CUMULATIVE DRIVER FATIGUE

GREGORY F. KUSHNIR

DAVID L. ARMITAGE

SAFETY REASONS FOR THE STUDY

- HOS rules attempt to do a better job of regulating the driver's hours behind the wheel to *manage fatigue*
- Oil & Gas Industry motor vehicle fatality rate is **8x** that of all industries, and is similar to the Transportation Industry [1]

SAFETY REASONS FOR THE STUDY

- Here are the Average Stats from the study [1] conducted by NIOSH & VTTI (with Cartasite providing IVMS Technology) for the small O&G Service Company:
  - **Combined** daily working time: **15.4 hrs**
    - **Commute**, daily time: **2.9 hrs**
    - **On-Duty**, daily time: **12.5 hrs**
  - **Commute**, daily distance: **147.6 miles** (including Home to Yard)
- There appears to be *more to fatigue management*:
  - It's not just how much time you spend driving
  - It's how much you've been working [including driving], your sleeping hours and habits, and so forth.

FATIGUE CAN CAUSE DISTRACTION

- A fatigued individual has a reduced ability to focus on the task of driving, and can, therefore, be considered a distracted driver.
- Unlike the distractions of cell phones, food, or navigation systems which can all be put away or delayed, it is not possible for a driver to ignore the *internal distraction* of fatigue.

RESEARCH FOCUS

Identify the ***cumulative*** effect of “all” activities [including driving] that individuals are involved in while being away from their ‘Homebase’ to determine if:

- The ***cumulative*** effect of “all” activities:
  - Has measurable effect(s) on the individuals’ driving behavior/performance
  - Could be qualified as ***Cumulative Driver Fatigue***
- Measurable effect(s) could be used as predictive indicators for the ***Cumulative Driver Fatigue***

RESEARCH FOCUS

Definitions, for the purposes of this study:

- *HomeBase:* the location where an individual was:
  - Most likely to rest and to sleep for extended periods of time
  - Where the individual spent midnight of local time.
- *Time Away From HomeBase* [AFHB]: the time away from one's *HomeBase*
- ***Time Away From HomeBase*** *is the* ***DIMENSION*** on which this study is focused

METHOD

Subset of Cartasite fleet customers selected for the study:

- **Ten** Customers:
  - Three Upstream O&G Companies (Large size)
  - One Midstream Oil & Gas Company (Large size)
  - Four Oil & Gas Field Services Companies (2 Large size, 1 Mid-size, 1 Small size)
  - One Utilities Services Company (Mid-size)
  - One Construction Company (Large size)
- **Light, small & medium size trucks** [or equivalent cars & SUV's]

METHOD

- **Data collected** over a **12 month** period (Oct 2015 – Oct 2016)
- **Initial Data Set (IDS)**:
  - **2637** Drivers
  - **3,967,303** - hourly intervals of being Away From HomeBase (AFHB)
  - **No more then 16** hourly intervals AFHB per day of the workweek
- **Filtered IDS** [Includes only the drivers - and their corresponding AFHB hourly intervals - who (1) started their workweek on Monday, after spending midnight at their HomeBase, (2) worked no further then Friday of the same week, (3) worked 5 or less days that week]:
  - **2551** Drivers
  - **2,245,804** - Hourly intervals of being AFHB
  - **52,791 –** weeks of driving processed

METHOD

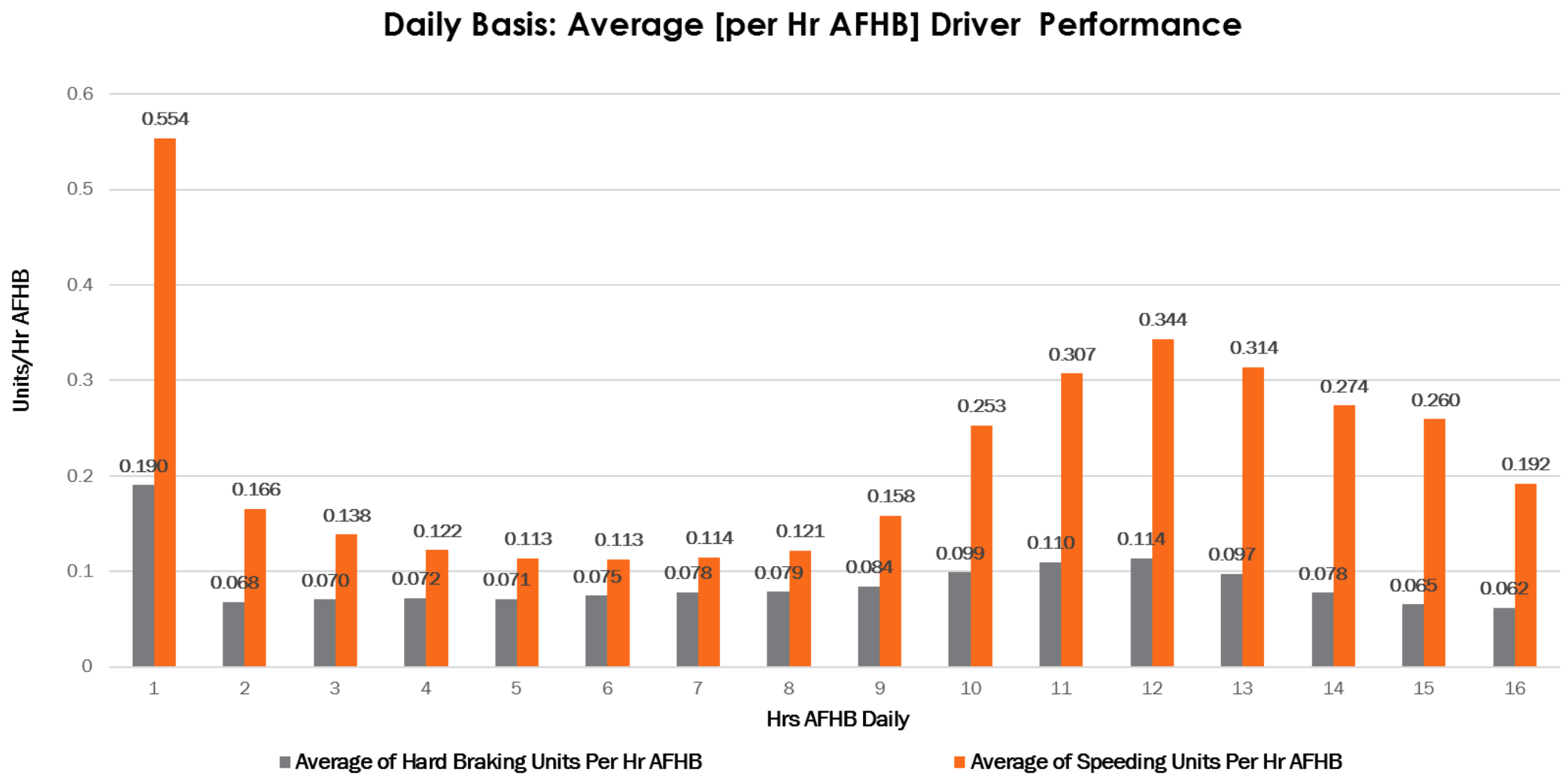
- **Speeding Events:**
  - Minor Speeding Event [6 *mph* <= **(Speed - Speed Limit)** < 11 *mph*]
  - Moderate Speeding Event [11 *mph* <= **(Speed - Speed Limit)** < 20 *mph*]
  - Severe Speeding Event [**(Speed - Speed Limit)** >= 20 *mph*]
- **Speeding Units:**
  - **1** Minor Speeding Event = **1** Speeding Unit
  - **1** Moderate Speeding Event ***is equivalent to* 2** Minor Speeding Events = **2** Speeding Units
  - **1** Severe Speeding Event ***is equivalent to* 3** Minor Speeding Events = **3** Speeding Units

METHOD

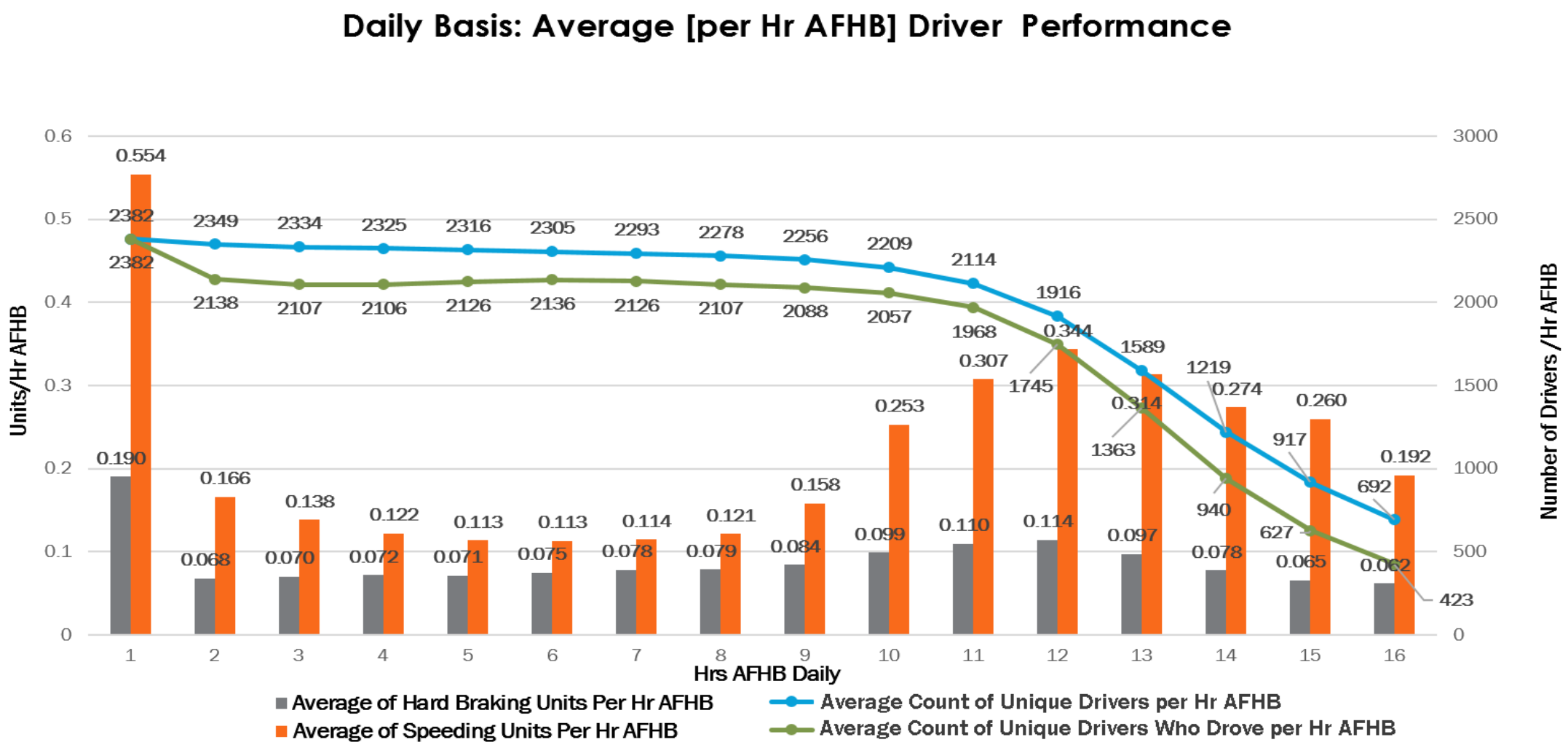
- **Hard Braking Events:**
  - Minor Hard Braking Event [5.4 *mph/sec* <= **ABS(Deceleration)** < 10 *mph/sec*]
  - Moderate Hard Braking Event [10 *mph/sec* <= **ABS(Deceleration)** < 15 *mph/second*]
  - Severe Hard Braking Event [**ABS(Deceleration)** >= 15 *mph/second*]
- **Hard Braking Units:**
  - 1 Minor Hard Braking Event = 1 Hard Braking Unit
  - 1 Moderate Hard Braking Event ***is equivalent to*** 2 Minor Hard Braking Events = 2 Hard Braking Units
  - 1 Severe Hard Braking Event ***is equivalent to*** 3 Minor Hard Braking Events = 3 Hard Braking Units

RESULTS & DISCUSSION

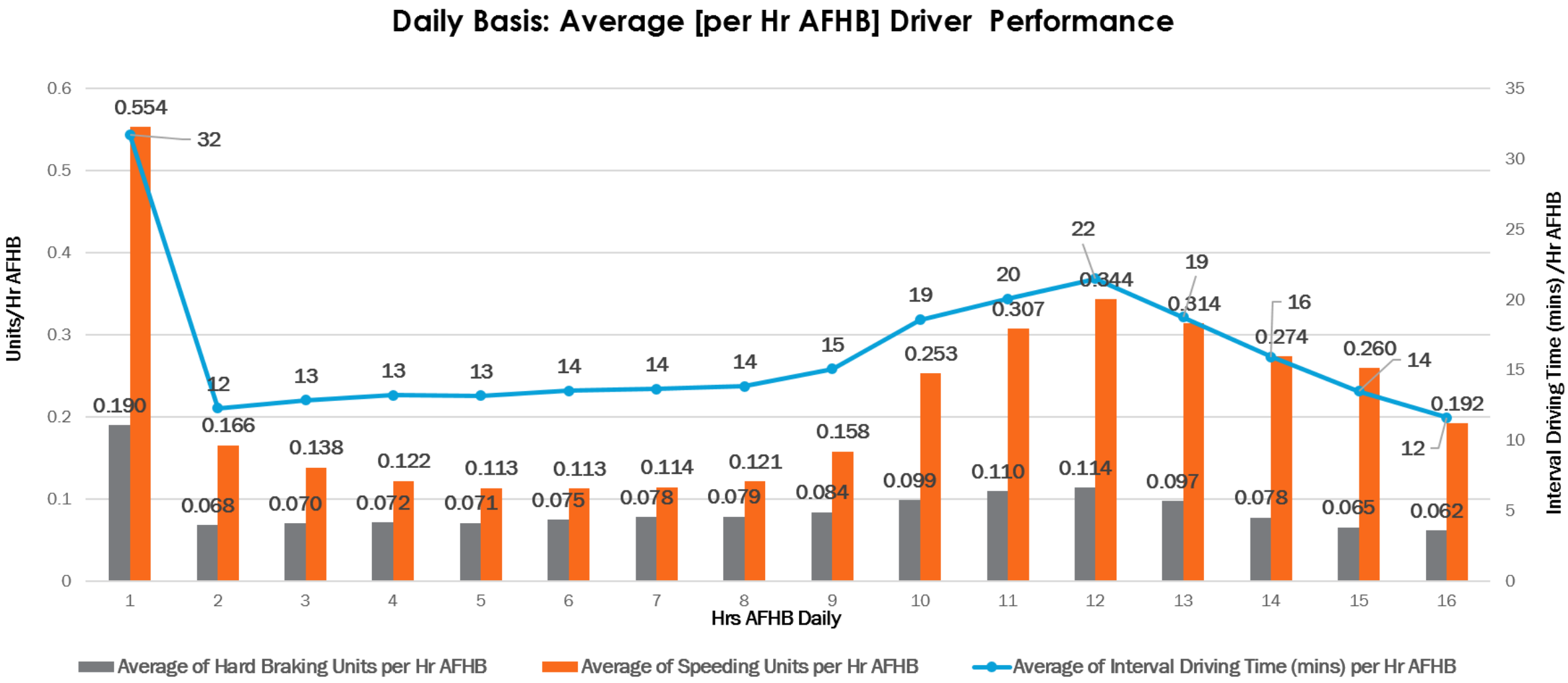
DAILY STATS: DRIVER PERFORMANCE



DAILY STATS: DRIVER PERFORMANCE AND NUMBER OF DRIVERS



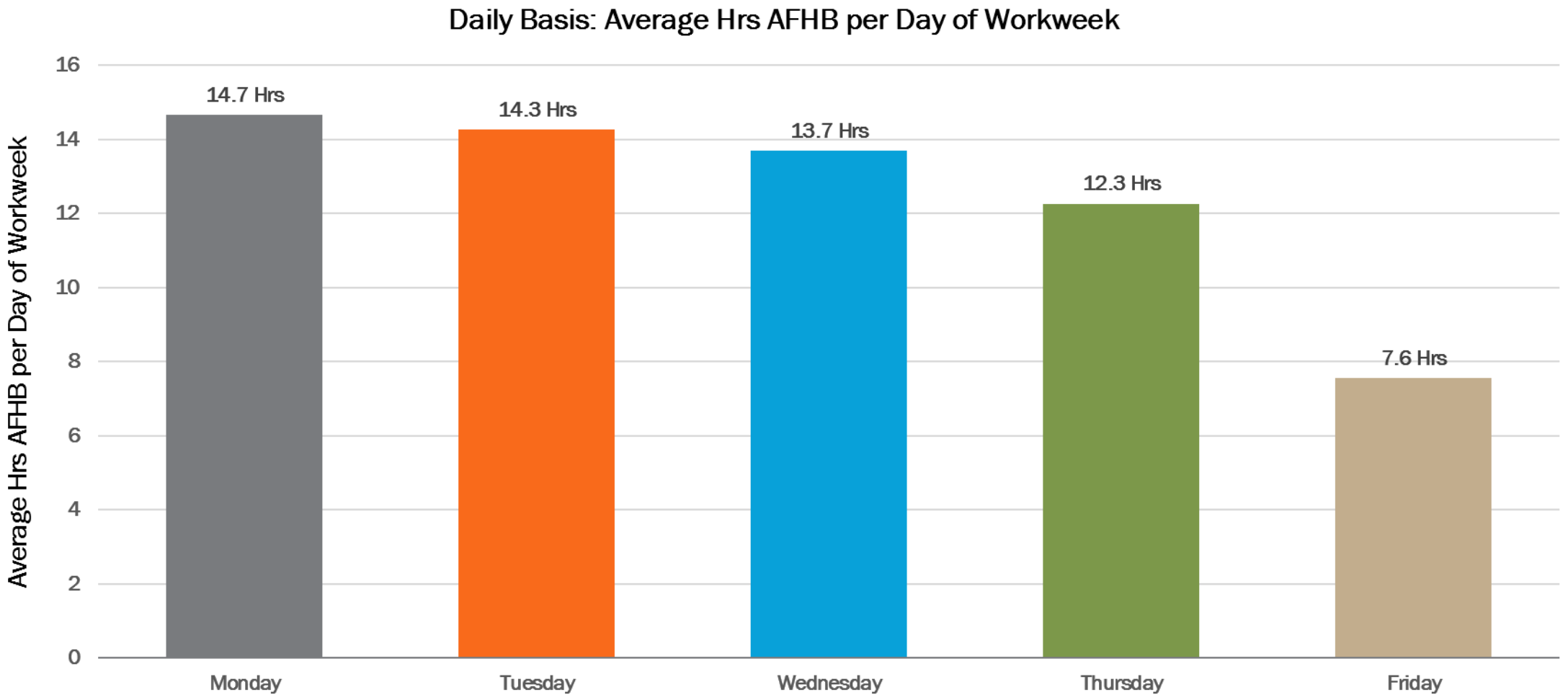
DAILY STATS: DRIVER PERFORMANCE AND HOURLY AFHB INTERVAL DRIVING TIME



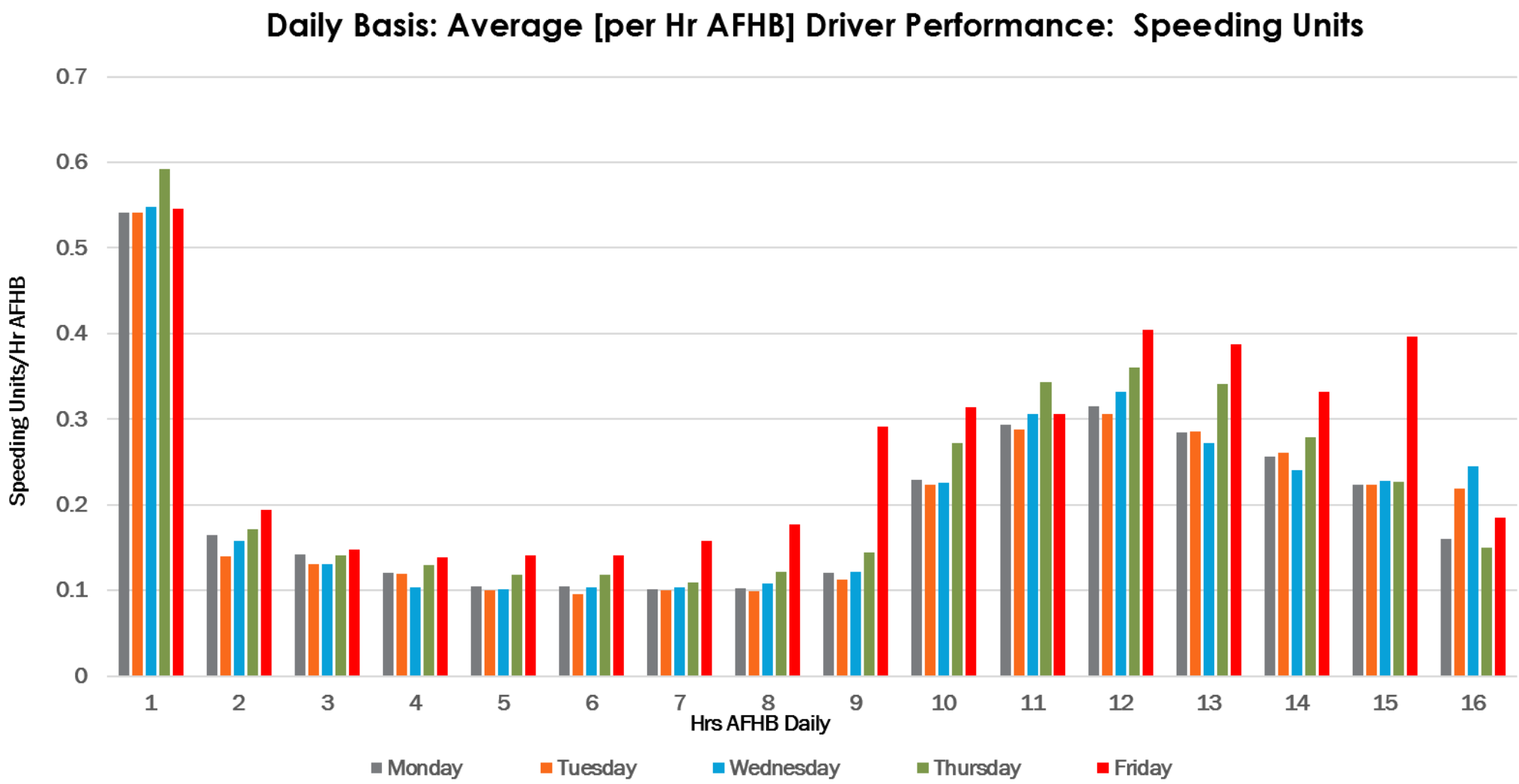
DAILY STATS: THERE ARE CLEAR PATTERNS IN SPEEDING UNITS PER HR AFHB AND HARD BRAKING UNITS HR AFHB STATS

- High volume of the **Speeding Units per Hr AFHB** and **Hard Braking Units per Hr AFHB** during 1st hour AFHB:
  - **Kyla Retzer (NIOSH) [4]**:
    - Long commutes to start shift;
    - Desire to be at home with family until last minute;
    - Sleep is low priority
  - **Colonel Mark V. Trostel** (Driving Safety Advisor, Encana Oil & Gas, Inc.) [Discussions]:
    - Driver might be concerned about tasks for the day/shift rather than focused on his/her driving
    - Factor of traffic volume as more people are on the roads during “rush hour” hours

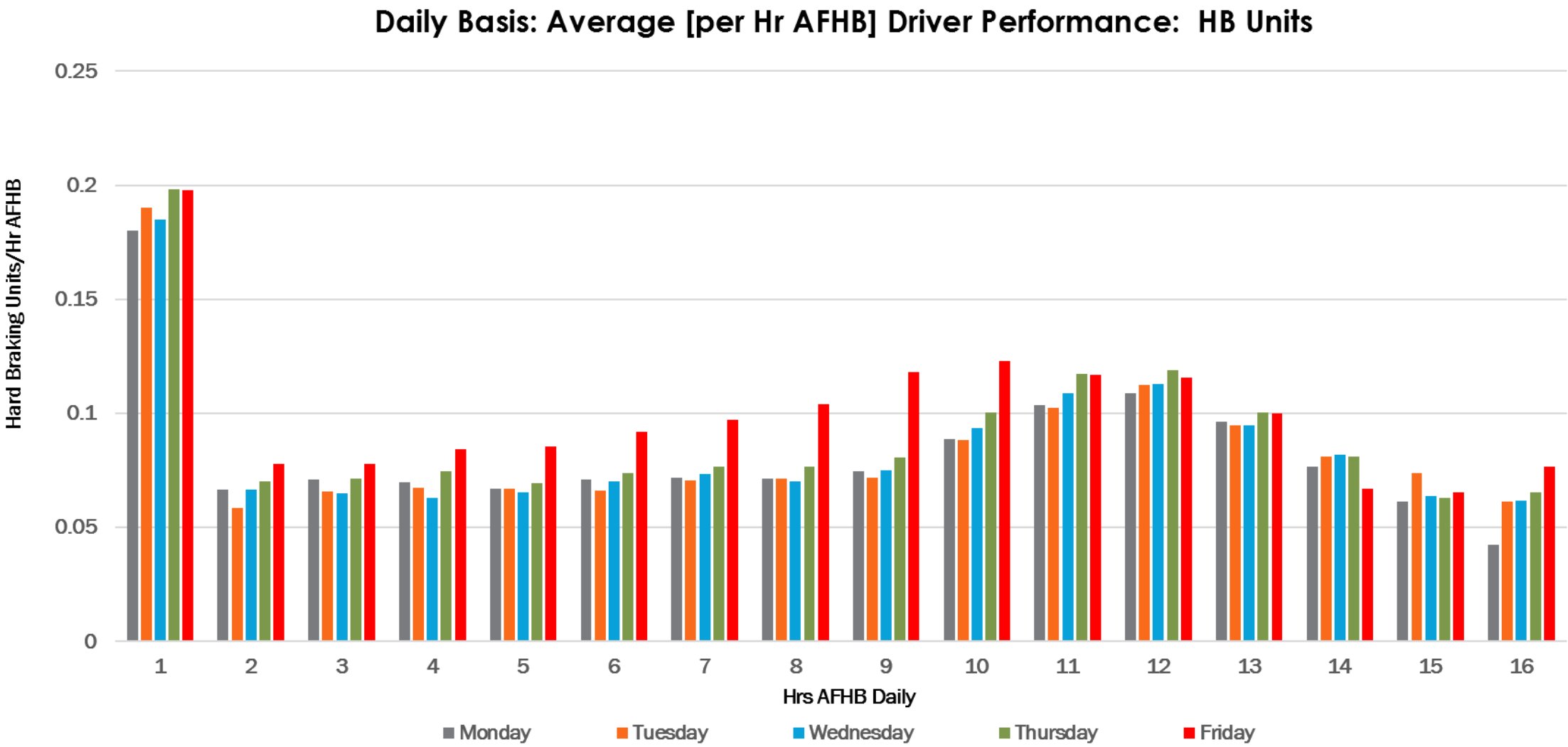
DAILY STATS: AVERAGE HRS AFHB PER EACH DAY OF WORKWEEK (AN ESTIMATE OF AVERAGE DURATION OF WORKDAY [INCLUDING DRIVING] PER EACH DAY OF WORKWEEK)



DAILY STATS: AVERAGE SPEEDING UNITS PER DAY OF THE WEEK



DAILY STATS: AVERAGE HARD BRAKING UNITS PER DAY OF THE WEEK



DAILY STATS: THERE ARE CLEAR PATTERNS ON FRIDAYS IN SPEEDING UNITS PER HR AFHB AND HARD BRAKING UNITS PER HR AFHB STATS

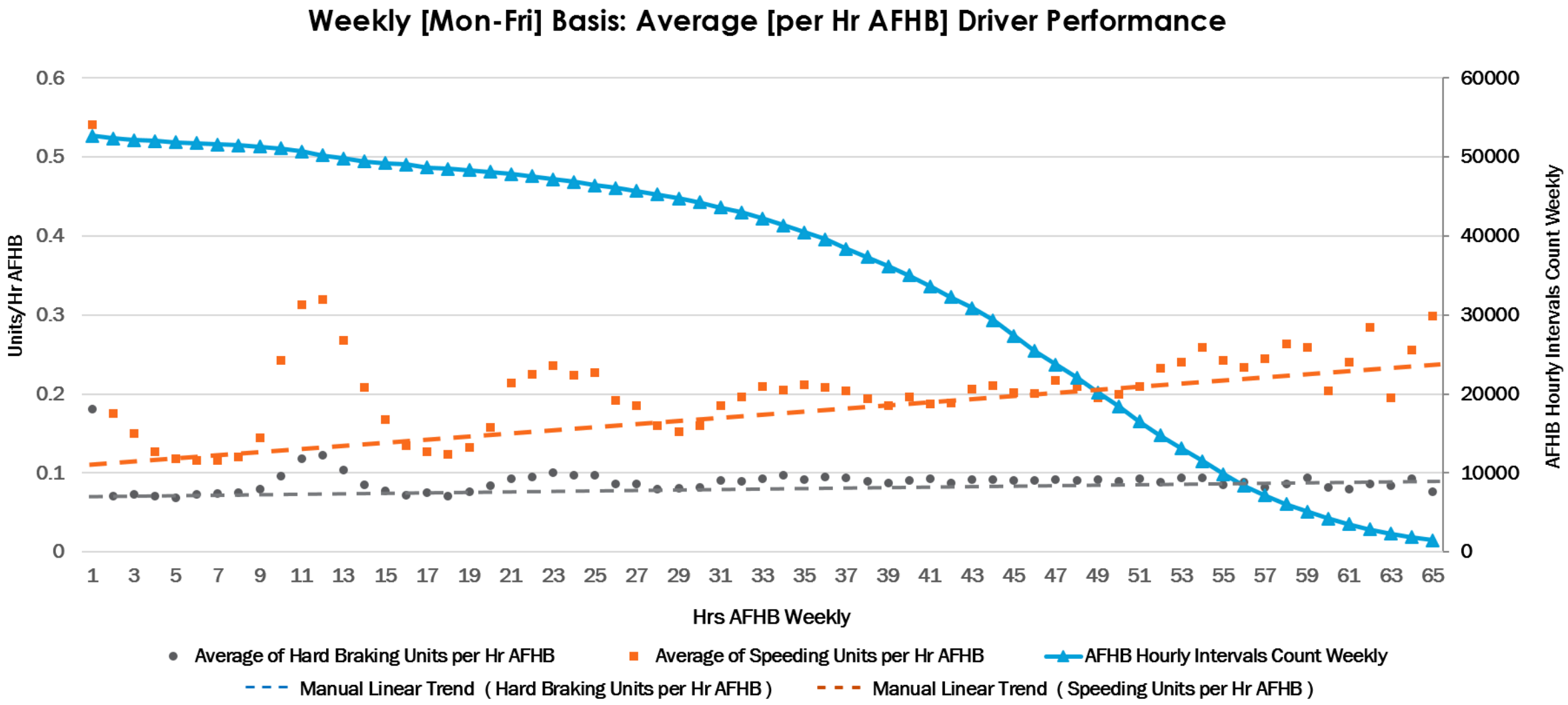
Findings:

- **Higher volume of the Speeding Units per Hr AFHB during almost all hours AFHB on Friday and specifically during the second half of the Hours AFHB on Friday:**
  - Clearly identifiable *risk pattern*
  - Correlates to the incident/accident data [*Layman* reference: https://www.theguardian.com/lifeandstyle/2013/may/29/most-dangerous-day-of-week]
- **Higher volume of the Hard Braking Units per Hr AFHB during the first half of the Hrs AFHB on Friday:**
  - Clearly identifiable *risk pattern*

WEEKLY STATS: WORKWEEK BY HOURS AFHB (MON-FRI)

- The daily trends led us to look at driving behavior during a longer period of time - during the workweek (Monday through Friday)
- Specifically, how does driving behavior change over the course of the week?

WEEKLY STATS: WORKWEEK BY HOURS AFHB (MON-FRI)

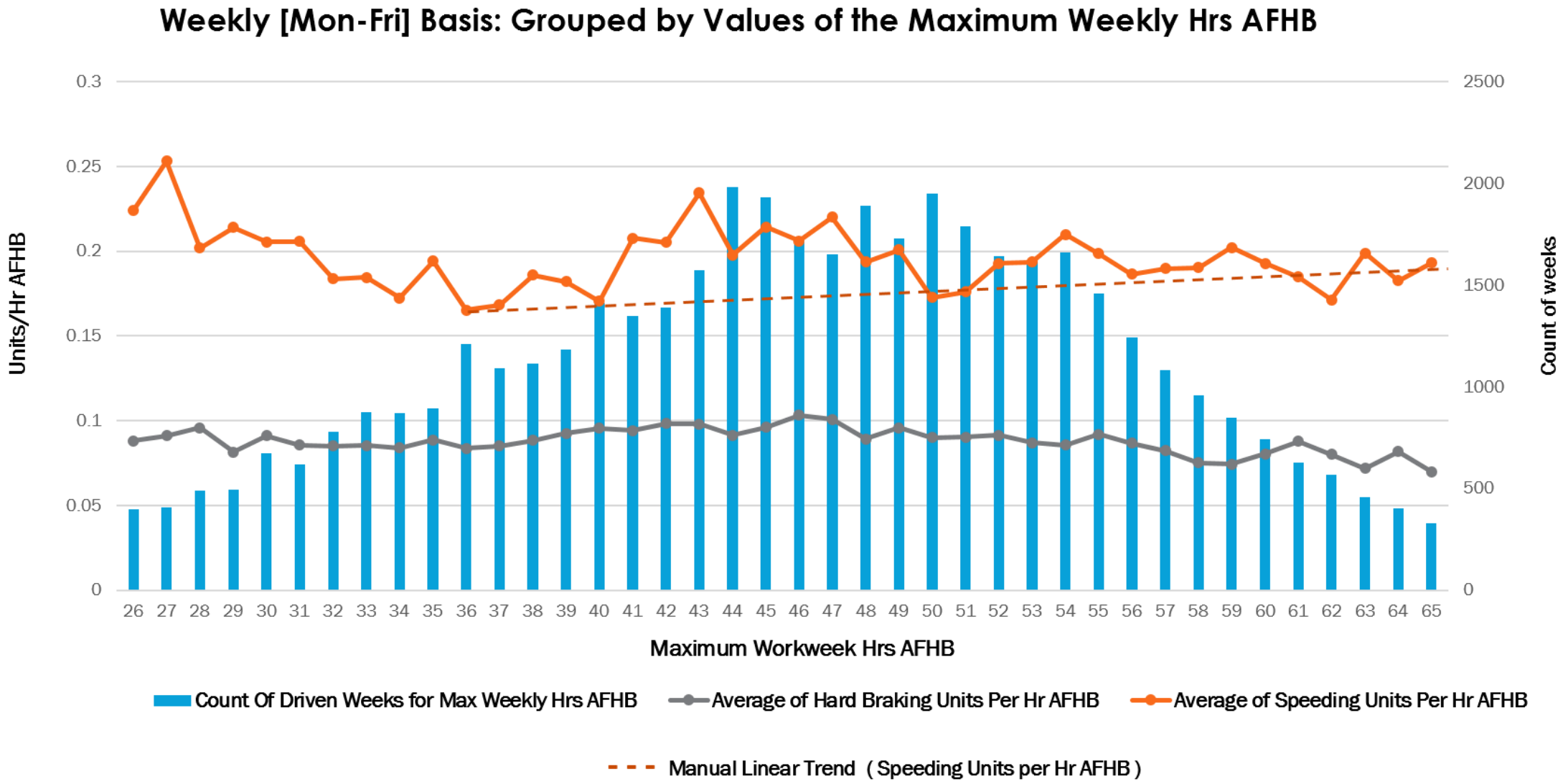


WEEKLY STATS: GROUPED BY VALUES OF THE MAXIMUM WORKWEEK HOURS AFHB

Findings:

- Upward Trends over the course of the week in ***Speeding Units per Hr AFHB Weekly*** *metric and in* ***Hard Braking Units per Hr AFHB Weekly*** metric are pointing out to increase of the risky driver behavior toward the end of the workweek
- Upward Trend for the ***Speeding Units per Hr AFHB Weekly*** metric is more pronounced…

WEEKLY STATS: GROUPED BY VALUES OF THE MAXIMUM WORKWEEK HOURS AFHB



WEEKLY STATS: GROUPED BY VALUES OF THE MAXIMUM WORKWEEK HOURS AFHB

- **Data:**
  - **Hourly Intervals AFHB:**
    - Total Number of Hourly Intervals: **2,245,804**
    - Number of Hourly Intervals between hour #26 (including) & hour #65 (including): **2,074,884**
    - % of Hourly Intervals between hour #26 (including) & hour #65 (including): **92.4%**
  - **Weeks:**
    - Total Number of Weeks: **52,791**
    - Number of Weeks between hour #26 (including) & hour #65 (including): **45,081**
    - % of Weeks between hour #26 (including) & hour #65 (including): **85.4%**
- Grouping occurred by the values of the **Maximum Weekly Hrs AFHB** attribute

WEEKLY STATS: GROUPED BY VALUES OF THE MAXIMUM WORKWEEK HOURS AFHB

Findings:

- **Speeding** Units per ***Maximum Weekly Hrs AFHB***:
  - ***Robust Upward Trend*** starting at hour ***#36*** and thru hour ***#65***
- **Hard Braking** Units per ***Maximum Weekly Hrs AFHB***:
  - Positive anomaly with low amplitude of approximately 0.024 Hard Braking Units Hr AFHB between hours **#29** & **#59**

SUMMARY

Variety of trends/patterns in the processed data were observed/identified:

- **Daily AFHB Charts:** Strong, quantifiable patterns of risky driving behavior in ***Speeding Units per Hr AFHB Daily*** metric *and in* ***Hard Braking Units per Hr AFHB Daily*** metric as individuals progress through their *daily* activities while *being AFHB and specifically* ***on Fridays***.
- **Workweek by Hrs AFHB (Mon-Fri) Chart:**
  - Upward Trends over the course of the week in ***Speeding Units per Hr AFHB Weekly*** *metric and in* ***Hard Braking Units per Hr AFHB Weekly*** metric are pointing out to increase of the risky driver behavior toward the end of the workweek
  - Upward Trend for the ***Speeding Units per Hr AFHB Weekly*** metric is more pronounced…
- Grouped by ***Values of the Maximum Workweek Hrs AFHB*** Chart**:**
  - ***Speeding Units per Hr AFHB*** metric: Robust Upward Trend starting at hour **#36** and thru hour **#65**

SUMMARY

What is next:

- Check for seasonal, regional and other trends/patterns in the data
- Further research/confirm the trends/patterns observed in the ***Speeding Units per Hr AFHB*** metric and ***Hard Braking Units per Hr AFHB*** metric in the processing of the 12 months of the data.
- Further qualify and quantify the ***Cumulative Driver Fatigue*** which is exhibiting itself in the individual's driving performance metrics to introduce predictive indicator(s)
- **Cartasite** will be partnering with **NIOSH** to more closely examine this data

REFERENCES

1. Ryan Hill , NIOSH, Andrew Krum, VTTI: “In-Vehicle Monitoring Systems – On and Off Duty: Evaluating Driver Performance and Schedules in a Small Well Servicing Fleet” (https://www.isnetworld.com/Events/ugm/Osha2016/Sessions/Andrew%20Krum%20&%20Hill%20-%20In-Vehicle%20Monitoring%20Systems.pdf)
2. Sarah Trotto: ”Fatigue and worker safety” (http://www.safetyandhealthmagazine.com/articles/15271-fatigue-and-worker-safety)
3. “Sleep deprivation, work environment drive on-the-job fatigue: study” (http://www.safetyandhealthmagazine.com/articles/14906-sleep-deprivation-work-environment-drive-on-the-job-fatigue-study)
4. Kyla Retzer, NIOSH: “*Oil and Gas Driver Fatigue”.* Presented at the Permian Basin Transportation Safety Coalition, 2016

Thank you

Gregory F. Kushnir gkushnir@cartasite.com

David L. Armitage darmitage@cartasite.com