Managing the Effects of Crew Endurance Degradation on Operational Hazard Exposure

April 2013

Carlos Comperatore, Ph.D. and Pik Kwan Ng
U.S. Coast Guard Office of Safety and Environmental Health
Washington, D.C.
Disclaimer: The following information solely represents the views of the authors and it does not represent the official position of the Department of Homeland Security or the U.S. Coast Guard
Search and rescue (SAR), medical evacuation, medical emergencies, and fire rescue are few of the many on-demand operations where dynamically changing contextual variables contribute to mission hazard exposure level.
CREW ENDURANCE MANAGEMENT (CEM)

- A method of identifying and controlling hazards that degrade crewmember alertness, rest, and recovery:
  - Assess operations to identify crew endurance hazards
  - Implement shipboard and organizational practices to protect crewmember endurance
CREW ENDURANCE RISK FACTORS

• **Core** Endurance Risk Factors – directly impact the ability to produce and restore physical and cognitive resources:
  – Insufficient Daily Sleep
  – Poor Sleep Quality
  – Fragmented Sleep
  – Main sleep during the day – night work
  – Changing work/rest schedules
  – Long work hours
  – No Opportunities to Make Up Lost Sleep
### Schedule Entry

**File Name:** 12on-12off stable

**Description:**

12on/12off stable

**Number of Days:** 14

**Initial Wakeup:** 07:00

**First Day of Week:** Tuesday

**Average Sunrise:** 06:00

**Crew Endurance Management:** Implemented

---

<table>
<thead>
<tr>
<th>Day</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>15</th>
<th>18</th>
<th>21</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Body Clock**
- **Main Sleep**
- **>12 Hrs Worked in 24 Hrs**
- **Wakefulness**
- **Long Work Period**
- **Sunlight Exp.**
- **Night Work**

---

*Click a time period column heading to expand or collapse the column display.*

*Click a risk factor column heading for information about the risk factor and the color codes.*

---

*Time Off* | *Watch* | *Work* | *Evolution* | *Sleep*
### Schedule Entry

**File Name:** 12 hr rotating  
**Description:** 12 hour rotating

- **Number of Days:** 31
- **Initial Wakeup:** 05:00
- **First Day of Week:** Sunday
- **Average Sunrise:** 06:30
- **Crew Endurance Management:** Not Implemented

*This option may be set when at least 85% of the days have sleep times entered.*

Click a **time period column** heading to expand or collapse the column display.  
Click a **risk factor column heading** for information about the risk factor and the color codes.

<table>
<thead>
<tr>
<th>Day</th>
<th>Week Day</th>
<th>00:00</th>
<th>03:00</th>
<th>06:00</th>
<th>09:00</th>
<th>12:00</th>
<th>15:00</th>
<th>18:00</th>
<th>21:00</th>
<th>24:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sun</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Mon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Tue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Wed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Thu</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Fri</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Sat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Sun</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Mon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Tue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Wed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Thu</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Fri</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Sat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Sun</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Body Clock**
- **Main Sleep**
- **>12 Hrs Worked In 24 Hrs**
- **Wakefulness**
- **Long Work Period**
- **Sunlight Exp.**
- **Night Work**
File Name: 12 hr rotating

Description: 8 hour nighttime with rotating start time

Number of Days: 25
Initial Wakeup: 06:00

First Day of Week: Sunday
Average Sunrise: 06:30

Crew Endurance Management: Not Implemented

Click a time period column heading to expand or collapse the column display.
Click a risk factor column heading for information about the risk factor and the color codes.
The Crew Endurance Management System (CEMS)
The Crew Endurance Management System (CEMS)

- Environment
- Organization
- Personnel

- Mission Demands
- Operational Safety
- 24/7 Operations
- Area of Operations

immutable Requirements
The Crew Endurance Management System (CEMS)

- Environment
  - Sleep management
  - Body clock
  - Physical fitness
  - Stress management

- Organization
  - Mission Demands
  - Operational Safety
  - 24/7 Operations
  - Area of Operations

- Personnel
  - Immutable Requirements
The Crew Endurance Management System (CEMS)

- Environment
  - Light/Noise levels
  - Vibration
  - Temperature
  - Work environments
  - Leisure facilities
  - Sleeping quarters

- Organization
  - Mission Demands
  - Operational Safety
  - 24/7 Operations
  - Area of Operations

- Personnel
  - Sleep management
  - Body clock
  - Physical fitness
  - Stress management

- Watch schedules
- Nighttime adaptation
- Overtime policy
- Napping policy
- Berthing courtesy policy
The Crew Endurance Management System

- Processes/Guidelines
  - Organizational and vessel implementation
  - Crew Endurance Risk Factors Assessment
- Knowledge
  - Education program
- Practices/Controls
  - Controls to mitigate the incidence of endurance risk factors in operations

- Equipment/Tools
  - CEMS tool
  - Crew Endurance Risk Factors Assessment
  - Schedule Evaluation Tool
  - CEMS Guide
- Develop Expertise
- Provide Assistance
Studies of brain function have shown that **seven to eight hours of continuous sleep** are necessary to restore cell function to normal levels.
DAILY SLEEP REQUIREMENTS

- **Varies with age**
  - Elementary students normally require 10-12 hours per day;
  - Pre-teens 9-11 hours;
  - Teens 8½-10 hours;
  - Most adults 7-8 hours per day

(For sleep to be restorative, it must be continuous and uninterrupted)
Daily Minimum Sleep Requirement

7-8 Continuous Hours
Figure 4. Mean number of lapses on the psychomotor vigilance task (and standard error) across days as a function of time in bed group.

Belenky et al. (2003). J. of Sleep Res. 12, 1-12
Sleep and Health

- Obesity
- Cardiovascular Disease
- Hypertension
- High Blood Pressure
- Diabetes
- Depression
- Stroke
- Immune Deficiencies
CREW ENDURANCE RISK FACTORS

- Modulating Endurance Risk Factors – contribute to “sap” energy levels and worsen the effects of the “core” risk factors
  - High Workload
  - Lack of Control Over Work Environment or Decisions
  - Poor Diet
  - No Opportunity for Exercise
  - High Work Stress
  - Family Stress
  - Isolation From Family
  - Excessive exposure to extreme environments
DECLINING ENDURANCE RESULTS IN HUMAN ERROR

<table>
<thead>
<tr>
<th>Contributing Factors</th>
<th>Symptoms</th>
<th>Human Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sleep deprivation</td>
<td>Physical Symptoms</td>
<td>• Unable to recognize input (e.g. nav aids, radio calls, gauges)</td>
</tr>
<tr>
<td>• Sleep cycle disruption</td>
<td>• Difficulty focusing eyes</td>
<td>• Forget to check critical info (e.g., fathometer, fuel levels)</td>
</tr>
<tr>
<td>• Working at inappropriate times of day</td>
<td>• Clumsy</td>
<td>• Fail to secure equipment (e.g., cargo transfer)</td>
</tr>
<tr>
<td>• Job role and life stress</td>
<td>• Sore muscles</td>
<td>• Alter something that did not need to be changed (e.g., course, fuel transfer)</td>
</tr>
<tr>
<td>• Physical stress</td>
<td>Mental Symptoms</td>
<td></td>
</tr>
<tr>
<td>• Environmental stress</td>
<td>• Forgetful</td>
<td></td>
</tr>
</tbody>
</table>

- Mental Symptoms
  - Forgetful
  - Hard to do mental arithmetic, recognize codes/symbols
  - Less motivated
  - Slow to respond
  - Tasks out of sequence

- Physical Symptoms
  - Difficulty focusing eyes
  - Clumsy
  - Sore muscles
Mission Hazard Assessment

Mission Setup  Crew Setup  Hazard Analysis

Total Hazard Exposure

Mission Type: SAR

- Plot Nap Period
- Weather:
  - Weather Simple
- Illumination:
  - Good
- IMC

Sunrise: 7:00 AM  Sunset: 7:00 PM

Analysis Start Time: 6:00 AM
Take-off Time: 19:00 AM

If any crew member has taken a nap, do not set Analysis Start Time later than the earliest Nap End

Nap Start times:
- 18:00
- 18:00
- 18:00
- 18:00
Nap End times:
- 23:00
- 23:00
- 23:00
- 23:00

Day

Night

SAR Simple  SAR Medium  SAR Hard

Hazard Exposure as a function of Proficiency, Mission Complexity, and Environmental Conditions

U.S. DEPARTMENT OF HOMELAND SECURITY
Circadian Rhythms
High alertness: 10:00
Highest testosterone secretion
Bowel movement likely: 08:30
Melatonin secretion stops: 07:30
Sharpest rise in blood pressure: 06:45
Lowest body temperature: 04:30
Deepest sleep: 02:00
Midnight: 00:00
Noon: 12:00
Best coordination: 14:30
Fastest reaction time: 15:30
Greatest cardiovascular efficiency and muscle strength: 17:00
Highest blood pressure: 18:30
Highest body temperature: 19:00
Melatonin secretion starts: 21:00
Bowel movements suppressed: 22:30
Sleep and Performance

Human Performance

Logical Reasoning
Mental Arithmetic
Aircraft Piloting
24-hour Rhythms

Alertness Level & Core Temperature

Time of Day

Sleep
Serotonin → N-acetylserotonin → Melatonin

serotonin-N-acetyltransferase → hydroxyindole-O-methyltransferase
ACROPHASE

ONSET

Melatonin

Hours

2000  2200  0000  0200  0400  0600  0800  1000

Pg/ml

80

60

40

20

0
Shifting Circadian Rhythms
Use of “Monochromatic” Green Light
24-hour Rhythms

Alertness Level & Core Temperature

Time of Day

Sleep
Light Induced Delays

Time of Day

Alertness Level & Core Temperature

Sleep

delay

0 5 10 15 20

12 15 18 21 24 3 6 9 12

Time of Day

U.S. DEPARTMENT OF HOMELAND SECURITY
Light Induced Delays

Rate of shift: app. 1 hr/day
Light Induced Delays

Alertness Level & Core Temperature

Time of Day

Sleep

delay
Light Management

24-hour Rhythms

Time of Day

Alertness Level & Core Temperature

Sleep
Light Induced Advances

Time of Day

Alertness Level & Core Temperature

Sleep
advance

Time of Day
Light Induced Advances

Alertness Level & Core Temperature

Time of Day
15 Minute Exposure by 2 hours Calibration
Hazard Exposure as a Function of Operational Complexity

• Each operational environment involves specific
  – Operational objectives,
  – Crew operational proficiency,
  – Crew State
  – Response platform capacities,
  – Platform tolerance thresholds for varying environmental conditions,
  – Variation in coordination of multiple (e.g., shipboard, afloat, aviation, command and control, etc.) assets, and in some cases inter-agency coordination.
**Mission Setup**

**PIC Name:** [Blank]

**Mission Date:** [Blank]  
**Take-Off Time:** 19:00

**Tail Number:** CG-

**Sunrise:** 07:30  
**Sunset:** 17:00

**Mission Type**
- **SAR**
  - Simple - Searches: fire, PIW, kayak, overdue. No hoisting; Daytime medevac - flat, unobstructed terrain.
  - Medium - Adequate time/information to plan; Adequate fuel margin; Adequate time to prep boat on scene. Hoisting; Simple/known hoisting area; Daytime medevac from or to ship; Nighttime medevac to an open field; RS ops; Rougher/more mountainous terrain.
  - Hard - Strict fuel management (long range); Limited time to prep boat on scene; Terrain includes obstructions - towers/cliffs/power lines; Limited time/information to plan; Low margin of error. Complex hoist - boat rigging, type of boat, unstable platform, vertical surface (e.g. cliff face); Night-time PIW.

- **Ferry Flight**
  - Simple - Flying a known route, e.g. E-city to Atlantic City; close to AOR, know course rules; few to no surprises on route.
  - Complex - Cross-country, e.g. North Bend to Atlantic city; unfamiliar areas; a lot of map work; long flights/long days.

- **External Load**
  - Simple - Weight well within platform limits; size, shape and materials of ext. load not challenging.
  - Complex - Weight may come closer to platform limits; size, shape and material of ext. load prone to salling, other maneuvering/aerodynamic challenges.

**Environmental Flight Conditions**
- **IMC**

**Illumination**
- **Low**
- **Adequate**
- **Good**

**Aircraft Status**
- All equipment operational. ACMS up to date.

**Loading**
- What is the expected loading condition during the mission?
- Normal Load, no extra equipment or passengers expected.

**Weather Conditions**
- **Weather Simple** - Within local mins (i.e. local 3710/read and initial file) and CG 3710 mins.
- **Weather Moderate** - Exceeding local mins (i.e. local 3710/read and initial file), but within CG 3710 mins.
- **Weather Hard** - Exceeding local mins (i.e. local 3710/read and initial file) and approaching but NOT exceeding CG 3710 mins.
- **Weather Extreme** - Exceeding both local mins (i.e. local 3710/read and initial file) and CG 3710 mins.
  - Require waiver from Command to begin or continue mission.
  - Any of the following (predicted/known/forecasted): severe turbulence; severe icing; embedded thunderstorms; extreme sea conditions; approaching/at hurricane-force winds.
Operational Proficiency

(OPNL Experience (w) + Skill Decay(w) + AOR Fam(w) + Platform Qual(w) + Last Flight(w))
<table>
<thead>
<tr>
<th>prof</th>
<th>SAR-h</th>
<th>Training-Recon</th>
<th>SM</th>
</tr>
</thead>
<tbody>
<tr>
<td>prof</td>
<td>WS</td>
<td>WM</td>
<td>WH</td>
</tr>
<tr>
<td>1</td>
<td>0.961538</td>
<td>0.792857</td>
<td>0.742857</td>
</tr>
<tr>
<td>0.961538</td>
<td>0.804286</td>
<td>0.638571</td>
<td>0.392857</td>
</tr>
<tr>
<td>0.846154</td>
<td>0.757143</td>
<td>0.604286</td>
<td>0.371429</td>
</tr>
<tr>
<td>0.846154</td>
<td>0.772857</td>
<td>0.615714</td>
<td>0.375714</td>
</tr>
<tr>
<td>0.730769</td>
<td>0.71</td>
<td>0.57</td>
<td>0.35</td>
</tr>
<tr>
<td>0.730769</td>
<td>0.691667</td>
<td>0.541667</td>
<td>0.338333</td>
</tr>
<tr>
<td>0.538462</td>
<td>0.618333</td>
<td>0.428333</td>
<td>0.291667</td>
</tr>
<tr>
<td>0.538462</td>
<td>0.6</td>
<td>0.4</td>
<td>0.28</td>
</tr>
<tr>
<td>0.480769</td>
<td>0.588462</td>
<td>0.396154</td>
<td>0.27</td>
</tr>
<tr>
<td>0.480769</td>
<td>0.565385</td>
<td>0.388462</td>
<td>0.25</td>
</tr>
<tr>
<td>0.423077</td>
<td>0.553846</td>
<td>0.384615</td>
<td>0.24</td>
</tr>
<tr>
<td>0.423077</td>
<td>0.542308</td>
<td>0.380769</td>
<td>0.23</td>
</tr>
<tr>
<td>0.384615</td>
<td>0.530769</td>
<td>0.376923</td>
<td>0.22</td>
</tr>
<tr>
<td>0.384615</td>
<td>0.519231</td>
<td>0.370777</td>
<td>0.21</td>
</tr>
<tr>
<td>0.346154</td>
<td>0.507692</td>
<td>0.369231</td>
<td>0.2</td>
</tr>
<tr>
<td>0.326923</td>
<td>0.496154</td>
<td>0.353846</td>
<td>0.19</td>
</tr>
<tr>
<td>0.307692</td>
<td>0.484615</td>
<td>0.351578</td>
<td>0.18</td>
</tr>
<tr>
<td>0.284615</td>
<td>0.473077</td>
<td>0.357692</td>
<td>0.17</td>
</tr>
<tr>
<td>0.269231</td>
<td>0.461538</td>
<td>0.353846</td>
<td>0.16</td>
</tr>
<tr>
<td>0.25</td>
<td>0.45</td>
<td>0.35</td>
<td>0.15</td>
</tr>
<tr>
<td>0.230769</td>
<td>0.426923</td>
<td>0.333077</td>
<td>0.146923</td>
</tr>
<tr>
<td>0.211538</td>
<td>0.403846</td>
<td>0.316154</td>
<td>0.143846</td>
</tr>
<tr>
<td>0.192308</td>
<td>0.380769</td>
<td>0.299231</td>
<td>0.140769</td>
</tr>
<tr>
<td>0.173077</td>
<td>0.357692</td>
<td>0.282308</td>
<td>0.137692</td>
</tr>
<tr>
<td>0.153846</td>
<td>0.334615</td>
<td>0.265385</td>
<td>0.134615</td>
</tr>
<tr>
<td>0.134615</td>
<td>0.311538</td>
<td>0.248462</td>
<td>0.131538</td>
</tr>
<tr>
<td>0.115385</td>
<td>0.288462</td>
<td>0.231538</td>
<td>0.128462</td>
</tr>
<tr>
<td>0.096154</td>
<td>0.265385</td>
<td>0.214615</td>
<td>0.125385</td>
</tr>
<tr>
<td>0.076923</td>
<td>0.242308</td>
<td>0.197692</td>
<td>0.122308</td>
</tr>
<tr>
<td>0.057692</td>
<td>0.219231</td>
<td>0.180769</td>
<td>0.119231</td>
</tr>
<tr>
<td>0.038462</td>
<td>0.196154</td>
<td>0.163846</td>
<td>0.116154</td>
</tr>
<tr>
<td>0.019231</td>
<td>0.173077</td>
<td>0.146923</td>
<td>0.113077</td>
</tr>
</tbody>
</table>
## Hazard Assessment Tool

### Crew Setup

<table>
<thead>
<tr>
<th>Required Position</th>
<th>EmplID</th>
</tr>
</thead>
<tbody>
<tr>
<td>R Seat</td>
<td>ops PIC</td>
</tr>
<tr>
<td>L Seat</td>
<td></td>
</tr>
<tr>
<td>BA</td>
<td></td>
</tr>
<tr>
<td>Flight Mech</td>
<td></td>
</tr>
<tr>
<td>RS</td>
<td></td>
</tr>
</tbody>
</table>

### Operational Experience:
- Estimate years of CG aviation experience
- 4 years

### Recency:
- Estimate months since you last used perishable skills critical to this mission
- <.5 Months

### Mission Management:
- Rate cognitive / emotional state and ability to fulfill role in crew coordination, situational awareness, on-scene coordination, risk management, and execution of evolutions critical to this mission
- able 90-100%

### Platform Experience:
- Estimate number of hours flown in this platform
- 300+ hours

### Primary Sleep Start:
- What time did you fall asleep last night? (Nearest 1/2 hour)
  - 22:00

### Primary Sleep End:
- What time did you wake up this morning? (Nearest 1/2 hour)
  - 06:00

### Nap 1 Start:
- What time did you take a nap? (Nearest 1/2 hour)
  - 12:00

### Nap 1 End:
- What time did you awake from the nap? (Nearest 1/2 hour)
  - 12:00

### Nap 2 Start:
- What time did you take a nap? (Nearest 1/2 hour)

### Nap 2 End:
- What time did you awake from the nap? (Nearest 1/2 hour)

### Crew Fatigue at Take Off:
- 19:00
Mission Hazard Assessment

Hazard Analysis

Total Hazard Exposure

- Mission Type: SAR
- Plot Nap Period
- Weather: Weather Simple
- Illumination: Good

Sunrise: 7:30
Sunset: 17:00
Analysis Start Time: 7:00
Take-off Time: 19:00

If any crew member has taken a nap, do not set Analysis Start Time later than the earliest Nap End.

Nap Start times:
12:00 12:00 12:00 12:00
Nap End times:
12:00 12:00 12:00 12:00

Day
Night
Contact Information

• Dr. Carlos Comperatore
• carlos.a.comperatore@uscg.mil
• 202-475-5182