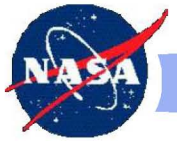
Fatigue Management Strategies for the Stratospheric Observatory for Infrared Astronomy

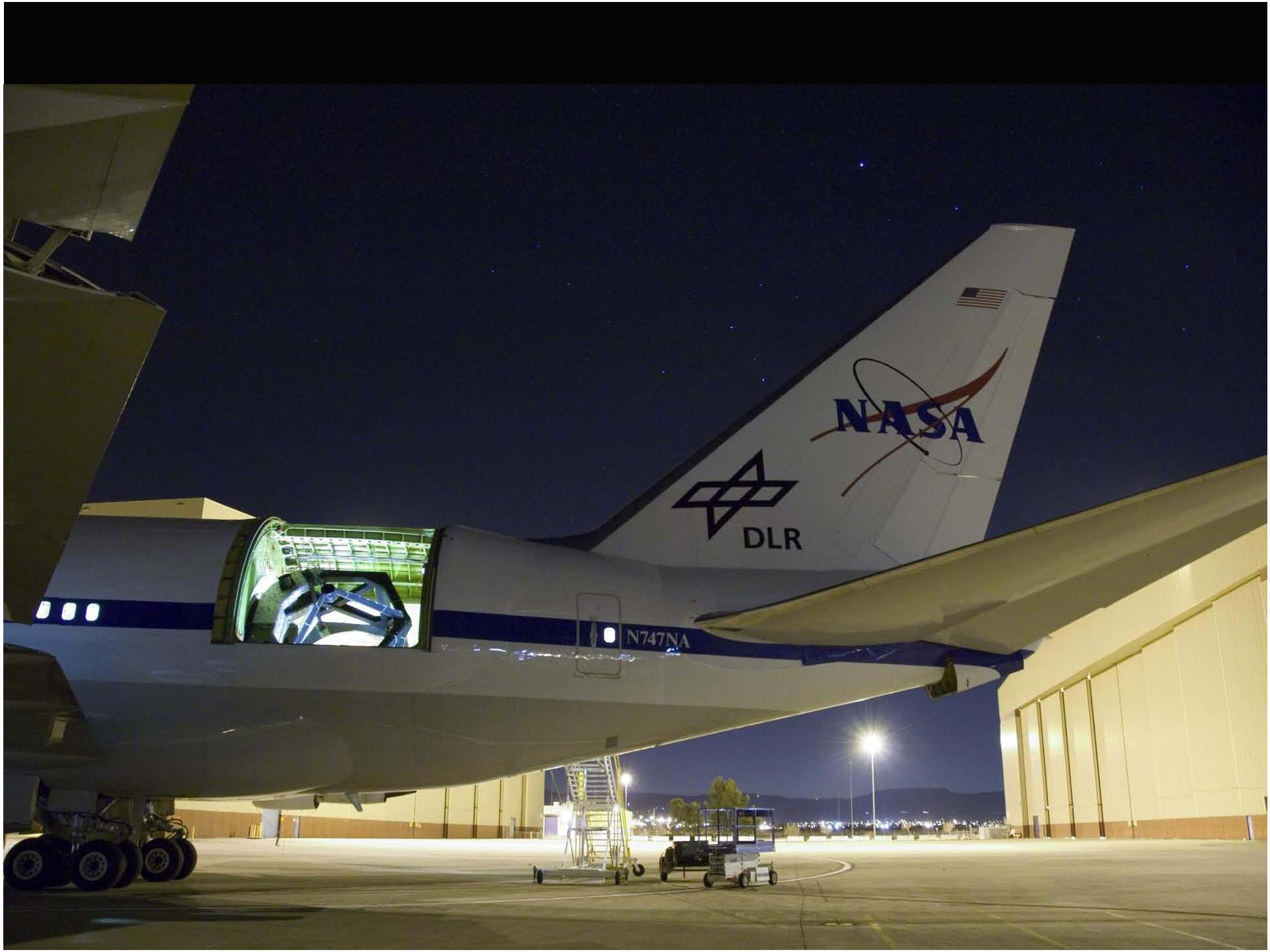
DLR

NASA

SOFIA Airborne Observatory

- Boeing 747SP2.5-meter (100-inch) telescope
- Partnership of NASA (Ames Research Center & Dryden Flight Research center) and DLR (Germany)
- 140 Research Flights (8-hrs) Per Year
- 20-Year Estimated Lifetime
- Operationally flies exclusively at night

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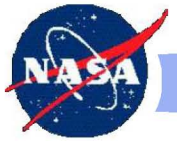
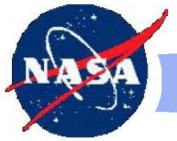
Fatigue Risk Management Plan

- Step 1:Education of Workforce
- Step 2: Work Scheduling
- Step 3: Individual Fatigue Assessment
- Step 4: Operational (Workplace) Mitigations
- Step 5: Close-Call & Mishap Investigation

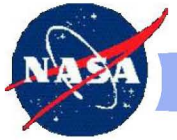


Work Schedule Scoring



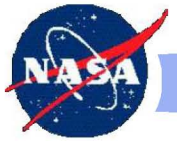
NASA Maximum Work Times (Critical Positions)

- 12 consecutive hours (16 consecutive hours in emergency, with approval by a supervisor “capable of evaluating human factors risk level for that function”).
- 60 hours during a 7 day work week*;
- Seven (7) consecutive days without at least 1 full day off*(deviations may be pre-approved, at a high level, for ≤18 consecutive days, followed by 2 full days off);
- 240 hours during a 4 week period*; and
- 2500 hours during a rolling 12 month period*.



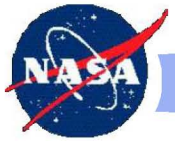
Dryden Flight Research Center Procedure
(Ref: Transport Canada)

Work Schedule Scoring Risk Matrix					
	0 points	**1 point**	**2 points**	**4 points**	**8 points**
a) Total hours per 7 days	≤ 36 hours	36.1 – 43.9	44 – 47.9	48 – 54.9	55+
b) Maximum shift duration	≤ 8 hours	8.1 – 9.9	10 – 11.9	12 – 13.9	≥ 14
c) Minimum short break duration	≥ 16 hours	15.9 – 13	12.9 – 10	9.9 – 8	≤ 8
d) Maximum night work per 7 days	0 hours	0.1 – 8	8.1 – 16	16.1 – 24	≥ 24
e) Long break frequency	≥ 1 in 7 days	≤ 1 in 7 days	≤ 1 in 8-14 days	≤ 1 in 15-21 days	≤ 1 in 22-28 days



Work Schedule Score Actions
(Ref: Transport Canada)

Work Schedule Score	Management Action
< 8	Good
8-16	Requires Manager's Approval (with Justification)
>16	Unacceptable



Title of Activity:						
Dates (*If applicable*):						
Requestor:						
Work Schedule Scoring Matrix						
	0 points	**1 point**	**2 points**	**4 points**	**8 points**	**Accrued Points**
a) Total hours per 7 days	≤ 36 hours	36.1 – 43.9 hours	44 – 47.9 hours	48 – 54.9 hours	55+ hours	
b) Maximum shift duration	≤ 8 hours	8.1 – 9.9 hours	10 – 11.9 hours	12 – 13.9 hours	≥ 14 hours	
c) Minimum short break duration	≥ 16 hours	15.9 – 13 hours	12.9 – 10 hours	9.9 – 8 hours	≤ 8 hours	
d) Maximum night work (*i.e., 6:00 PM – 6:00 AM*) per 7 days	0 hours	0.1 – 8 hours	8.1 – 16 hours	16.1 – 24 hours	≥ 24 hours	
e) Long break frequency	≥ 1 in 7 days	≤ 1 in 7 days	≤ 1 in 8-14 days	≤ 1 in 15-21 days	≤ 1 in 22-28 days	
Justification for Waiver (*If score ≥ 8*):					**TOTAL POINTS** (***Add points to determine total score***)	

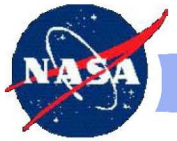
SCHEDULE SCORE	ACTION
< 8	Acceptable
8 to 16	Requires Mid-Level Approval (*with appropriate justification*)
> 16	Requires Senior-Level Approval *(with appropriate justification*)

SIGNATURES
Approver:
Waiver Authority (*Score: 8-16*):
Senior Waiver Authority (*Score >16*):

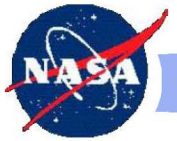
Reference: Transport Canada

Exchanging Shifts: “Shift Swapping”

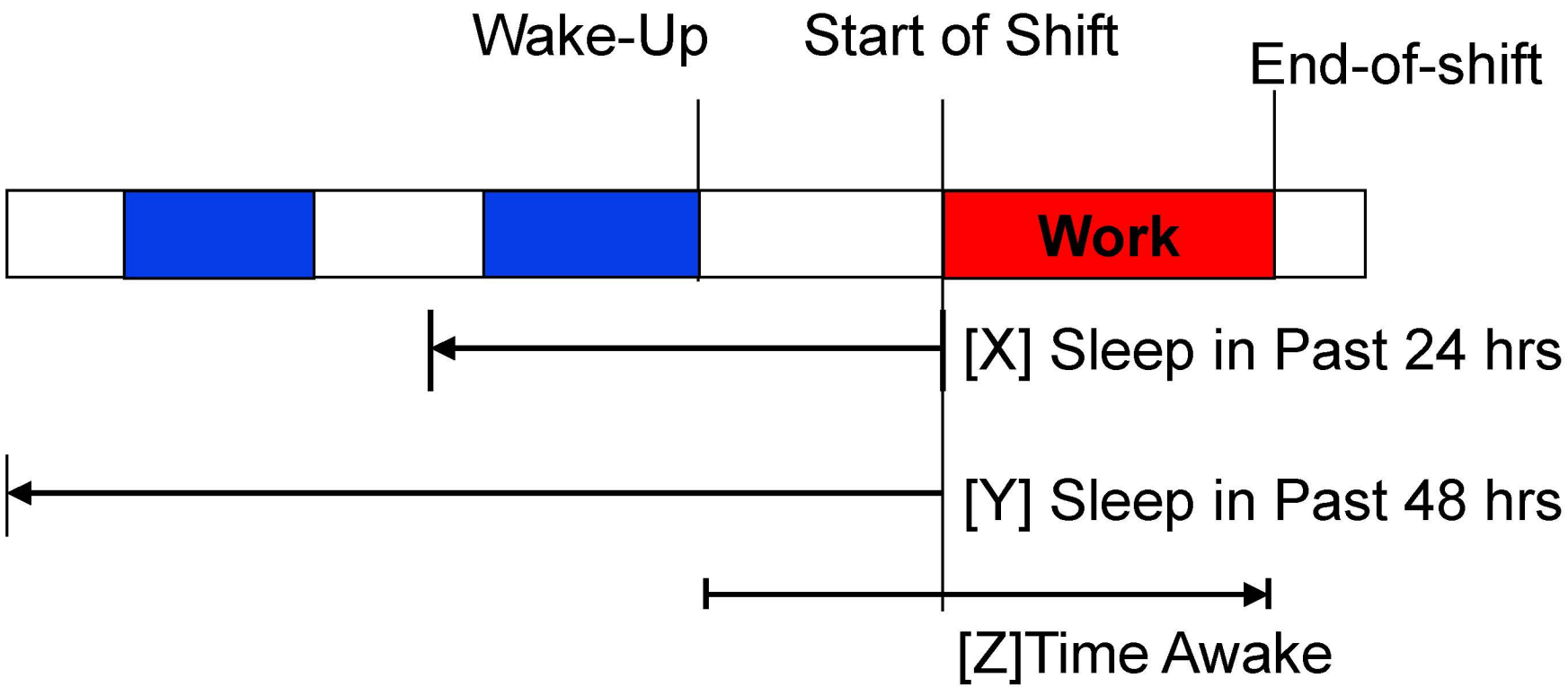
- This scheduling process assumes that individuals do NOT change the schedule on their own (i.e. exchange shifts)
- Shift exchange (swapping) should NOT be allowed if one will then work more than one shift consecutively



Individual Fatigue Assessment

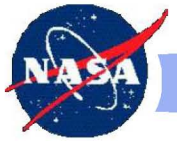


Individual Fatigue Assessment
(Obtained Sleep Metric)



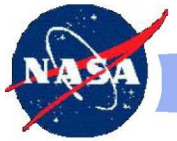
Calculating the Sleep Metric
(Ref: Transport Canada)

Prior Sleep Factor	Threshold Value	Score
X = Sleep in Past 24 hrs	5 hours	Add 4 points for each hour below threshold
Y = Sleep in Past 48 hrs	12 hours	Add 2 points for each hour below threshold
Z = Time Awake Since Last Sleep	12	Add 1 point for each hour of wakefulness greater than 12



Sleep Metric Management Actions (Ref: Transport Canada)

Sleep Metric	Management Action
0 to 5	None
6 to 10	No High-Risk Activities Double-Check/Buddy System Caffeine/Nap Opportunity
11+	Not Fit For Duty

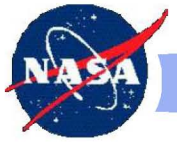


OBTAINED SLEEP METRIC		
Individual Fatigue Score	**Points Assigned**	**Score** (Indicate the number of points, as they apply to you)
1) Amount of Sleep You Obtained in the Past 24 Hours:		
≤ 2 hours	12	
3 hours	8	
4 hours	4	
5+ hours	0	
2) Amount of Sleep You Obtained in the Past 48 hours:		
≤ 8 hours	8	
9 hours	6	
10 hours	4	
11 hours	2	
12+ hours	0	
3) Number of Hours You Have Been Awake (i.e. since last sleeping ≥ 90 minutes):		
13	1	
14	2	
15	3	
16	4	
17	5	
18	6	
19	7	
20	8	
21	9	
22	10	
23	11	
24	12	
TOTAL POINTS (Add points to determine total score)		

EMPLOYEE ACTION	
Obtained Sleep Metric (# Total Points)	**Action**
< 6	None
6 to 10	No High-Risk Operations
	Caffeine/Nap Opportunity
	No Overtime
>10	Not Fit For Duty

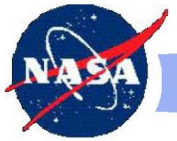
Reference: Transport Canada

Workplace/Operational Mitigations



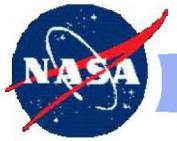
Workplace Mitigations

- Caffeine
- Lighting
- Napping



Workplace Mitigations: Naps

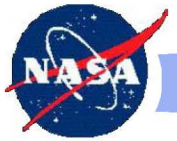
- Only *real* countermeasure for sleep loss is sleep
- Other countermeasures cover-up symptoms, but do not address the fundamental problem of *sleep loss*
- Planned naps: *30-min, 90 min or 3-hr* are generally good time limits
- Naps too close to scheduled sleep can interfere with regular sleep cycle



Fatigue Countermeasures Facility (FCF)

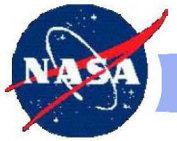
Facility Usage (CY2011)

2011	June	July	Aug	Sept	Oct	Nov	Dec	TOTAL	Avg
Total Minutes Slept	515	1216	1015	1235	1190	1455	1477	8103	1158
# Entries	8	10	13	13	9	10	11	74	11
Avg Minutes / Entry	64	122	78	95	132	146	134		110
Max	120	466	120	180	180	330	262		466
Min	30	40	30	60	100	70	30		30



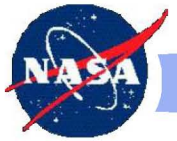
Sleep Inertia

- State of impaired cognition, grogginess, disorientation upon waking from sleep
- Can be worse if one has taken antihistamine or other sleep medication
- Most pronounced if waking up from deep sleep (e.g. “Stage 4” or “Slow Wave Sleep”)
- Individuals who are sleep-deprived (i.e. > 26 hr sleep deprivation) may go into SWS sooner, and thus may be more likely to experience prolonged sleep inertia



Sleep Inertia: Operational Mitigations

- Need enough time (20-30 minutes) to ensure one is fully awake & alert before starting any task that requires high concentration
  - –Especially if sleep-deprived beforehand
  - –Implications for response to emergencies
- Importance of getting adequate sleep before starting fatigue-promoting activity



Conclusion

Questions?