



National Transportation Safety Board

Investigating Human Fatigue Factors

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NIOSH Working Hours, Sleep and Fatigue Webinar Series

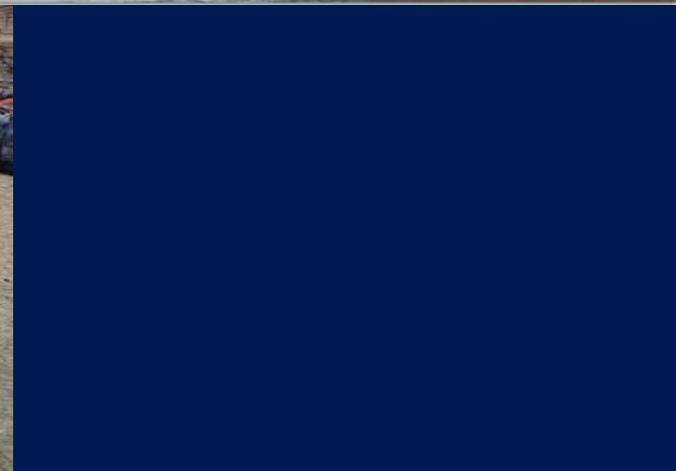
September 27, 2017

NTSB Mission

Independently advancing transportation safety

- Investigating accidents
- Determining probable cause
- Issuing safety recommendations





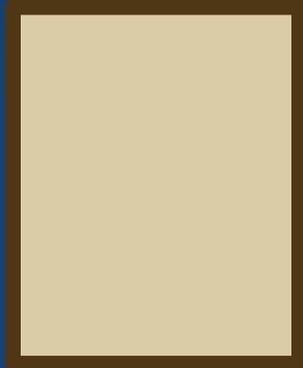
Multi Modal



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Recommendations, Not Regulations

- Recommendations to improve safety
 - Vehicle manufacturers
 - Operators
 - Regulatory agencies
 - State or local governments
 - Associations, labor, others...
- 13,000+ recommendations since 1967
- 82% “acceptance rate”



NTSB 2017-2018

MOST WANTED LIST OF

TRANSPORTATION SAFETY IMPROVEMENTS



AVIATION



HIGHWAY



MARINE



RAIL

MWL

MOST WANTED LIST



PIPELINE



NTSB 2017-2018 Most Wanted List

- Reduce fatigue-related accidents
- End alcohol and other drug impairment in transportation
- Increase implementation of collision avoidance technologies
- Eliminate distractions
- Require medical fitness for duty
- Strengthen occupant protection
- Ensure the safe shipment of hazardous materials
- Expand recorder use to enhance safety
- Prevent loss of control in flight in general aviation
- Improve rail transit safety oversight

NTSB 2017-2018 Most Wanted List

- Reduce fatigue-related accidents
- 200+ recommendations
- ~67% acceptance

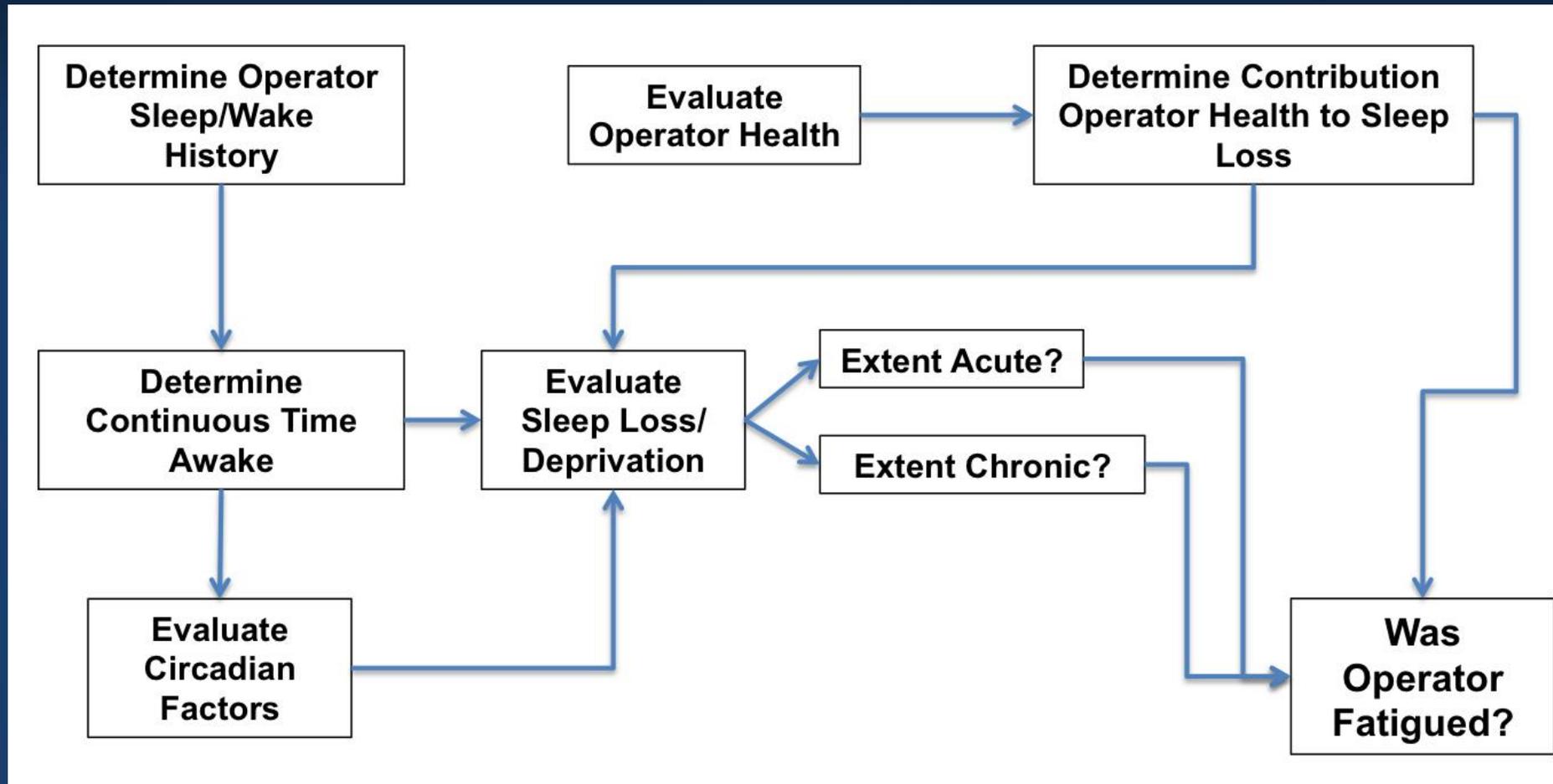


Investigating Human Fatigue Factors

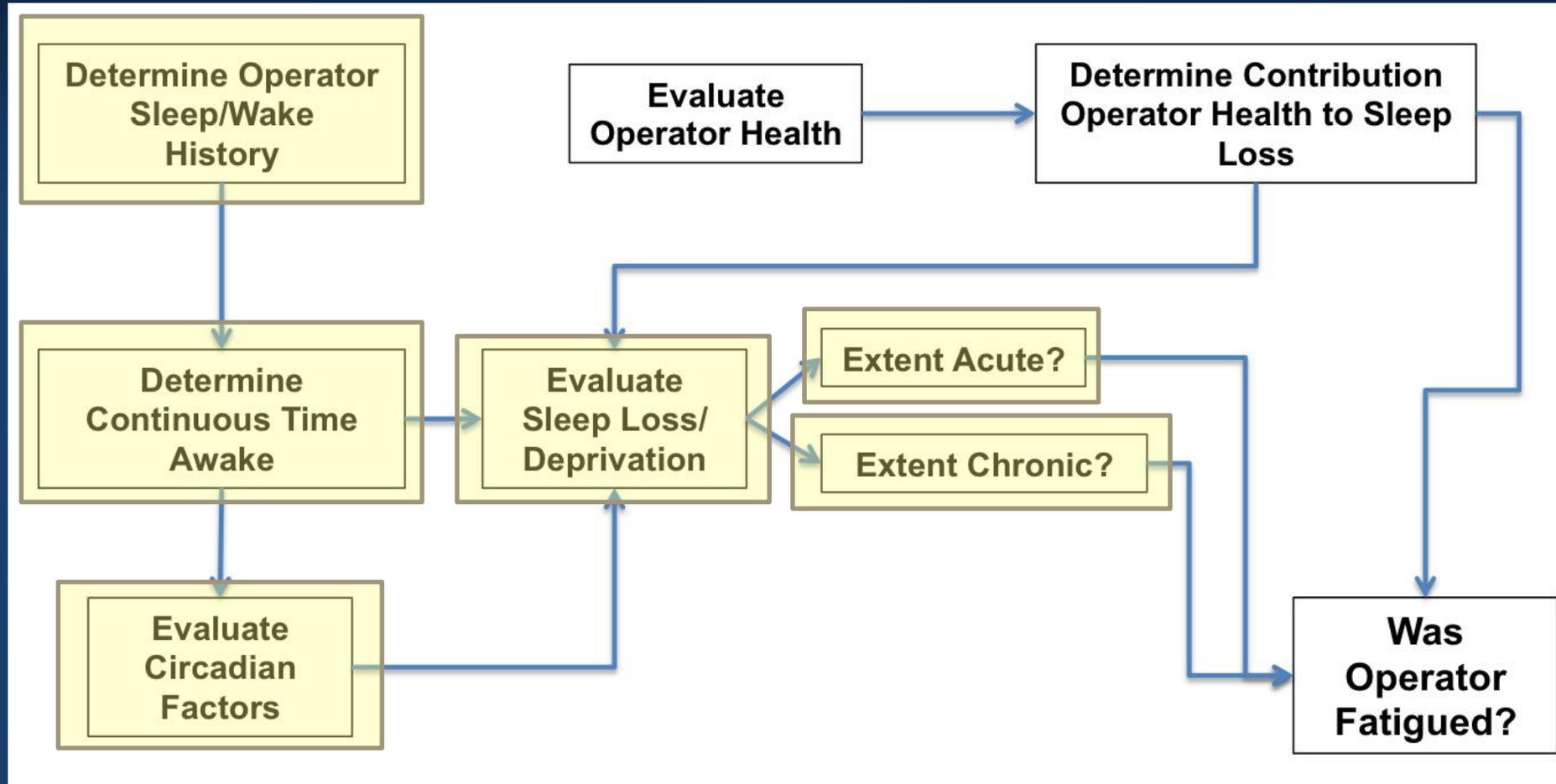
NTSB two-day course

- Was the operator fatigued?
- Did fatigue contribute to the event?

Step 1: Was the Operator Fatigued?



Operator Sleep/Wake History



Key Evidence Sources

- Interviews with the operator or others
- Schedules/logbooks
- Cell phone records
- Audio/video/data recordings
- Other time-stamped records

Operator Interview Topics

- Sleep/wake times (recent and typical)
- Time and duration of ALL activities
- Times/amounts of any drugs/alcohol
- Sleep quality (recent and typical)
- Subjective sleepiness at the time of the accident

Different Ways of Asking Questions

A. Did you get enough sleep last night?

- Yes.

B. How much sleep did you get last night?

- About 8 hours.

C. What time did you go to sleep/wake up?

- I went to sleep around 11:00-11:30.
I woke up when my alarm went off at 5:00.

Other Interview Tips

- Know as much as you can before you start the interview
- Use a voice recorder or note taker if possible so you can focus on conversation
- Consider filling in a grid or log to document schedule data during interview
- Ask for confirmation sources



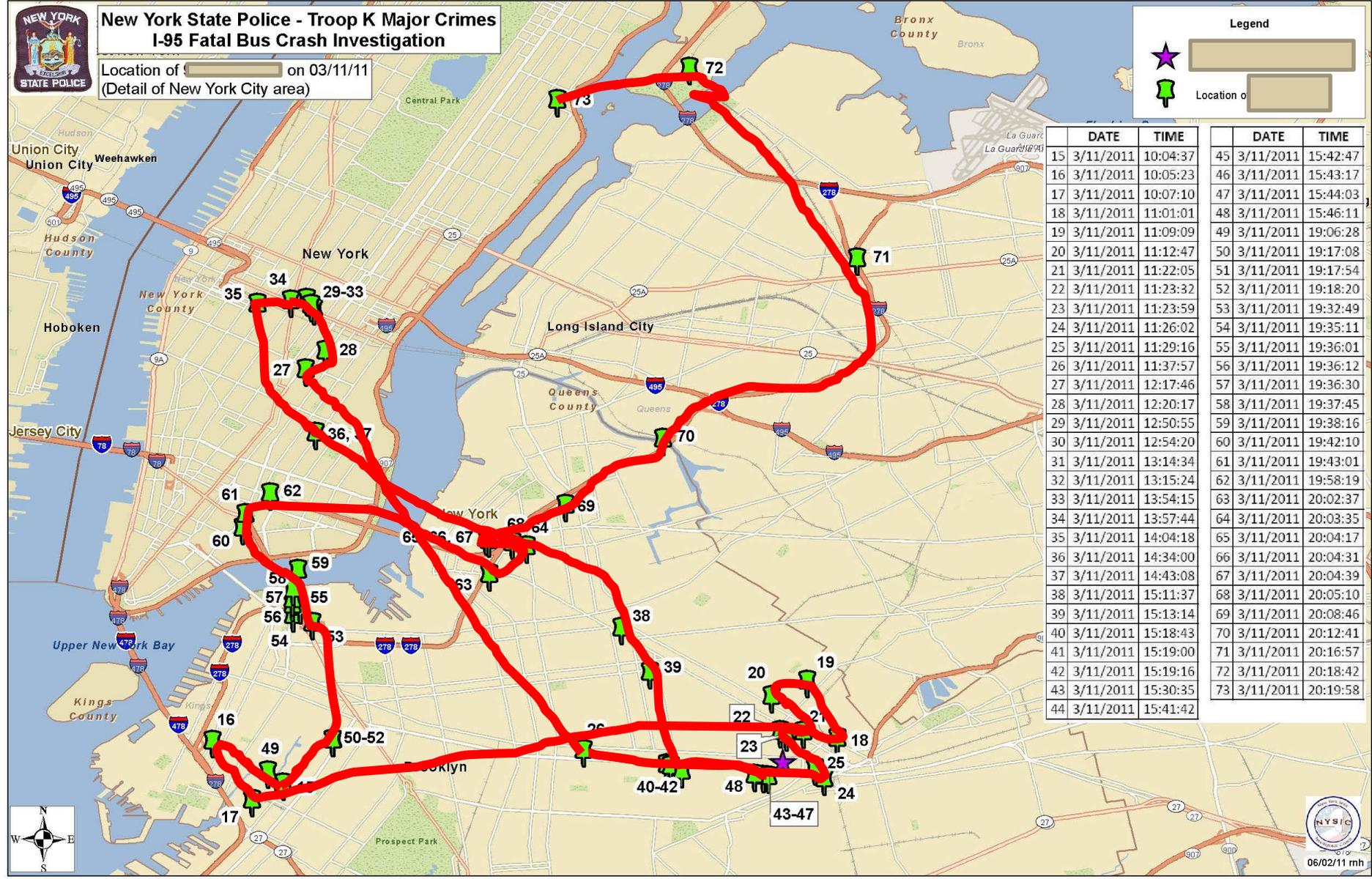
New York State Police - Troop K Major Crimes I-95 Fatal Bus Crash Investigation

Location of [redacted] on 03/11/11
(Detail of New York City area)

Legend

★ [redacted]

📍 Location of [redacted]



DATE	TIME	DATE	TIME
15	3/11/2011 10:04:37	45	3/11/2011 15:42:47
16	3/11/2011 10:05:23	46	3/11/2011 15:43:17
17	3/11/2011 10:07:10	47	3/11/2011 15:44:03
18	3/11/2011 11:01:01	48	3/11/2011 15:46:11
19	3/11/2011 11:09:09	49	3/11/2011 19:06:28
20	3/11/2011 11:12:47	50	3/11/2011 19:17:08
21	3/11/2011 11:22:05	51	3/11/2011 19:17:54
22	3/11/2011 11:23:32	52	3/11/2011 19:18:20
23	3/11/2011 11:23:59	53	3/11/2011 19:32:49
24	3/11/2011 11:26:02	54	3/11/2011 19:35:11
25	3/11/2011 11:29:16	55	3/11/2011 19:36:01
26	3/11/2011 11:37:57	56	3/11/2011 19:36:12
27	3/11/2011 12:17:46	57	3/11/2011 19:36:30
28	3/11/2011 12:20:17	58	3/11/2011 19:37:45
29	3/11/2011 12:50:55	59	3/11/2011 19:38:16
30	3/11/2011 12:54:20	60	3/11/2011 19:42:10
31	3/11/2011 13:14:34	61	3/11/2011 19:43:01
32	3/11/2011 13:15:24	62	3/11/2011 19:58:19
33	3/11/2011 13:54:15	63	3/11/2011 20:02:37
34	3/11/2011 13:57:44	64	3/11/2011 20:03:35
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37	3/11/2011 14:43:08	67	3/11/2011 20:04:39
38	3/11/2011 15:11:37	68	3/11/2011 20:05:10
39	3/11/2011 15:13:14	69	3/11/2011 20:08:46
40	3/11/2011 15:18:43	70	3/11/2011 20:12:41
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43	3/11/2011 15:30:35	73	3/11/2011 20:19:58
44	3/11/2011 15:41:42		



06/02/11 mh

New York, NY, March 12, 2011



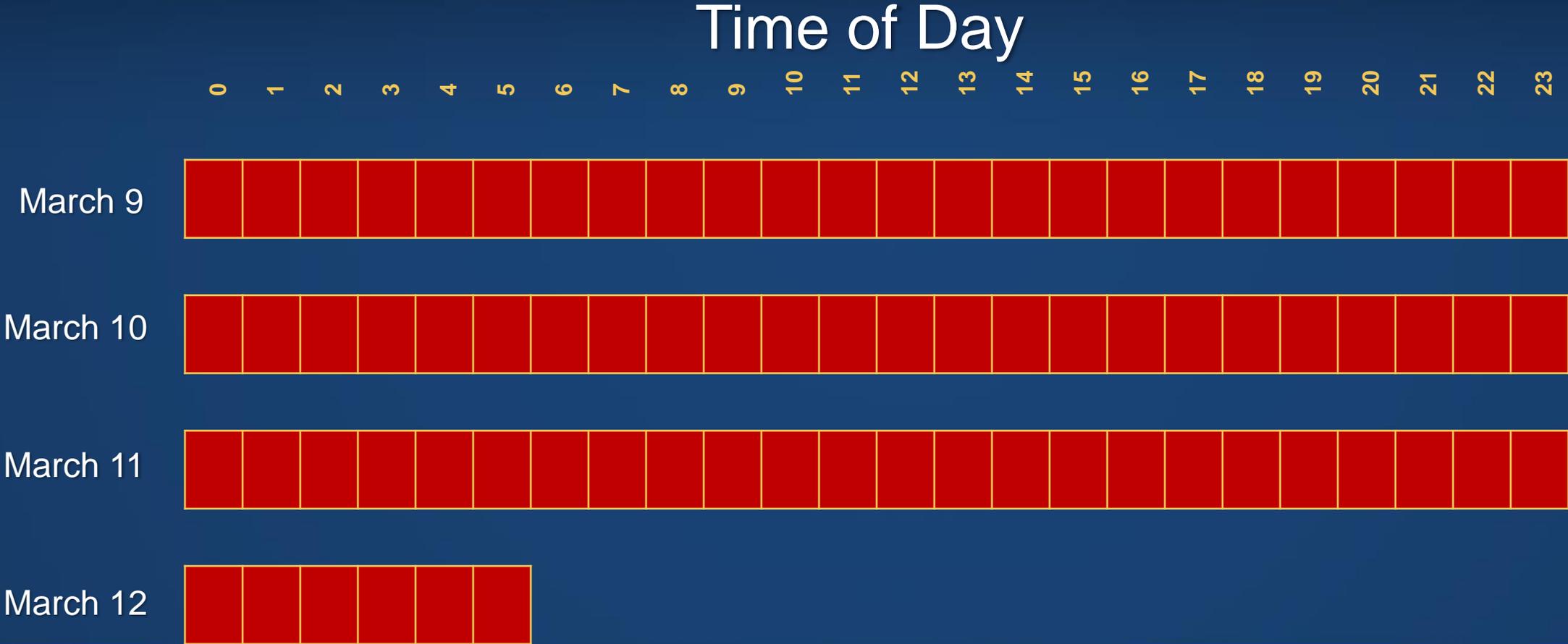
Sleep Quantity and Quality

- Driver self-reported 7.5 hours sleep on workdays; 13–16 hours on days off
- Cell phone and car rental records indicate few sleep opportunities

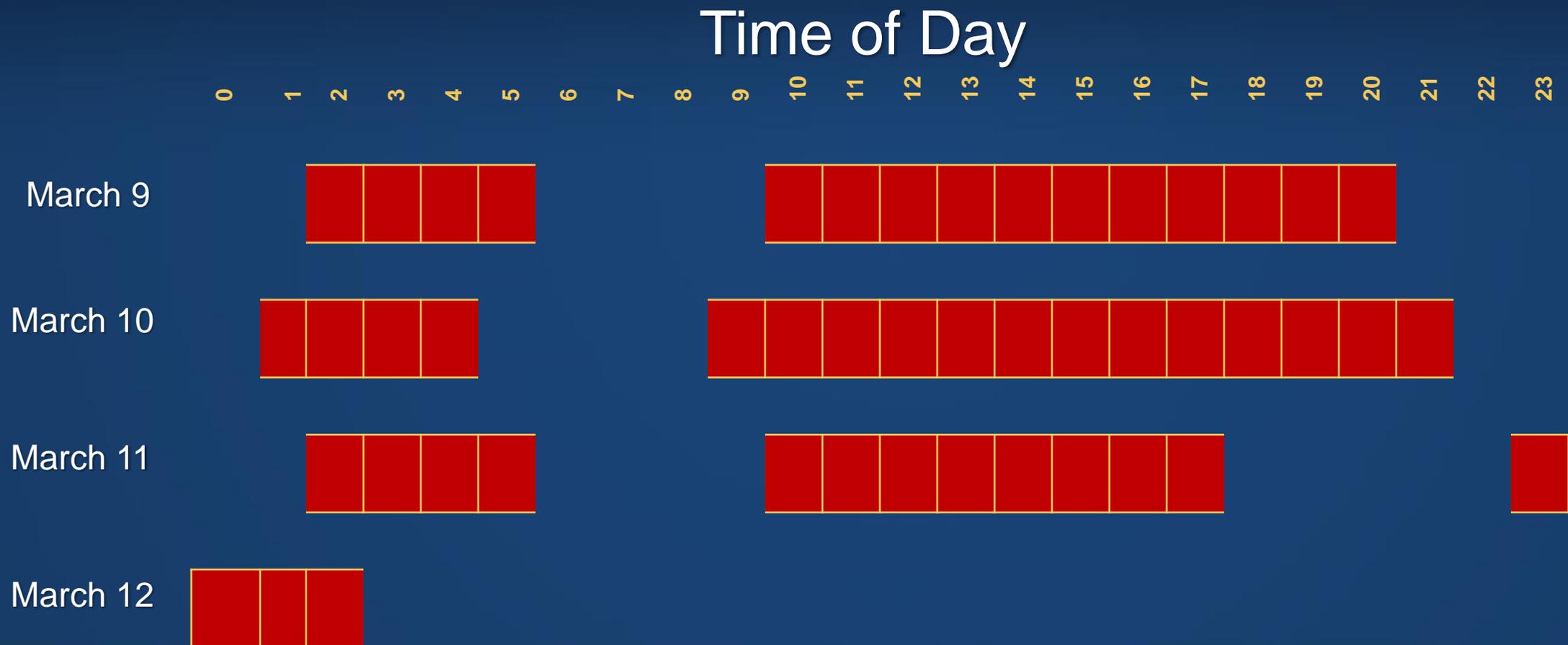
Master Activity Log

Time	Activity	Source
1:56 a.m.	Arrive casino	Casino video
2:00 – 6:00 a.m.	Asleep in bus	Driver interview
6:30 a.m.	Depart casino	Casino video
9:50 a.m.	Arrive World Wide Travel Terminal	Records
11:00 a.m. – 4:00 p.m.	Asleep	Driver interview
10:15 a.m. – 12:03 p.m.	Cell phone used multiple times	Cell phone records
3:39 p.m.	24-second cell phone call	Cell phone records
6:15 p.m.	Arrive for duty, World Wide Travel Terminal	Records
7:40 p.m.	Pickup passengers at Bowery stop	Records

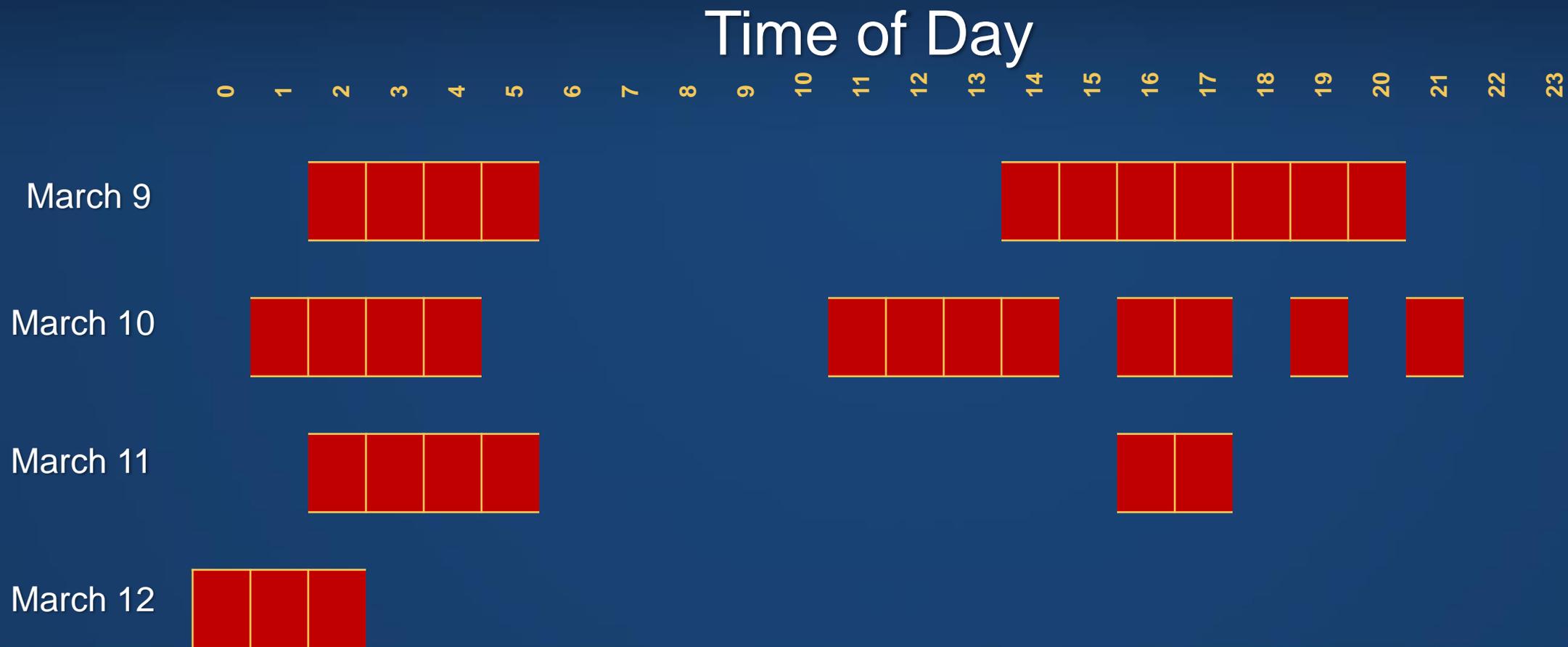
Driver Sleep Opportunities



Driver Sleep Opportunities



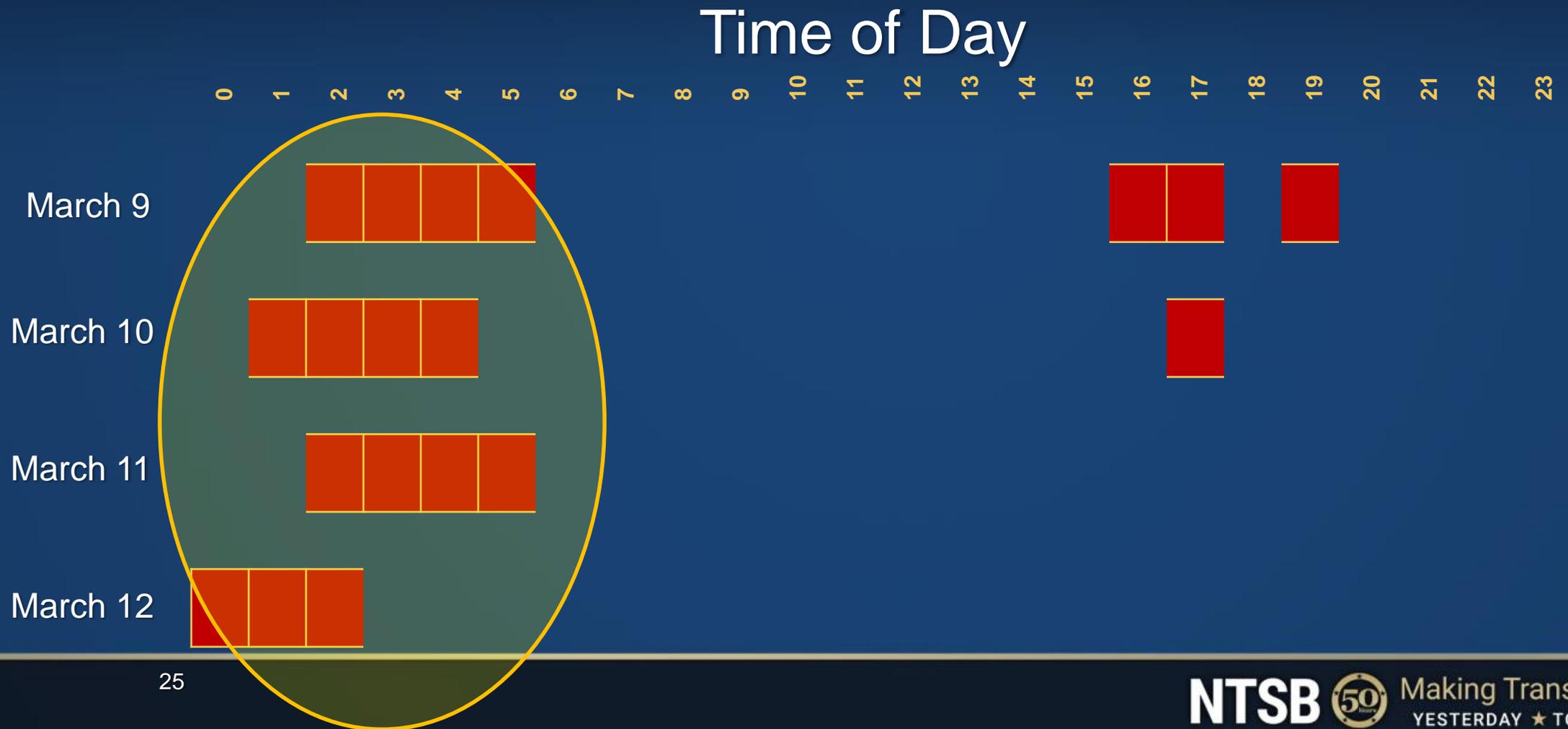
Driver Sleep Opportunities



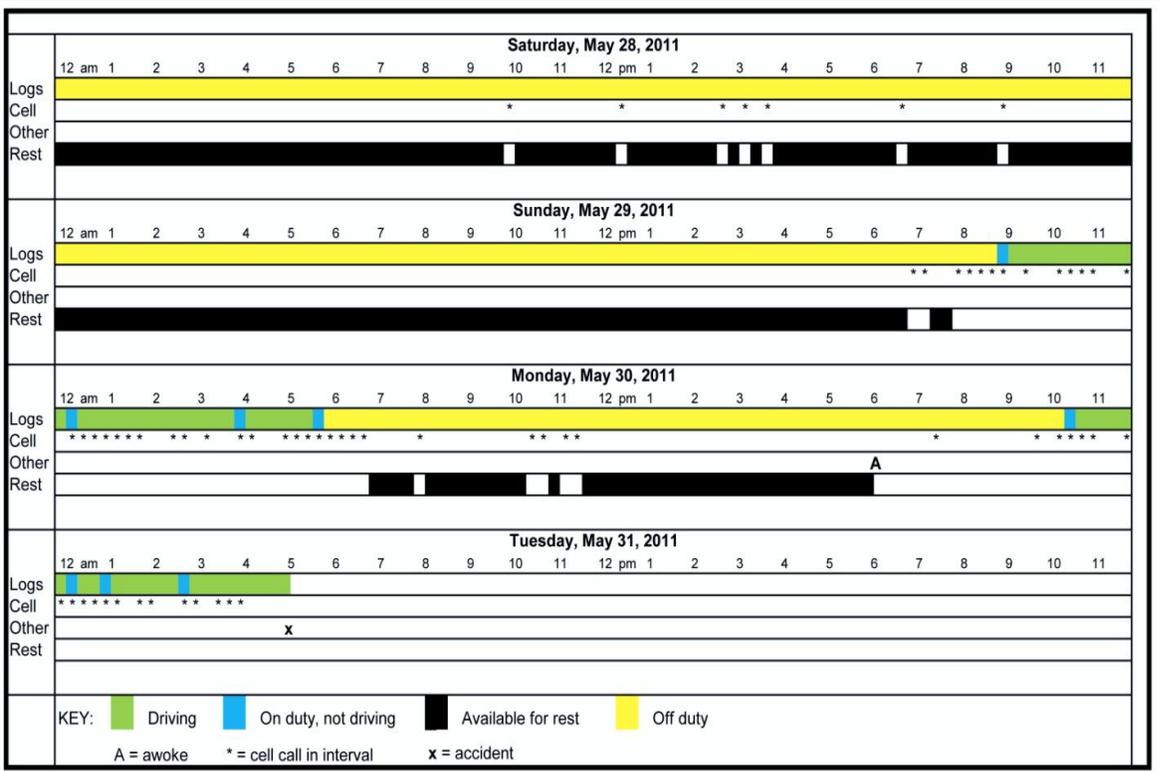
Driver Sleep Opportunities



Driver Sleep Opportunities



What can sleep/wake history tell you?



Sleep Deprivation

- Acute
- Chronic

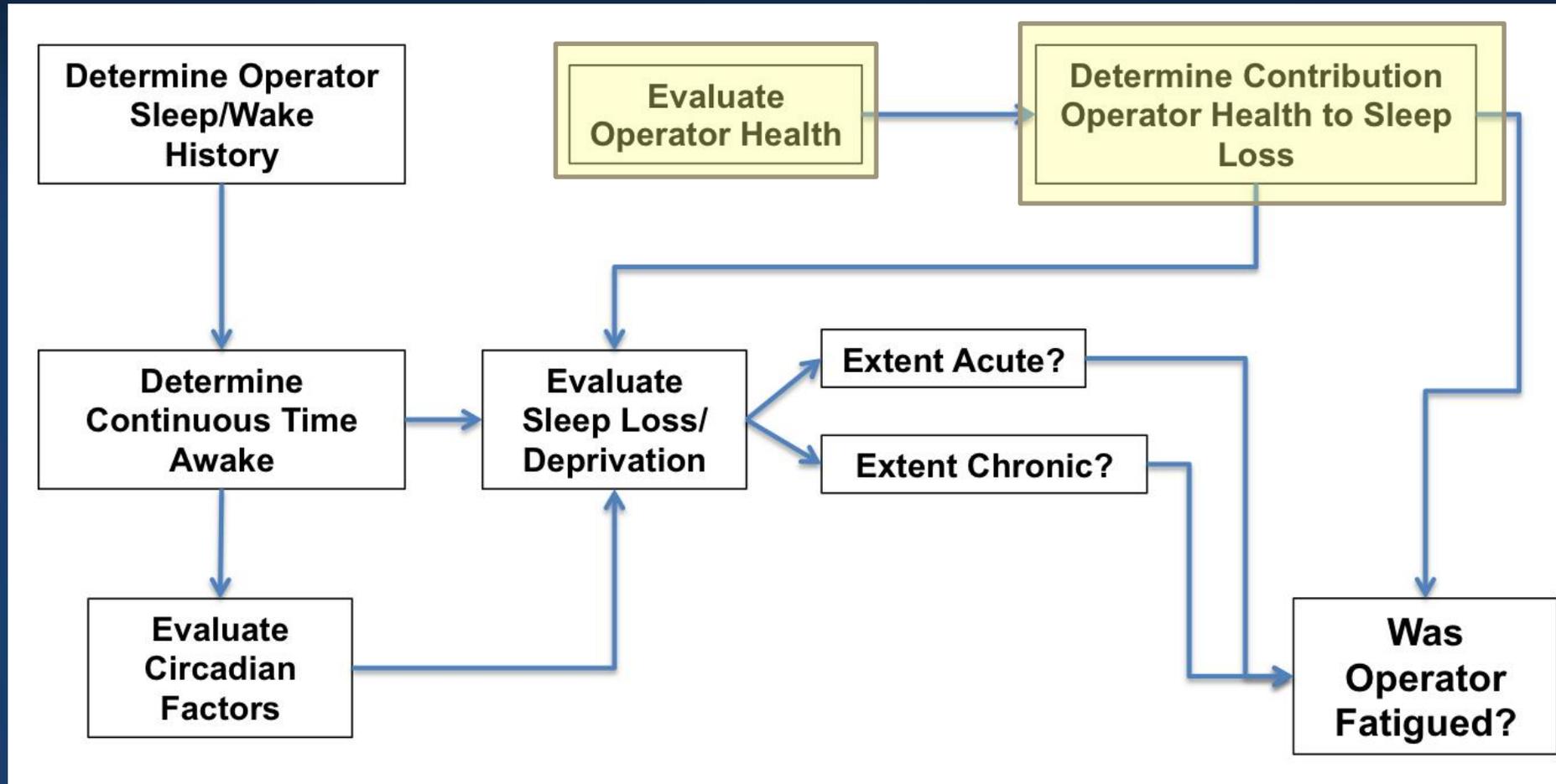
Circadian Dysrhythmia

- Time of day
- Schedule inversion
- Jet-lag

Time Awake/On-Task

- Continuous hours awake
- Hours of operation

Evaluate Operator Health



What Can Health-Related Evidence Tell You?

- Sleep disorders or risk factors
 - Obstructive sleep apnea
 - Insomnia
 - Restless legs syndrome
- Other health issues that affect alertness
- Presence of sedating drugs and/or alcohol

Diseases and drugs...

- Can impair sleep
- Can cause wake-time sleepiness
- Can have interactive effects with sleep deprivation

Key Evidence Sources

- Toxicology analyses
- Interviews (operator and/or family)
- Medical examiner records
- Personal physician records
- Pharmacy records

Bronx, NY, December 1, 2013



Toxicology

- Valuable... yet,
- Challenging to obtain
- Perishable
- Subject to protections
- Requires medical expertise to interpret



Chesterfield, NJ, July 23, 2013

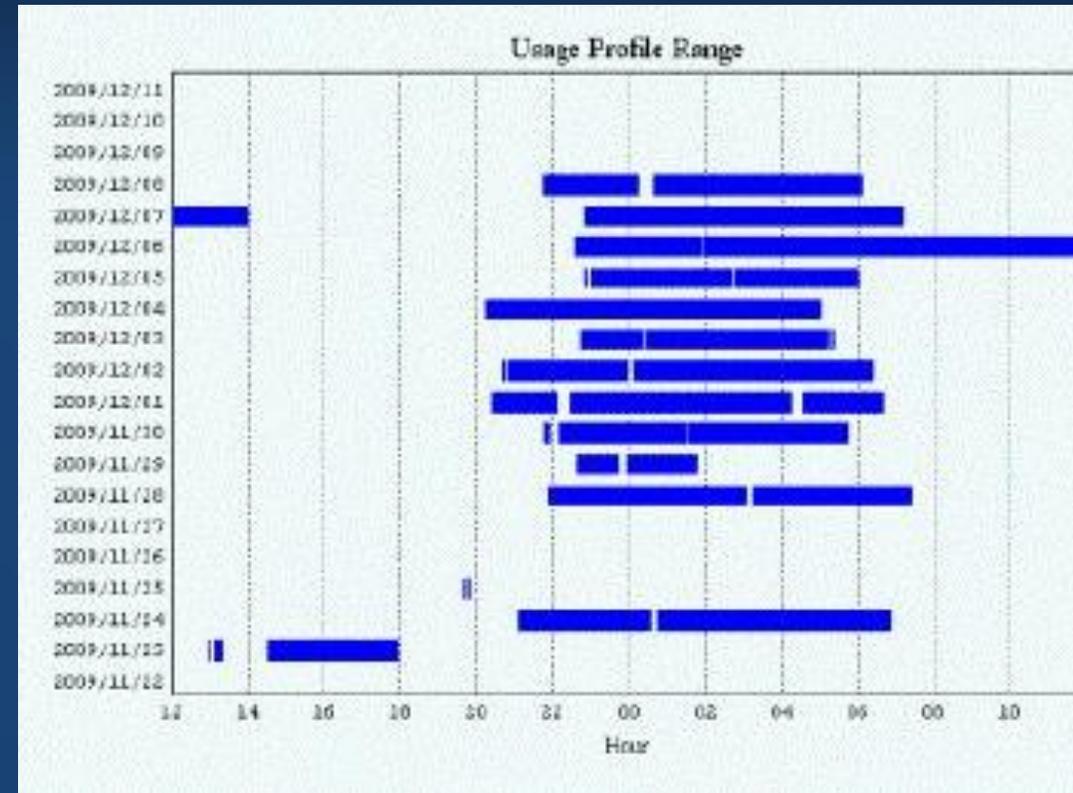


School Bus Driver Fatigue Risk Factors

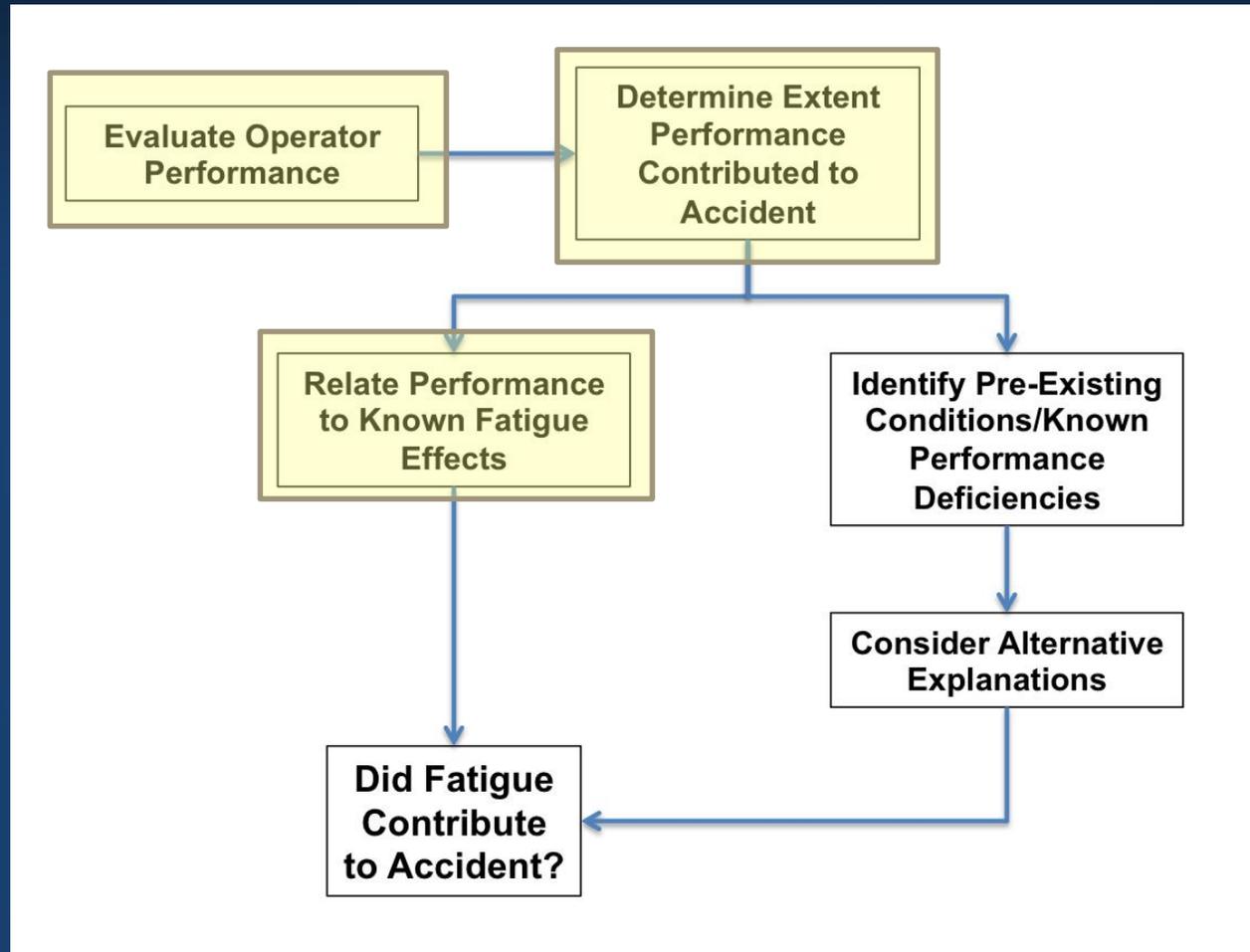
- 5 hours of sleep per night
- History of back, hip, and leg pain
- Alcohol abuse/nightly drinking
- Toxicology:
 - Tramadol
 - Clonazepam
 - Desmethylvenlafaxine

CPAP Treatment Compliance Data

- Cirrus SR-22 crash
- Pilot and 3 passengers died
- Medical certificate documented OSA
- Continuous positive airway pressure (CPAP) device data showed > 4 hours use on 3 nights preceding accident



Step 2: Did Fatigue Contribute to the Event?

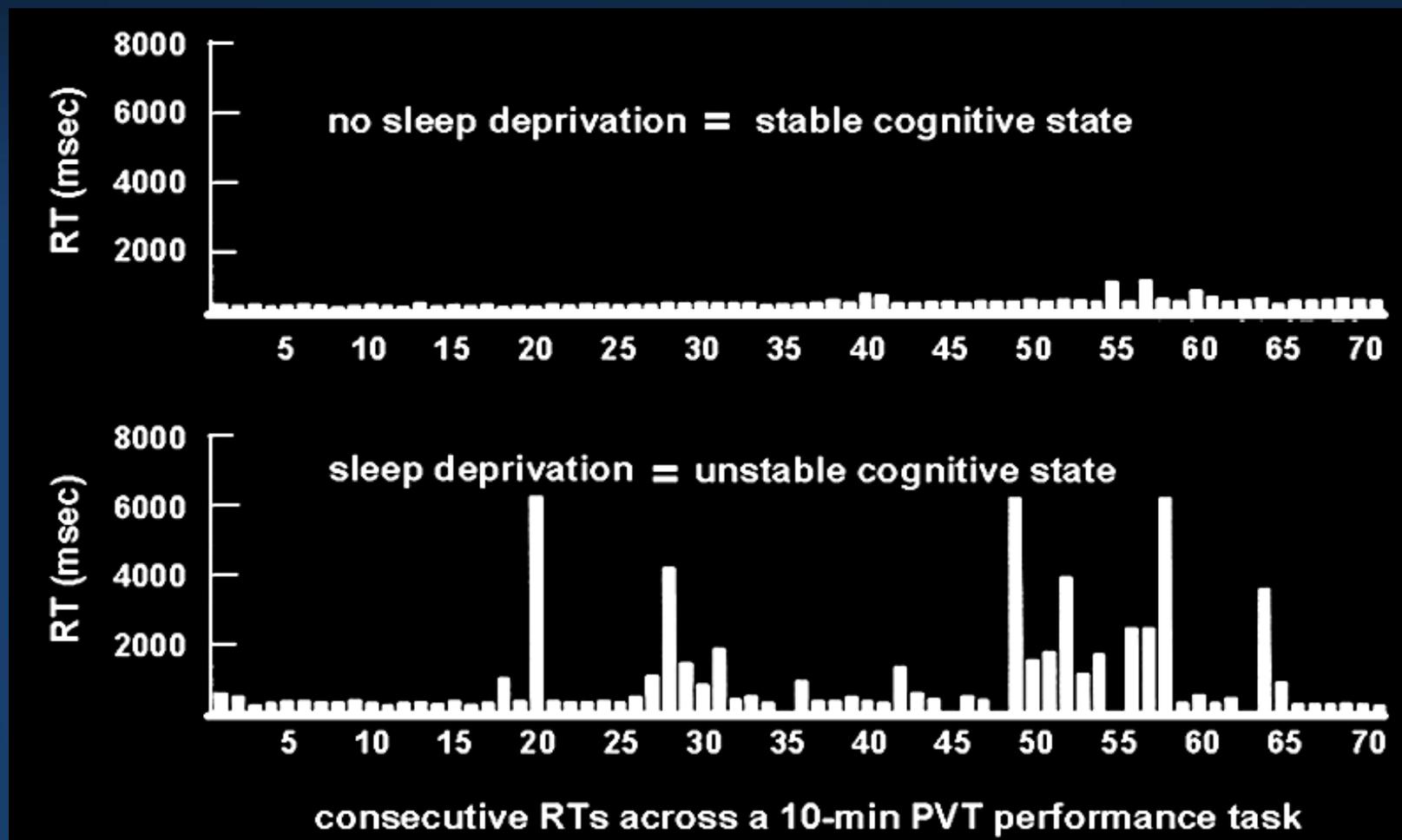


Evaluating Operator Performance

- Data/voice/video recorders
- Self report
- Interviews with others
- Vehicle/wreckage



Relate to Known Fatigue Effects



Doran SM, Van Dongen HP, Dinges DF. Sustained attention performance during sleep deprivation: evidence of state instability. *Archives of Italian Biology: Neuroscience* 2001;139:253-267.

Typical Effects of Sleep Deprivation

- Overlooking or skipping tasks
- Unresponsiveness or delayed responses
- Impaired decision making
- “Tunnel vision”
- Inability to adapt to changing information
- Reduced short term memory

Performance Outcomes

- Slow reaction time when braking or steering from obstacles
- Narrowed focus of attention
- Visual or cognitive fixation
- Procedural/tactical decision errors
- Microsleep

New York, NY, March 12, 2011



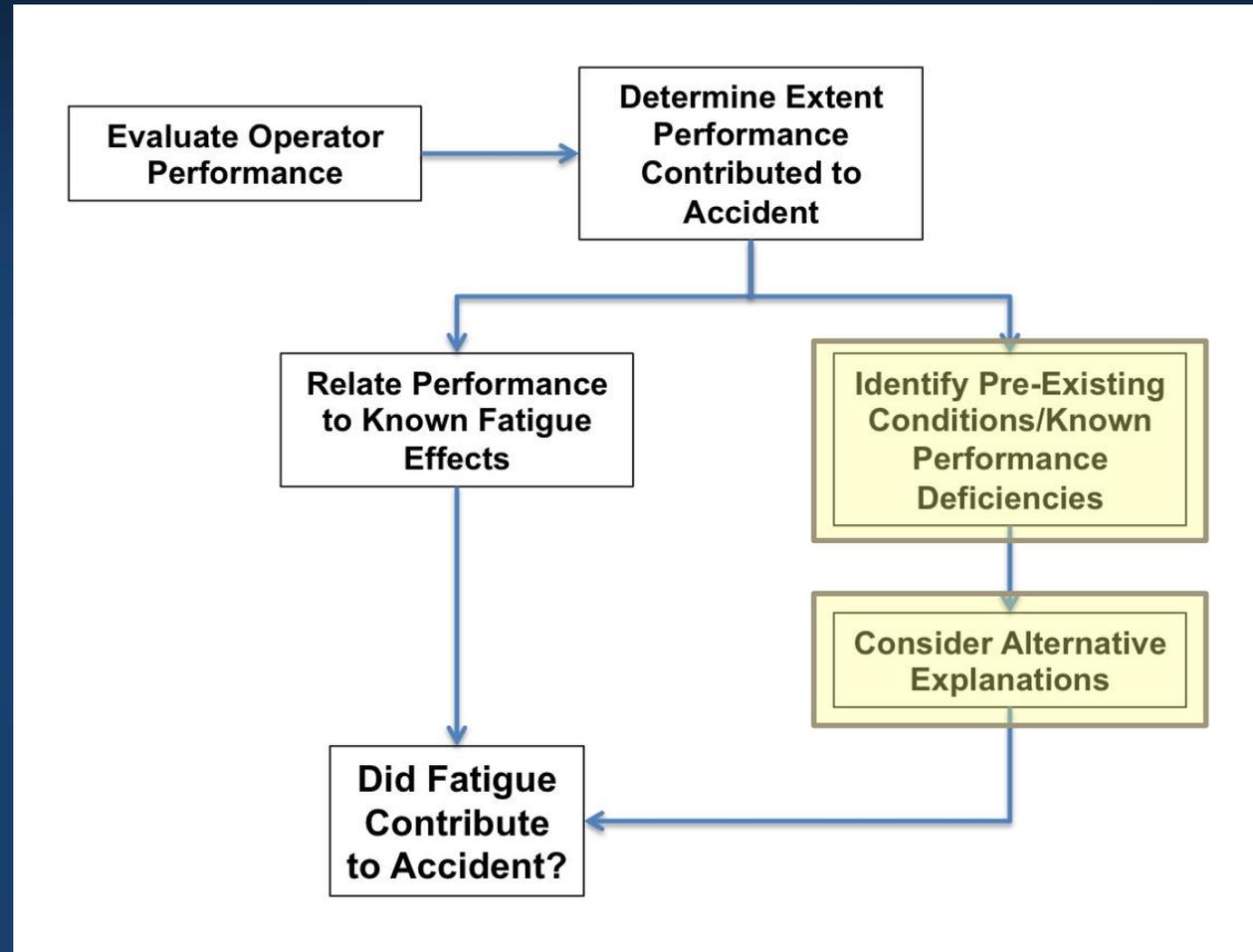
- Lane excursions
- Shallow angle of departure
- No tire marks
- No evidence of braking

Titan, December 15, 2014

- Captain activated autopilot but not watch alarm
- Boat did not turn at channel
- Nearby boat radioed warning with no response



Step 2: Did Fatigue Contribute to the Event?



Clarence Center, NY, February 12, 2009



Documenting Work Environment and Organization

Key Evidence Sources

- Company policies and training materials
- Interviews
- Direct observation

Cleveland, OH, February 18, 2007



Cleveland Environmental Factors

- Heavy flying schedule
- Last flight of day
- Company fatigue policy
- Warning letter

Take Away Messages

- Sleep (or lack thereof) is key
- Gather perishable evidence first
- Use multiple sources of evidence whenever possible
- Operator fatigue that is not causal is still important for safety

Williston, FL, May 7, 2016



Courtesy of Florida Highway Patrol

Probable Cause

The truck driver's failure to yield the right of way to the car, combined with the car driver's inattention due to overreliance on vehicle automation, which resulted in the car driver's lack of reaction to the presence of the truck. Contributing to the car driver's overreliance on the vehicle automation was its operational design, which permitted his prolonged disengagement from the driving task and his use of the automation in ways inconsistent with guidance and warnings from the manufacturer.