National Transportation Safety Board

A Human Factors Analysis of the Asiana Flight 214 Accident

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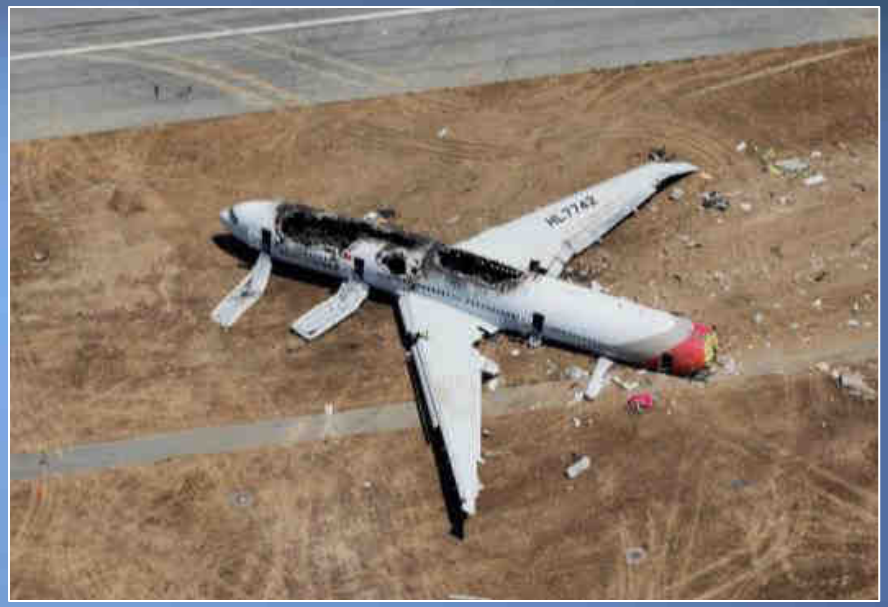
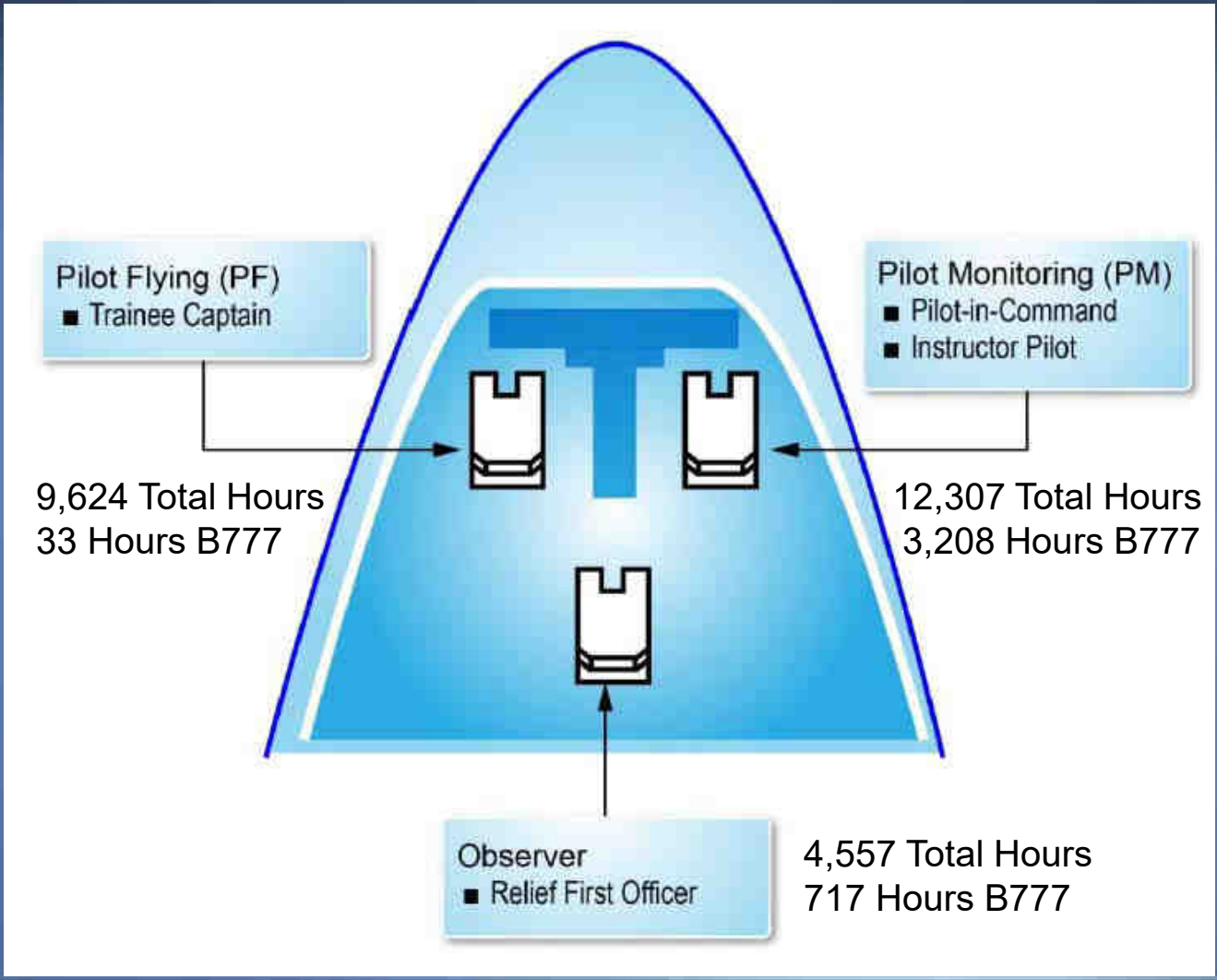
Accident Information

- July 6, 2013
- Boeing 777-200ER
- Scheduled flight
- Seoul → San Francisco
- Training flight
- Visual meteorological conditions
- Light winds



Crew Information



Accident Information

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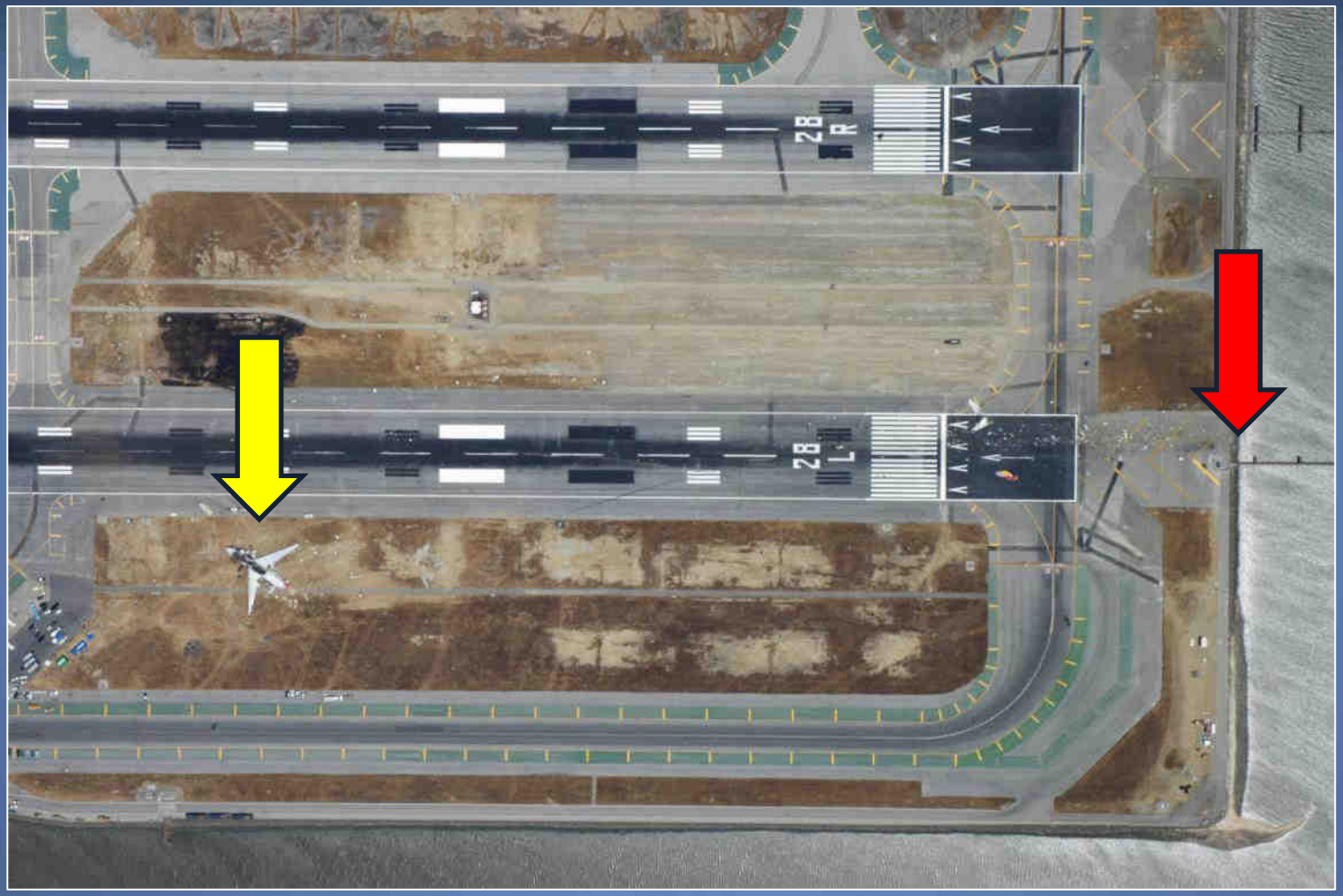

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Investigation

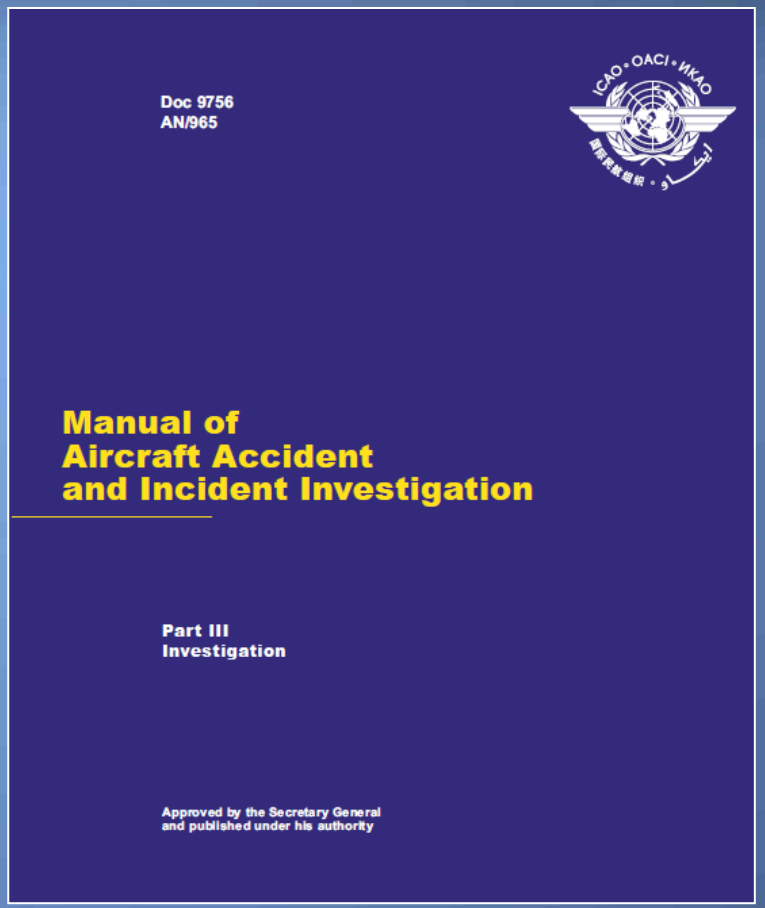
- Extensive media coverage
- Joint Ops / HP group

- Full go-team launch
- NTSB Chairman on Scene

Investigating Human Factors

"… from unsafe acts and inadequate or removed defenses, through the accident trajectory, all the way back to upper-management levels."

- ICAO



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NTSB Probable Cause Statement

"…the flight crew's mismanagement of the airplane's descent during the visual approach, the pilot flying's unintended deactivation of automatic airspeed control, the flight crew's inadequate monitoring of airspeed, and the flight crew's delayed execution of a go-around after they became aware that the airplane was below acceptable glidepath and airspeed tolerances."

NTSB Probable Cause Statement

1

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2

3

4

Probable Cause

Flightcrew's mismanagement of airplane's descent

PF's unintended deactivation of automatic airspeed control

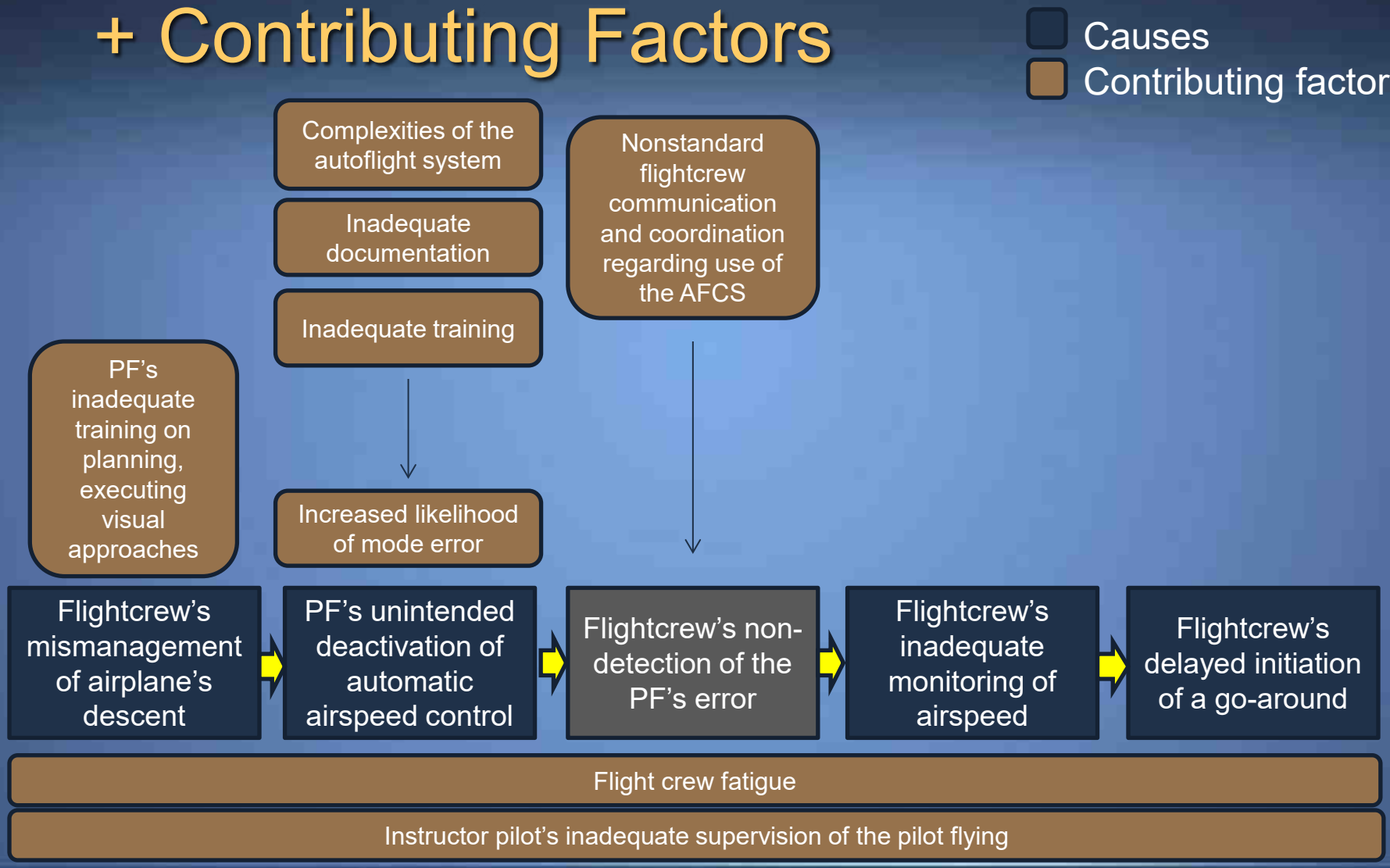
Flightcrew's inadequate monitoring of airspeed

Flightcrew's delayed initiation of a go-around

Probable Cause

Flightcrew's mismanagement of airplane's descent → PF's unintended deactivation of automatic airspeed control → Flightcrew's non-detection of the PF's error → Flightcrew's inadequate monitoring of airspeed → Flightcrew's delayed initiation of a go-around

Probable Cause + Contributing Factors



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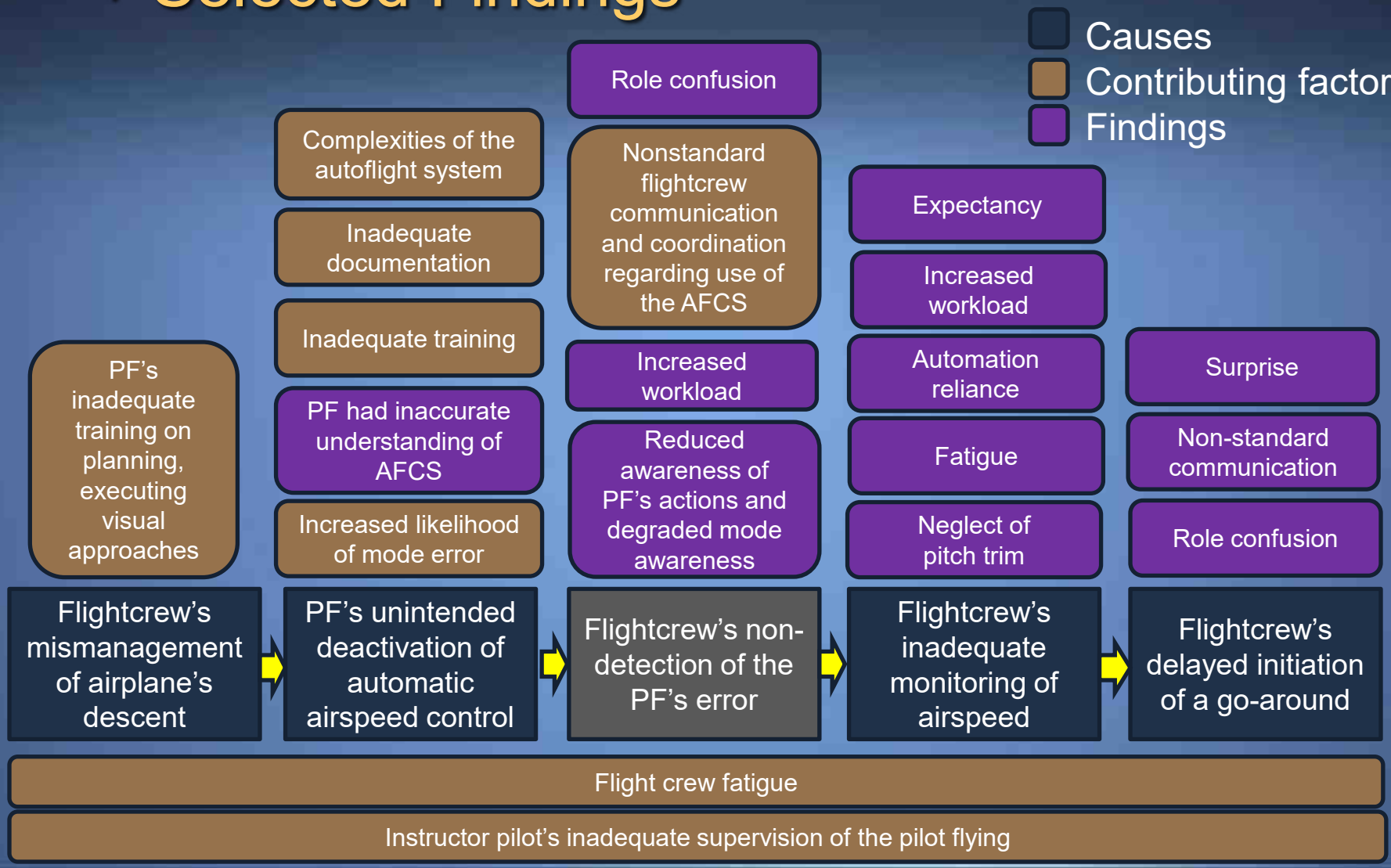
Probable Cause + Contributing Factors + Selected Findings



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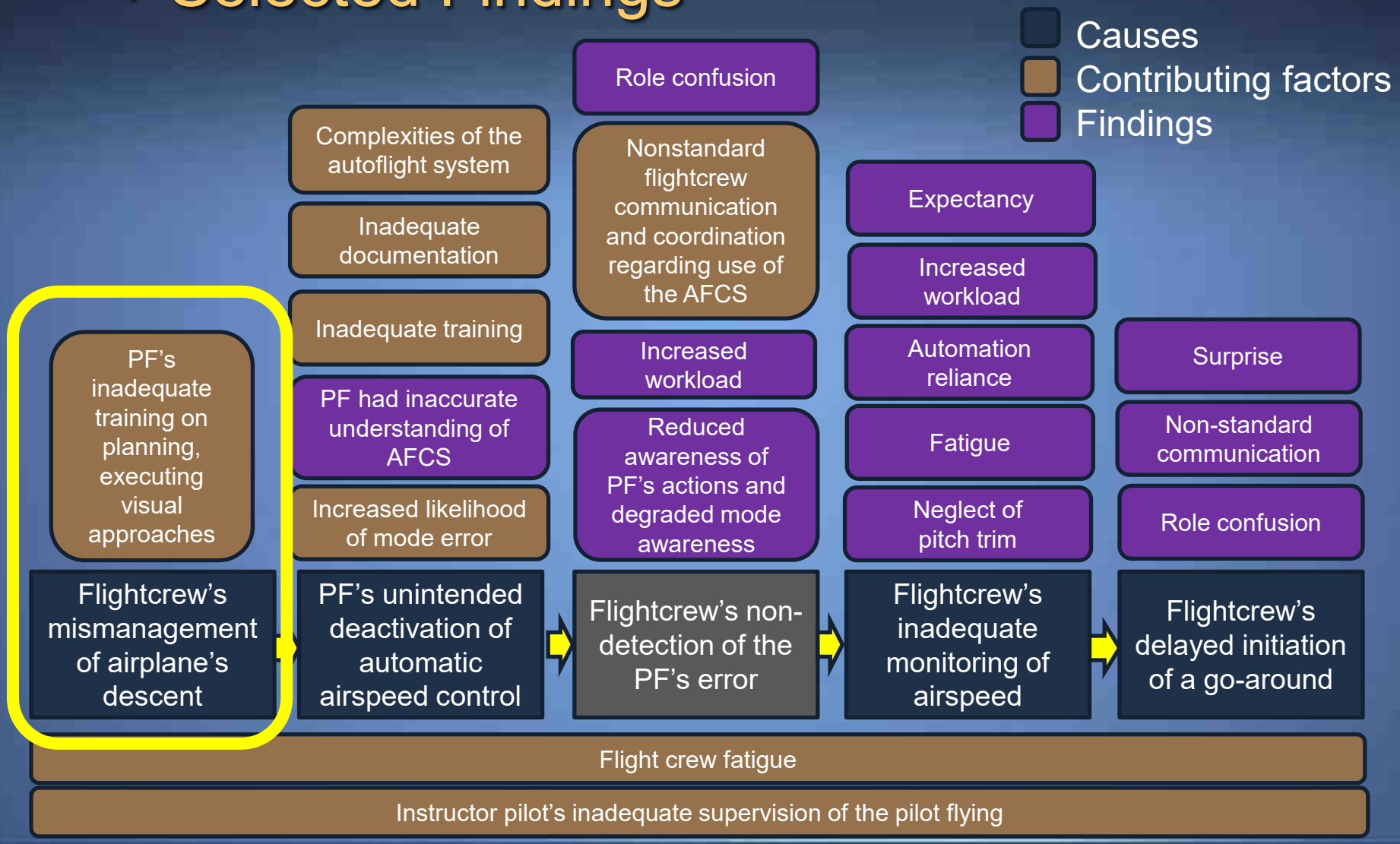
Probable Cause + Contributing Factors + Selected Findings



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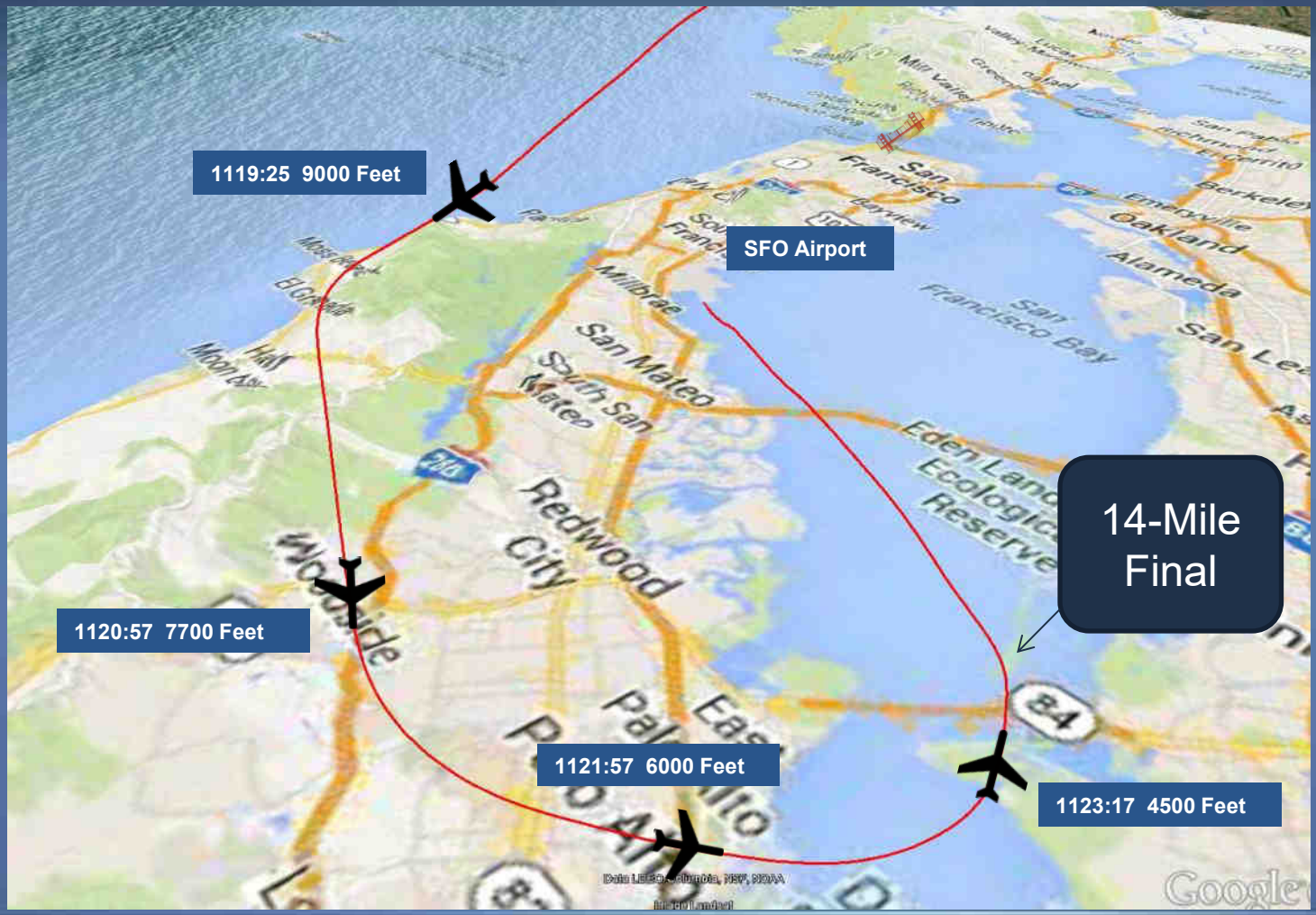
Arrival



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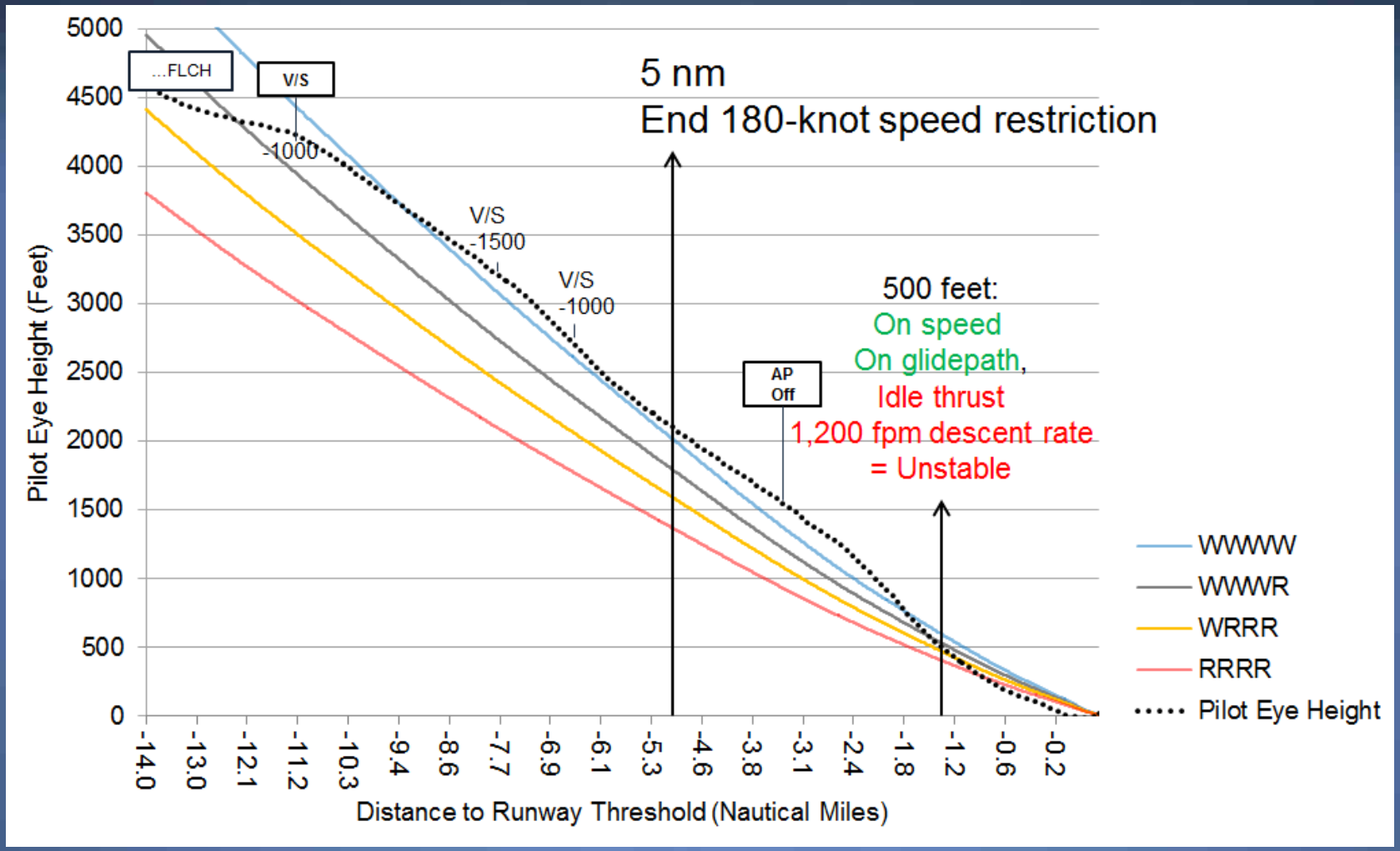
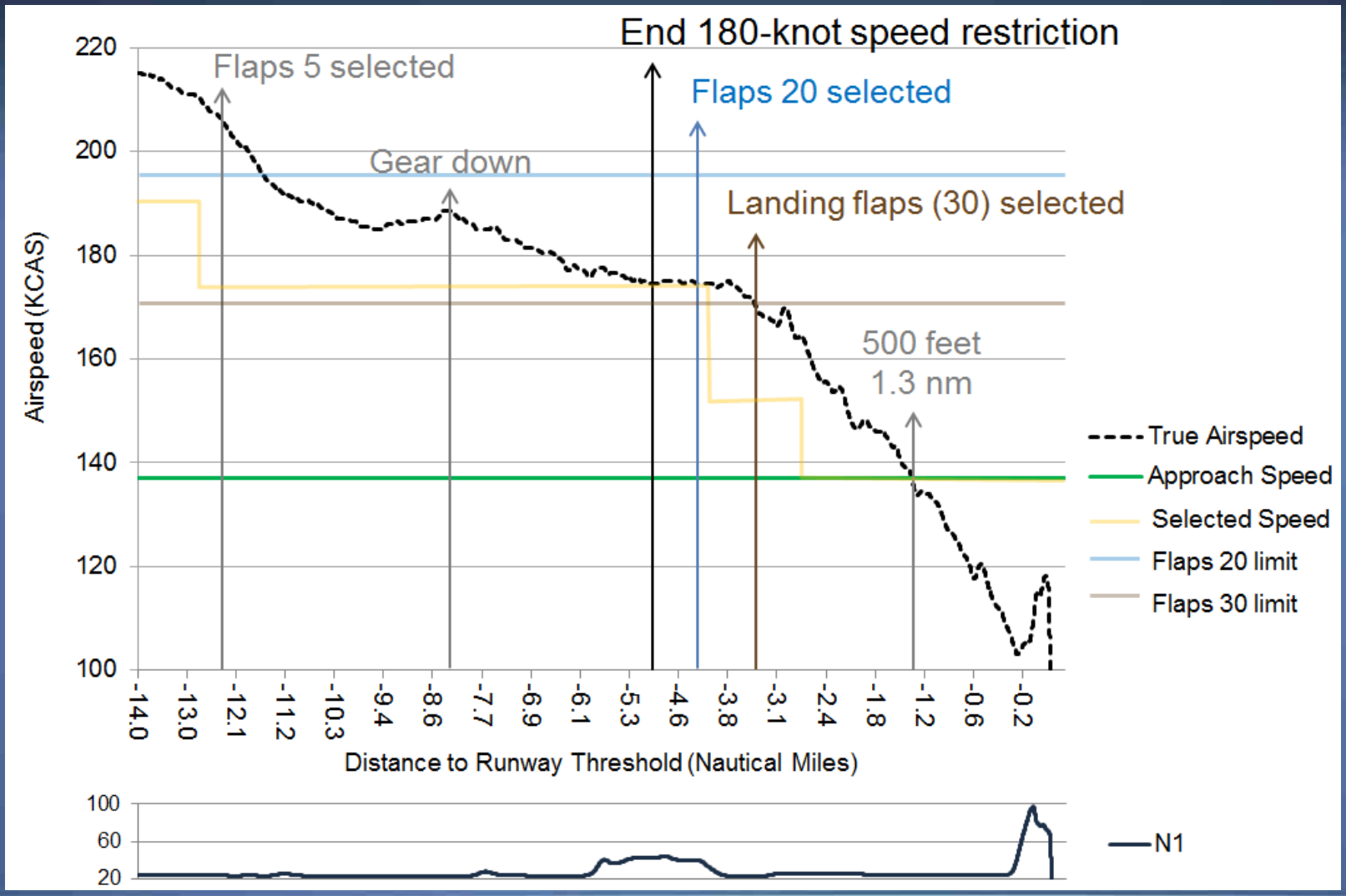
Mismanagement of the Descent



*Notations on the figure are approximate

Mismanagement of the Descent



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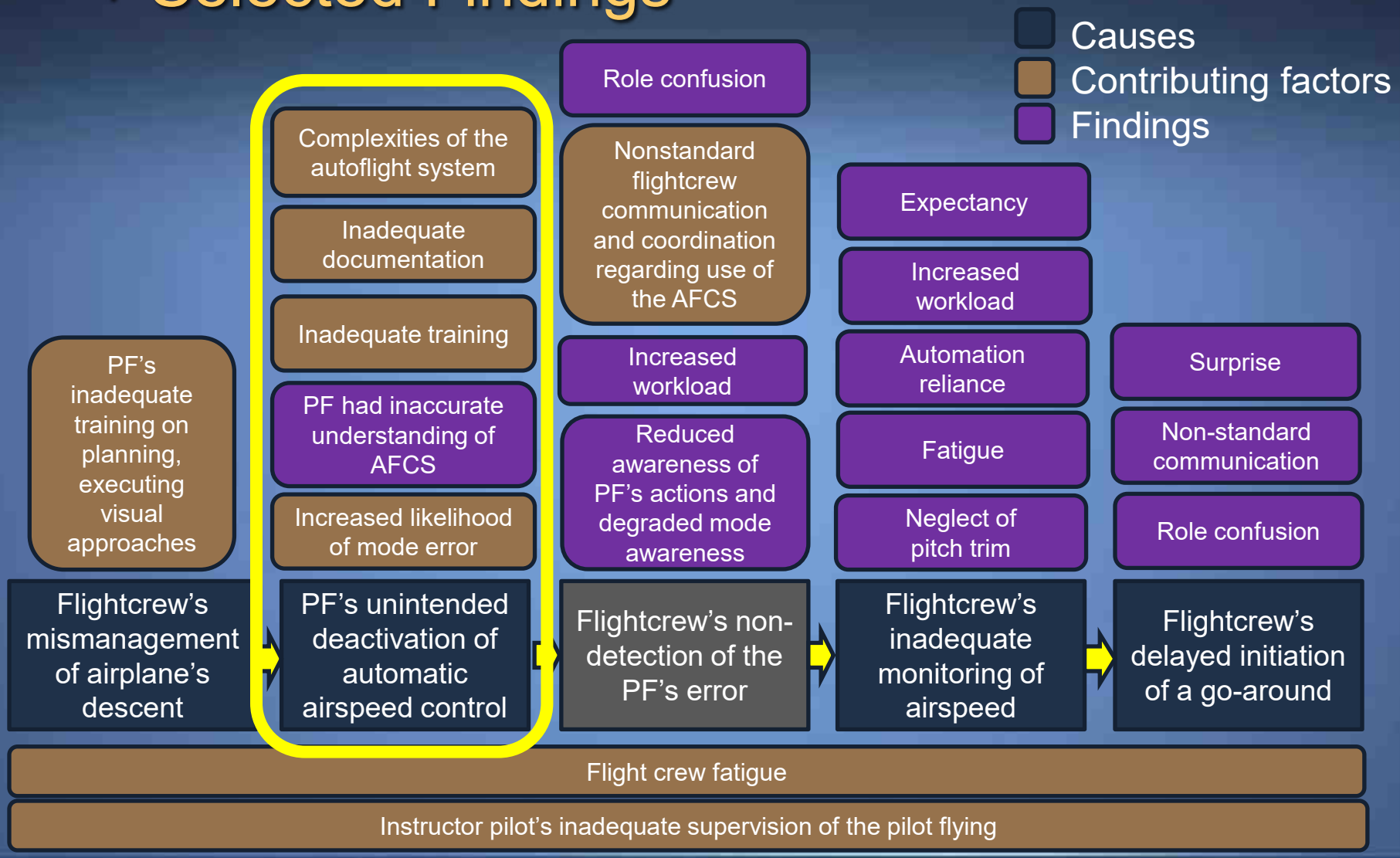
Mismanagement of the Descent

- Pilots "often lack sufficient in-depth knowledge and skills to most efficiently and effectively accomplish flightpath management related tasks" *
- The PF had practiced speed-restricted, high energy, straight-in visual approaches without a glideslope
- Flight path management skills can atrophy from lack of practice

*Final Report of the Performance-Based Operations Rulemaking Committee / CAST Flight Deck Automation Working Group (2013)

Probable Cause + Contributing Factors + Selected Findings



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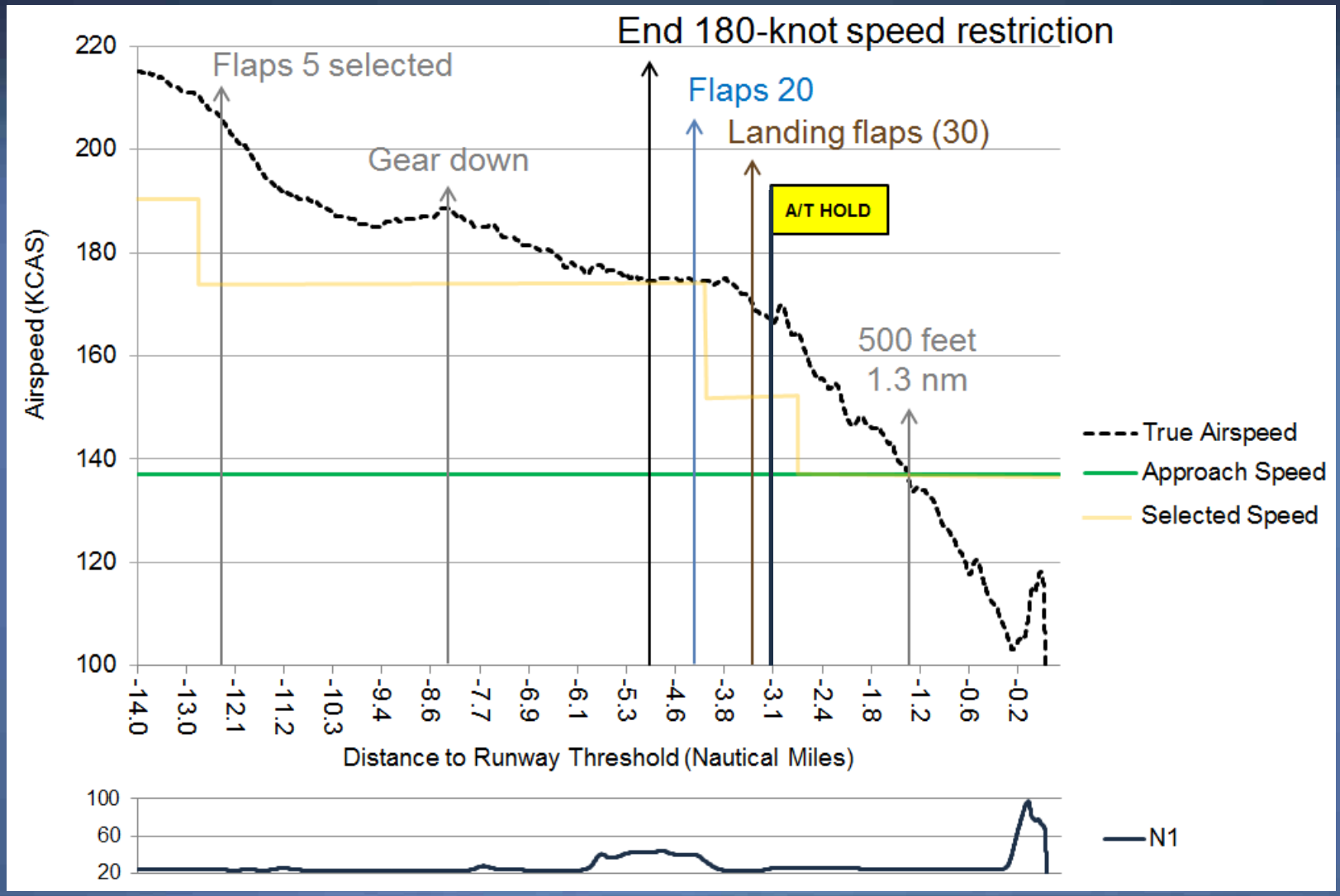
Deactivation of Automatic Airspeed Control



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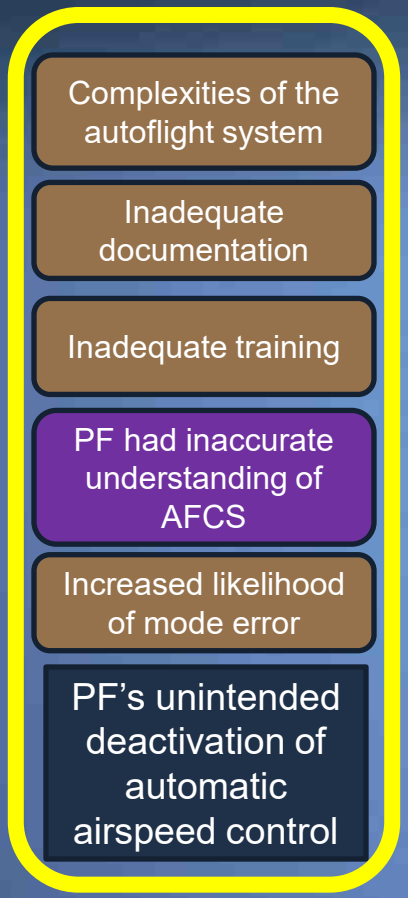
Deactivation of Automatic Airspeed Control

	A/P Status	A/P Pitch	A/T Thrust	Speed Control
1	A/P	V/S	SPD	With thrust (A/T)
2	A/P	FLCH SPD	THR	With elevator (A/P)
3	FLT DIR	FLCH SPD	THR	With elevator (Pilot)
4	FLT DIR	FLCH SPD	HOLD	With elevator (Pilot)
5		FLCH SPD	HOLD	Not specified

Deactivation of Automatic Airspeed Control

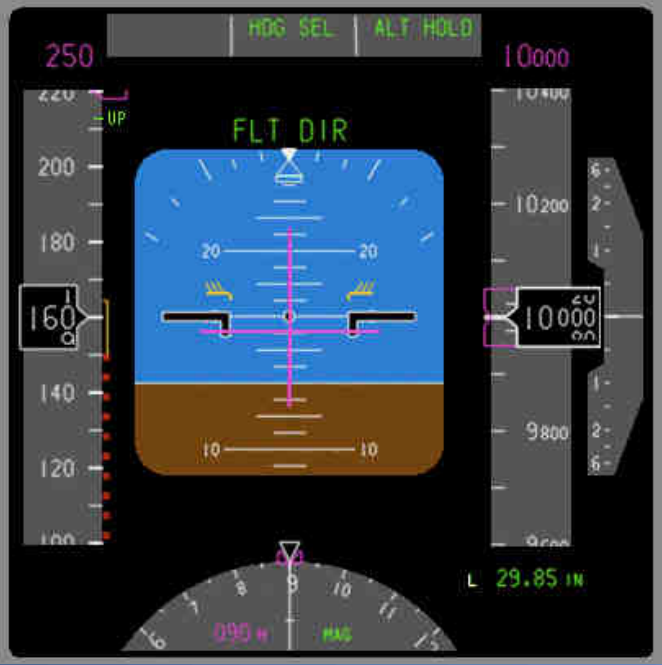


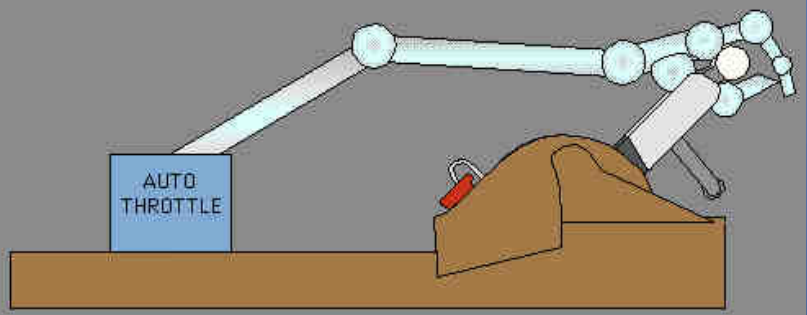
- Pilots often have difficulty comprehending subtle interconnections between aircraft sub-systems and AFCS mode logic
- Much learning occurs on the line
- Gaps in pilot mental models are problematic in dynamic, nonroutine situations, and can lead to "automation surprise"
- FAA and EASA had described certain aspects of the 777 AFDS/AT system as unintuitive
- 777 AFCS documentation and training was not sufficiently clear and comprehensive

777 Stall Protection System Training

Stall Protection Feature

- Reduces the possibility of reaching stick shaker
- No trim below minimum maneuvering speed
- Slow speed requires continuous back pressure
- Autothrottles engage automatically





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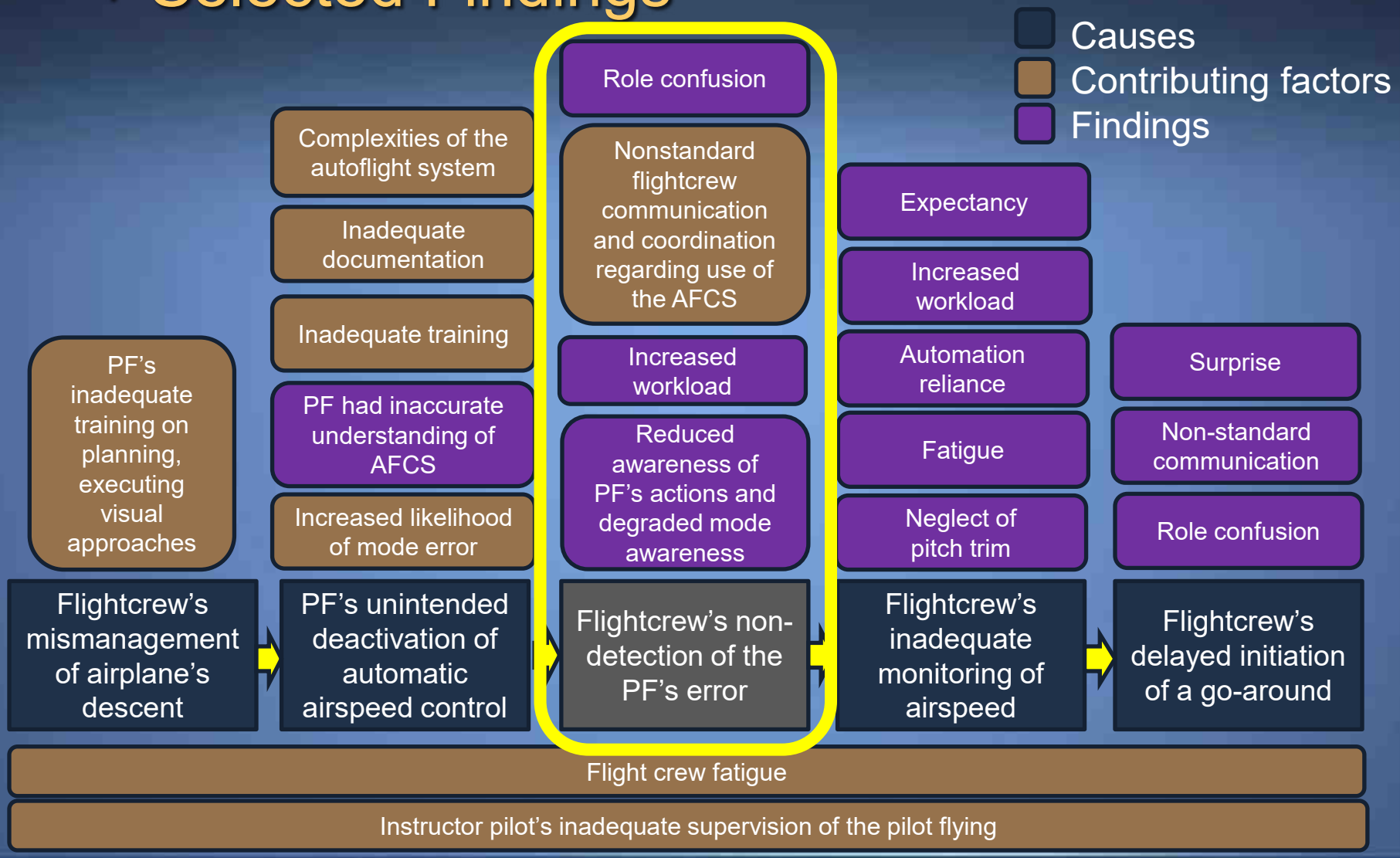
Probable Cause + Contributing Factors + Selected Findings



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Flightcrew Non-Detection of the PF's Error

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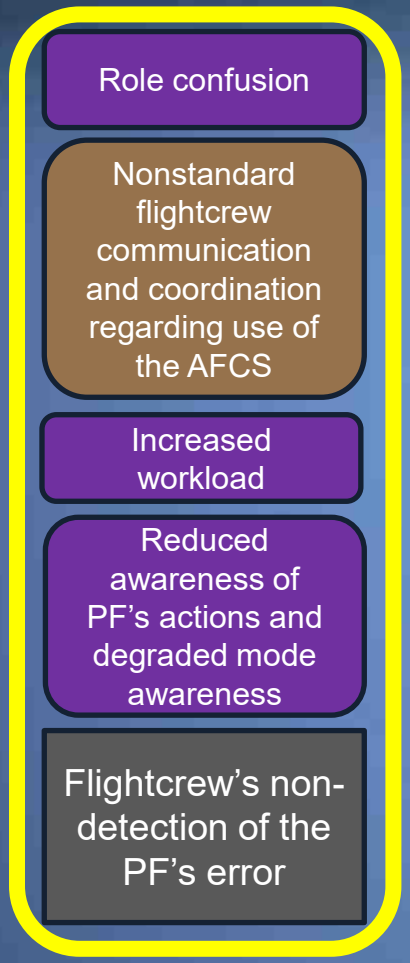
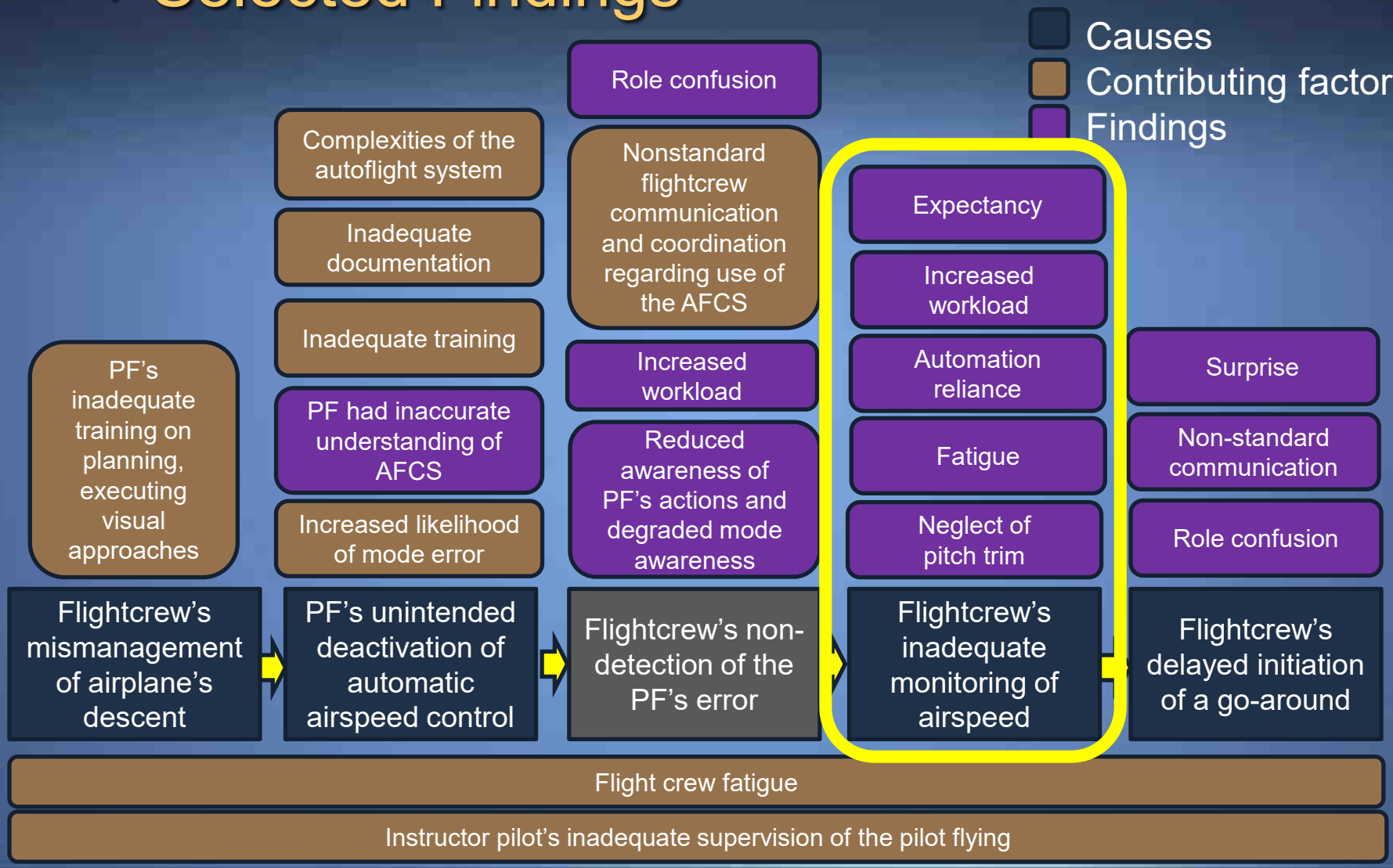


- The instructional nature of the flight led to blurring of PF and PM roles
- This lessened adherence to SOPs involving mode selections and callouts
- The PM was occupied with a configuration task when the PF's mode selection occurred
- The flightcrew did not detect the FLCH selection or subsequent, related mode changes
- Pilots often overlook unexpected mode changes
- The absence of a callout contributed to the flightcrew's degraded mode awareness

Probable Cause + Contributing Factors + Selected Findings



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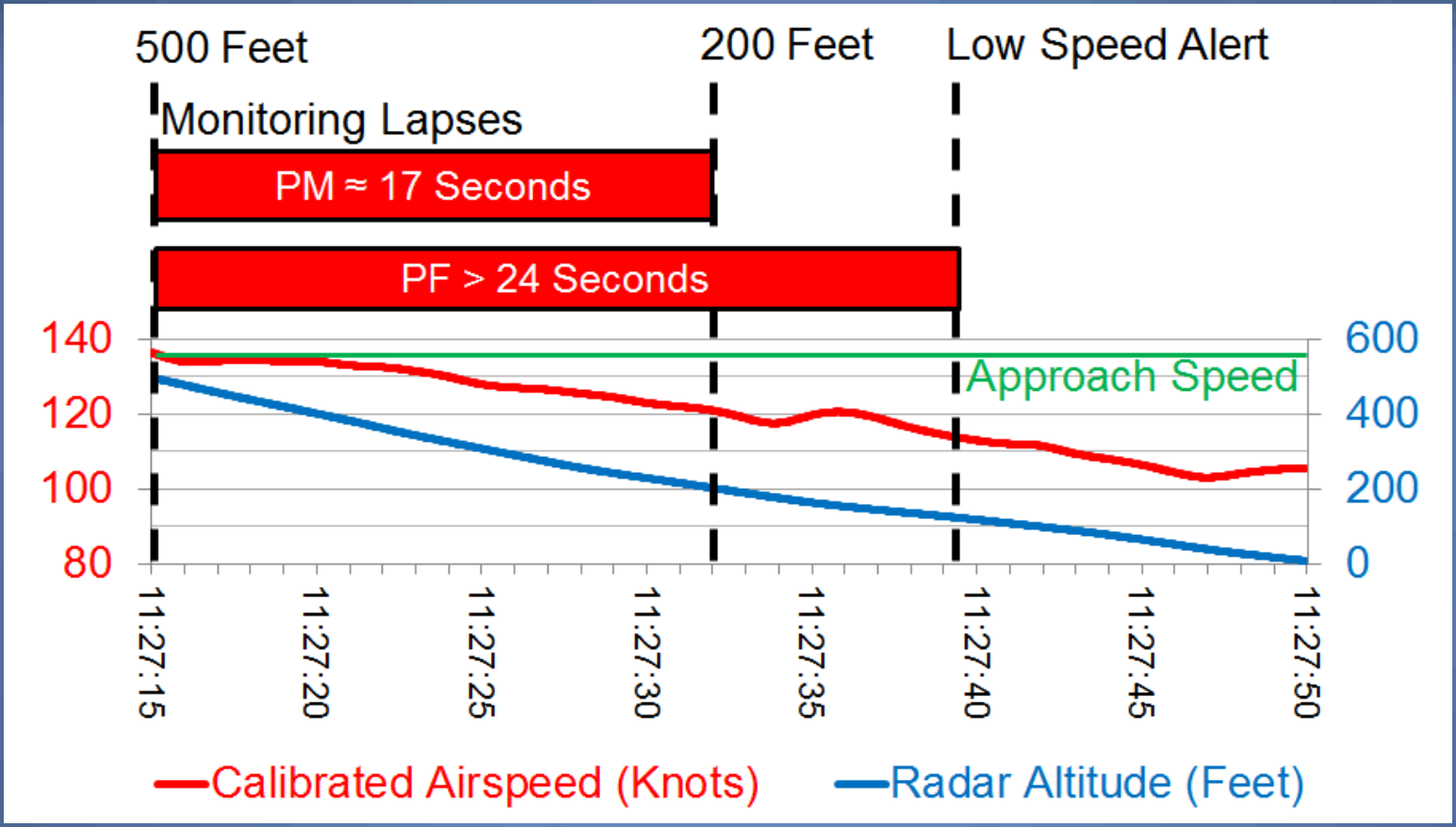
Inadequate Monitoring of Airspeed



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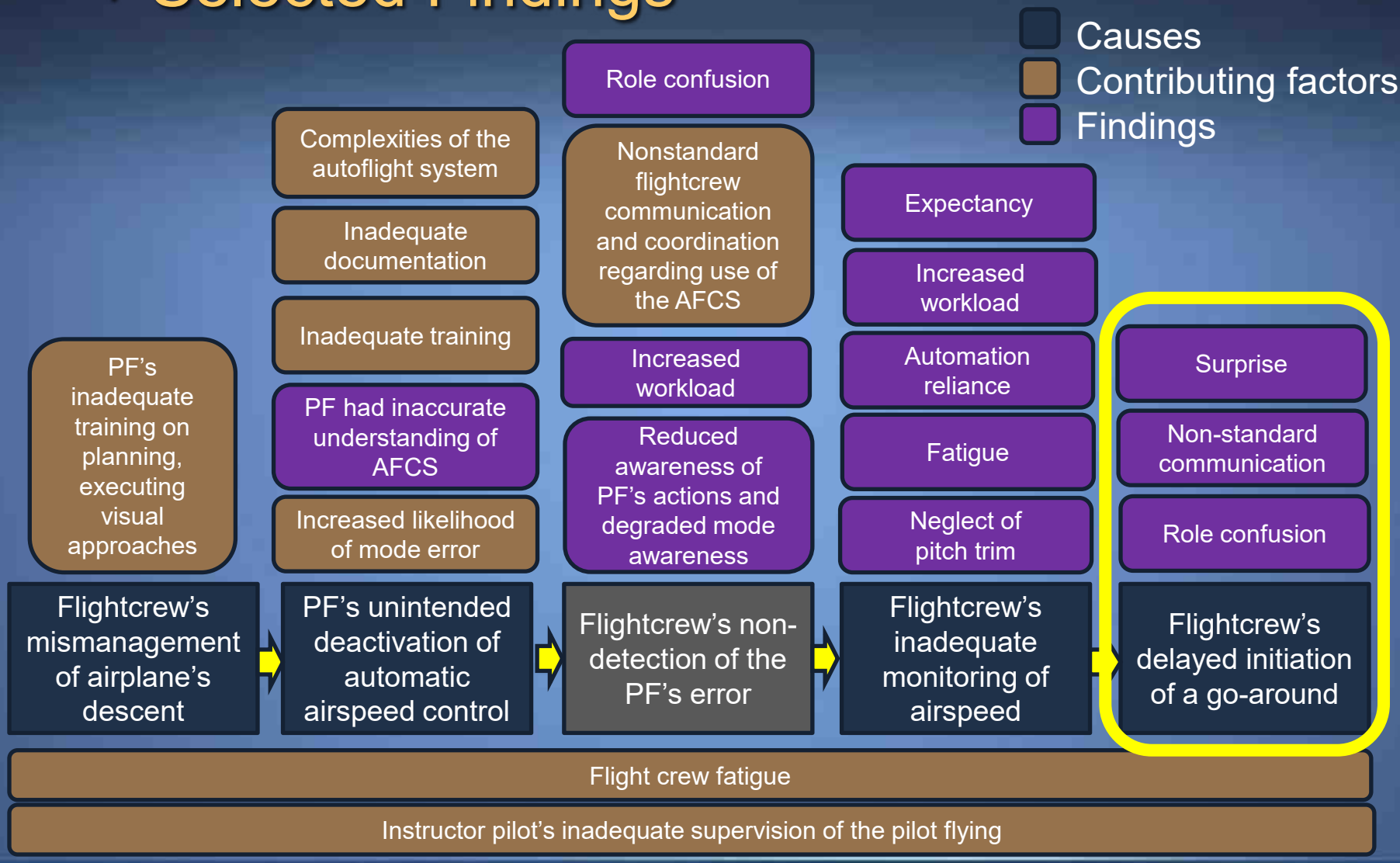
Inadequate Monitoring of Airspeed

- The crew expected the A/T would maintain selected speed
- The thrust levers behaved as expected (at idle) for 50 seconds after the A/T transitioned to HOLD
- Airspeed reached $V_{approach}$ at 500 feet
- Workload was high on short final
- Monitoring of automated sub-systems decreases as workload increases (automation reliance)
- The PF did not use pitch trim
- The crew was fatigued, degrading vigilance
- First officer's view of primary displays partially obscured

Probable Cause + Contributing Factors + Selected Findings



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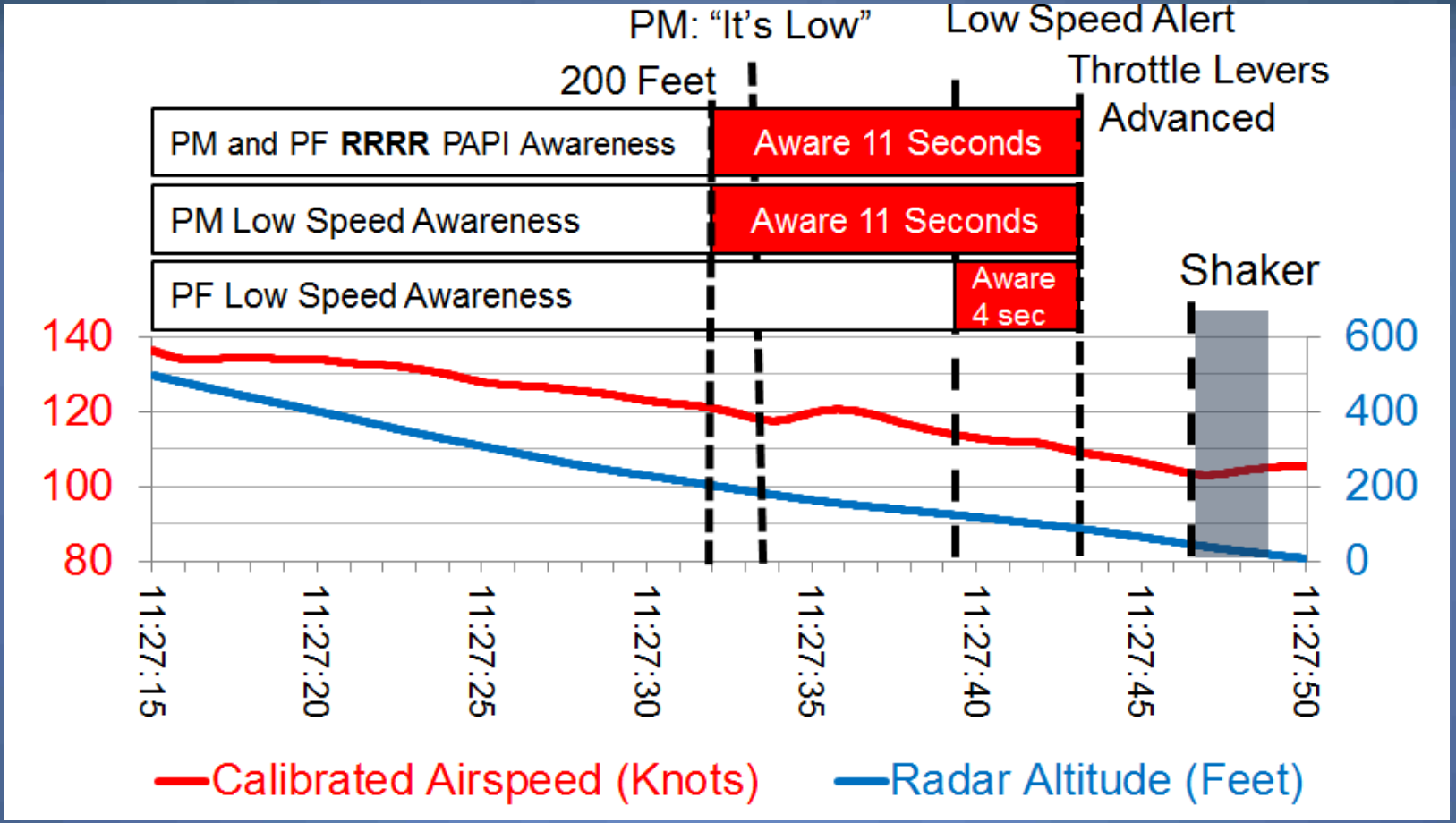
Delayed Go-Around



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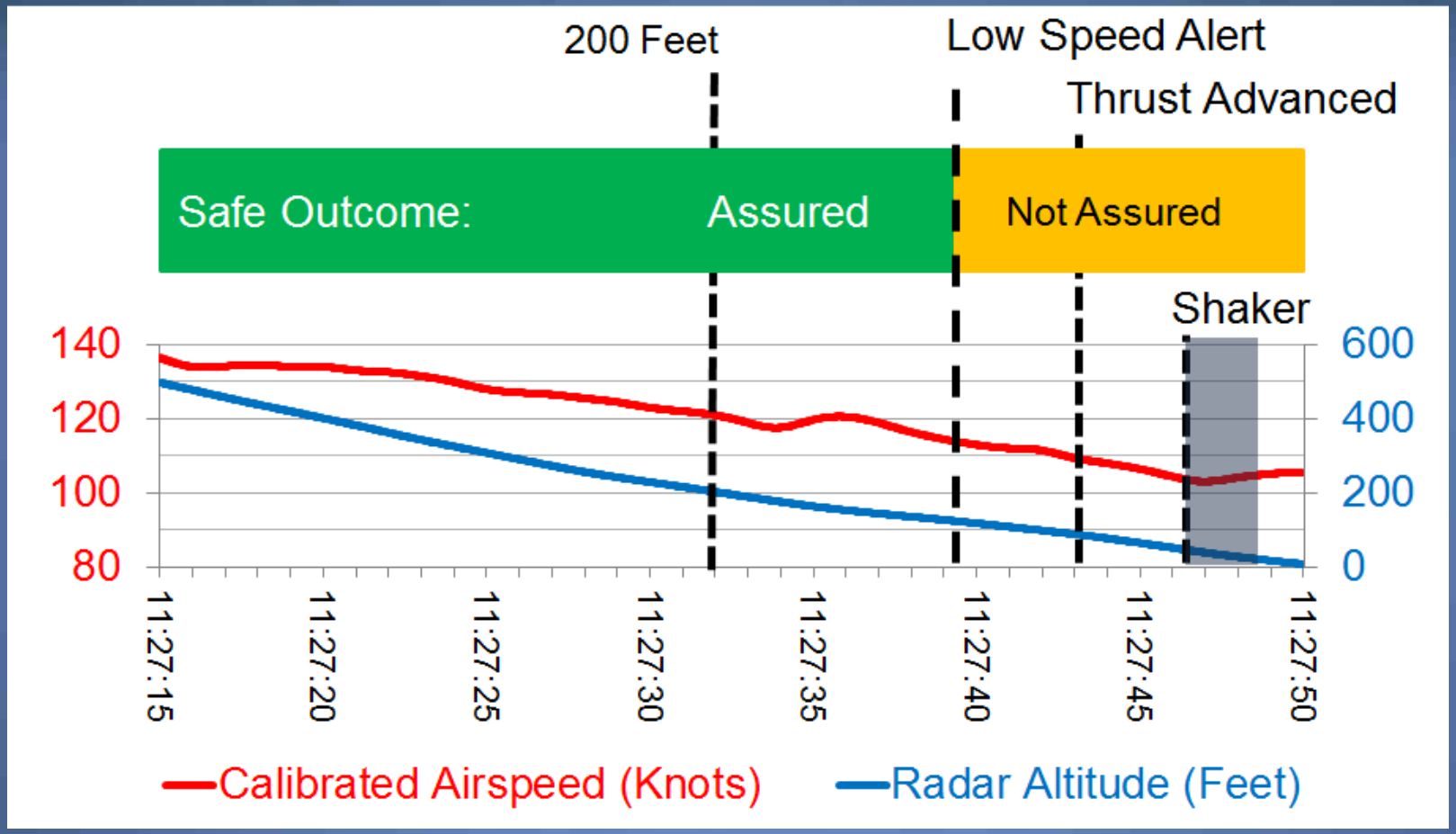
Delayed Go-Around

- Flightcrew response times are longer for unexpected events
- PM: "It's low" was nonspecific and possibly contributed to a delay in addressing the low airspeed
- The PF and PM each thought the other was responsible for initiating a go around

Low Speed Alert



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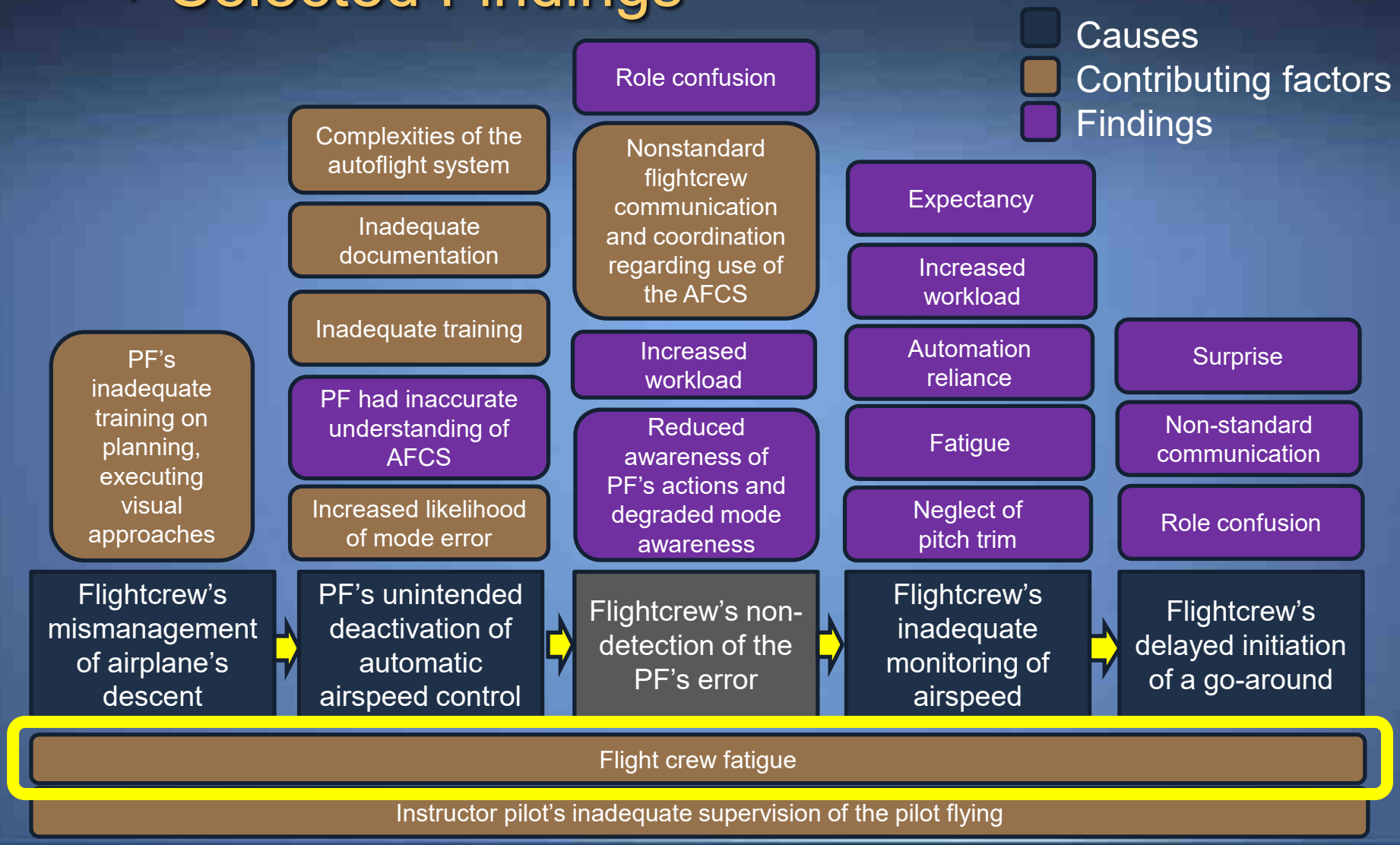
Probable Cause + Contributing Factors + Selected Findings



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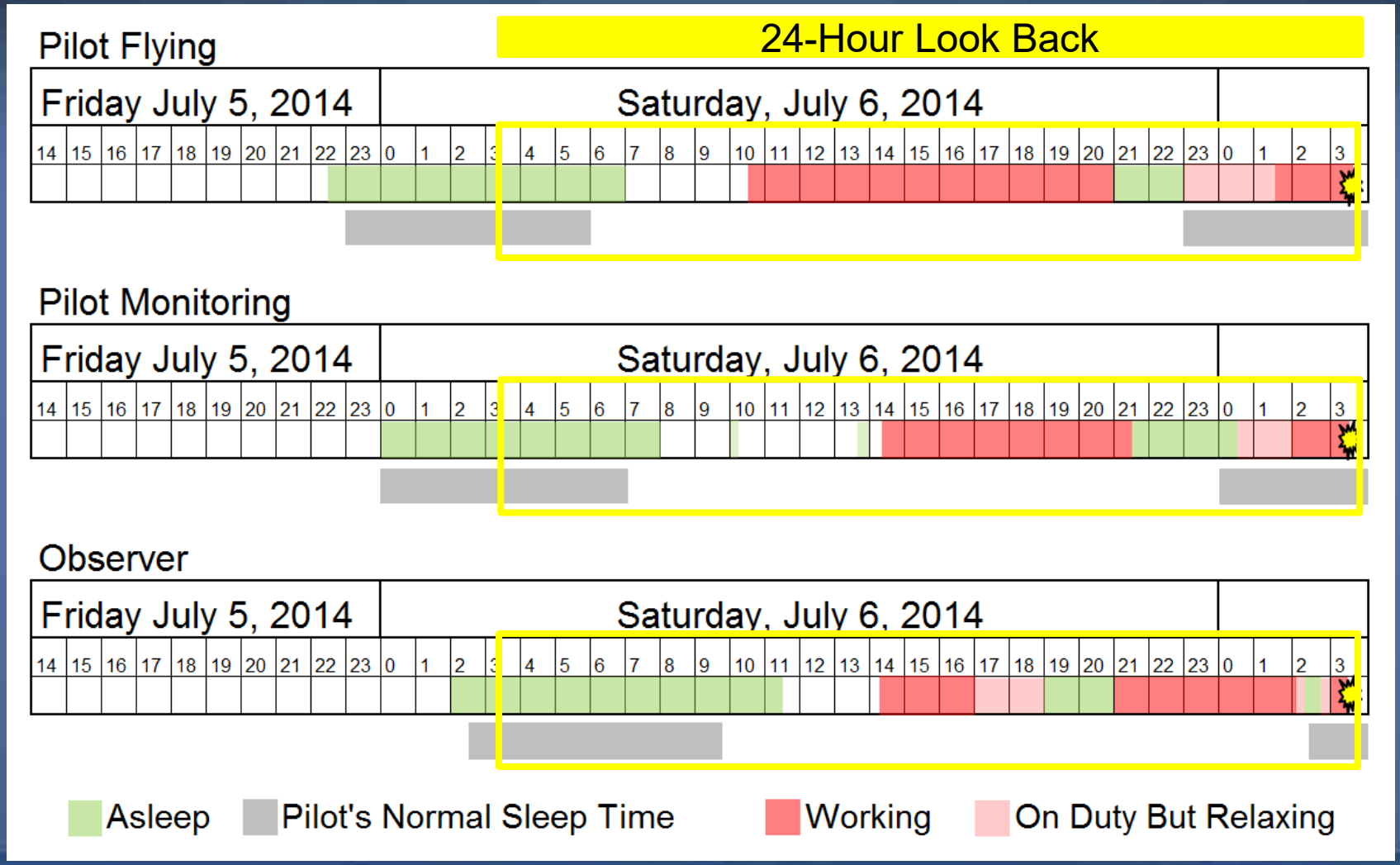
Flight Crew Fatigue



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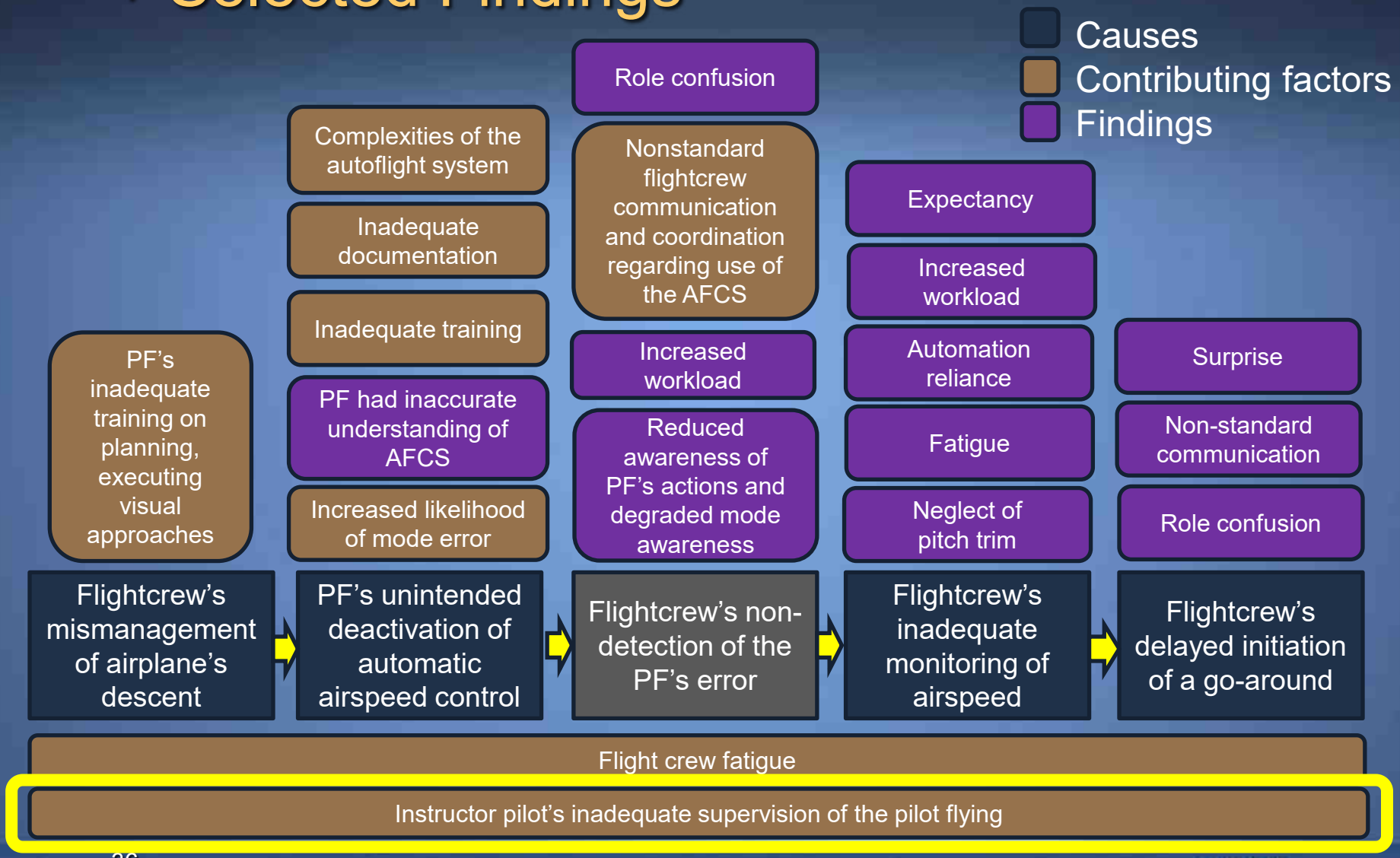

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Recommendation Areas

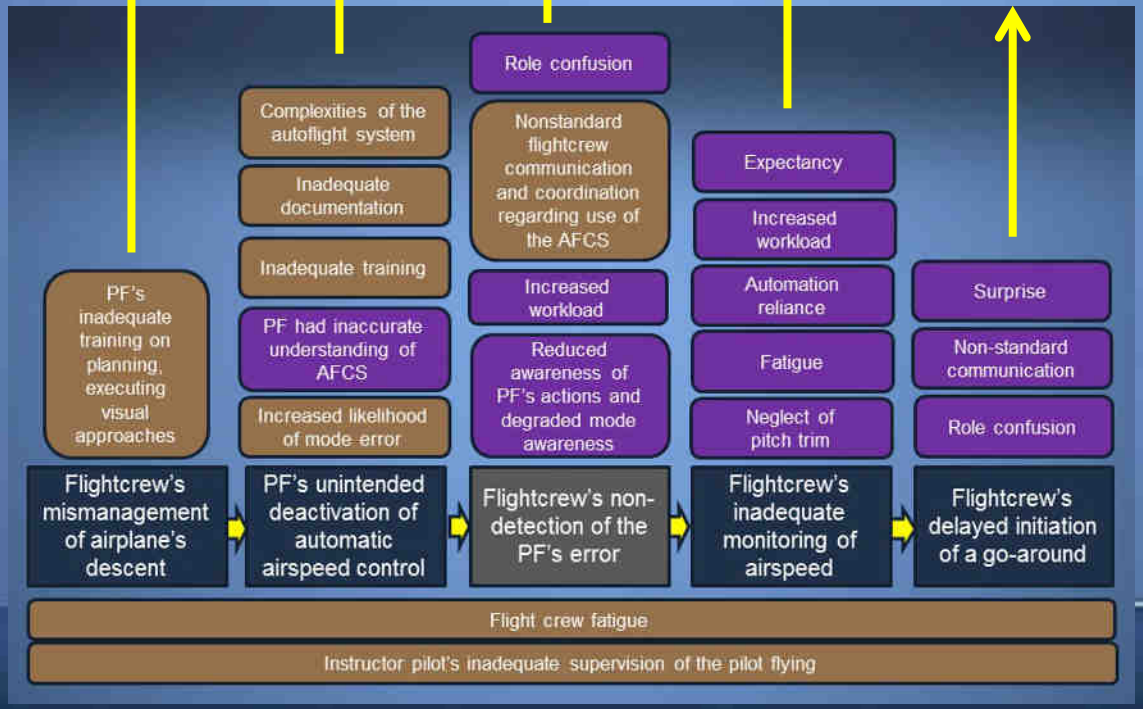
- Enhance 777 autoflight system training, and documentation
- Evaluate methods for training autoflight systems
- 777 special certification design review
- Flight director switches off for visual approach

- Enhanced policies to encourage manual flying practice and proficiency

- Reinforce automation SOPs / callouts

- Develop requirements for low energy alerting
- Modify systems to ensure minimum energy

- Enhance instructor preparation



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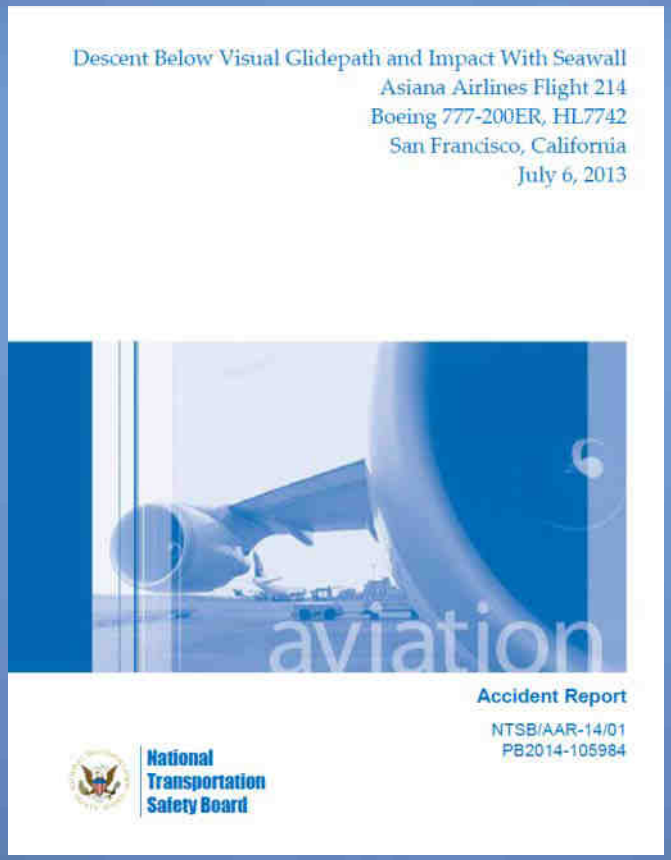
For a Complete List of Findings and Recommendations, see the NTSB final report:

http://www.ntsb.gov/investigations/summary/AAR1401.html



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