

# Sleep Improved

## *How Data-Driven Decisions Enhance Firefighter Health and Safety*

Presented by

**Dr. Joel Billings**

Program Chair, B.S. in Emergency Services  
Embry-Riddle Aeronautical University

**Dr. Joe Pennino**

Deputy City Administrator – Roswell, GA

Science to the Station:

NERDSTOCK 2025

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# Overview

*How science and leadership came together to improve firefighter health and safety*

- Fatigue and sleep deprivation remain persistent risks in the fire service.
- Data-driven scheduling can improve both safety and performance.
- Roswell Fire Department partnered with researchers to test and refine shift timing.
- Findings revealed measurable improvements in rest, family well-being, and morale.
- The project could serve as a model for evidence-based innovation in firefighter wellness.

# Overview

## City Snapshot

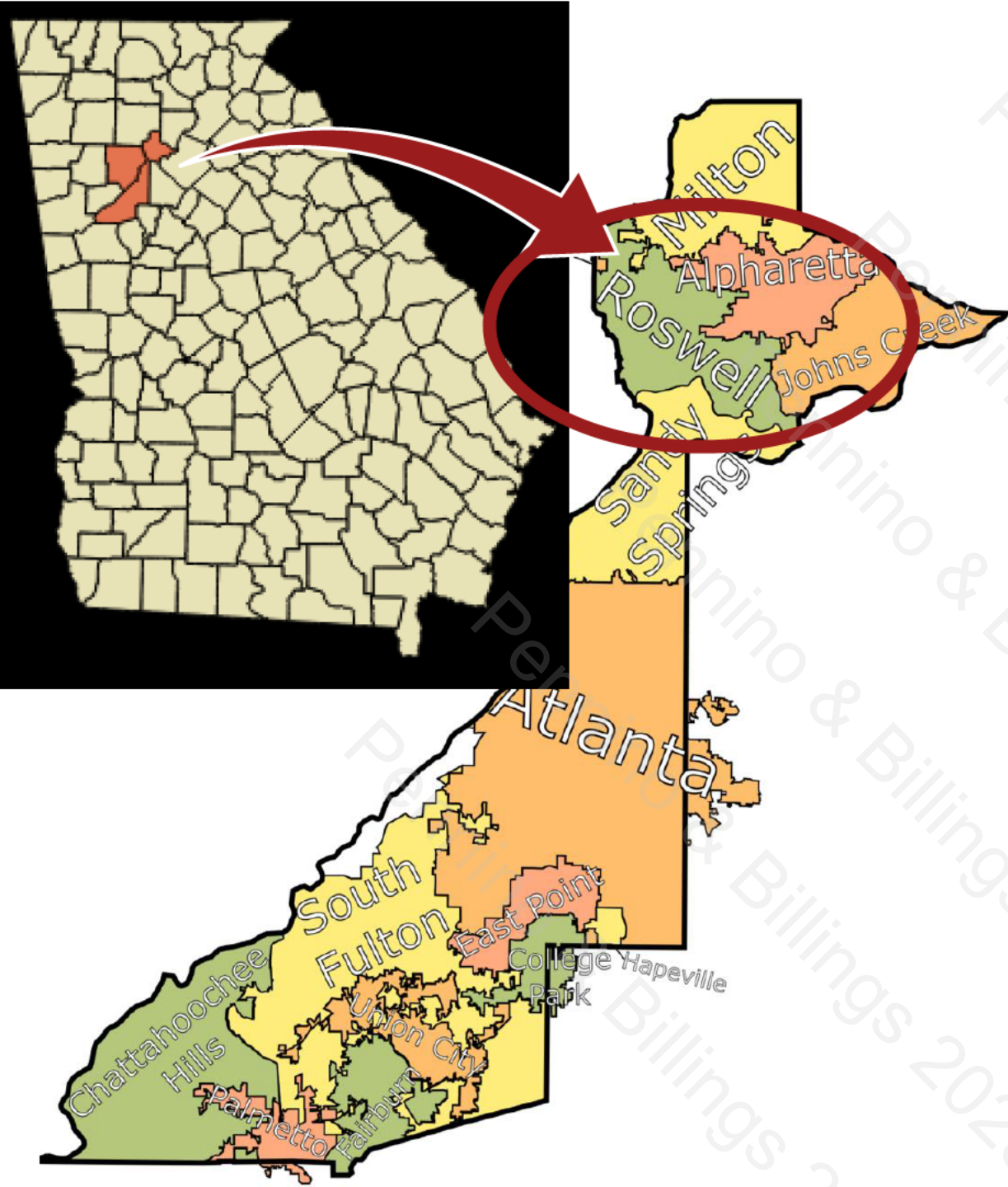
- Northern suburb of Atlanta, located in Fulton County
- 42 square miles
- Population: ~95,000 residents

## Staffing

- 2 Battalions
- 7 Engines
- 2 Ladder Trucks
- 1 Heavy Rescue
- 2 Medical Units

## Service Profile

- ~10,000 calls for service annually
  - **Fire:** 29%
  - **EMS:** 71%





# Fire Response Zones





# The “Why”



# The “Why”

*"The vision of the Roswell Fire Department is to be an innovative world-class public safety organization."*

- You Asked (we are listening)
- You matter, and it is our obligation to “Protect the Team”
- There is new research on the subject
- Recruitment and Retention
- Global View On Firefighter Health Safety - “Our greatest responsibility is to be good ancestors.”

## **RFD Expectation and Rules of Engagement**

- Be open to new ideas and continuous improvement.
- Be willing to make tough decisions, when necessary, even when unpopular – BE A LEADER.
- Be a problem solver, not just a problem finder. Let’s work together and do what it takes to make our department better!



ELSEVIER

SCIENTIFIC DATA

ARTICLE INFO

ABSTRACT

1. Introduction

2. Methods

3. Results

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6. Acknowledgments

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# Intra-Tour Variation of Firefighter Sleep Duration and Sleep-Wake Cycle within the 24/48 and 48/96 Shift Schedules

Joel M. Billings\*, C. K. Haddock\*, and S. A. Jahnke\*

\*Department of Security and Emergency Services, Embry-Riddle Aeronautical University, Daytona Beach, Florida, USA;  
\*Center for Fire, Rescue & EMS Health Research, NDRI-USA, Leawood, Kansas, USA

## ABSTRACT

**Objective:** The purpose of this paper is to investigate intra-tour variation in total sleep time (TST) and sleep-wake cycle among US firefighters working the 24 hours on and 48 hours off shift schedule (24/48) and the 48 hours on and 96 hours off shift schedule (48/96).

**Methods:** Twenty-four firefighters were recruited for this sleep study and were evaluated over 18 days during a 24/48 shift schedule and again 6 months after firefighters transitioned to a 48/96 shift schedule. The primary outcome variables included TST, measured by actigraphy, and sleep-wake cycle (in-bed time and sleep offset) using the Emergency Services Sleep Diary.

**Results:** Firefighters experienced intra-tour variations in TST and sleep offset. The least TST occurred at home prior to starting shift on the 24/48 and 48/96 schedules (5.80 hours and 5.66 hours, respectively). The second least TST occurred the night preceding shift and (3.64 hours and 3.81 hours, respectively).

**Conclusion:** When firefighters sleep free, sleep generally the following day increased. TST increased in night prior to commencing subsequent shifts longer sleep without sufficient sleep and data have shown sufficient sleep, that firefighters greatest sleep propensity.

**Conclusion:** Results indicate that firefighters' sleep is complex and should not be reduced to singular averages. In both schedules, firefighters arrived at work with insufficient sleep, received insufficient sleep while on shift, and would commute home with insufficient sleep. These findings can inform future firefighter sleep research by accounting for intra-tour variations.

## Introduction

The purpose of this research is to explore how total sleep time (TST) varies night-by-night throughout firefighters' shift schedules. Fire and emergency services are a unique occupation in that sleep can be influenced exogenously by several factors (Vincent et al., 2018). Sleep is often fragmented due to emergency response during the night (Billings, 2022). The sleeping environment at work may not be conducive to promote quality sleep as firefighters commonly bunk in the same area, rotate sharing beds with other shifts, and are exposed to light, noise, and odor from their coworkers and environment (Carey et al., 2018). Some firefighters may rotate stations, exposing them to varying sleep environments each shift. In fire stations that house multiple units, firefighters may wake from alarms intended for other firefighters (Koskinen & Korhonen, 1981), which further fragments and truncates sleep. Fire department shift schedules also play an important role in sleep (Billings & Focht, 2016; Haddock et al., 2013; Vincent et al., 2016) as the unique pattern of work and non-workdays may impact the sleep/wake cycle. In turn, firefighters often must wait several days until the end of the tour to recover lost

## SCIENTIFIC INVESTIGATIONS

### Firefighter sleep: a pilot study of

# The “Why”

## 5. Innovation and Responsiveness to the Environment:

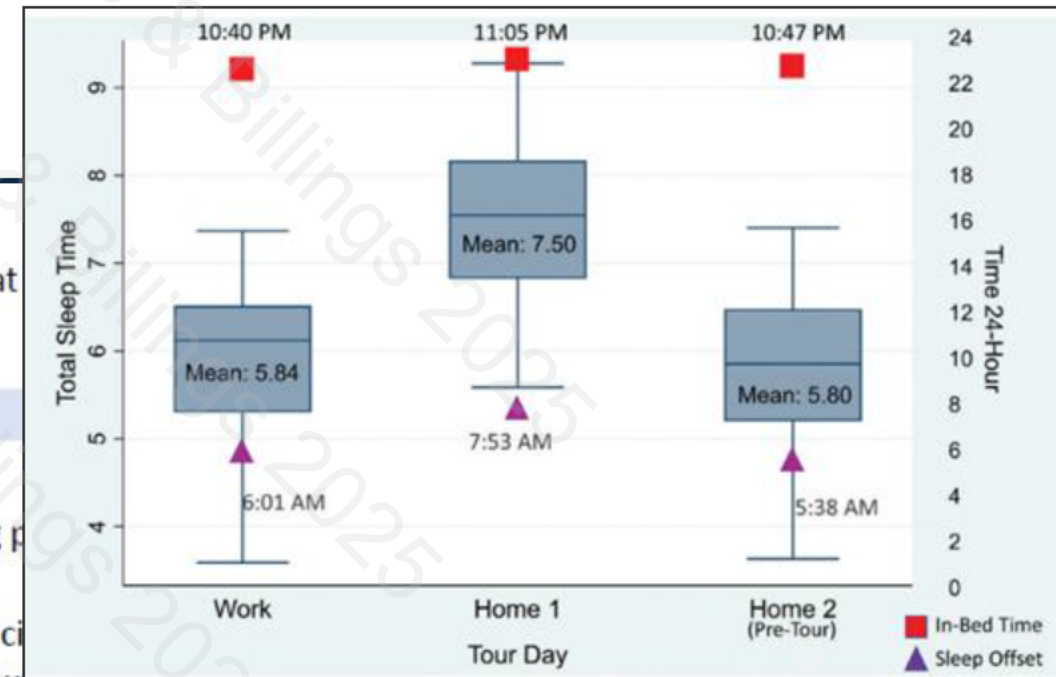
Talent Incubators “play on offense and embrace change” and are the organizations “that follow the trends but create the trend.”

### RFD STRENGTHS

- The Roswell Fire Department is rapidly becoming an industry leader.
- Among fire departments in Georgia and possibly the nation, none are implementing changes as quickly or aggressively.
- The department excels in developing policies, identifying and rectifying deficiencies, innovating, and receiving robust support in equipment and financing from taxpayers, stakeholders, the mayor and council, and the current fire administration.

### RFD OPPORTUNITIES

- There is an opportunity to adopt a more proactive approach to developing unique Roswell innovations, leveraging the department's wealth of successful and even failed trends. By capitalizing on its diverse pool of ideas and experiences, the department can set new trends and evolve into an innovative, world-class organization.





# PROS of 48/96

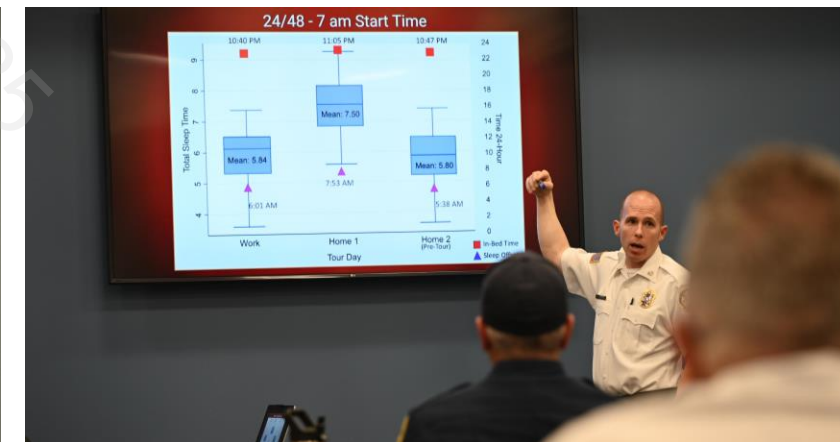
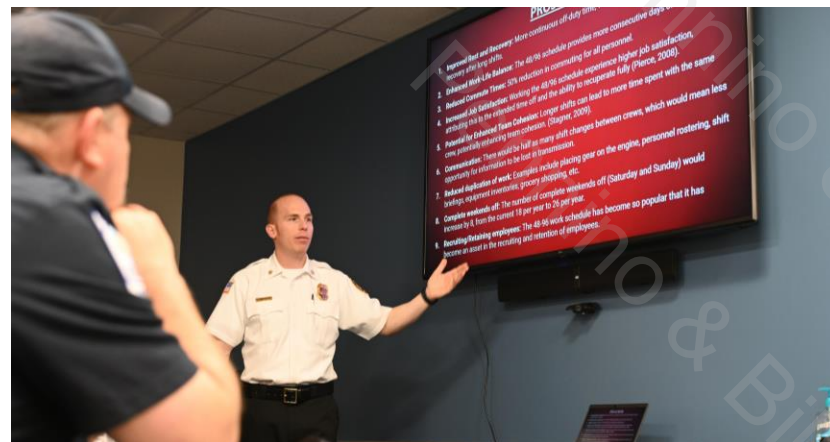
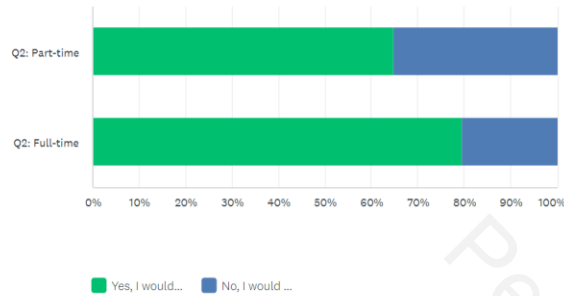
1. **Improved Rest and Recovery:** More continuous off-duty time, which can lead to better rest and recovery after long shifts.
2. **Enhanced Work-Life Balance:** The 48/96 schedule provides more consecutive days off.
3. **Potential for Enhanced Team Cohesion:** Longer shifts can lead to more time spent with the same crew, potentially enhancing team cohesion. (Stagner, 2009).
4. **Reduced duplication of work:** Examples include placing gear on the engine, personnel rostering, shift briefings, equipment inventories, grocery shopping, etc.
5. **Recruiting/Retaining employees:** The 48-96 work schedule has become so popular that it has become an asset in the recruiting and retention of employees.
6. **Increased Uninterrupted Sleep:** Firefighters can enjoy more nights of uninterrupted sleep at home, enhancing their overall well-being.
7. **Later Start Time:** Starting shifts at 11 am means firefighters don't have to wake up early, contributing to better sleep quality.
8. **Reduced Commute Times:** Monthly commute times are reduced by an average of 60%, giving our firefighters more time for themselves and their families.
9. **More Weekends Off:** Firefighters will have 44% more weekends off, increasing from 18 two-day weekends to 26 four-day weekends annually.

# Logistics for Change

## *Operational readiness preserved through smart coordination*

Please read the information from Cedar Park, Texas and Perry, GA. As a full-time employee at the Roswell Fire Department, would you be in favor of the 48/96 schedule? Please answer even if you are a current part-time member.

Answered: 76 Skipped: 0

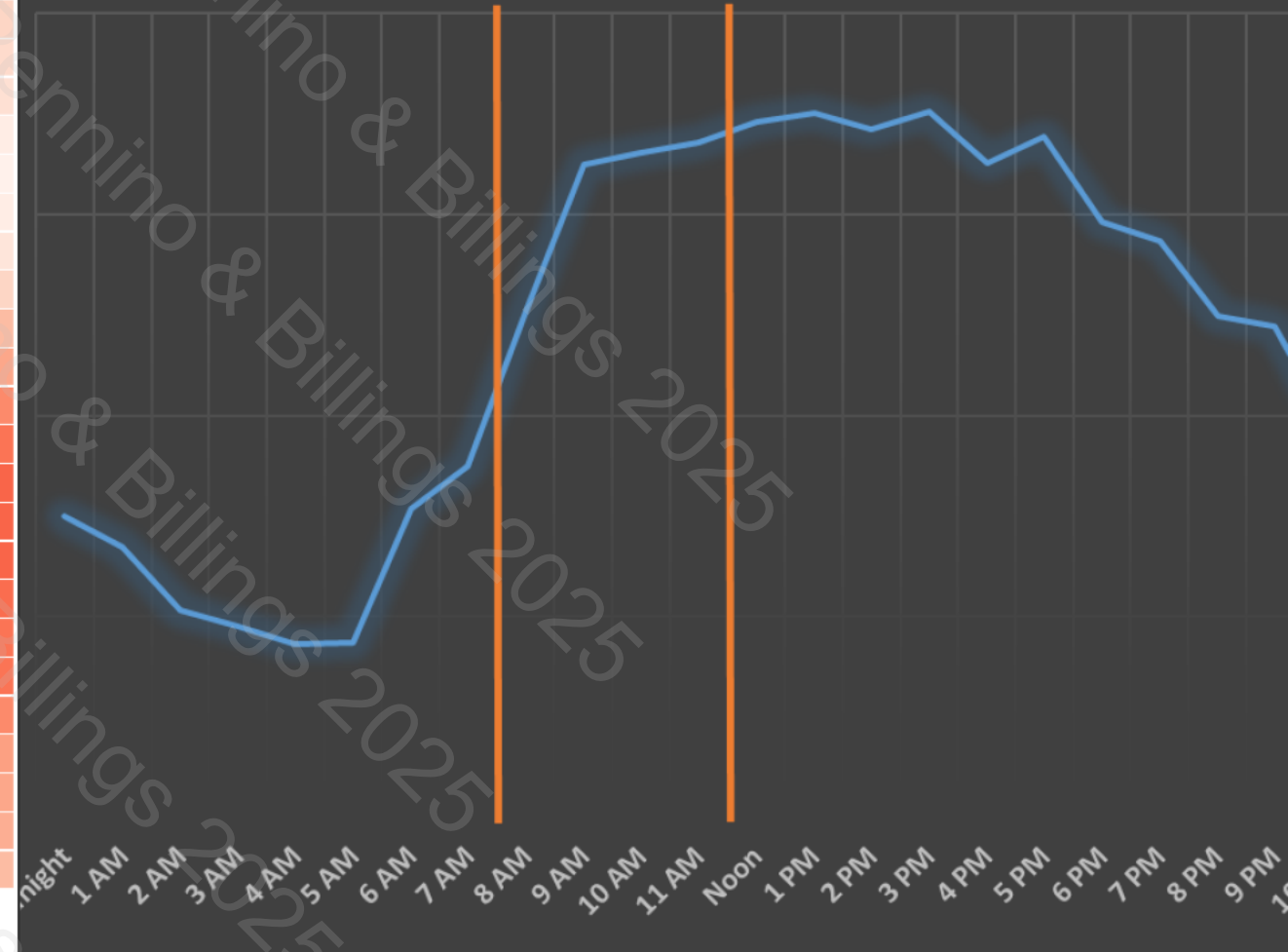




	Sun	Mon	Tue	Wed	Thu	Fri	Sat
12:00 AM	28 min 58 s	26 min 17 s	26 min 17 s	26 min 49 s	26 min 49 s	26 min 49 s	27 min 53 s
	27 min 53 s	25 min 44 s	25 min 44 s	25 min 44 s	26 min 17 s	26 min 17 s	27 min 21 s
02:00 AM	27 min 53 s	25 min 12 s	25 min 12 s	25 min 12 s	25 min 12 s	25 min 44 s	26 min 49 s
	27 min 21 s	24 min 8 s	24 min 8 s	24 min 40 s	24 min 40 s	24 min 40 s	26 min 17 s
04:00 AM	25 min 12 s	23 min 36 s	23 min 36 s	23 min 36 s	23 min 36 s	23 min 36 s	24 min 40 s
	24 min 40 s	24 min 8 s	24 min 40 s	24 min 40 s	24 min 40 s	24 min 40 s	24 min 8 s
06:00 AM	24 min 8 s	27 min 53 s	28 min 25 s	28 min 58 s	28 min 25 s	27 min 53 s	24 min 40 s
	24 min 40 s	34 min 52 s	37 min 33 s	37 min 33 s	37 min	33 min 47 s	25 min 44 s
08:00 AM	26 min 17 s	36 min 28 s	41 min 18 s	41 min 18 s	39 min 9 s	34 min 19 s	27 min 21 s
	27 min 21 s	32 min 43 s	36 min 28 s	36 min 28 s	35 min 24 s	32 min 11 s	29 min 30 s
10:00 AM	28 min 58 s	31 min 6 s	33 min 15 s	33 min 15 s	33 min 15 s	32 min 11 s	31 min 6 s
	30 min 2 s	32 min 11 s	33 min 15 s	33 min 47 s	33 min 47 s	33 min 47 s	33 min 15 s
12:00 PM	32 min 11 s	33 min 47 s	34 min 52 s	35 min 24 s	35 min 24 s	36 min 28 s	34 min 52 s
	32 min 43 s	33 min 47 s	34 min 52 s	35 min 24 s	35 min 56 s	37 min	35 min 56 s
02:00 PM	32 min 43 s	34 min 52 s	35 min 56 s	36 min 28 s	37 min 33 s	39 min 9 s	35 min 56 s
	32 min 11 s	37 min	39 min 9 s	39 min 41 s	40 min 46 s	41 min 50 s	35 min 56 s
04:00 PM	32 min 11 s	39 min 41 s	43 min 27 s	43 min 59 s	43 min 59 s	42 min 54 s	35 min 24 s
	31 min 39 s	41 min 50 s	47 min 44 s	47 min 44 s	47 min 12 s	42 min 22 s	34 min 52 s
06:00 PM	31 min 39 s	37 min	41 min 50 s	41 min 50 s	41 min 18 s	38 min 37 s	34 min 52 s
	30 min 34 s	32 min 11 s	34 min 19 s	34 min 19 s	34 min 52 s	34 min 52 s	33 min 15 s
08:00 PM	29 min 30 s	30 min 34 s	31 min 6 s	31 min 39 s	31 min 39 s	32 min 11 s	31 min 39 s
	28 min 25 s	29 min 30 s	30 min 2 s	30 min 2 s	30 min 2 s	31 min 6 s	31 min 6 s
10:00 PM	27 min 53 s	28 min 25 s	28 min 58 s	28 min 58 s	28 min 58 s	30 min 34 s	30 min 34 s
	26 min 49 s	26 min 49 s	27 min 21 s	27 min 53 s	27 min 53 s	28 min 58 s	29 min 30 s

☒ Show travel time per 20 mi

2023 Calls by Hour of the Day



# Logistics for Change

Pennino & Billings 2025

*Operational readiness preserved through smart coordination*

# Cultural Considerations

*Tradition meets science to support firefighter wellness*

**“I’ve worked this schedule for so long, my body is used to it.”**

**“Even if we switched to 11:00, I’d still get up at 5:00 am.”**

Pennino & Billings 2025

**"two hundred  
years of tradition  
unimpeded by  
progress"**

**-- common fire  
service saying**





# Firefighter-Spouse Survey Results

(48/96 Schedule – April 2025 | 32 Respondents)

Pennino & Billings 2025

- **Overall Satisfaction:** 90% of spouses like the new schedule.
- **Mental & Emotional Health:** 84% believe partner's mental health improved; noted less burnout and more relaxation.
- **Presence & Engagement:** 70%+ report partners are more "present" both mentally and physically when off duty.
- **Sleep & Energy:** 63% observed improved sleep and restfulness.
- **Family Dynamics:** Most spouses say children enjoy more time with parent; 78% report greater help at home.
- **Communication & Intimacy:** 72% note stronger emotional availability and connection.

## Concerns & Comments

- **11 AM start time** cited repeatedly as problematic. It limits family time and reduces the number of days off.

# Observations

- Not willing to give up the 48/96 for a different start time.
- People “feel” better rested.
- There has been a greater emphasis on sleep.
- People don’t want to come to HQ on a 5-day work week.

## Roswell Fire Department was awarded the 2025 Senator Paul S. Sarbanes Fire Service Safety Leadership Award

For studying how new shift schedules and adjusted start times affect firefighter performance, sleep quality, and overall well-being, and how improving sleep and recovery can reduce long-term physical and mental health risks.

Pennino & Billings 2025





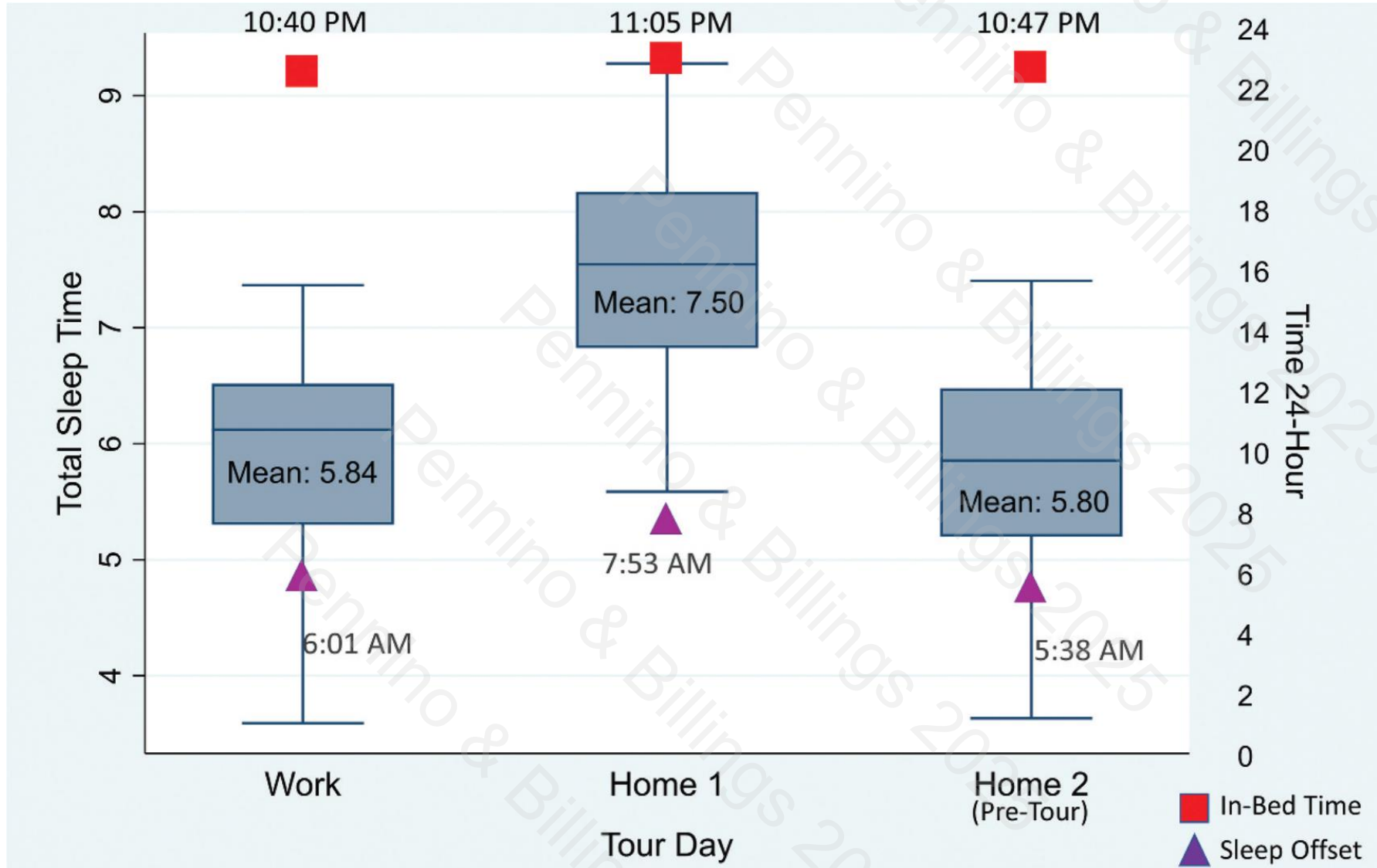
# Research Partnership

*Evidence-based insights through transparent collaboration*

## Primary objectives

1. Assess the immediate (acute) and/or long-term (chronic) impacts of shift start times and schedules on firefighter sleep and alertness.
2. Evaluate the potential benefits of adjusting shift start times and schedules on firefighter well-being and performance metrics.
3. Offer evidence-based recommendations for optimizing firefighter work schedules to improve overall safety and performance.

# The “Theory”



Pennino & Billings 2025

## Finding

Firefighters arriving sleep deprived and low afternoon performance

## Facts:

1. 7:00 AM "official" Start
2. ~8:00 AM H Sleep offset
3. 90 min Commute to Shift Start Latency

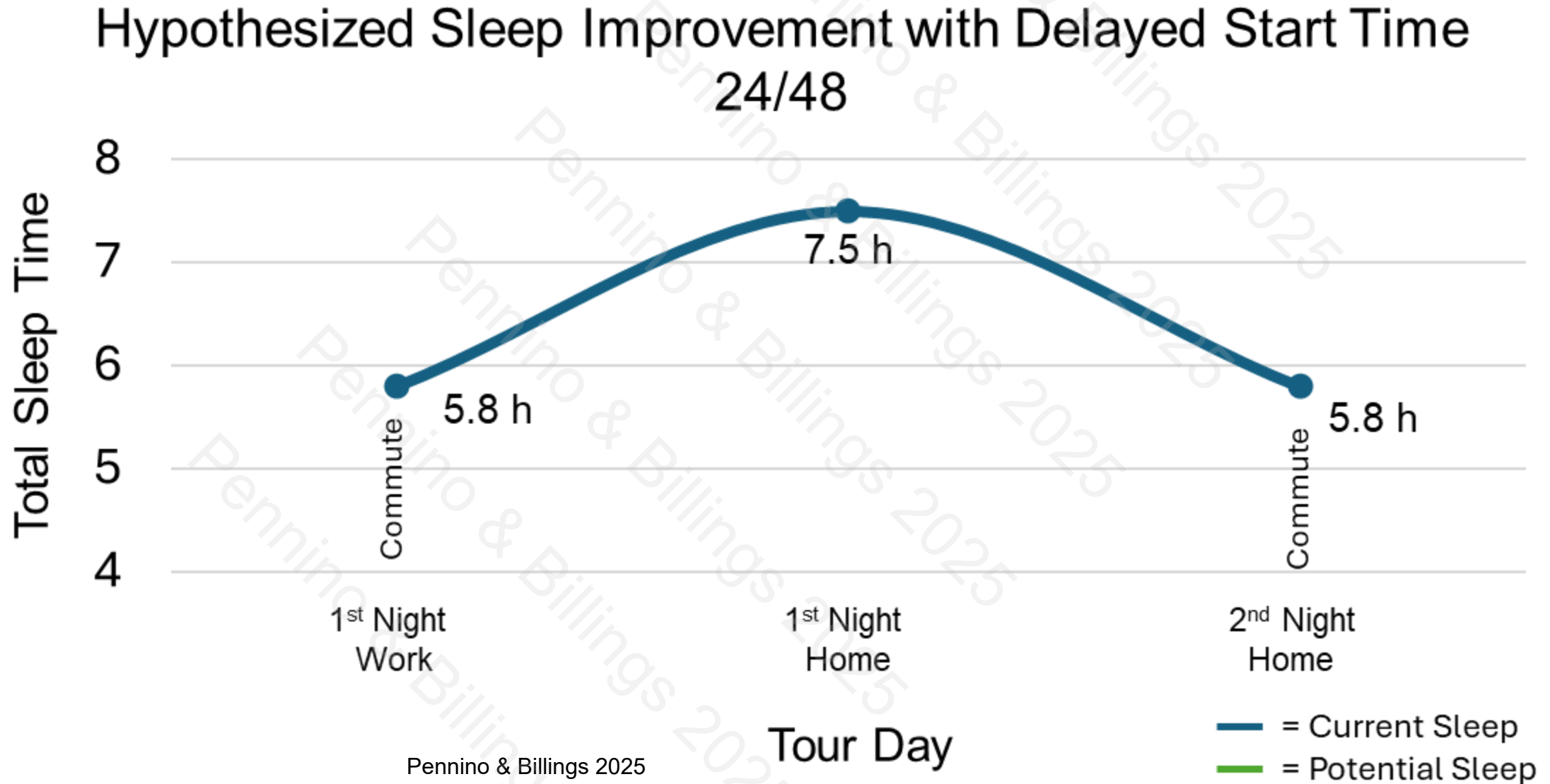
## Theory

1.5 hour delay from 8:00 = 9:30 AM Shift Start

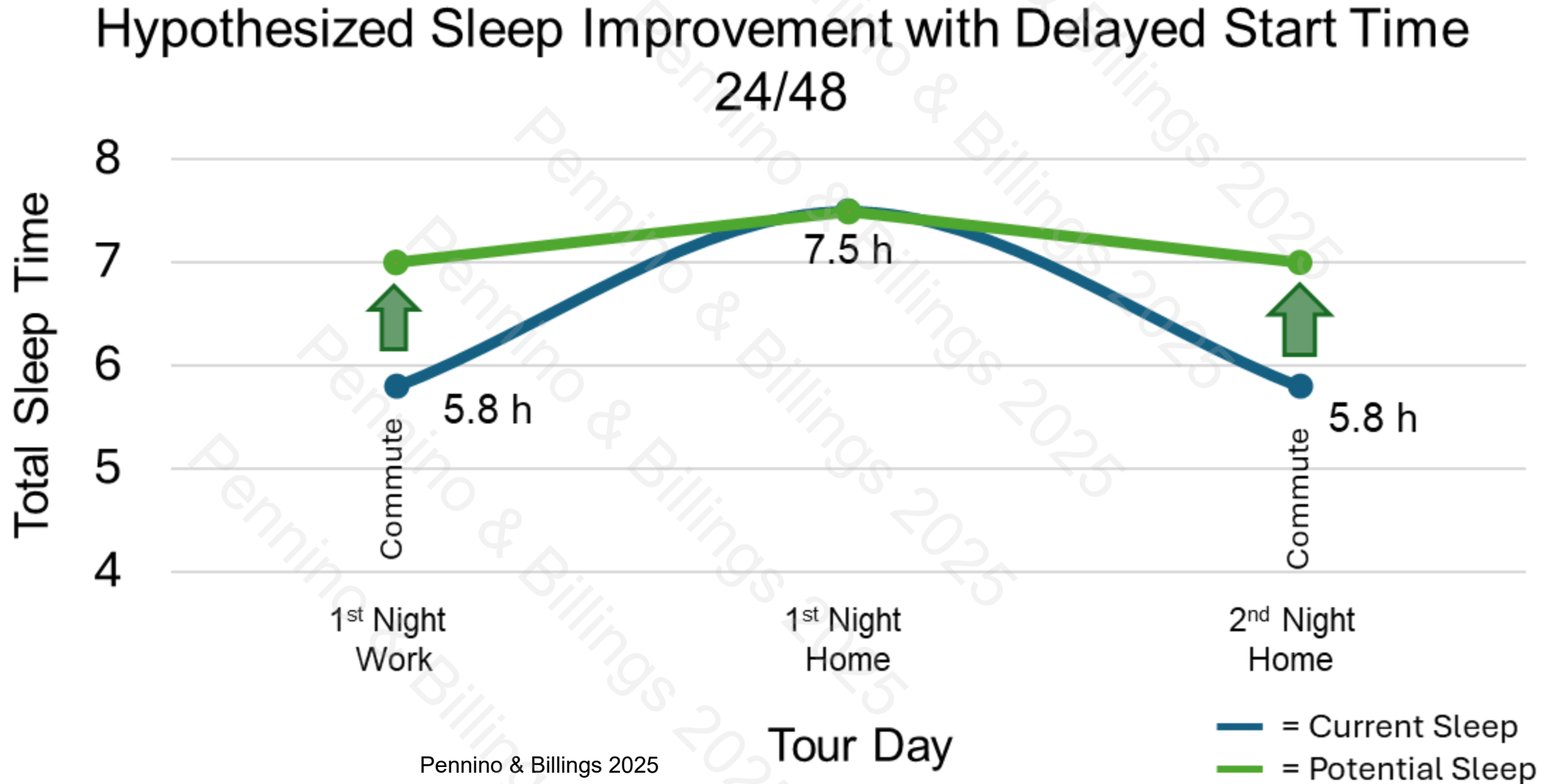
What impact would that have?



# The “Theory”

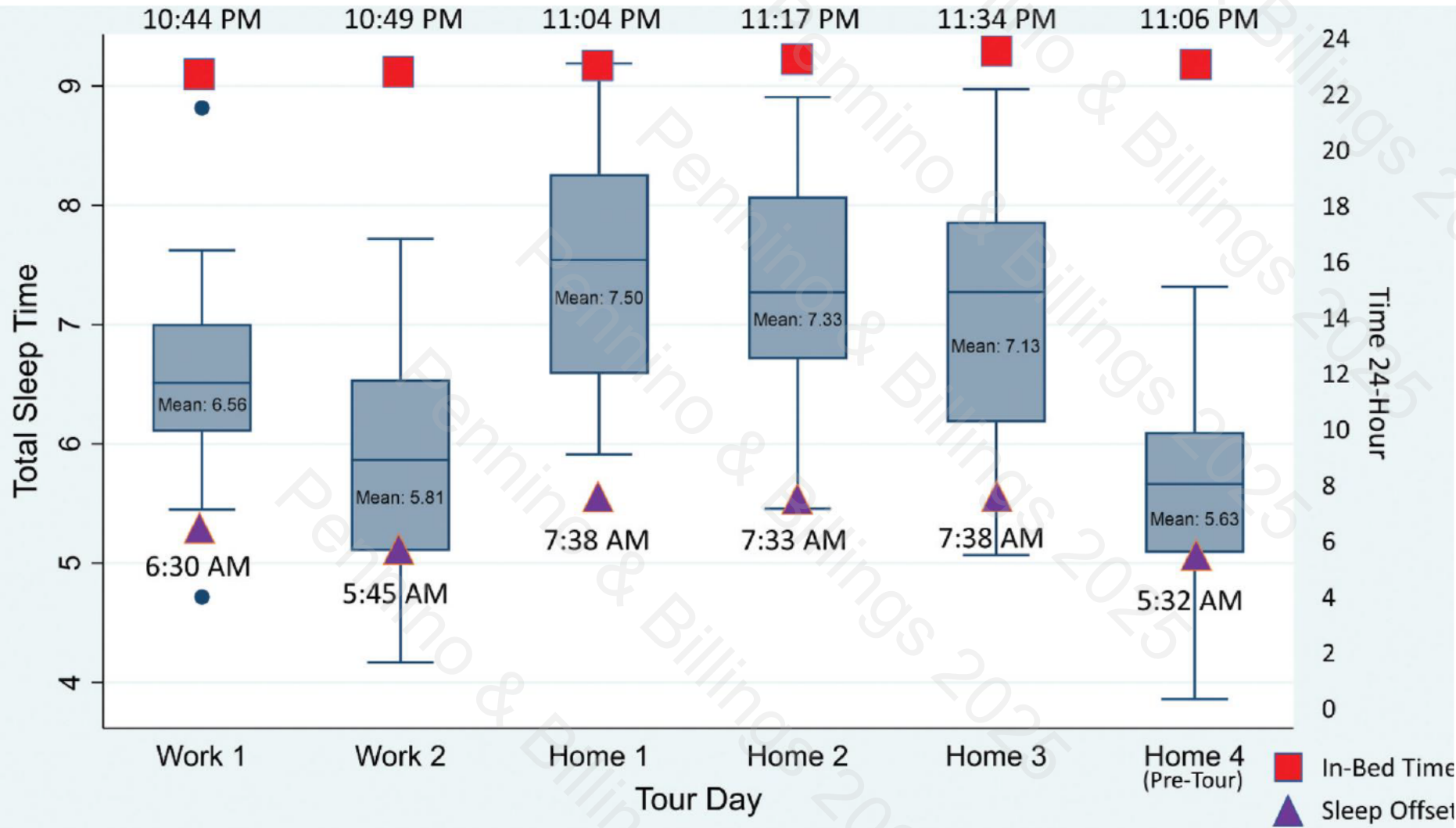


# The “Theory”





# The "Theory"



Pennino & Billings 2025

## Finding

Firefighters arriving sleep deprived and low afternoon performance

## Facts:

1. 7:00 AM "official" Start
2. ~7:30 AM H Sleep offset
3. 90 min Commute to Shift Start Latency

## Theory

1.5-hour delay from 7:30 = 9:00 AM Shift Start

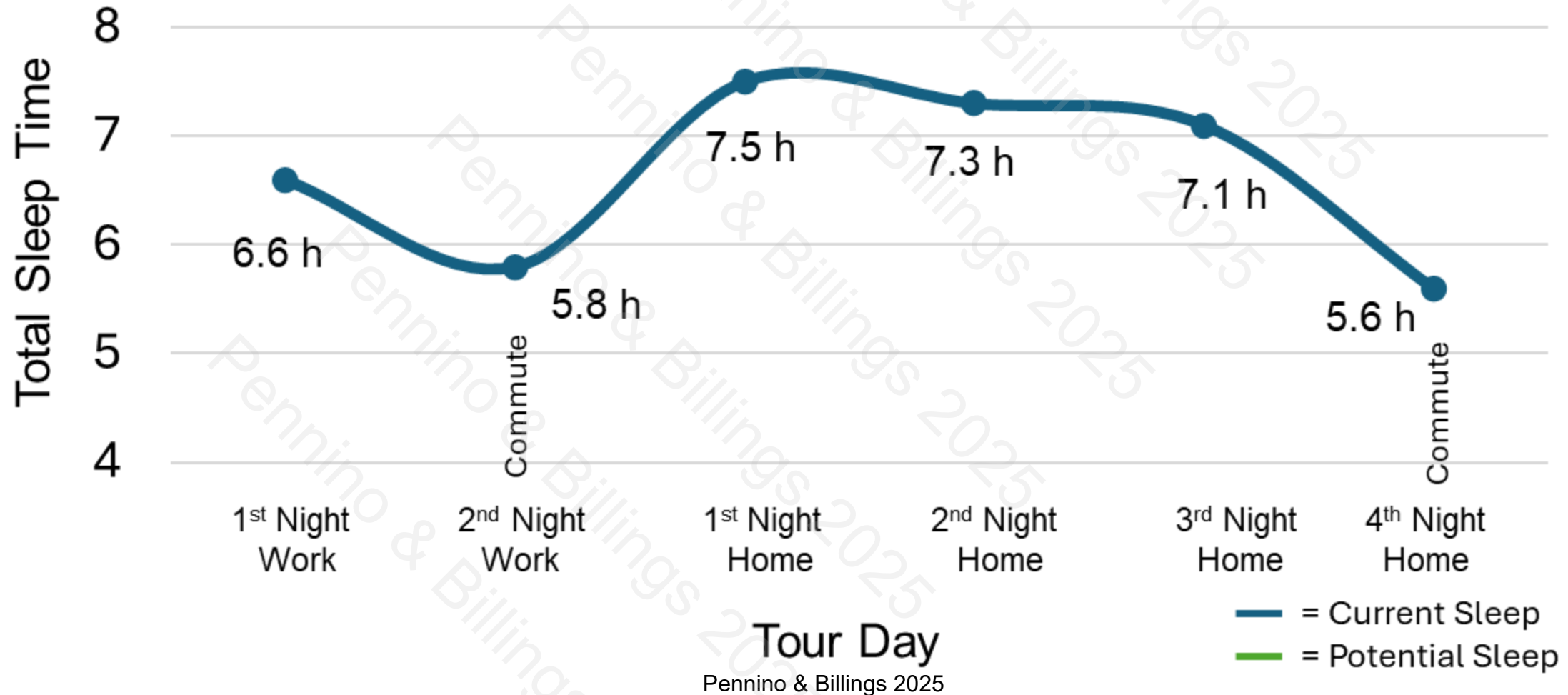
~9:00 – 9:30 Official Start

What impact would that have?

# The “Theory”

## Hypothesized Sleep Improvement with Delayed Start Time

48/96

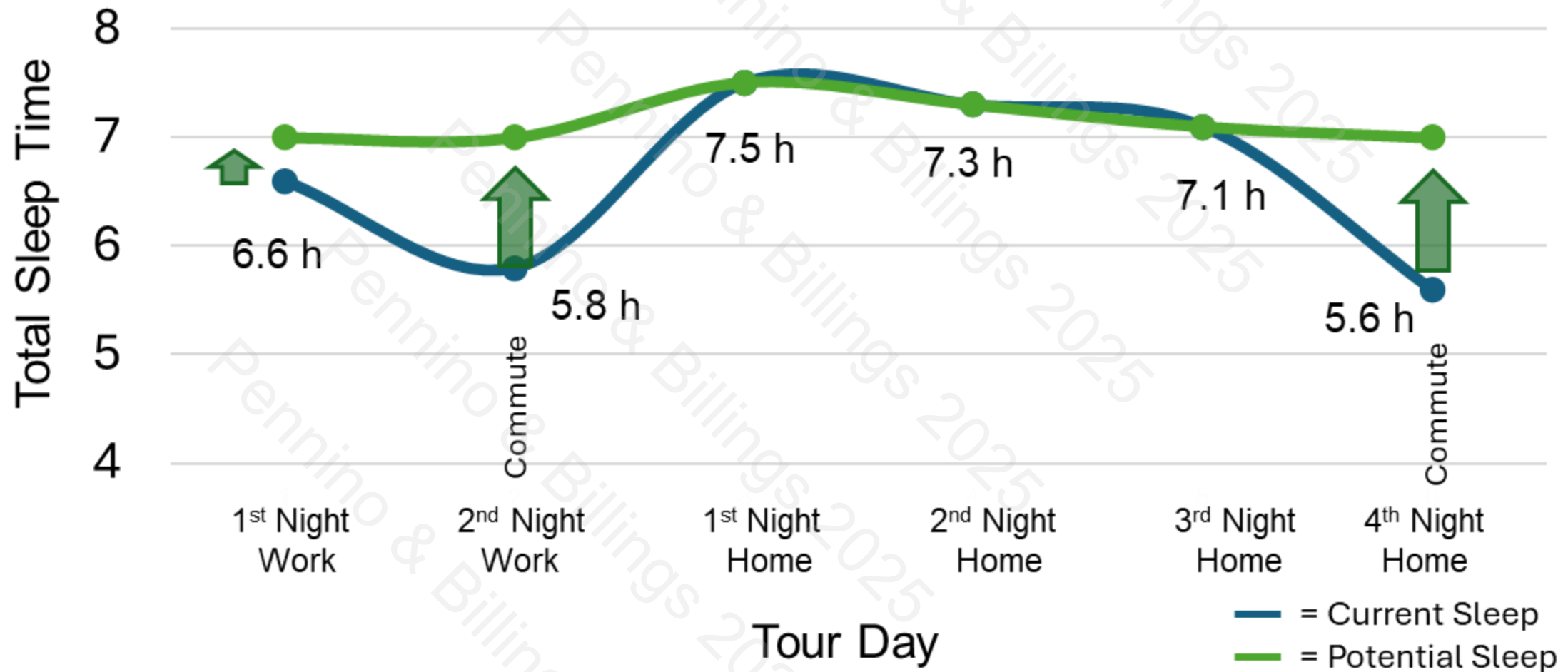




# The “Theory”

## Hypothesized Sleep Improvement with Delayed Start Time

48/96



# Study Design & Project Timeline

*A data-driven approach to understanding operational change*





# Data Collection

## Baseline & Follow-up Questionnaires



- Sleep Quality
- Sleep Habits
- Insomnia
- General Health
- Fatigue
- Anxiety
- Depression
- Job Satisfaction
- Demographics (Age, gender, marital status, children, BMI, Exercise, alcohol, Caffeine)

## Daily Questionnaires



- Call Burden
  - Frequency
  - Duration
  - Timing
  - Type
- Sleep Quality
- Sleepiness
- Daily Fatigue
- Daily Mood
- Daily Stress

## Sleep Tracking



- Total Sleep Time
- Sleep Efficiency
- Sleep Onset Latency
- Awakenings
- Wake After Sleep Onset
- Sleep Pattern

# Overall Results

---

- **For Sleep Analysis Only**
- Participation rate 33%
- Follow-up had several deviations from schedule

Pennino & Billings 2025

PARTICIPANTS	
Total Pop	48
Firefighter Participants (consented)	43
Withdrew/ineligible	6
Completed Baseline	33
Completed Follow-up	14



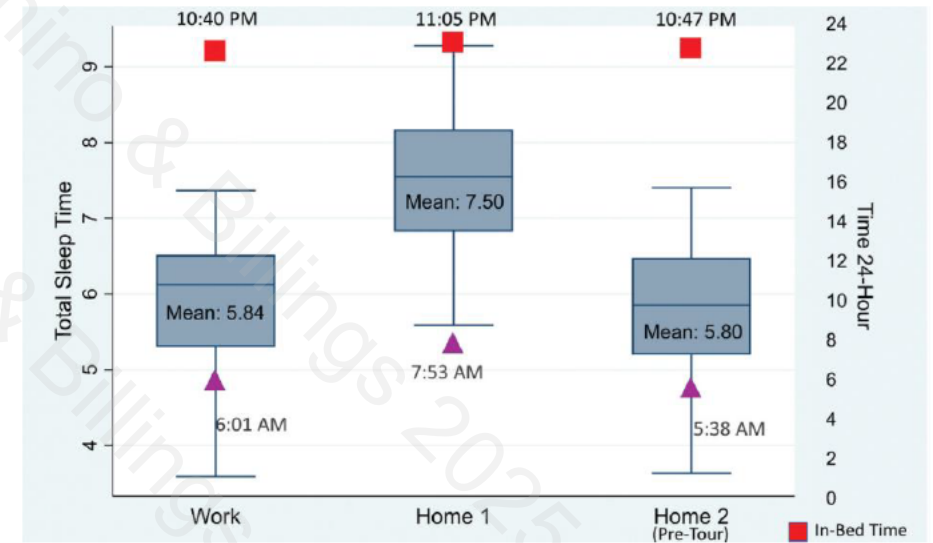
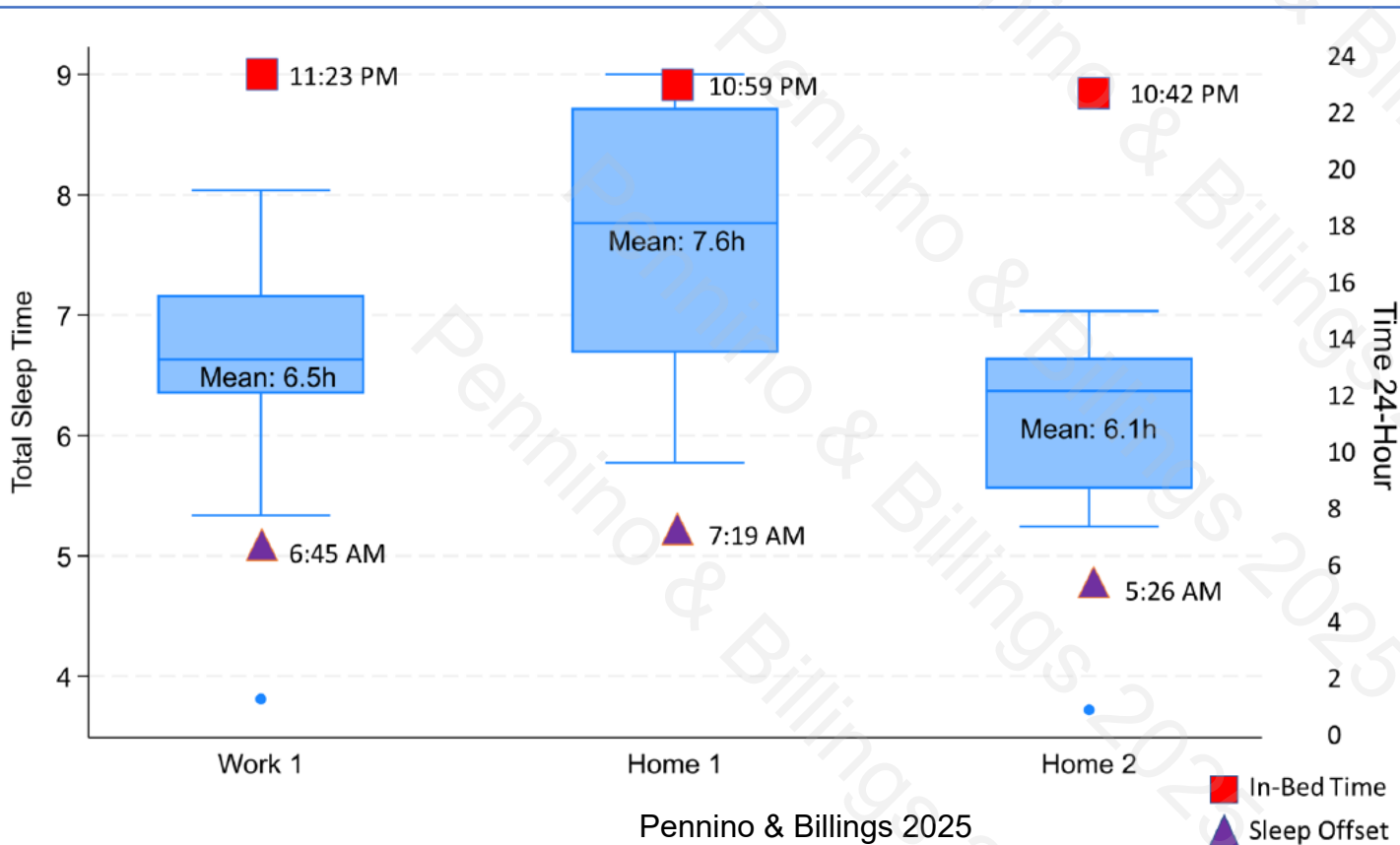
# Overall Results

	24/48	48/96
Work	6.5 h	6.6 h
Home	6.9 h	7.2 h
Commute	6.3 h	6.8 h
Overall	6.7 h	7.0 h



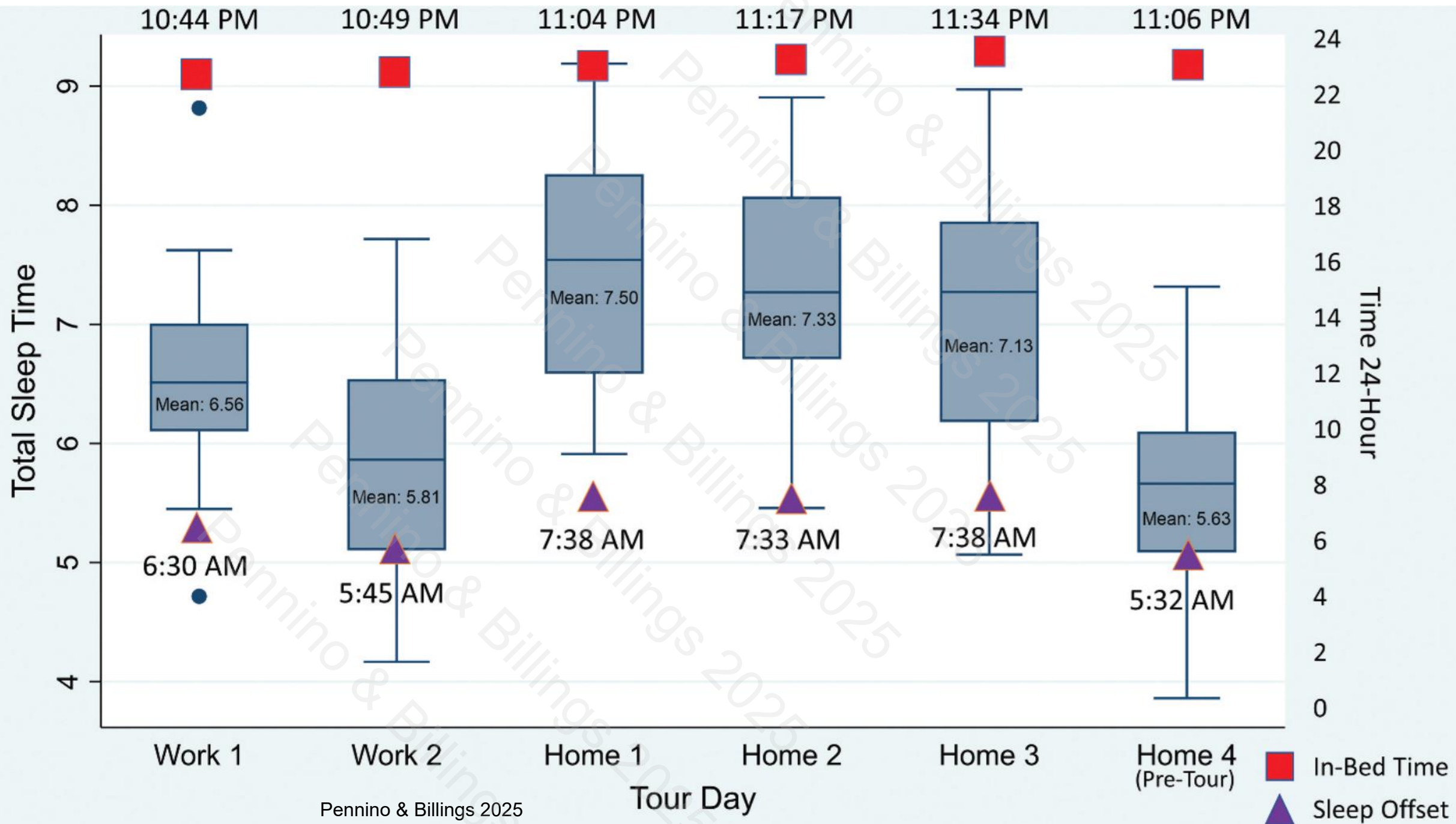
# Baseline Sleep

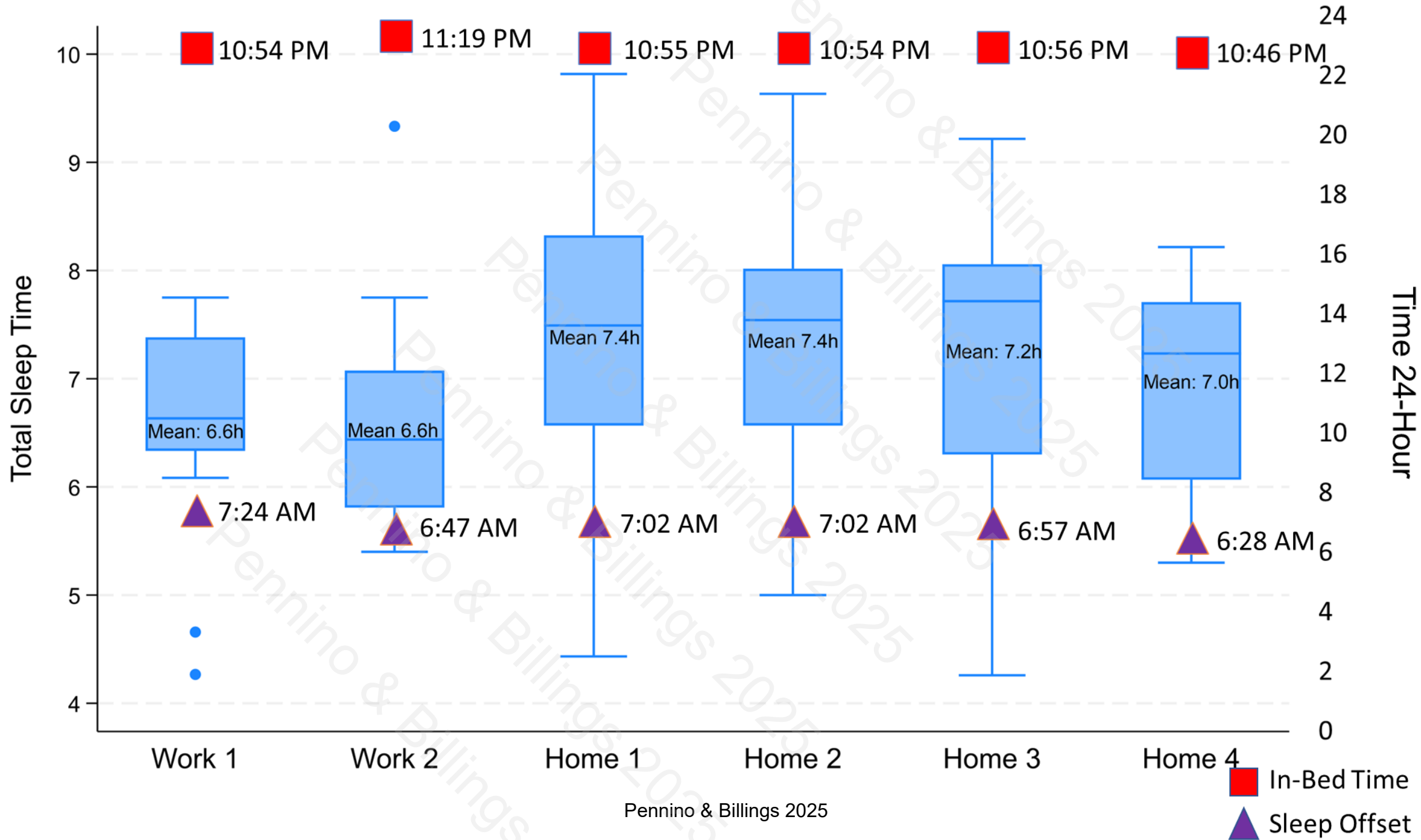
*Positive movement, room for greater impact*



Sleep pattern on 24/48 was nearly identical to previously published research.

- Sleep Onset similar among nights (range 41 min)
- Sleep Offset varied with schedule







# Sleep Pattern

24/48

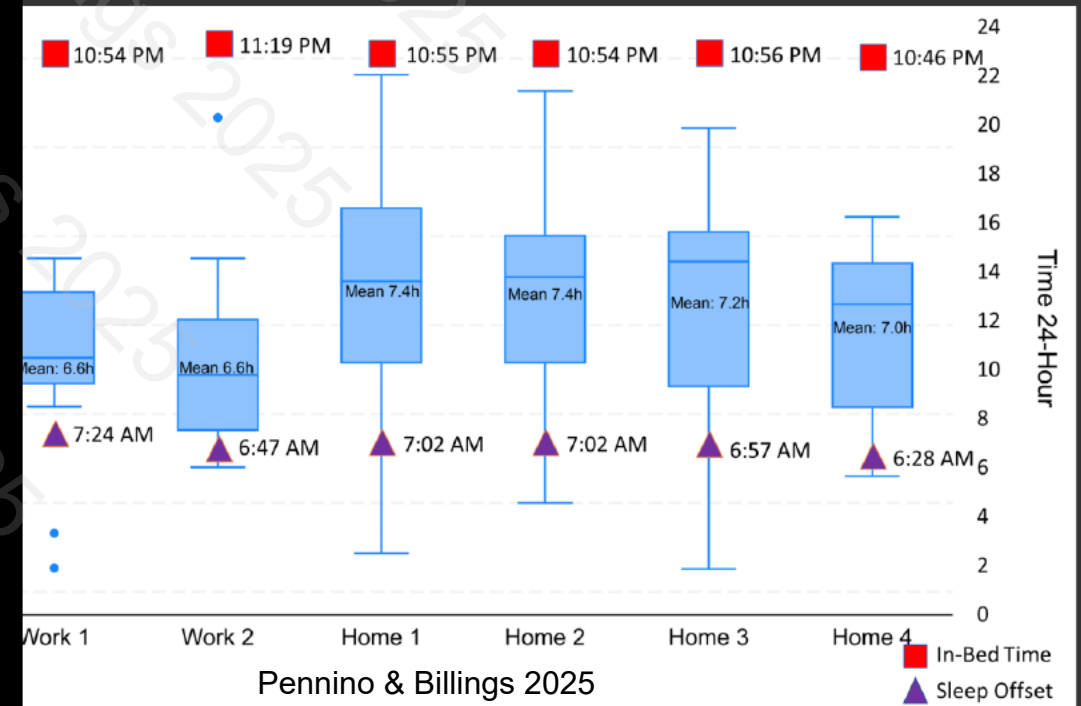
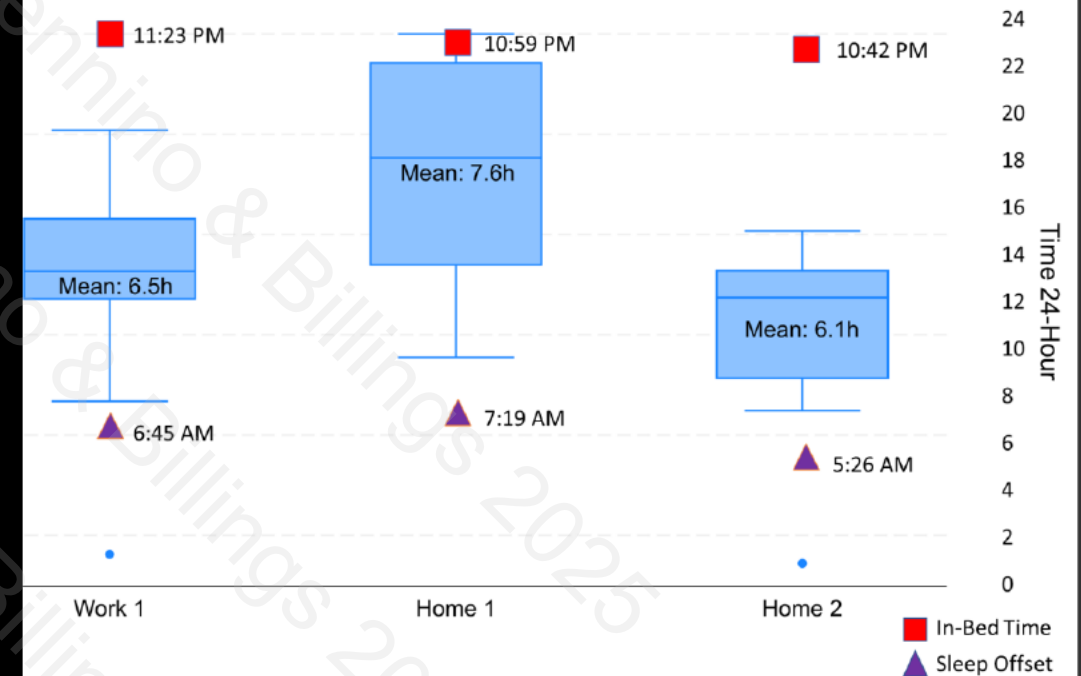
- Sleep Onset 10:42-11:30 (range 41 min)
- ~7:20 AM Home sleep offset
- ~5:30 AM Commute to work
- ~6:45 AM Commute home

48/96

- Sleep Onset 10:46-11:19 (range 33 min)
- ~7:00 AM Home sleep offset
- ~6:30 AM Commute to work
- ~6:45 AM Commute home

## Conclusion

- Sleep Onset: earliest, last night at home. Latest last night at work.
- Pre-tour sleep improved ~1 hour
- Sleep pattern normalizes
- More sleep at work first night

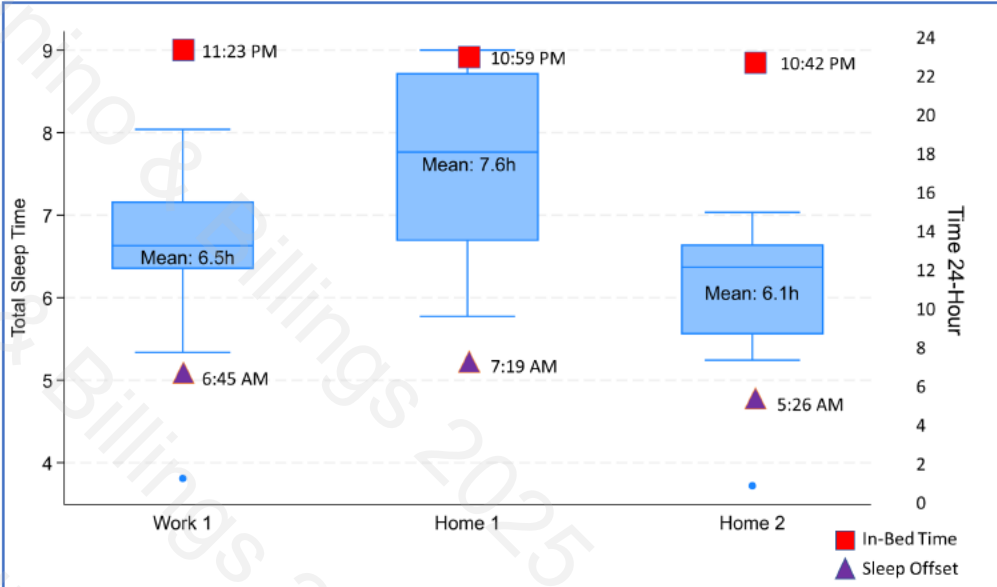




A closer look into  
the data

# Baseline Sleep (24/48)

*Positive movement, room for greater impact*



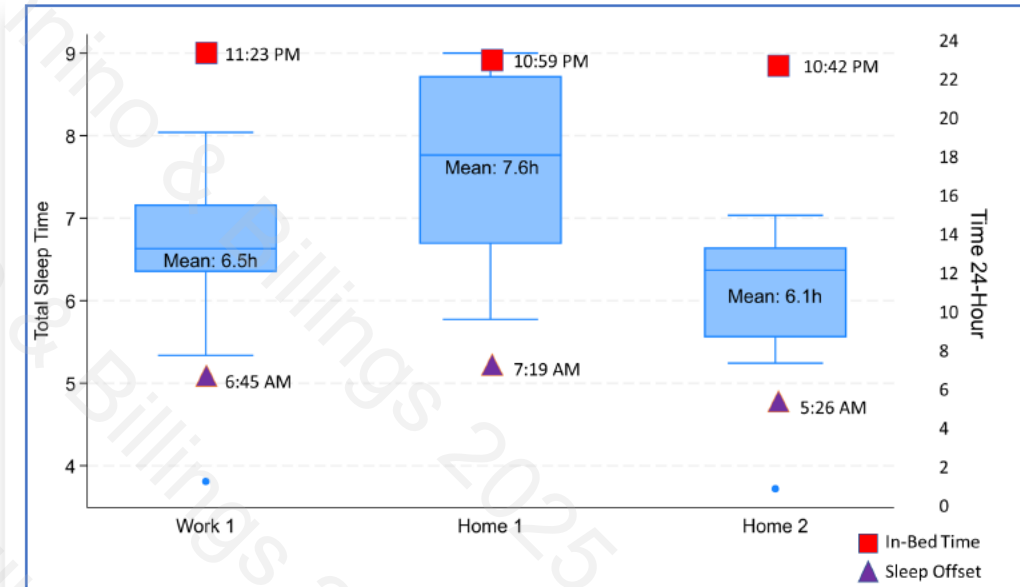
Tour Day	TIB	TST	EFF	WASO	# Awakes	N Calls per FF
Work Night 1	7.1 h	6.5 h	91%	40 min	14	.77
Home Night 1	8.2 h	7.6 h	93%	33 min	15	-
Home Night 2	6.7 h	6.1 h	91%	33 min	14	-
Std Dev	0.63	0.63	0.94	3.30	0.47	Pennino & Billings 2025



# Baseline Sleep (24/48)

*Positive movement, room for greater impact*

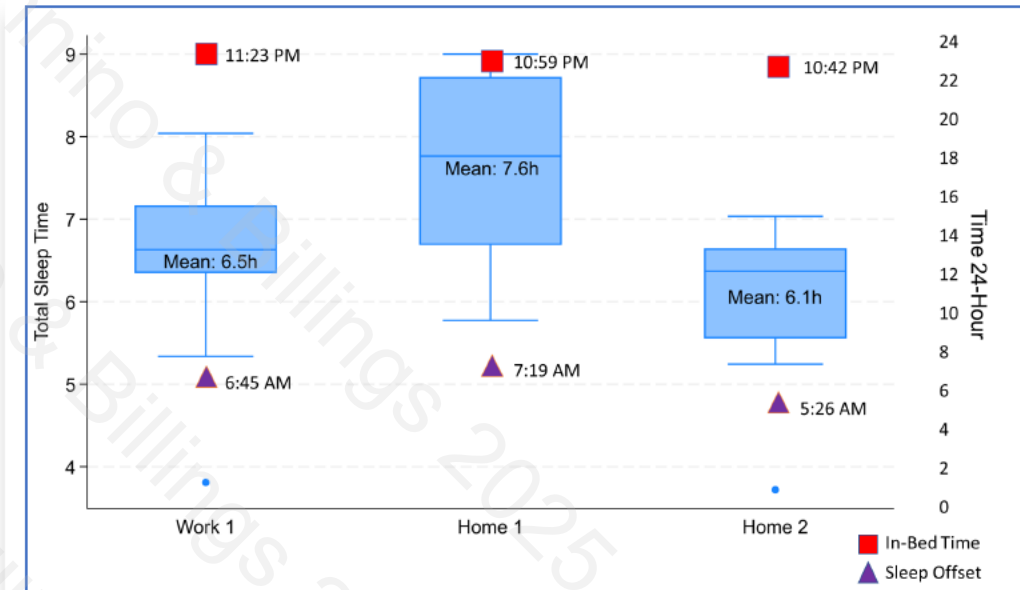
Pennino & Billings 2025



Tour Day	Feel upon waking morning at	Sleep Quality last night	Stress/ Anxious at night (1-8)
Work Night 1	Tired (work)	Fairly Good	2.2
Home Night 1	Rested (home)	Fairly Good	2.0
Home Night 2	Tired (commute)	Fairly Good	2.4

# Baseline Sleep (24/48)

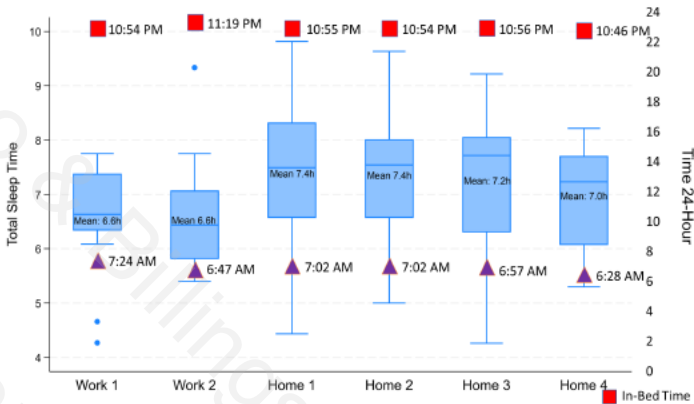
*Positive movement, room for greater impact*



Tour Day	Sleepiness Afternoon	Stress / Anxiety	Workload	Fatigue	Day Calls per FF
Workday 1	1.9	2.2	4.8	16.5	1.7
Home 1	2.4	2.3	4.4	16.3	-
Home 2	1.7	2.7	4.7	16.6	-
Std Dev	0.29	0.22	0.17	0.12	Pennino & Billings 2025

# Follow-up Sleep (48/96)

*Positive movement, room for greater impact*



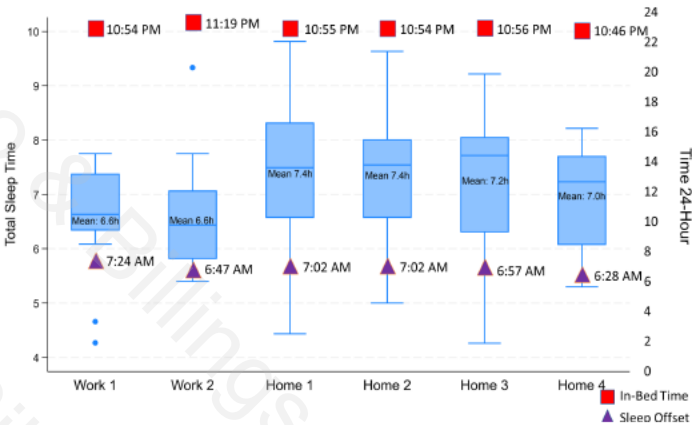
Tour Day	TIB	TST	EFF	WASO	# Awakes	Calls N per FF
Work Night 1	7.2 h	6.6 h	91%	36 min	14	1.3
Work Night 2	7.3 h	6.6 h	91%	35 min	14	0.5
Home Night 1	8.0 h	7.4 h	93%	36 min	16	-
Home Night 2	8.1 h	7.4 h	91%	40 min	18	-
Home Night 3	7.9 h	7.2 h	92%	37 min	15	-
Home Night 4	7.7 h	7.0 h	91%	44 min	18	-
Std Dev	0.34	0.33	0.76	3.11	1.67	Pennino & Billings 2025



# Follow-up Sleep (48/96)

*Positive movement, room for greater impact*

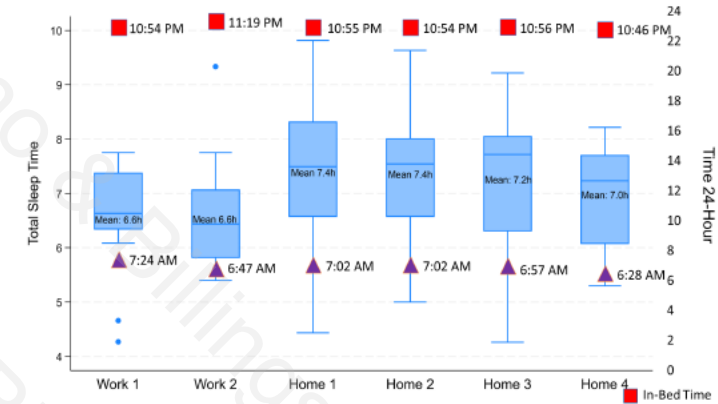
Pennino & Billings 2025



Tour Day	Feel upon waking morning of	Sleep Quality at night	Stress/Anxious at night (1-8)
Work Night 1	Rested (work)	Fairly Good	1.6
Work Night 2	Rested (work)	Fairly Good	2.0
Home Night 1	Well Rested	Fairly Good	1.9
Home Night 2	Rested	Fairly Good	1.3
Home Night 3	Rested	Fairly Good	1.6
Home Night 4	Rested (commute)	Fairly Bad	1.5

# Follow-up Sleep (48/96)

*Positive movement, room for greater impact*

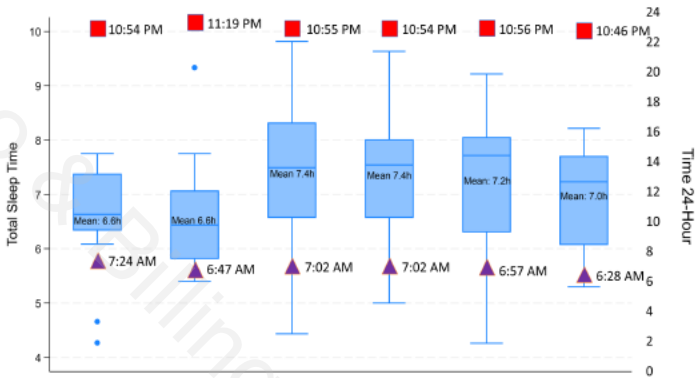


Tour Day	Sleepiness Afternoon	Stress / Anxiety	Workload	Fatigue	Day Calls per FF
Workday 1	1.9	2.3	4	17.7	1.4
Workday 2	2.9	1.8	3.9	15.1	1.2
Home 1	1.8	2.4	4	15.7	-
Home 2	1.7	1.6	4.7	15.0	-
Home 3	1.7	2.1	4.1	15.4	-
Home 4	1.7	2.9	4.3	15.1	-
Std Dev	0.43	0.42	0.27	1.03	Pennino & Billings 2025

# Follow-up Sleep (48/96)

## *Positive movement, room for greater impact*

Pennino & Billings 2025



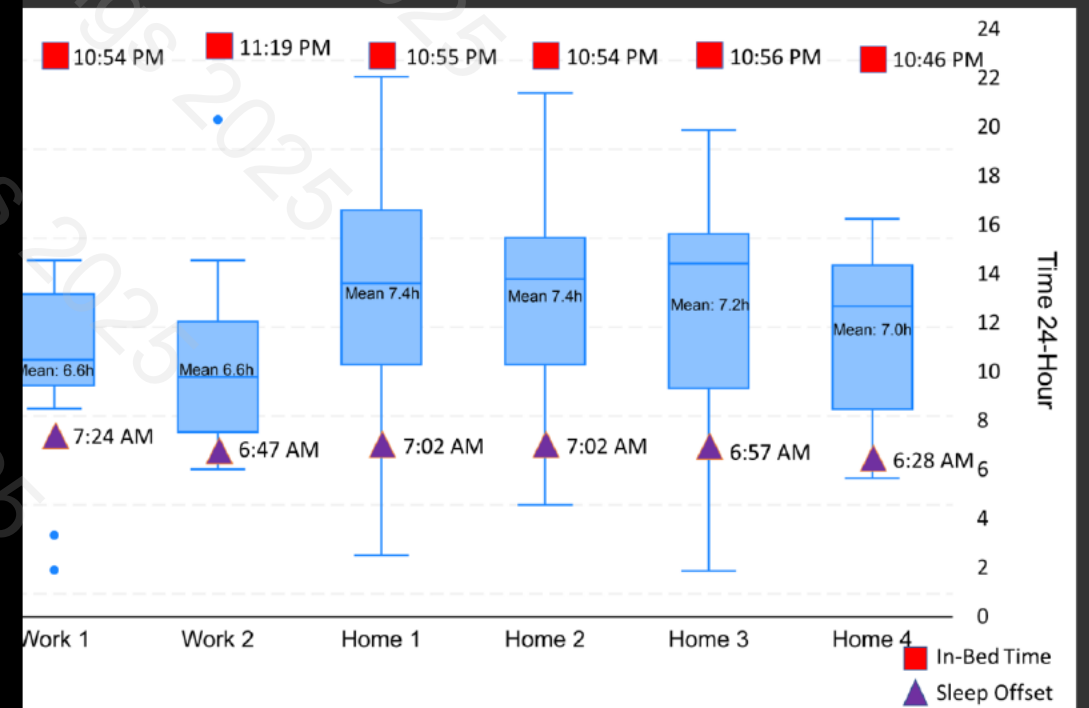
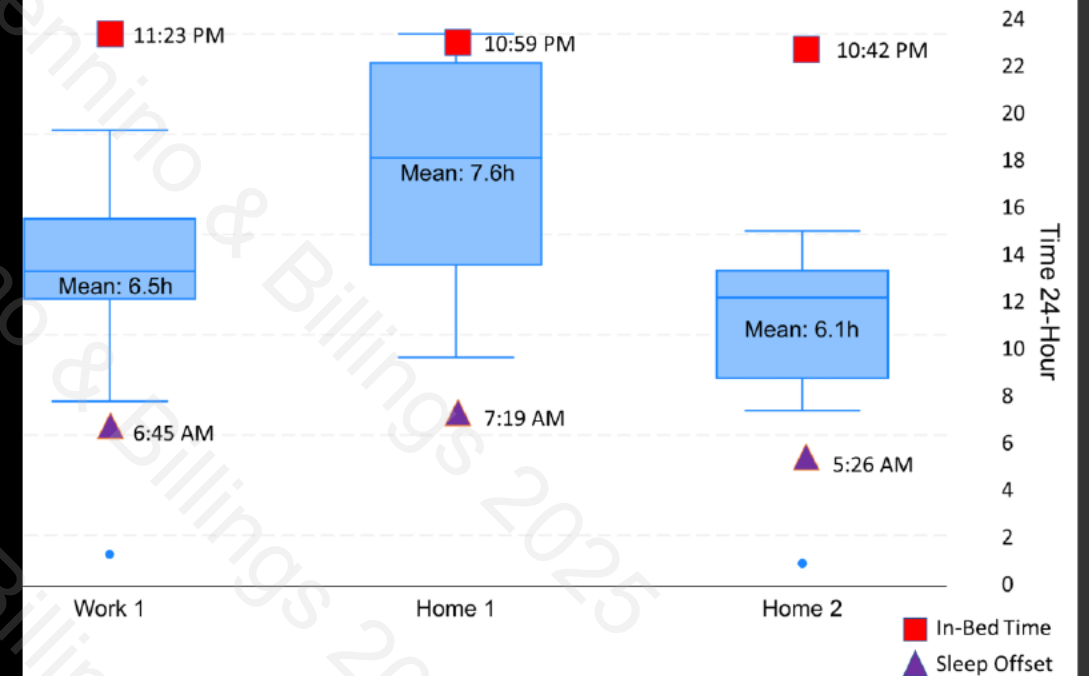
Tour Day	Feel upon waking morning at	Sleep Quality last night	Stress/Anxious at night (1-8)
Work Night 1	Tired (work)	Fairly Good	2.2
Home Night 1	Rested (home)	Fairly Good	2.0
Home Night 2	Tired (commute)	Fairly Good	2.4

How do you feel upon waking today?

Tour Day	Feel upon waking morning of	Sleep Quality at night	Stress/Anxious at night (1-8)
Work Night 1	Rested (work)	Fairly Good	1.6
Work Night 2	Rested	Fairly Good	2.0
Home Night 1	Well Rested	Fairly Good	1.9
Home Night 2	Rested	Fairly Good	1.3
Home Night 3	Rested	Fairly Good	1.6
Home Night 4	Rested (commute)	Fairly Bad	1.5

# Results Summary

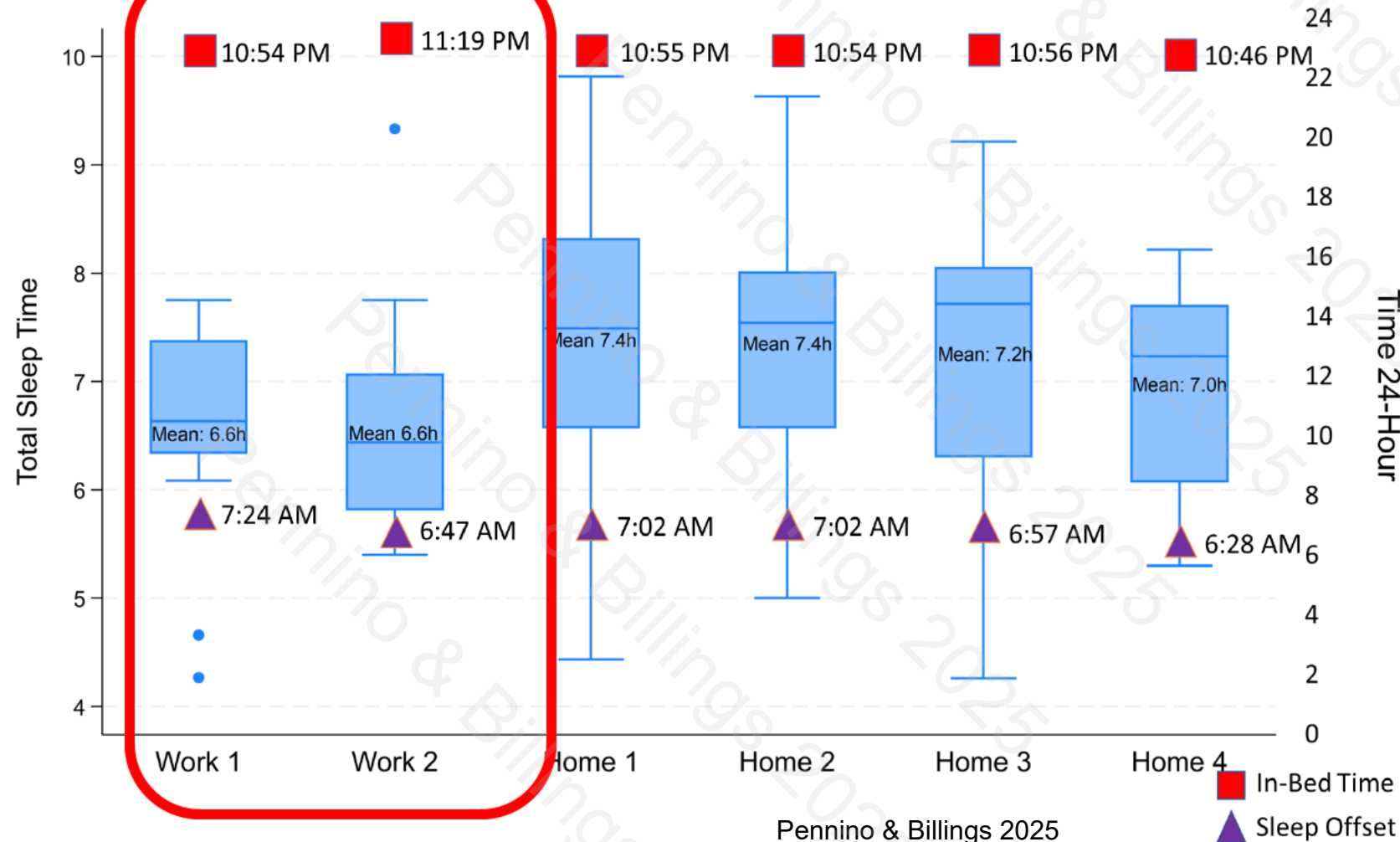
- Sleep Pattern Normalized
- Pre-tour sleep improved ~ 1 hour
- Sleep at home in the normal range
- 48/96 allows extra sleep at work first night
- Firefighters go to work well rested and don't show signs of poor alertness





# Debrief & Unexpected Barriers

*Learning and adapting*



## Sleep at Work?

1. Part time staff
2. Apparatus paperwork
3. Assignment / call-ins part-time
4. Maintenance staff
5. Adjusting to new pattern

## Sleep at home?

1. Getting ready to leave for 48 h

# Follow-Up Adjustments


*refining program impact*



- Department Training
- Wake up times
- Public Relations events
- Part-time staffing transition
- Ongoing education

# Broader Lessons for the Fire Service

*Insights to support innovation across the fire service*

- 
- Question everything
  - Fix what you can fix
  - Start with the "why"
    - Hard decisions are easier if they're for the right reasons
  - Tradition is important (sometimes)

**THANK YOU !**



**LinkedIn**



**Joel Billings:** Joel.billings@erau.edu

**Joe Pennino:** pennino.joe@gmail.com