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1.0 BACKGROUND AND RESEARCH OBJECTIVES

In 2010, the Federal Motor Carrier Safety Administration (FMCSA) commenced a process to significantly change the Hours-of-Service (HOS) rules governing commercial driver operating hours. The final rule was implemented July 1, 2013 and included a requirement that each 34-hour restart include two 1 a.m. to 5 a.m. time periods, and that use of the restart provision be limited to one time per 168 hours (1 week).

Prior to July 2013 commercial drivers regulated by the HOS rules could “restart” weekly on-duty time restrictions by taking 34 consecutive hours off-duty. The 34-hour restart off-duty period could be taken as often as a driver wanted, and during any time of day.

In 2013, the American Transportation Research Institute (ATRI) published two studies analyzing the impacts of the changes to the HOS rules. ATRI’s first study, Assessing the Impacts of the 34-Hour Restart Provisions, documented direct and indirect impacts from more than 500 motor carriers and 2,000 commercial drivers prior to the implementation of the rules changes. The study also utilized an extensive dataset of over 40,000 commercial driver logs to assess the efficacy of the Federal Motor Carrier Safety Administration’s (FMCSA’s) Regulatory Impact Analysis (RIA), which estimated industry costs and benefits that would be generated by the rules changes. ATRI’s analysis identified a net industry cost from the new restart provisions that ranged from $95 million to $376 million, and which differed significantly from FMCSA’s projection that the industry would experience net benefits from the restart provisions totaling $133 million annually.

ATRI’s second HOS study, Operational and Economic Impacts of the New Hours-of-Service, utilized a similar methodology to quantify actual industry operational impacts post-rules change through October 2013. In that analysis ATRI documented driver-reported increased fatigue levels, decreased quality of life and negative pay impacts being experienced by commercial drivers as a result of the rules change.

Given the magnitude of the industry impacts documented in ATRI’s November 2013 study, ATRI’s Research Advisory Committee (RAC) identified as a 2014 top research priority a series of continuing analyses to quantify actual industry safety and operational impacts from the changes to the 34-hour restart. This Technical Memorandum documents the findings of the first of these ongoing analyses.

In particular, this Tech Memo examines whether or not the changes to the 34-hour restart had an influence on when trucks are operated by day-of-week and time-of-day...
and any resulting safety consequences from those changes. Data analyzed for this Technical Memorandum include ATRI’s extensive truck GPS dataset\(^4\) and FMCSA’s Motor Carrier Management Information System (MCMIS) crash files. The methodology for the data analysis is described later in this Tech Memo.

### 1.1 Nighttime Driving and Truck Driver Fatigue

FMCSA states that the new rule was intended to deter drivers from operating under “extreme” schedules, yet research from June 2013 and November 2013 showed that drivers rarely operated under “extreme” schedules when defined as an average of 65 or more hours per week on duty.\(^5\) While the research shows there was little change in drivers’ overall on-duty time after the rules change, empirical data is now available that demonstrates that a shift in on-duty hours occurred from less congested to more congested time periods post-July 1, 2013.\(^6\)

This shift of drivers’ on-duty time to more congested driving periods is not unexpected. In fact, FMCSA’s new 34-hour restart regulation directly and indirectly advocates for this day-part shift. At a July 29, 2014 Senate hearing, FMCSA Administrator Anne Ferro “touted the benefits of nighttime sleep vs. daytime sleep, saying the rule’s requirement that a weekly restart include two 1 a.m. to 5 a.m. periods pushes drivers to nighttime rest.”\(^7\)

There is circadian rhythm literature that indicates that fatigue levels are higher among all individuals for nighttime versus daytime activities. Furthermore, a large U.S. DOT-sponsored field test in 1996\(^8\) identified a fatigue effect of nighttime versus daytime driving, but theorized that much of the effect could derive from ineffective sleep scheduling by drivers, rather than nighttime driving itself.

That same study warned FMCSA’s predecessor\(^9\) in 1996 that, “It cannot be concluded, however, that shifting truck traffic to daylight hours would result in lower accident rates.

\(^4\) ATRI’s anonymized truck GPS dataset is comprised of a continuous stream of truck position data that is reported from more than five hundred thousand trucks. For each individual truck, a latitude/longitude, date and time stamp, speed and other information is recorded continuously. Rates of position are extremely frequent; anywhere from every 30 seconds to every several minutes.


\(^9\) The Federal Motor Carrier Safety Administration was established within the U.S. Department of Transportation on January 1, 2000, pursuant to the Motor Carrier Safety Improvement Act of 1999 (49 U.S.C. 113). Prior to that, FMCSA was the Office of Motor Carriers within the Federal Highway Administration.
This measure would increase daytime traffic congestion, possibly with a corresponding increase in accidents, and would further increase the risk of accidents with passenger vehicles which are more vulnerable in accidents with trucks because of their difference in mass.\textsuperscript{10}

That study went on to conclude, “research is needed to establish the relative risks of accidents between day and night driving for a variety of road and vehicle types, and levels of traffic density, to establish the net impacts on highway safety of day/night scheduling practices.”\textsuperscript{11}

The complex and often contradictory role of nighttime driving on truck driver fatigue may be best exemplified in FMCSA’s 2014 congressionally mandated HOS Field Study of the 34-Hour Restart Provisions.\textsuperscript{12} Using the results of the FMCSA study as a surrogate for truck driver fatigue impacts by time-of-day, a peer-reviewed evaluation of the field test analysis concludes that no practical significance can be found in any of the data outcomes which compared two groups of drivers: one group operating under the old HOS rules with one nighttime restart period and a second driver group operating under the new HOS rules with two or more nighttime restart periods.\textsuperscript{13} The findings of the peer review included the following:

- Drivers in the field test completed a Psychomotor Vigilance Test (PVT) several times throughout each day in the study. The PVT data showed that drivers with one nighttime restart period on average exhibited 2.0 lapses of attention per PVT, and drivers with two or more nighttime periods on average exhibited 1.7 lapses of attention per PVT\textsuperscript{14}. This 0.3 difference between the two conditions is not practically significant.
- The Lane Departure deviation impact of 1 millimeter between the two groups was not practically significant, and the field test researchers ultimately discounted the LDWS data as meaningful;\textsuperscript{15} and
- Neither group of drivers registered fatigue on the subjective Karolinska Sleepiness Scale (KSS).\textsuperscript{16}

\textbf{1.2 Shifting Trucks to Daytime Driving}

While there has been little impact on a truck driver’s overall driving and on-duty time, there does appear to be agreement by the industry at large that the new regulation’s

\textsuperscript{11} Ibid.
\textsuperscript{15} Ibid.
\textsuperscript{16} Ibid.
objective and impact has been a shift to daytime driving, as well as driving on more congested weekdays rather than weekends.

While much anecdotal industry data substantiates this shift, FMCSA statements and research findings can also be used to validate the daytime impact. The 2014 FMCSA field study reported that among study participants “a driver was likely to be driving primarily at night during a duty cycle following a restart break with only one nighttime period.” 17 Additionally, the FMCSA field study found that those drivers with on-duty cycles preceded by two or more nighttime periods had a more even distribution of their hours across both daytime and nighttime driving (see Figure 1).

![Figure 1. FMCSA Finding, Driver Hours Logged as Driving](https://www.fmcsa.dot.gov/newsroom/statement-fmcsa-administrator-anne-s-ferro-house-transportation-and-infrastructure-0)

In written testimony submitted for a Congressional hearing held on June 18, 2013, Anne Ferro, FMCSA Administrator at that time, noted that, “Only nighttime drivers who work more than 60 hours in 7 consecutive days, or 70 hours in 8 consecutive days will be impacted by this change.” 19

Thus, one of several key research queries that must be answered is: What are the trucking-related operational and traffic impacts associated with “nighttime drivers” shifting operations into daytime driving periods? This question is addressed in the first of two analyses conducted by ATRI in the following sections.

18 Ibid.
2.0 ATRI ANALYSIS #1: HOS IMPACTS ON DAYTIME OPERATIONS

A post-July 1, 2013 survey of 2,370 drivers found that, to utilize the restart and comply with the 1 a.m. to 5 a.m. requirement, many driver respondents had to make changes to their schedules. The research found that:

- 20.1 percent of drivers had adjusted their start times;
- 15.6 percent of drivers had adjusted their end times; and
- 18.9 percent reported changes to their overall driving schedules.

More significant was the impact of the one restart per week restriction with 25.5 percent of drivers citing a need to adjust their overall driving schedule as a result of the rules change. Additionally, 39.1 percent indicated that they had shifted back to the use of a rolling recap for calculating available hours rather than utilizing the more restrictive 34-hour restart. For some in the latter group of drivers, the shift to a rolling recap meant that taking 34 consecutive hours or more of off-duty was no longer necessary. The shift back to a rolling recap likely results in more drivers logging driving hours in the beginning of the weekend.

This previous research, combined with anecdotal industry evidence, and the expectations of FMCSA, suggests that significant changes to U.S. trucking operations occurred as a result of the July 1, 2013 restart rule change. In particular, it is widely believed that those changes include significant shifts in patterns of when (time-of-day and day-of-week) and where trucks operate in the U.S.

To analyze the impact of the HOS rules change on the times and days in which trucking operations occur, ATRI formulated several research questions that would be analyzed utilizing empirical data:

1) Was there an increase in driving on weekdays as a result of the one restart per week provision, particularly on Mondays?
2) Was there a decrease in driving from noon Saturday through 5 a.m. Monday due to both restart provisions?
3) Was there a decrease in nighttime driving or an increase in daytime driving due to the 1 a.m. to 5 a.m. provision?

---

2.1 Methodology

To answer these questions, ATRI developed algorithms using SAS and applied the algorithms to its truck GPS dataset.\textsuperscript{21} Through this process, discrete truck travel can be monitored and analyzed. Some of the metrics that could be captured for this analysis include: travel speed; delay (speed deviation from free-flow/posted speeds); moving versus stopped vehicles; and, all data points are cross-referenced by spot-speed, date/time-stamp, latitude/longitude position, and heading.

In general, this Analysis #1 provides both a historical and near-real-time assessment of truck activity in the U.S. More specifically, the algorithms and data streams document pre- and post-July 1 HOS impacts.

2.1.1 Development of Research Data Set

To identify the impacts of HOS changes on the time-of-day and day-of-week in which trucking operations occur, the following tasks were undertaken to identify representative datasets:

a. A pre- and post-July 1, 2013 dataset was selected and compared. October 2012 and October 2014 were selected as the study periods.\textsuperscript{22}

b. These pre-/post-datasets were standardized by month and avoid certain unique seasonal externalities that might confound the analysis.

c. The selected datasets were paired down to include only data for trucks operating on a large U.S. highway network of 60,000 centerline miles. This network included all U.S. interstates within the continental U.S. as well as many key non-interstate highways. Figure 2 displays this network.

\textsuperscript{21}ATRI’s anonymized truck GPS dataset is comprised of a continuous stream of truck position data that is reported from more than five hundred thousand trucks. For each individual truck, a latitude/longitude, date and time stamp, speed and other information is recorded continuously. Rates of position are extremely frequent; anywhere from every 30 seconds to every several minutes.

\textsuperscript{22}To ensure that truck drivers were adequately familiar with, and applied, the new HOS regulation correctly, the researchers used a post-July 1, 2013 dataset comprised of all truck GPS data in October 2014. In turn, to ensure that pre-HOS protocols were fully applied, the researchers selected pre-impact data from October 2012.
2.2 DATA ANALYSIS

Applying this methodology, the target data were binned by date and time. To do this, a SAS code was written to count each moving point that fell within each hourly bin. The procedure accounted for time zone (converting from GMT to local time). The end result of this step was a table with total number of position points by hourly bin. Table 1 offers an example of a single one-hour time bin.

Table 1: Sample One-Hour Time Bin

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Count</th>
</tr>
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<tbody>
<tr>
<td>10/09/2014 11:00:00</td>
<td>267,543</td>
</tr>
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Once the count data were compiled, several adjustments were incorporated. To address both the increase in truck units as well as the increase in position pings per truck over the two-year period, the hour bins for each period were converted into an index. Each single hourly bin was divided by the arithmetic mean of the full month of hourly bins for each of the 2012 and 2014 datasets. This process standardized data for each year's sample. Additionally, the data from 2014 was "shifted" so that days of the week matched instead of days of the month. As an example, October 22, 2012 is a Monday, and corresponds with Monday, October 20, 2014.

23 This shift allowed for a comparative analysis of three distinct one-week periods for each October (Sunday through Saturday).
2.3 RESULTS

The hourly bin indices for the 21 corresponding days of data for each year were inserted in a table, and the percent change for each bin index was calculated and plotted on a chart. Figure 3 shows the percent change between 2012 and 2014 across each hour of the October study periods.

**Figure 3: Percent Change for each 1-Hour Bin across the Study Period**
To further illustrate comparative trends, the time periods for each week were juxtaposed as shown in Figure 4.

**Figure 4: Percent Change for the Average of each 1-Hour Bin across the Study Period**

Percent Increase/Decrease from Oct/2012 to Oct/2014
2.4 Findings: Analysis #1

Based on the initial research questions, Figures 3 and 4 and their related analyses provide important insight for each of the research questions posed.

**Research Question #1 – Was there an increase in driving on weekdays as a result of the one restart per week provision?**

When all weekdays are considered, the data generally show a correlation between HOS changes on July 1, 2013 and increased weekday operations. A chi square analysis was conducted and all of the shifts referenced were significant at .05. That said, the assumption that the impact would be equally strong, or stronger, on Mondays did not materialize. In addition, the late week / early weekend activity was initially unexpected.

Sunday operations plummeted after the July 1, 2013 change. As shown in Figure 5, both daytime and nighttime Sunday averages were down (-4.9% and -8.1% respectively). Truck operations that would have normally occurred on Sunday appear to have been redistributed to weekdays, as well as the first half of Saturday. Again, this holds true across the weekdays with the caveat of a “Monday effect,” where truck activity unexpectedly dropped. Referring back to Figure 4, early Monday mornings saw a drop in activity. This, however, may be due to both the one restart per week, and more so, the 1 a.m. to 5 a.m. provision.

**Figure 5: Percent Increase/Decrease by Daytime/Nighttime**

The graph shows the percent increase or decrease in NHS truck activity by time of day and day of the week.

- **Daytime (6am-6pm):**
  - Sun: 0.5%
  - Mon: -0.5%
  - Tue: -0.6%
  - Wed: 0.5%
  - Thu: 1.6%
  - Fri: 1.7%
  - Sat: 0.8%
  - Sun: 0.8%
  - Mon: 1.9%
  - Tue: 3.1%
  - Wed: 2.4%

- **Nighttime (7pm-5am):**
  - Sun: -4.9%
  - Mon: -8.1%
  - Tue: -4.9%
  - Wed: -8.1%
  - Thu: -8.1%
  - Fri: -8.1%
  - Sat: -8.1%
Research Question #2 – Was there a decrease in driving from noon Saturday through 5 a.m. Monday due to both restart provisions?

The data unequivocally shows a decrease for most of this time period, although the Friday / Saturday time section experienced unexpectedly higher truck activity. As illustrated in Figure 6, truck activity increased on Saturday mornings – possibly indicating a shift to late-week days or a rolling recap – but the data may show drivers going off-duty in time to have two 1 a.m. to 5 a.m. periods as well as a full 34 hours off before Monday rush hour.

![Figure 6: Percent Increase/Decrease in NHS Truck Activity by Hour of Day](image)

Research Question #3 – Was there a decrease in nighttime driving or an increase in daytime driving due to the 1 a.m. to 5 a.m. rule?

A clear relationship between shifts in driving by time period and the 1 a.m. to 5 a.m. rule is less distinct, because the largest driving changes were day of week, particularly from weekend driving to weekday driving. The research team is undertaking further statistical analyses to elucidate whether correlations exist by day-of-week and the 1 a.m. - 5 a.m. rule. That said, specific weekday driving, day or night, shows the same overall increase (see Figure 5 and Figure 7)
Figure 7: Percent Increase/Decrease in NHS Truck Activity by Time of Day

Percent Increase/Decrease in NHS Truck Activity by Time of Day
(Change from Oct/2012 to Oct/2014)

Day of Week

Percent Change

-10% -5% 0% 5% 10%

Morning (5 am-11 am) Afternoon (12pm-4pm) Evening (5pm-8pm) Night (9pm-4am)
3.0 ATRI ANALYSIS #2: HOS IMPACTS ON TRANSPORTATION SAFETY

The findings from Analysis #1 establish that the new restart regulation has shifted truck travel to a new “time-of-day” paradigm. The critical question now becomes what safety consequence, if any, is associated with increased daytime driving crash risk. FMCSA has acknowledged that the agency did not evaluate the safety impact of increased traffic on the road during daytime hours. National truck crash data, documented in FMCSA’s Motor Carrier Management Information System (MCMIS) crash files, confirm that daytime driving is considerably less safe. The probability and impact of increased crash risk resulting from the new restart regulation, along with the requisite cost-benefit analysis, was not addressed by the FMCSA’s Regulatory Impact Analysis or by the 2014 HOS Field Study. Consequently Congress mandated that an expanded field test be conducted.

According to MCMIS data, daytime driving between 6 a.m. and 6 p.m. is substantially less safe than nighttime driving, with greater rates of large truck crash fatality and injury per 100 million miles traveled than nighttime driving (see Figure 8). Other data sources appear to substantiate this as well. The FMCSA-sponsored Large Truck Crash Causation study found that only 28 percent of large truck crashes occurred between 6 p.m. and 6 a.m., and those that did had the fewest critical factors attributed to the truck driver. In a 2008 naturalistic driving study, Virginia Tech also documented this phenomenon by comparing critical safety events by truck drivers in night- versus day-time periods. In that research, incident rates were lowest during night-time driving and highest during the afternoon rush hour.

26 The full text can be found online at: https://www.congress.gov/bill/113th-congress/house-bill/83/text
Finally, from a modeling perspective, calculations generated by Knipling and Bocanegra\(^{30}\) estimated that a 65 percent reduction in serious crash risk could be experienced by shifting vehicles from the highest crash risk period – daytime driving between 5:00 a.m. and 2:59 p.m. – to the lowest crash risk period, nighttime driving between 4:00 p.m. and 1:59 a.m.

Consequently, ATRI undertook this Analysis #2, recognizing that adequate MCMIS data likely existed for a statistical analysis of truck crash data both pre- and post-implementation date. Prior to Analysis #2, ATRI researchers developed several suppositions and hypotheses, including:

- Since Analysis #1 results identified a decrease in Monday operations, Monday crashes would also see a requisite decline.
- Truck-involved fatalities would decrease during daytime hours since vehicle speeds would be reduced; however, injuries and towaways would increase due to increased traffic exposure.
- While the research team originally assumed that truck crashes of all types would decrease on weekends due to less overall activity and less vehicle exposure, Analysis #1 hints that weekend crashes would increase.

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3.1 Methodology

Data for this analysis were downloaded from FMCSA’s Analysis & Information (A&I) Online web site, using the Crash Query Tool. Specifically, data for all crashes involving large trucks of carriers domiciled in the United States were downloaded for the time frame of one year prior to July 1, 2013 and one year after and including July 1, 2013. In addition to including the day of the week of the crash, each crash report included the time of the crash and an indication if fatalities, injuries, and/or a towaway occurred. Note these data were from the FMCSA Motor Carrier Management Information System (MCMIS) data snapshot as of February 20, 2015.

Data were imported into and analyzed using a SAS statistical software package. Duplicate crash records were removed (for crashes involving multiple commercial vehicles), then chi-square tests were used to determine if there were significant differences in the numbers or types of crashes occurring on different days of the week and/or at different times of the day before and after July 1, 2013. Analyses included: all crashes; fatal crashes; injury crashes; and towaways by day of the week, mornings of the week, nights of the week, as well as specific day comparisons (e.g. Mondays versus all other days and Saturdays versus all other days) among others. In all, approximately 30 separate analyses were conducted, although not all are referenced and discussed in this Tech Memo.

For reference:

- The definition for “morning” is 6:00 a.m. to 8:59 a.m., and “nighttime” is defined as 1:00 a.m. to 5:00 a.m.
- Analyses that use “pre-“ and “post-“ are referencing crash or time data from pre-July 1 HOS change, and post-July 1 HOS change, respectively.
- P-value calculations are listed in parentheses following relevant chi square metrics.

3.2 Findings: Analysis #2

ATRI initially assessed a six-month pre-July 1, 2013 dataset and a six-month post-July 1, 2013 crash dataset to determine if any statistically significant trends warranted the expanded data analysis, particularly in reference to the suppositions and hypotheses listed above.

- As expected, post-July 1 there was not a statistically significant increase in truck-involved fatalities across all-days for the six-month period, but there was a statistically significant increase in injuries (.0002) and towaways (.0001).

31 The website can be accessed at: http://ai.fmcsa.dot.gov
Predicated on the six-month findings, ATRI then assessed a full 12 months of pre- and post-July 1 data, and similar findings were derived.

- Using 12 months of pre-/post- data, again there was no statistically significant increase in truck-involved fatalities across the all-days bin, but increases continued for injuries (.0124) and towaways (.0001).
- Drilling into more detail, post-weekdays saw no significant increase in fatalities, but injury crashes increased (.0227) as did towaways (.0081).

Since it was hypothesized that towaway crashes would increase due to increased vehicle interactions (albeit at lower speeds) the towaway data were further investigated (See Appendix A).

- Towaways for the all-days bin increased (.0001), but this was driven by the increases experienced on Sundays, Mondays, Tuesdays, and Saturdays.
- Towaways for the all-mornings bin increased (.0102), but much of the effect is associated with towaway increases on the mornings of Sundays, Mondays, Tuesdays, and Saturdays.
- The weekend towaway increases cannot be overlooked; increases were significant for both weekend all-day bins (.008), and weekend mornings (.0065) when compared to their weekday counterparts.

When weekend crashes were assessed both pre- and post-July 1 against pre-/post-weekdays, unexpected results included:

- Significantly higher injury crashes (.022) and towaway crashes (.008) on post-July 1 weekends. When Sunday morning crashes (pre- to post-) are compared to Monday morning crashes (pre- to post-), Sunday morning fatalities experienced a statistically significant (.031) increase of 74 percent.

In reference to the “Monday Effect” where truck activity decreased according to the GPS data:

- The analysis did document a three percent decreased likelihood of a crash on a post-July 1 Monday versus (i.e. relative to) any other weekday.
- However, in simply comparing pre- Mondays to post- Mondays, the all crash-type bin is statistically higher (.0015), climbing 2.8 percent.
- Assessing towaways on pre- versus post- Monday mornings, seems to corroborate the original supposition that Monday mornings would experience truck travel increases and, hence, towaway crashes. Yet the findings of Analysis #1 show that truck activity was down considerably on Mondays. So this significant increase in post-July 1 Monday towaways may reflect a dramatically higher relative crash risk factor for Monday mornings now (i.e. higher crash risk for the smaller volume of Monday trucks).
When looking at pre- vs post- crashes by individual days for the entire week, the following crash increases were found to be statistically significant (See Appendix B):

**Pre-/Post- Mondays**
- All-crashes on Mondays were up 2.8 percent after July 1, 2013 (.0015).
- Towaway crashes were up 3.7 percent (.0017).
- Injury crashes that occur on Mondays increased pre- to post-July 1 from 16.97 percent to 18.28 percent.

**Pre-/Post- Tuesdays**
- All-crashes were up by 2.2 percent (.012).
- Towaways were up 3.1 percent (.007).

**Pre-/Post- Saturdays**
- All-crashes increased by 3.9 percent (.0037).
- Towaway crashes increased 5.7 percent (.0016).

**Pre-/Post- Sundays**
- Injury crashes on Sunday (pre- to post-) increased 6.3 percent (.0364).
- All-crashes were significant (.0011) with the Sunday morning crashes increasing 19 percent when compared to all other morning crashes.
- Sunday morning injury crashes significantly increased 28 percent (.0097) when compared to all other morning injury crashes.
- Sunday morning towaways increased 13.3 percent.
- When compared to Monday mornings, Sunday morning fatal truck crashes were up 74 percent (.0310).
- When compared to Monday mornings, Sunday morning injury crashes are up 22 percent (.025).
4.0 CONCLUSIONS

In summary, overall crashes increased post-July 1, 2013 and certain statistically significant changes and shifts occurred, ostensibly due to some effect associated with implementation of the 34-hour restart provisions.

When the data findings of Analyses #1 and #2 are juxtaposed with other resources, several interesting concepts arise relating to the direct and indirect impact of the July 1, 2013 regulation on truck operations and safety. ATRI researchers interviewed five industry executives (representing Truckload, Less-than-Truckload, and Specialized, along with commercial drivers), and asked that they review the data and provide anecdotal guidance and interpretation of the results. Several theories and explanations follow.

Drivers are Reverting to Use of Rolling Recap for Calculating Available Hours

Based on the decrease in Monday truck activity and the moderate shift of crashes to the second part of the week, there is some indication that drivers may be decreasing or eliminating their use of the 34-hour restart and instead reverting back to the use of the “rolling recap” for compliance. Using the rolling recap, drivers calculate available on-duty hours for the current day based on their combined on-duty time over the previous six or seven days (depending on which weekly schedule they use). The move by drivers away from use of the 34-hour restart to the rolling recap essentially negates any safety benefit that FMCSA purported the industry would experience with use of the restart provisions.

Expanded Use of Weekend Productivity

One industry executive noted “productive, efficient drivers will find ways to maintain productivity in light of losing a night of driving, and weekends are good alternatives.” The motivation behind such a shift was identified in previous ATRI research, whereby both carriers and drivers indicated a loss of productivity and/or pay impacts resulting from the rule changes (see Figures 9 and 10).

32 Drivers using the rolling recap simply follow the 70-hour/8-day or 60-hour/7-day regulation without taking restarts. If a driver operating under the 70-hour/8-day schedule has been on-duty for a total of 65 hours in the previous 7 days, then he/she may only be on-duty for 5 hours on the 8th day. If that driver remains off-duty from that point forward for 7 full days, the driver will have used no on-duty time on the 8th day and will therefore have a full 70 hours available for the next 8 days.
Figure 9: Driver Survey: Pay Impact Associated with Restart Rule

- 67.4% have decreased pay
- 24.7% have pay that is unchanged
- 15.7% have decreased pay by 1 to 5%
- 19.4% have decreased pay by 5 to 10%
- 15.8% have decreased pay by 10 to 15%
- 16.5% have decreased pay by 15% or more
- 7.1% are uncertain

Figure 10: Carrier Survey: Productivity Impacts Associated with Restart Rule

- 9.1% no answers applicable
- 15.0% we have had to purchase more tractors
- 11.9% we have had to purchase more trailers
- 80.1% our company has lost productivity
- 49.9% our company requires more drivers to haul the same amount of freight
- 22.7% we have raised driver pay to attract new drivers and to keep the ones we have

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34 Ibid.
Based on the post-July 1 increase in truck activity on Fridays and Saturdays in particular, it appears that drivers have shifted schedules and drive-time activity has moved into early weekends. While Sunday data has decreased considerably, Saturday activity – including early Sunday mornings – is up dramatically. The safety impacts from this new Saturday activity can be seen in the statistically significant increases in all-crashes and towaways. Injuries also increased on Saturdays albeit it with a p-value = 0.25.

While the data show dramatically more use of Saturday driving, the decrease in Sunday activity hints that the Expanded Weekend theory is only a partial explanation of activity and crash shifts.

*Earlier Weekend Start-Times*

A second weekend-related theory is that drivers are starting trips earlier on Sundays or even moving trip starts to Saturdays. Since the truck GPS data for “Saturday night” included Sunday mornings up to 5 a.m. it appears to be a plausible explanation for some or all of the activity and crash impact. Further, at least two carrier reviewers noted that their dispatching centers were actively increasing earlier weekend starts, in response to the new rules, to ensure that Monday and Tuesday operations were not delayed.

*Reducing Early Week Hours*

Both the data and carrier commentary seem to indicate that drivers may be decreasing driving hours earlier in the week and increasing them on Thursdays, Fridays and Saturdays. By reducing early week driving hours, drivers may be able to position themselves to get home on some or all of the weekend. This scenario more likely favors those drivers who utilize the rolling recap.

*Larger Fleets Impacted More*

It was speculated that many owner-operators and smaller fleets have shifted to the rolling recap in greater numbers than larger fleets to ensure continued nighttime (and weekend) driving. If that were true, the data may conclude that higher crash rates and crash risk exists for those fleets who currently under-utilize nighttime driving and weekends or focus primarily on weekday / daytime driving schedules.

*Entry Level Driver Impact*

Upon review of carrier hiring data between 2013 and 2015, it is apparent that the driver shortage crisis is driving more carriers to hire entry-level drivers in large numbers. Several carriers had increased their annual percentage of entry-level drivers by 10 percent or more.
While the impact that entry-level drivers (those with one year or less of driving experience) had on overall crash rates is both real and considerable – based on both research and the carrier-provided data – there is no basis to conclude that stable and continuous hiring of entry-level drivers over the last three years would create the pre- / post-July 1 2013 significance levels that were identified. However, ATRI is now attempting to disaggregate crash data by experienced versus entry-level drivers to understand the magnitude of the entry-level crash rate effect on the overall crash data set.
5.0 NEXT STEPS

The data and analyses presented in this paper appear to support the contention that the July 1 2013 restart rule did, in fact, have the outcome intended by FMCSA; that being the shift of truck trips from nighttime driving to daytime driving. However, the unintended consequence of higher numbers of crashes at other points in the driving schedule also appears to have occurred.

What is presently not known is whether the net direct costs of the post-July 1 crashes are higher than any ostensible benefit that might be associated with the driving shifts described herein.

As noted in an earlier HOS report published by ATRI in 2014:\textsuperscript{35}

\begin{quote}
“Assuming the new restart rule caused CMV drivers to convert only 10 percent of nighttime miles to daytime miles, this would equate to a net increase of 237 large truck crashes (17 fatal and 220 injury). If 30 percent of the nighttime miles (12 a.m. – 6 a.m.) shifted to the daytime morning period (6 a.m. – 12 noon), there would be an estimated net increase of 712 large truck crashes (53 fatal and 659 injury).\textsuperscript{36}
\end{quote}

Based on the driving shifts and resulting safety impacts documented in this Tech Memo, ATRI intends to work with industry researchers and stakeholders to develop a methodology and analysis framework for calculating the net direct costs based on increased crash risk.


\textsuperscript{36} ATRI estimated the change in crashes using a combination of MCMIS crash data and estimates of truck GPS volume by time of day. Crashes by time of day were determined using fatality and injury crash data for large trucks from the 2011 MCMIS crash file. ATRI determined truck volume distribution by time of day using its national database of truck probe data, which is based on GPS data from 500,000+ large trucks. ATRI then applied the distribution of the GPS data by time of day to FHWA estimates of total truck vehicle miles traveled (VMT) to determine national truck volume by time of day. Total crashes were divided by VMT to calculate crash rates by time of day. For the 10 percent and 30 percent shift scenarios, VMT from the overnight hours (12am-6am) was shifted ahead 6 hours and a projected number of crashes was calculated based on the existing crash rates and the new VMT by time of day.
Several additional analyses have arisen from the findings in this Tech Memo which ATRI will explore next.

Table 2: Summary of Conclusions and Next Steps

<table>
<thead>
<tr>
<th>Conclusion</th>
<th>Next Steps</th>
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</table>
| Drivers may be reverting to use of the rolling recap rather than utilizing the 34-hour restart. | 1) ATRI will examine driver use of the rolling recap post-July 1, 2013 through an analysis of its extensive database of 40,000+ commercial driver logs. ATRI’s driver logbook database contains logs from January 1, 2012 – December 31, 2014.  
2) ATRI is talking with fleets and driver groups about creating a knowledge test to assess both the use of the restart as well as driver understanding and accuracy of the rule's application.  
3) ATRI is also proposing to map traditional pick-up and delivery schedules by sector and commodity, and overlay different driving schedule regulations to assess “reasonableness of fit.” |
| Fleets and drivers may be moving dispatches and drive times to earlier in the weekend to mitigate the impact of the 34-hour restart restrictions and provide the fewest disruptions to weekday pick-up and delivery schedules. | ATRI will collect and assess fleet policies and schedules to determine if and how dispatching schedules have changed. This activity will also assess the root cause for any formal or informal changes in routing and dispatching. |
| Drivers may be driving fewer hours during the first part of the week but increasing driving hours later in the week. | ATRI will work with carriers and truck driver groups to collect and assess qualitative data on why drivers have shifted driving hours to later in the week. |
| Larger fleets may be experiencing higher safety risks from the 34-hour restart changes due to their continued use of daytime and weekday driving schedules. | ATRI is attempting to design a data methodology that cross-references carrier size, driving schedules and crash rates. Secondary variables may or may not include employee vs leased drivers. The goal is to identify primary driver scheduling regimen by fleet size |
| Entry-Level Driver Impacts on Crash Data                                  | ATRI is working with carrier data to stratify and distinguish crash rates between experienced and entry-level truck drivers. |
APPENDIX A

All Towaway Crashes by Day of the Week

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<th>Friday</th>
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Chi-Square = 42.2434, Prob. <.0001

The percentage of towaway crashes increased on Sundays, Mondays, Tuesdays, and Saturdays in the one-year period after 7/1/2013.

All Towaway Crashes by Mornings* of the Week

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* Morning is defined as 6:00 a.m.-8:59 a.m.

Chi-Square = 16.7497, Prob. = 0.0102

The percentage of morning towaway crashes increased on Sundays, Mondays, Tuesdays, and Saturdays in the one-year period after 7/1/2013.
APPENDIX B

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### Statistics for Table of Cat1 by Cat2

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Row Pct Col Pct

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## Statistics for Table of Cat1 by Cat2

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