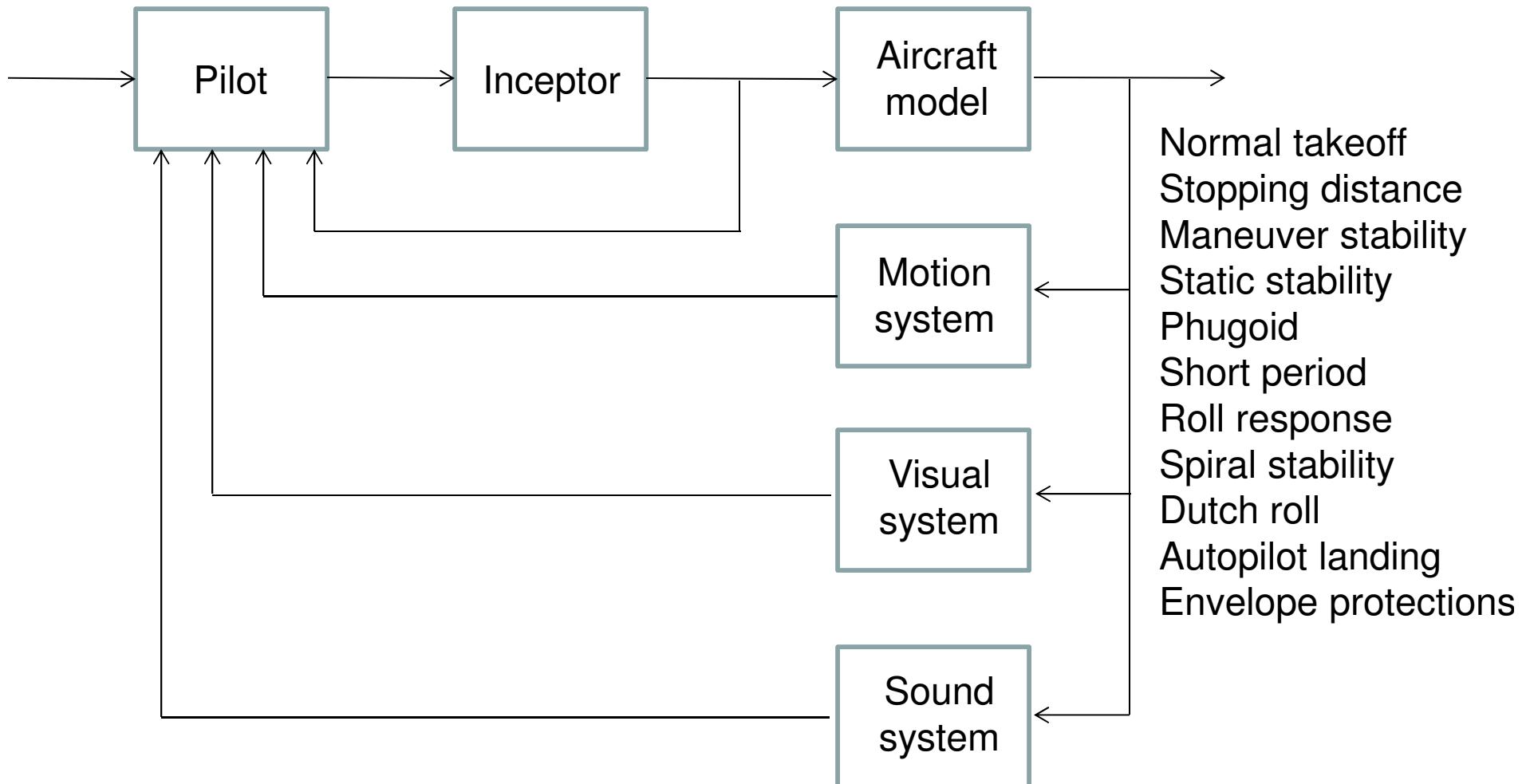
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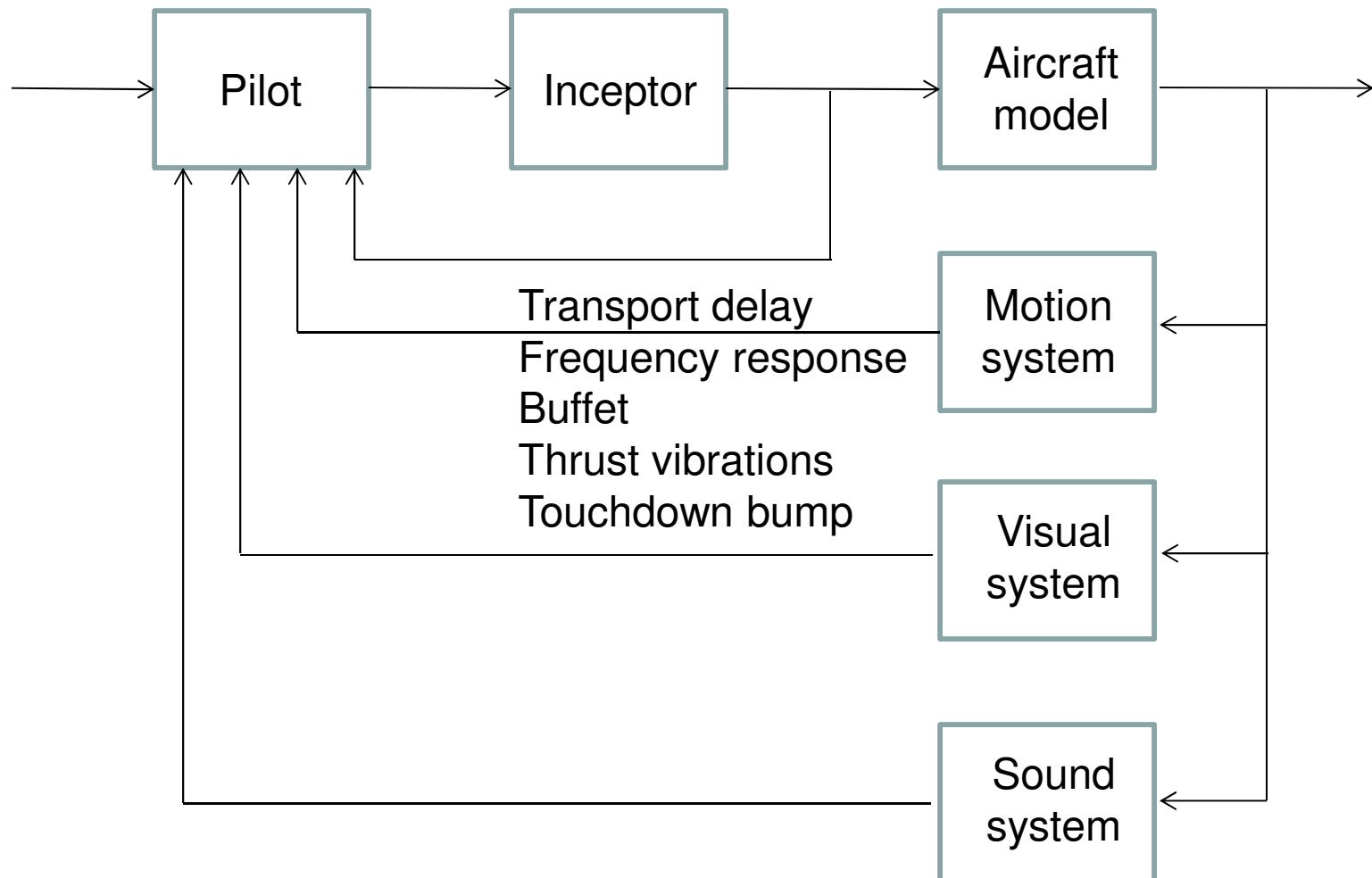
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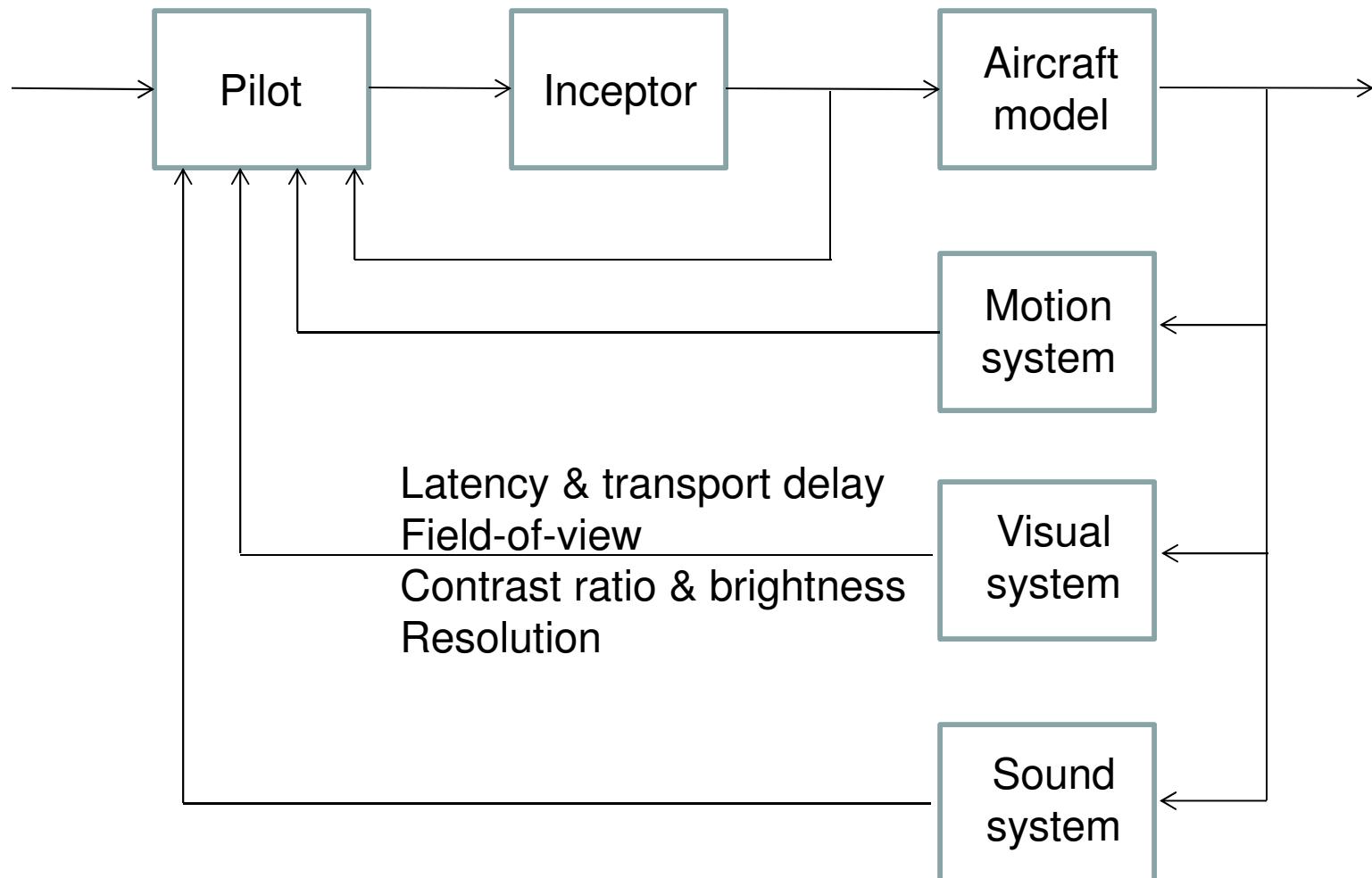
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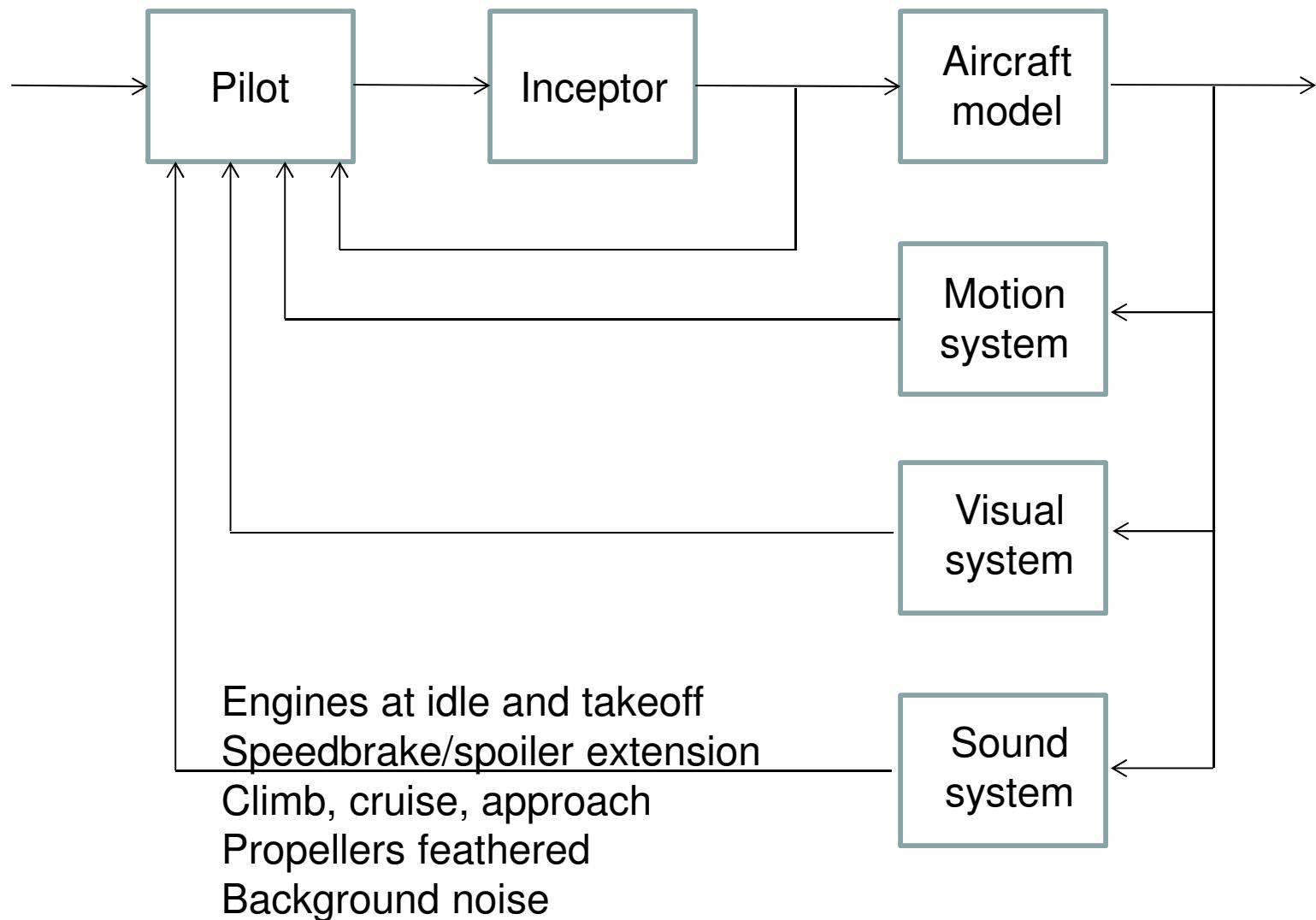
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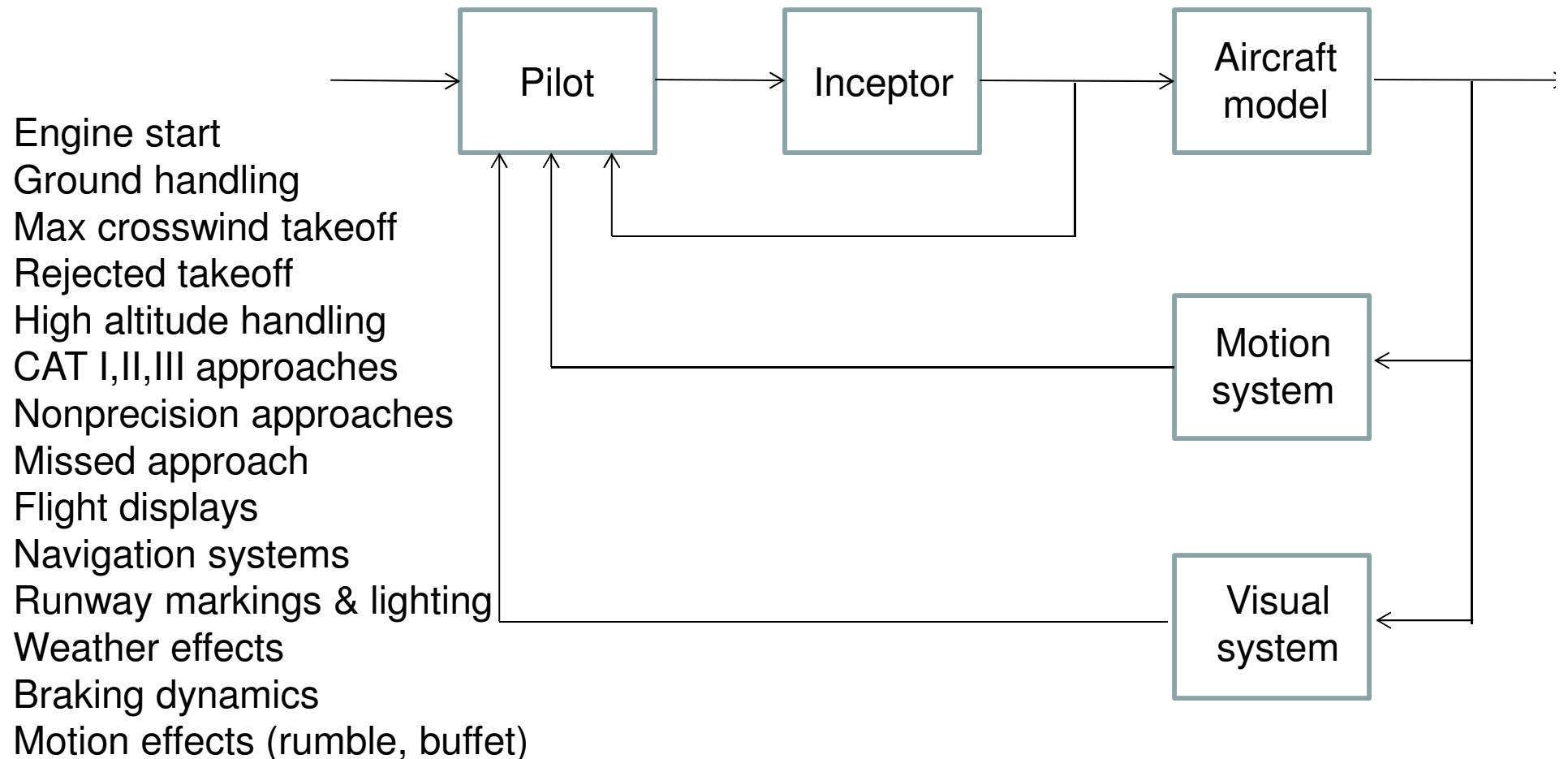
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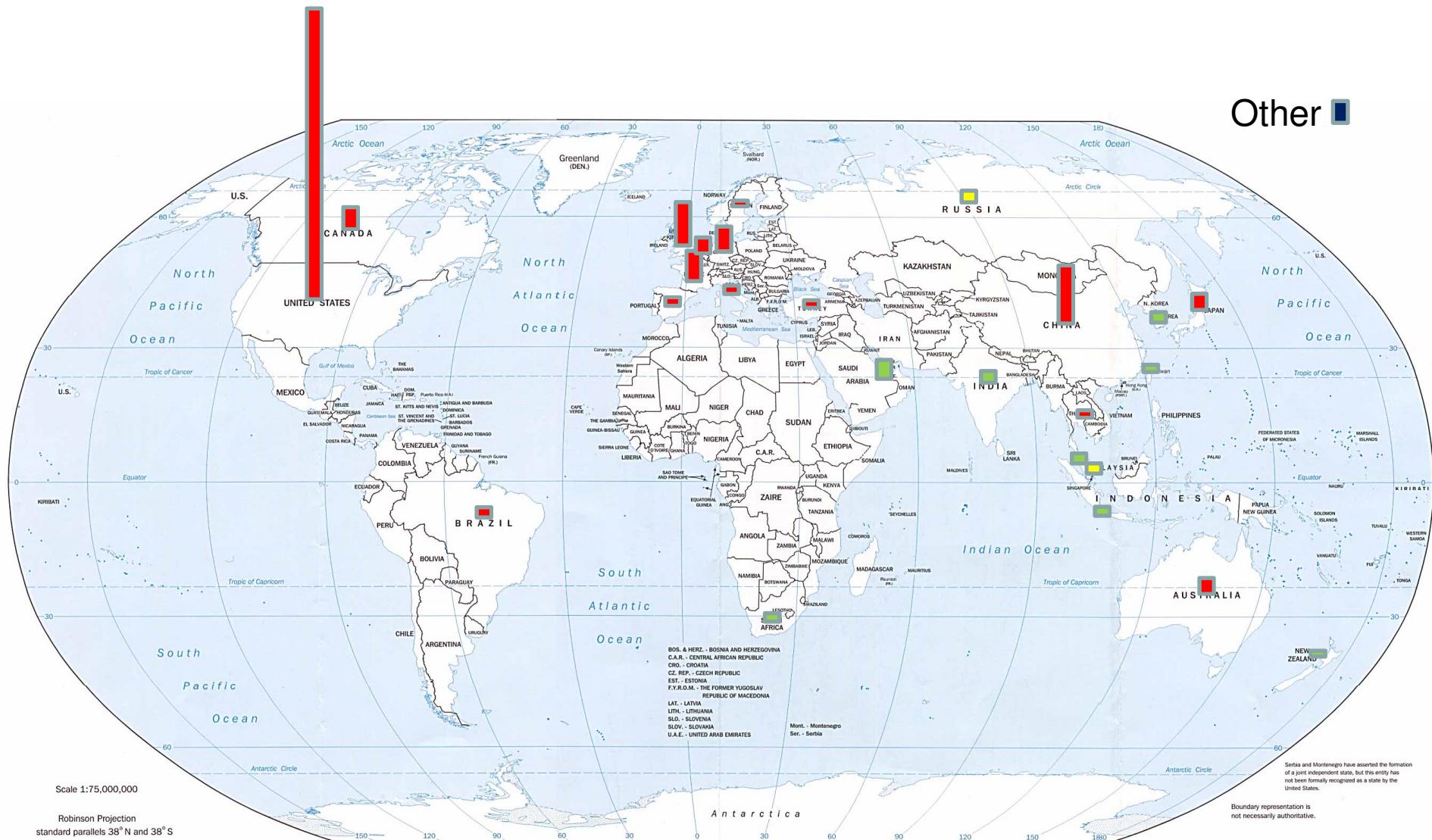


How are simulators qualified?

Subjective tests



Is the U.S. different from the rest of the world?



US/Europe regs

ICAO, Ed. 3 regs

National authority regs.

Is it all worth it?

- Benefits (hard to put \$ value on)
 - Enforces consistent standards community-wide
 - Provides incentive to give attention to simulators
 - Provides traceability
- Costs (easier to put \$ value on)
 - Industry labor: several person-weeks
 - Government labor and travel: 2 person-weeks
- Most say it is worth it
 - It is a fair and transparent process
 - Most all simulators pass tests (>99%), but undoubtedly everyone gets ready for test
 - Looking at ways to make overall process better

Do the standards change, and if so, how?

- Yes, they change
- Industry/government/academia team makes recommendations
- Changes are proposed and published
- Anyone can comment
- Comments considered, then new rules take effect
- Just published changes for upset training
 - New stall models
 - Better icing models
 - New instructor tools

Do the standards change, and if so, how?

AC 121-14 1969	Adv. Sim. Plan	14 CFR 121 App. H	AC 121-14C 1980	AC 120-40 1983	AC 120-40A 1986	AC 120-40B 1991	AC 120-40C 1995	14 CFR 121 App.H 1996	Part 60 2008
Visual Nonvis	Visual Nonvis Phase I Phase II Phase III	Visual Nonvis Phase I Phase II Phase III	Basic Phase I Phase II Phase III	Level A Level B Level C Level D					

How much do simulators vary at a given qualification level?

- Typically, the aerodynamics come from a common source
- Avionics can vary
 - Some simulated
 - Some the real hardware
- Items like airports simulated vary
- Certainly the subjective testing can result in some variance
- Some pilots don't like to fly particular simulators
 - e.g., incorrect aspects of simulated autopilots can result in expressed discomfort
- Bigger differences across older qualifications

What are the strengths and weaknesses of qualification?

- Strengths
 - A codified, widely-accepted standard is in place
 - Safety is complex, but it is hard to argue that the system isn't working
- Weaknesses
 - Little direct proof exists between qualification levels and training effectiveness
 - Subjective tests allow for variability
 - A lot of time can be spent qualifying simulators to satisfy multiple countries

What is the future going to look like?

- Standards will improve and be even more consistent
- More mutual recognition of qualification among countries
- See more cut-and-pasting of subsystems
- Will improve the guidance on what you can and cannot do in a particular simulator
- Will simulate more of the immersive environment like air-traffic-control, other agents, etc.
- Hopefully will use simulators more to replicate incidents so as to prevent accidents
- Will likely improve scenarios to expose typical human errors, as they are what lead to accidents now

For Further Reading

- No one-stop-shop for understanding training devices within FAA
 - Have a working group trying to fix that
- See note pages for additional regulations and advisory circulars

Conclusions

- Civil simulators have detailed qualification requirements...it's the law
- Qualification has objective and subjective parts
- Most devices in use are qualified at the highest qualification levels