PREPARING A SAFETY CASE FOR A FLIGHT CREW FRMS

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Outline: preparing a safety case

- When and why
- How (example: in-flight rest allocation in 3-pilot operations)
  - Element 1: Scope
  - Element 2: Risk assessment
  - Element 3: Risk management
  - Element 4: Monitoring
- Conclusions

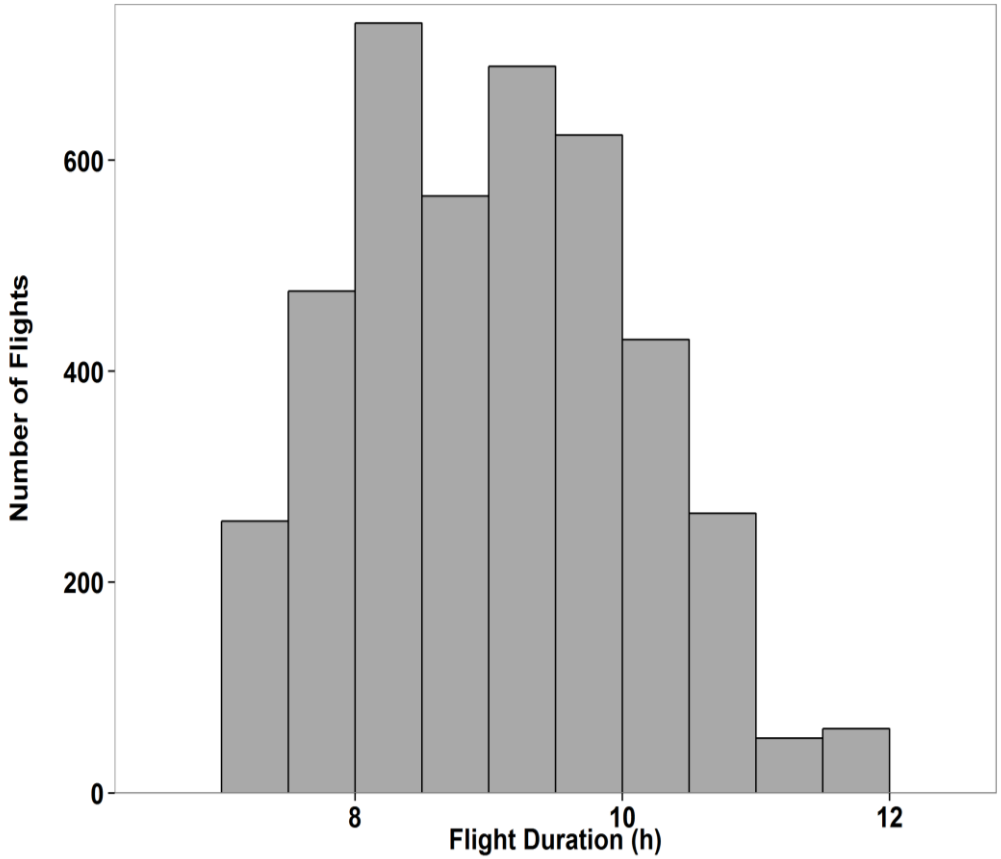
Element 1: Scope

1. Specify the part(s) of the prescriptive rules not met by operations covered by the safety case
2. Explain why an alternative means of compliance (AMOC) is needed.
3. Specify in detail the operation(s) to which the safety case applies

Prescriptive rule affected and why an AMOC is needed: in-flight rest allocation example

- Need for an AMOC
  - 3rd break not always the best sleep opportunity
    - depends on when break occurs in the circadian body clock cycle
  - customary practice prior to 14CFR Part 117.17
    - PF usually takes the 2nd break (often between meal breaks)
    - Captain retains flexibility to alter break allocation on the day
  - Delta mitigation to reduce workload of PF and PM
    - Relief pilot (RP) performs all ancillary and administrative duties from TOD - also needs good rest opportunity
    - This limits reallocation of rest break time from RP to PF and PM
- Requested AMOC, PF can
  - take 2nd or 3rd break; and
  - be given at least $^1/_3$ of the available rest time, but not less than 1hr 45 min; and
  - begin rest period up to an hour earlier than the last half of the FDP

Duration of 4,151 flights potentially covered by the AMOC, April 2014



Descriptors

- city pair
- number of flights/month
- number of fleets servicing the flight
- maximum scheduled block time
- scheduled departure time (local time and UTC)

1,537 do not require augmentation

- Company policy – augment outbound and inbound flights between a city pair if one direction requires augmentation

Element 2: Risk Assessment

1. Review scientific literature
2. Estimate maximum time awake at TOD on shortest and longest flights
3. Compare in-flight sleep opportunities, AMOC vs 14CFR Part 117.17
4. Re-analyse two studies that predate 14CFR Part 117.17
   - confirmed that PFs rarely use the 3rd rest
   - 1st or 2nd preferred, depending on flight timing
5. Validation study

Factors affecting in-flight sleep

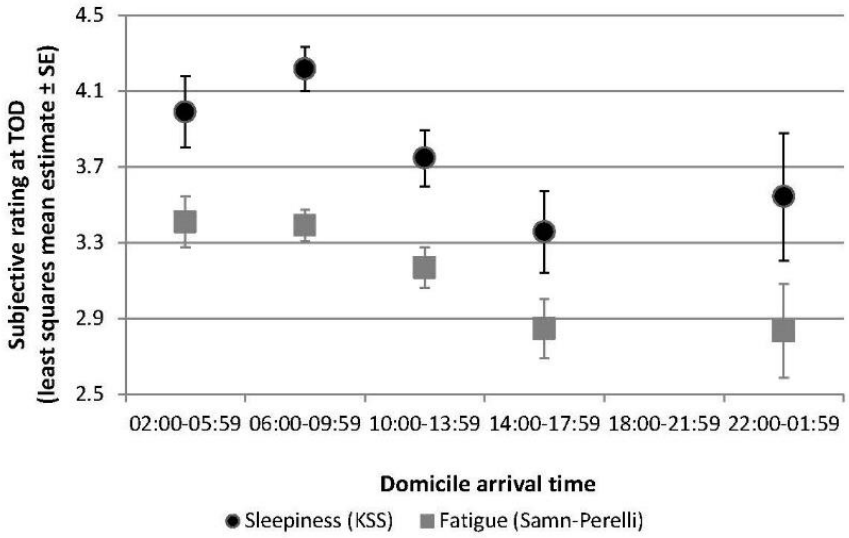
- Bunk sleep is not as good as sleep at home
  - Survey studies
  - Polysomnography studies
    - not an effect of altitude (hypobaric chamber studies)

- Amount and quality of in-flight sleep (actigraphy) depends on
  - circadian body clock cycle
  - prior time awake

- Main factors affecting in-flight sleep (survey studies)
  - noise, turbulence, thoughts on one's mind

Factors affecting fatigue at TOD

- 4 studies (actigraphic sleep)
  - 237 crewmembers, 4-pilot crews, Class 1 rest facilities,730 out-and-back flights, 13 city pairs, 1-3 day layovers
- Every additional hour of in-flight sleep
  - sleepiness ↓ 0.3 points (KSS, 9-point scale)
  - fatigue ↓ 0.2 points (Samn-Perelli,7-point scale)
- Every additional hour awake at TOD
  - sleepiness ↑ 0.2 points (KSS, 9-point scale)
  - fatigue ↑ 0.1 points (Samn-Perelli,7-point scale)
- Time of landing (acclimated blocks on)
  - Sleepiness, fatigue, PVT response speed
    - worst 0200-1000

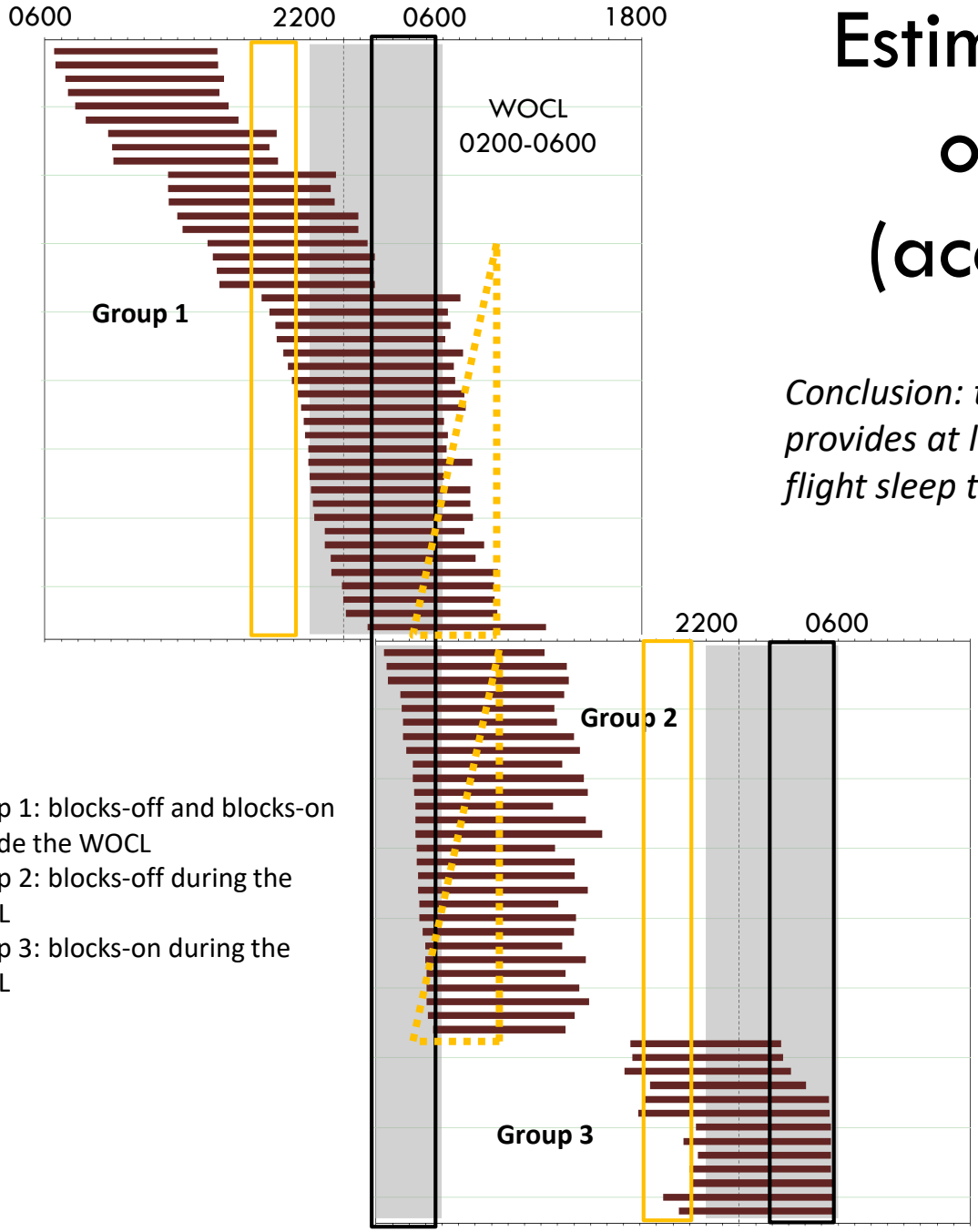


Maximum time awake at TOD

	Shortest flight Maximum scheduled block time 7 hrs 2 mins	Longest flight Maximum scheduled block time 11 hrs 59 mins
Report time (blocks-off – 1hr)	18:13	18:06
Time awake at TOD (end break 1-20 min)	**4 hrs 11 min**	**7 hrs 29 min**
Time awake at TOD (end break 2-20 min)	**2 hrs 30 min**	**4 hrs 9 min**
Time awake at TOD (end break 3-20 min)	**50 min**	**50 min**
TOD (blocks-on-0.5 hr)	01:45	06:35
Off duty (blocks-on + 0.5 hr)	02:45	07:35

- based on 4,151 scheduled flights, April 2014
- assuming equal breaks and wake up 20 mins before break end

Estimating PF sleep opportunities (acclimated time)



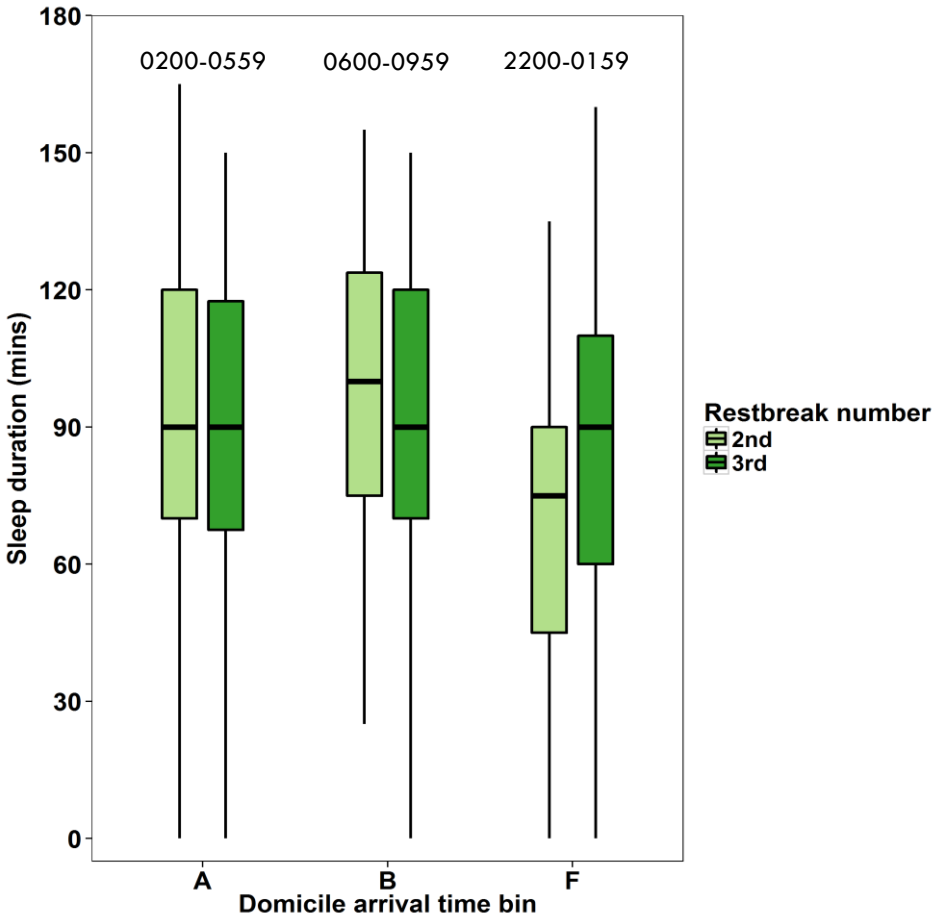
- Group 1: blocks-off and blocks-on outside the WOCL
- Group 2: blocks-off during the WOCL
- Group 3: blocks-on during the WOCL

Conclusion: the flexibility offered by the AMOC provides at least an equivalent opportunity for in-flight sleep to the 14CFR Part 117 requirements

Validation study: design

- Blocks-on in three 4-hour time bins:
  - 0200-0549 (Bin A) – highest fatigue at TOD (WOCL)
  - O600-1059 (Bin B) - high fatigue at TOD (cumulative fatigue across FDP)
  - 2200-0159 (Bin F) – in-flight sleep affected by the evening wake maintenance zone
- Required participants in each time bin
  - 80% power to detect a 1-point difference in Samn-Perelli fatigue ratings and Karolinska Sleepiness Scale ratings at TOD
    - 35 crewmembers who took 2nd break
    - 35 who took 3rd rest break
  - total = 210 crewmembers
- 1-page survey on outbound and inbound flights (1-day layovers)
  - blocks-on, blocks-off times, break times
  - sleep duration and quality if sleep attempted
  - fatigue and sleepiness ratings at TOD

Validation study: results



- PFs used 2nd break on 95% of flights
- PMs used 3rd break on 94% of flights
- Break duration: 2nd vs 3rd not significant
- Sleep duration: 2nd vs 3rd not significant
- For every 1-hr increase in flight duration, sleep duration increased by 12.3 mins

Conclusion: no evidence that the 3rd break provided a better sleep opportunity than the 2nd break

Benchmarking flights landing in Bins A and B versus compliant B777 4-pilot crews (Bin A, n=44; Bin B, n=96)

- KSS and SP ratings at TOD did not differ between 2nd versus 3rd rest break versus compliant 4-pilot crews

Conclusion: sleepiness and fatigue at TOD are comparable to compliant 4-pilot crews, 0200-1000

Element 3: risk management

- Training
  - All crewmembers have had training as required by AC 117-2
    - two 45-min basic courses
    - two 15-min refresher courses
    - paid to work through computer-based training outside of duty time
  - Schedulers and others involved in management of the operations covered by the AMOC
    - 45-min fatigue management training session
    - why crewmember fatigue is a safety concern, physiology behind fatigue symptoms, role of scheduling in flight crew fatigue, purpose and processes of the Delta FRMS.
- Mitigations
  - 36.7% of flights covered by the AMOC can be flown with two pilots.
    - third pilot is an operational mitigation to reduce fatigue risk - crewmembers can take in flight breaks and obtain sleep
  - Relief Pilot performs all ancillary and administrative duties from TOD
    - reduces workload of PF and PM

Element 4: monitoring - fatigue reports

- Crewmember responsibilities
  - make management aware of the situation
  - if appropriate, remove themselves from duty or refuse an assignment to duty
  - requirements for calling in fatigued
    - call the Crew Scheduler, if it is prior to sign-in
    - call Crew Tracking, if is after sign-in
    - or call the Duty Pilot / Chief Pilot Support Centre
    - inform the Dispatcher (if applicable)
    - file an ASR report or alternatively an ASAP report, if they wish to have their report reviewed in a de-identified format
  - if fatigue is a flight safety concern, file an ASR or ASAP report
  - if fatigue is not a flight safety concern, file an ACR report

Fatigue reports

- Flight operations personnel responsibilities
  - Report fatigue hazards to appropriate supervisor or manager
- Pilot Fatigue Program Director and Fatigue Risk Management Team responsibilities
  - Acknowledge all fatigue reports
  - Carefully evaluate and discuss fatigue reports associated with the operations covered by the AMOC
  - Using FRM processes to act on fatigue reports when appropriate
  - Providing regular feedback to the pilot group

Conclusions

- Safety cases to support a request for an AMOC need to be:
  - explicit and detailed about the scope of AMOC
  - well-supported by both scientific and operational data and analyses
  - able to convince the regulator that the operator has adequately identified the risk associated with the AMOC and can manage it to a level of safety at least equivalent to that achieved by operating within Part 117 limits
- Regulator needs to be confident that the risk management and monitoring processes in the operator's FRMS are:
  - fully functional
  - sufficient to manage any risk associated with the AMOC
- Approach used in other successful safety cases
  - We are all still on a learning curve

Acknowledgements

- We are indebted to the flight crewmembers who participated with outstanding professionalism and attention to the details of the study protocol

- Work funded by Delta Air Lines