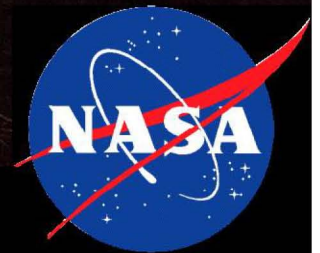


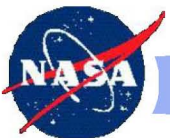
# Fatigue Management Strategies for the Stratospheric Observatory for Infrared Astronomy



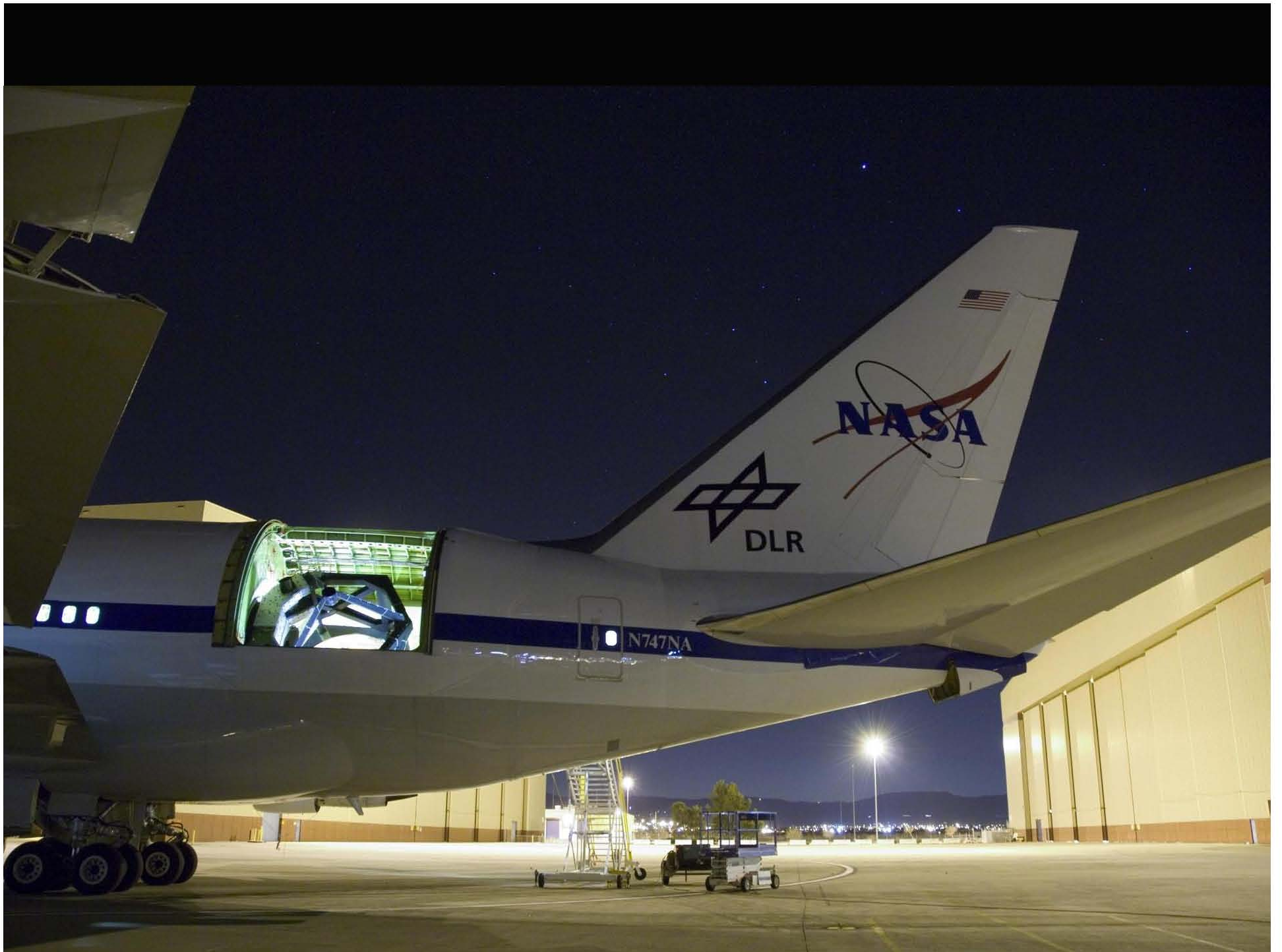
# SOFIA Airborne Observatory

---

- 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














# 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)

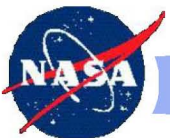
---

- 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  $\leq 18$  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)

<b>Work Schedule Scoring Risk Matrix</b>					
	<b>0 points</b>	<b>1 point</b>	<b>2 points</b>	<b>4 points</b>	<b>8 points</b>
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



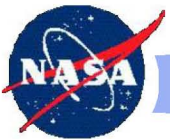
<b>Title of Activity:</b>						
<b>Dates (If applicable):</b>						
<b>Requestor:</b>						
<b>Work Schedule Scoring Matrix</b>						
	<b>0 points</b>	<b>1 point</b>	<b>2 points</b>	<b>4 points</b>	<b>8 points</b>	<b>Accrued Points</b>
<b>a) Total hours per 7 days</b>	≤ 36 hours	36.1 – 43.9 hours	44 – 47.9 hours	48 – 54.9 hours	55+ hours	
<b>b) Maximum shift duration</b>	≤ 8 hours	8.1 – 9.9 hours	10 – 11.9 hours	12 – 13.9 hours	≥ 14 hours	
<b>c) Minimum short break duration</b>	≥ 16 hours	15.9 – 13 hours	12.9 – 10 hours	9.9 – 8 hours	≤ 8 hours	
<b>d) Maximum night work (i.e., 6:00 PM – 6:00 AM) per 7 days</b>	0 hours	0.1 – 8 hours	8.1 – 16 hours	16.1 – 24 hours	≥ 24 hours	
<b>e) Long break frequency</b>	≥ 1 in 7 days	≤ 1 in 7 days	≤ 1 in 8-14 days	≤ 1 in 15-21 days	≤ 1 in 22-28 days	
<b>Justification for Waiver (If score ≥ 8):</b>					<b>TOTAL POINTS</b> <i>(Add points to determine total score)</i>	
<b>SCHEDULE SCORE</b>	<b>ACTION</b>					
<b>&lt; 8</b>	Acceptable					
<b>8 to 16</b>	Requires Mid-Level Approval <i>(with appropriate justification)</i>					
<b>&gt; 16</b>	Requires Senior-Level Approval <i>(with appropriate justification)</i>					
<b>SIGNATURES</b>						
<b>Approver:</b>						
<b>Waiver Authority (Score: 8-16):</b>						
<b>Senior Waiver Authority (Score &gt;16):</b>						
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



---

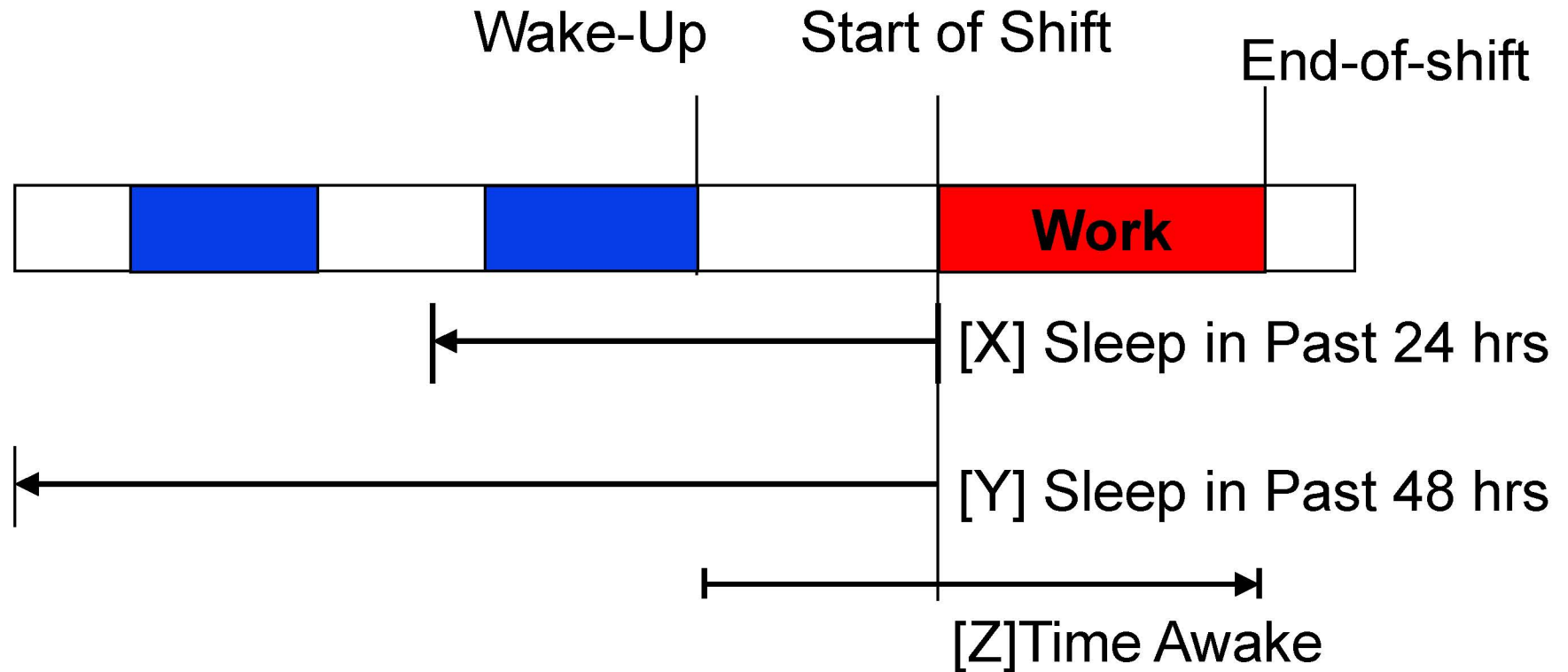
# Individual Fatigue Assessment





# Individual Fatigue Assessment (Obtained Sleep Metric)

---



# Calculating the Sleep Metric (Ref: Transport Canada)

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



# Sleep Metric Management Actions (Ref: Transport Canada)

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





OBTAINED SLEEP METRIC		
Individual Fatigue Score	Points Assigned	Score (Indicate the number of points, as they apply to you)
<b>1) Amount of Sleep You Obtained in the Past 24 Hours:</b>		
≤ 2 hours	12	
3 hours	8	
4 hours	4	
5+ hours	0	
<b>2) Amount of Sleep You Obtained in the Past 48 hours:</b>		
≤ 8 hours	8	
9 hours	6	
10 hours	4	
11 hours	2	
12+ hours	0	
<b>3) Number of Hours You Have Been Awake (i.e. since last sleeping ≥ 90 minutes):</b>		
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)		
<b>EMPLOYEE ACTION</b>		
<b>Obtained Sleep Metric (# Total Points)</b>	<b>Action</b>	
< 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)

---

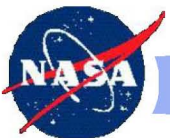
2011	June	July	Aug	Sept	Oct	Nov	Dec	TOTAL	Avg
<b>Total Minutes Slept</b>	515	1216	1015	1235	1190	1455	1477	8103	1158
<b># Entries</b>	8	10	13	13	9	10	11	74	11
<b>Avg Minutes / Entry</b>	64	122	78	95	132	146	134		110
<b>Max</b>	120	466	120	180	180	330	262		466
<b>Min</b>	30	40	30	60	100	70	30		30



# 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?

