The Relationships between obesity, obstructive sleep apnea and commercial motor vehicle operator performance

Jennifer Ann O'Neil

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THESIS:
The Relationships between Obesity, Obstructive Sleep Apnea and Commercial Motor Vehicle Operator Performance

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Abstract:

Obesity and Obstructive Sleep Apnea will impair Commercial Motor Vehicle operator performance. Obesity will increase the risk of developing serious medical conditions that may cause harm to human health and wellbeing. One condition that can be associated with obesity is known as Obstructive Sleep Apnea. Various symptoms of obstructive sleep apnea will impair a commercial motor vehicle operator’s ability to safely maneuver a vehicle. Many commercial motor vehicle collisions have been caused by operator fatigue and have resulted in serious injury and death. Due to unhealthy lifestyles, commercial motor vehicle operators are at a high risk of being obese. Obesity will increase the risk of developing obstructive sleep apnea. Both obesity and obstructive sleep apnea have an impact on commercial operator performance. Recognizing these relationships and understanding this information can be used to prevent the effects of obesity and obstructive sleep apnea on commercial motor vehicle operator performance.

Literature, statistical analysis, surveys, and interviews confirm the prevalence of obesity in commercial motor vehicle operators. Literature, statistical analysis, surveys, and interviews verify a relationship between obesity and obstructive sleep apnea. Literature, statistical analysis, surveys, interviews, and case studies discuss the relationship between obesity, obstructive sleep apnea and commercial motor vehicle operator performance. Finally all of this information is used to substantiate preventative methods that will minimize or eliminate the detrimental effects of obesity and obstructive sleep apnea on commercial motor vehicle operator performance; furthermore reduce the risk of serious injury and death.
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Acronyms

BMI – Body Mass Index
CDC – Centers for Disease Control
CDL – Commercial Driver’s License
CMV – Commercial Motor Vehicle
CPAP - Continuous Positive Airway Pressure
CSP – Certified Safety Professional
CSRN – Center for Sleep and Respiratory Neurobiology
DFAS – Driver Fatigue and Alertness Study
DOT – Department of Transportation
EDS - Excessive Daytime Sleepiness
FARS – Fatality Analysis Reporting System
FHWA – Federal Highway Administration
FMCSA – Federal Motor Carriers Safety Administration
FNP – Family Nurse Practitioner
HOS – Hours Of Service
LTCCS – Large Truck Crash Causation Study
MPH – Miles Per Hour
NIH – National Institutes of Health
NHTSA – National Highway Transportation Safety Administration
NSTSCE - National Surface Transportation Safety Center for Excellence
NTSB – National Transportation Safety Board
OSA – Obstructive Sleep Apnea
RCA – Root Cause Analysis
REM – Rapid Eye Movement
1. **Introduction**

1.1. **Topic**

Obesity is a term used when body fat accumulates to an amount that is considered unhealthy. Obesity will increase the risk of developing serious medical conditions that may cause harm to human health and wellbeing; such as a condition known as Obstructive Sleep Apnea. Obstructive Sleep Apnea (OSA) is a serious disorder that triggers fatigue-related symptoms. If left untreated, these symptoms will impair a person’s ability to perform routine tasks. More specifically, the symptoms of OSA will deteriorate cognitive ability, impair judgment, slow reaction time, and delay decision making. The following thesis will focus on three primary issues. (1) The prevalence of obesity in Commercial Motor Vehicle (CMV) operators, (2) the relationship between obesity and OSA, (3) and the impact of obesity related OSA on CMV operator performance.

1.2. **Problem Statement**

Due to their unhealthy lifestyles, obesity is a common problem among CMV operators. Being obese raises the risk of developing OSA. The symptoms of OSA will impair driver performance and increase the risk of collision; a collision that may result in serious injury and death. This not only impacts the CMV operator, it impacts everyone on the road.

Although the following scenarios are not directly linked to OSA, the narratives will portray the potential consequences of operating a CMV while experiencing fatigue. Fatigue is a well-known symptom of OSA. All three of the CMV operators described
below had a Body Mass Index (BMI) that was categorized as obese at the time of the collisions.

In February of 2002, a tractor trailer departed the roadway, jackknifed and rolled over. The collision resulted in the death of the CMV operator. The National Highway Transportation Safety Administration (NHTSA) determined that the probable cause of this incident was fatigue; the driver fell asleep while operating the vehicle (National Highway Transportation Safety Administration, LTCCS Case 2002-078-004). The CMV operator had a BMI of 36.2 and was categorized as obese. Figure 1 shows the condition of the tractor trailer after the collision.

In June of 2002, a passenger motor coach departed the roadway and plummeted down a steep embankment. The motor coach was occupied by 1 operator and 47 passengers. The collision resulted in five fatalities, 7 serious injuries, and 35 minor injuries. The National Transportation Safety Board (NTSB) determined that the probable cause of this incident was fatigue; the driver fell asleep while operating the vehicle (National Transportation Safety Board, HAR 04/03). The CMV operator had a BMI of 33.9, and was categorized as obese. Figure 2 shows the collision site and the vehicle’s final resting position.

In July of 2004, a tractor trailer was traveling approximately 60 miles per hour (mph) when it rear-ended another tractor trailer. The collision resulted in the death of the CMV operator who collided with the other vehicle. The NTSB determined that the probable cause of this incident was fatigue; the driver was in a reduced state of alertness due to inadequate rest (National Transportation Safety Board, HAB 07/01). The CMV operator had a BMI of 33.9.

---

1 BMI Retrieved from the Fatality Analysis Reporting System Encyclopedia
operator had a BMI of 40.5\(^2\), and was categorized as obese. Figure 3 shows the interior cab of the tractor trailer after the collision.

---

\(^2\) BMI Retrieved from the Fatality Analysis Reporting System Encyclopedia
1.3. Purpose

The purpose of this research is to establish relationships between obesity, OSA, and CMV operator performance. Healthier lifestyles will minimize the risks associated with obesity and OSA; furthermore, improve driver performance and reduce the risk of serious injury and death. The information obtained from this research will be used to establish methods of prevention.

1.4. Focus

The focus of this research will be to answer the following questions:

- Is obesity prevalent among CMV operators?
- Is there a relationship between Obesity and OSA?
- Does obesity and OSA have an impact on CMV operator performance?
- How can CMV operators prevent the risks associated with obesity and OSA?
1.5. Terminology

Apneas: A term for the pauses or gaps in breathing.

Barriers: In RCA this refers to a physical device or organizational/governmental control used to reduce the risk of an undesired outcome. For example, the hours of service (HOS) regulations that control the amount of time commercial motor vehicle operators spend on the road.

Body Mass Index (BMI): A measurement that is calculated by a person’s weight and height. This calculation is used to estimate a healthy body weight.

Casual Factor Tree Analysis: An investigative technique used to display events, conditions, and barriers that occurred during a sequence of events that lead to an undesired outcome.

Centers for Disease Control (CDC): According to their website, the CDC is a website managed by the National Center for Health Marketing. The website provides credible health information diseases, emergencies, healthy living, injuries, and much more.

Commercial Driver’s License (CDL): A class of license that is required to operate a vehicle with a gross weight of 26,001 pounds or over. This includes, but is not limited to, straight trucks, tractor trailer combinations, and passenger motor coaches.

Commercial Motor Vehicle (CMV): A vehicle with a gross vehicle weight rating of 26,001 or more pounds; a vehicle designed to transport 16 or more passengers (including driver); any vehicle transporting hazardous materials which is required to be placarded. This includes, but is not limited to, straight trucks, tractor trailer combinations, and passenger motor coaches. In some circumstances a vehicle with a gross vehicle weight rating of 10,001 or more pounds may be considered a CMV.
Condition: In RCA this is any circumstance related to the event. This may or may not have an impact on the event. For example, a CMV operator’s health condition that contributes to a motor vehicle collision.

Continuous Positive Airway Pressure (CPAP) – A device used by patients for the treatment of sleep apnea.

Daytime Symptoms: The symptoms of Obstructive Sleep Apnea that are experienced during the hours the person is awake. These symptoms include, but are not limited to, fatigue and sleepiness.

Degree of Obstructive Sleep Apnea: The extent to which a person is suffering with the condition. This ranges from mild to moderate to severe. The more severe the apnea the more apnea episodes the person will experience.

Department of Transportation (DOT): According to their website, the DOT is a governmental organization that was designed to ensure safe, efficient, and accessible transportation systems. These systems shall meet national interests and enhance the quality of American life.

Event: In RCA this refers to an occurrence or action which results in or contributes to an undesired outcome. This can be a human error or mechanical failure. For example, a vehicle struck another vehicle.

Excessive Daytime Sleepiness (EDS): Persistent sleepiness and lack of energy that may cause sudden, involuntary sleep.

Fatality Analysis Reporting System (FARS) - FARS is an online encyclopedia that provides statistics on motor vehicle crashes in the United States. This data represents
crashes that occurred on a public roadway and involved at least one fatality. A query tool allows users to select multiple variables.

**Fatigue:** Weariness and weakening from physical exertion or a physical disorder. For the purpose of this thesis fatigue will be defined as drowsiness, sleepiness, and falling asleep while performing daytime activities.

**Federal Motor Carrier Safety Administration (FMCSA):** According to their website, the FMCSA is an administration within the United States Department of Transportation. Their mission is to reduce crashes, injuries, and fatalities that involve large trucks and buses.

**Hours of Service (HOS):** Transportation laws documented in the Code of Federal regulations (CFR). These regulations are designed to limit the amount of time drivers can operate a CMV. This is to ensure CMV drivers are receiving the appropriate amount of sleep to safely operate the vehicle.

**Jackknife:** The accidental folding of a vehicle with a pivoting joint in its construction. For example a tractor trailer combination unit.

**Motor Carrier:** An individual, partnership, or a corporation that is engaged in the transportation of good

**National Highway Transportation Safety Administration (NHTSA):** According to their website, the NHTSA is an administration within the United States Department of Transportation. Their mission is to save lives, decrease injuries, and reduce the economic costs associated with motor vehicle collisions.

**National Transportation Safety Board (NTSB):** According to their website, the NTSB is an independent Federal agency that is in charge of investigating significant accidents in
various modes of transportation. The NTSB determines the probable cause of accidents and issues recommendations aimed to prevent future accidents.

**Obesity:** A body weight that is considered unhealthy for a given height.

**Obstructive Sleep Apnea:** A sleep disorder caused by a physical blockage in air flow. This obstruction interrupts breathing while a person is sleeping.

**Root Cause Analysis (RCA):** An investigative method used to identify the underlying explanation for an event that lead to an undesired outcome. This type of analysis can be used to implement change and take preventative steps for the future.

**Sedentary Lifestyle:** A lack of physical exercise

**Sleep Debt:** An accumulation of the need for sleep which is typically caused by not receiving sufficient rest during the night.

**Sleep Insights:** A medical clinic that provides diagnostic testing and treatment for sleep disorders.

**Sleep Study:** Also known as a polysomnogram. This is a test that is used to diagnose sleep disorders and is performed while the patient is asleep.

**Standard Operator:** A driver who is not qualified to operate a motor vehicle that is greater than 26,000 pounds.

**Vehicle Related Collision:** a collision that resulted from the mechanical failure of the commercial motor vehicle and was not considered being a direct liability of the operator, for example failure of the vehicle brakes.
2. Background

In recent years, obesity has become a growing concern. Larger food portions, unwholesome choices, and physical inactivity encourage the epidemic of obesity. Between 2005 and 2006, it was estimated that 32.7% of adults\(^3\) in the United States were categorized as overweight, 34.3% were categorized as obese, and 5.9% were categorized as extremely obese (Centers for Disease Control and Prevention, Overweight and Obesity). Obesity is a serious problem. Health risks increase in conjunction with increasing weight. Obese Americans are at risk of developing OSA. This condition affects up to 18 million Americans; it estimated 10 million of these people have never been diagnosed with the condition (American Association for Respiratory Care 2004).

Similar to the general public, obesity and OSA are growing concerns for CMV operators. The unhealthy lifestyle of a CMV operator increases the risk of obesity. Obesity increases the risk of developing OSA. The symptoms of OSA increase the risk of a motor vehicle collision (Wiegand et al 2009). Although it is difficult to calculate the magnitude of this problem, studies suggests CMV operators with obesity-related OSA are at a greater risk of being involved in a motor vehicle collision that may result in injury and/or death.

In 1995, Stoohs et al. conducted a study to determine the prevalence of sleep-disordered breathing among CMV operators. This study is referred to as Stoohs Study. Stoohs study discovered a high rate of sleep-disordered breathing among CMV operators. It also discovered that the prevalence of sleep-disordered breathing had a direct relationship with the frequency of collisions (Stoohs 1995).

\(^3\) In this section, “adults” are defined as individuals who are 20 years and older.
From 1996 to 1998 the University of Pennsylvania’s Center for Sleep and Respiratory Neurobiology (CSRN) conducted a study to determine a relationship between OSA and CMV operator performance. This study is referred to as The U Penn Sleep Study. Although the study did not find a significant relationship between collision frequency and OSA, it did discover a relationship between OSA and BMI (Barr et al 2004).

The studies above examined the relationships between obesity, OSA, and CMV operator performance. Although the results of these studies differed, they provided knowledge about the problem and strengthened awareness. The following literature review will continue to examine these studies, as well as others, and discuss the relationships between obesity, OSA, and CMV operator performance. This literature review will provide enough information to introduce the thesis research.

3. Literature Review

3.1 Introduction

Unhealthy lifestyles lead to weight gain and weight gain may lead to obesity. Obesity will contribute to the potential development of OSA. The symptoms of OSA will impair a CMV operator’s ability to safely maneuver a vehicle. This will increase the risk of a motor vehicle collision that may result in injury and death. The following review will present information from literature that recognizes the connection between obesity, OSA and CMV operator performance.
3.2 Obesity

3.2.1 Obesity Defined

The Centers for Disease Control and Prevention (CDC) defines obesity as a “range of weight that is generally considered unhealthy for a given height” (Centers for Disease Control and Prevention, Overweight and Obesity). Weight gain typically occurs when caloric intake exceeds caloric expenditure; this imbalance may lead to obesity. In general, Obesity is measured by Body Mass Index (BMI). BMI is a calculated number that reflects both the height and weight of the individual\(^4\). A BMI greater than or equal to 30.0 categorizes a person as obese (Centers for Disease Control and Prevention, Overweight and Obesity). See table 1 for all BMI categories. For the purpose of this thesis, the following information will only consider the problem of obesity in CMV operators.

<table>
<thead>
<tr>
<th>BMI Range</th>
<th>BMI Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 16.5</td>
<td>Severely Underweight</td>
</tr>
<tr>
<td>16.5 to 18.4</td>
<td>Underweight</td>
</tr>
<tr>
<td>18.5 to 24.9</td>
<td>Average</td>
</tr>
<tr>
<td>25.0 to 29.9</td>
<td>Overweight</td>
</tr>
<tr>
<td>30.0 to 34.9</td>
<td>Obese</td>
</tr>
<tr>
<td>35.0 to 40.0</td>
<td>Excessively Obese</td>
</tr>
<tr>
<td>Above 40.0</td>
<td>Dangerously Obese</td>
</tr>
</tbody>
</table>


3.2.2 Obesity in CMV Operators

Obesity is a major problem for CMV operators. The U Penn Sleep Study discovered, out of a sample of 406 CMV operators, 50.3% of the study participants were categorized as obese. Of these obese operators, 40.8% were categorized as excessively

\(^4\) BMI = (Weight (lbs) / Height (in) \(^2\)) \times 703
obese (Barr et al 2004). In 2007, the Journal of American Dietetic Association published a study that discovered similar results. Out of a random sample of 92 CMV operators, 66% of the survey participants were categorized as obese (Jacobson et al 2007). Finally, The National Surface Transportation Safety Center for Excellence (NSTSCE) conducted a study on CMV operator fatigue; referred to as the Commercial Motor Vehicle Health and Fatigue Study. This study discovered, out of a sample of 103 CMV operators, 53.4% of the participants were categorized as obese (Wiegand et al 2009).

Based on the information above, obesity seems to be a significant problem for CMV operators. In general, CMV operators do not eat healthy and live sedentary lifestyles. According to Health and Wellness Programs for Commercial Drivers, Kruger defines a sedentary lifestyle “as one in which a person exercises less than once per week” (2007). There are many reasons why CMV operators are susceptible to obesity. (1) Restaurant selections are limited; truck and rest stops are typically the only eateries that allow long-term, large vehicle parking (Jacobson et al 2007). (2) At these eateries, the quality of the food is poor, the choices are inadequate, and the portions are very large (Wiegand et al 2009). (3) CMV operators have irregular eating schedules; this causes them to snack on junk foods throughout the day (Jacobson et al 2007). (4) CMV operators are exposed to long periods of inactivity; they do not exercise regularly. The Transportation Research Circular reported that only about 10% of CMV operators engage in aerobic activity; and operators believe that this estimate is high (Kruger 2007). (5) Overloaded driving schedules do not allow operators enough time to get out of the truck and engage in regular exercise (Wiegand et al 2009).
3.2.3 Summary

Is obesity prevalent among CMV operators? The information above is consistent with the argument that CMV operators are at a greater risk of being obese than standard drivers. This statement can be made because CMV operators, unlike standard operators, are inherently exposed to unhealthy lifestyles. The research described in the Findings and Results section will expectantly confirm this assumption.

3.3 Obstructive Sleep Apnea (OSA)

3.3.1 Obstructive Sleep Apnea Defined

The National Institutes of Health (NIH) defines Obstructive Sleep Apnea (OSA) as “a condition in which a person has episodes of blocked breathing during sleep” (MedLine Plus, Obstructive Sleep Apnea). A person suffering from OSA will literally stop breathing for a period of 10 or more seconds because the relaxed throat muscles will block the airway. The pauses in breathing are referred to as apneas (MedLine Plus, Obstructive Sleep Apnea). See figure 4 for an illustration of the constricted airway of OSA. OSA can be characterized by loud snoring, irregular breathing, snorts, gasps, and paused breathing while asleep (Pascualy 2008). OSA does not target a specific age, gender, or occupation. It is a widespread condition with various causes. There are many factors that will increase the risk of developing OSA. One significant factor is obesity (National Sleep Foundation, Obstructive Sleep Apnea). For the purpose of this thesis the following information will explain the relationship between obesity and OSA.
3.3.2 Obesity and Obstructive Sleep Apnea

Obese people are more susceptible to OSA. This is largely due to the narrowing of the upper airway. This narrowing is often caused by widening of the neck area, and the accumulation of fat in the lining of the airway (National Sleep Foundation, Obstructive Sleep Apnea). The U Penn Sleep Study discovered 35.9% of the study participants were diagnosed with sleep apnea. Of these participants, 30.7% were categorized as obese and 40.1% were categorized as excessively obese. The average BMI for participants diagnosed with OSA was determined to be 34.2; this was compared to an average BMI of 29.1 for the participants without OSA (Barr et al 2004). In 2004, the *American Journal of Respiratory and Critical Care Medicine* published a journal regarding a study that encompassed the risk factors of sleep-disordered breathing in CMV operators. This study discovered, out of 161 CMV operators who underwent a sleep study, 59.7% of the participants were diagnosed with some degree of sleep-disordered breathing; of these 41.6% were categorized as obese. The high prevalence of sleep disordered breathing can be attributed to the pervasiveness of obesity (Howard et al 2004).
3.3.3 Summary

Is there a relationship between obesity and OSA? The information above is consistent with the argument that obese CMV operators are at a high risk of developing OSA. This statement can be made because, due to the lifestyle, CMV operators are at risk of being or becoming obese. Due to the anatomy of the throat, obesity is a significant contributor to the development of OSA. The research described in the Findings and Results section will expectantly confirm this assumption.

3.4 Obesity, OSA and CMV Operator Performance

3.4.1 Symptoms of OSA

The daytime symptoms of OSA will impair a CMV operator’s ability to safely maneuver a CMV; this increases the risk for motor vehicle collisions that may result in injury and death. The daytime symptoms of OSA are difficult to diagnose; they are misunderstood and unique to each individual. For the purpose of this thesis the following information will only consider the symptoms that are recognized during the daytime, or wakeful, hours. Also, the symptoms discussed below will be specific to those symptoms that impair CMV operator performance.

3.4.1.a Excessive Daytime Sleepiness

Excessive daytime sleepiness (EDS) is a prominent symptom of OSA. EDS is the result of insufficient sleep. Disordered breathing leads to interruptions in sleep. After awhile, the accumulation of inadequate rest will result in a sleep debt (Pascualy 2008). A sleep debt creates a constant need for sleep. Eventually, the human body will demand it; this will have serious consequences on a person’s judgment and reaction time (National Institute of Neurological Disorders and Stoke, Understanding Sleep). EDS is difficult to
recognize. In 2009, the *American Family Physician* published an article regarding a study on the subjective evaluation of sleepiness. This study discovered people with EDS are typically more tired than they realize (Pagel 2009). EDS may result in a person unwilling and unknowingly falling asleep while performing routine activities; for example, a person suffering from EDS may fall asleep while operating a motor vehicle (Pascualy 2008).

3.4.1.b Fatigue

Fatigue is another major symptom of OSA. The NIH defines fatigue as “a lack of energy and motivation” (2009). Fatigue can usually be divided into two categories, normal fatigue and chronic fatigue. Normal fatigue is the body’s natural response to physical activity, stress, and lack of sleep. Chronic fatigue is a pattern of perpetual exhaustion that may be a sign of an underlying medical disorder (MedLine Plus, Chronic Fatigue Syndrome). Chronic fatigue cannot be alleviated with rest and may lead to muscle pain, weakness, confusion, and impaired mental ability (Centers for Disease Control and Prevention, Chronic Fatigue Syndrome). Similar to EDS, chronic fatigue is difficult to recognize; it is often believed to be a normal sign of aging (Pascualy 2008). In 2003, the FMCSA and the NHTSA completed a three year study that examined the various reasons for large vehicle collisions; it is referred to as the Large Truck Crash Causation Study (LTCCS). This study estimated, out of 963 CMV collisions, 13% of these collisions were related to driver fatigue (Federal Motor Carrier Safety Administration, LTCCS Summary).

3.4.1.c Loss of Alertness

Loss of alertness is a decrease in consciousness and/or a reduced level of awareness (Medline Plus, Consciousness - Decreased). Similar to both EDS and fatigue,
loss of alertness can be difficult to recognize. In 1996, the Federal Highway
Administration (FHWA) completed a study on CMV operator fatigue and alertness; it
was referred to as the Driver Fatigue and Alertness Study (DFAS). This study discovered
CMV operators had difficulty evaluating their own levels of alertness; the level of
performance was much poorer than the participants’ self-assessments (Federal Motor
Carrier Safety Administration, DFAS). Loss of alertness will make it difficult for an
operator to concentrate and will quickly deteriorate performance; this may lead to motor
vehicle collisions (Pascualy 2008).

3.4.2 Impaired Performance

The symptoms of obesity related OSA will impair CMV operator performance. People suffering from OSA are 3 times more likely to be involved in a motor vehicle collision (American Association for Respiratory Care 2004). Between 20-30% of all CMV collisions are related to sleep; meaning these collisions are determined to be the result of the CMV operator falling asleep at the wheel or driving while fatigued. The degree of risk is similar to that of using a cellular phone while operating a vehicle (Howard et al 2004). The consequences of fatigued driving are comparable to driving while under the influence of alcohol (Federal Motor Carrier Safety Administration, DFAS).

When compared to people without OSA, the Commercial Motor Vehicle Health
and Fatigue Study discovered OSA participants performed worse on driving vigilance
tests; this was primarily because the OSA participants were found to have significant
delays in reaction time and difficulty concentrating (Wiegand et al 2009). The U Penn
Sleep Study discovered CMV operators with a severe form of OSA were 4.6 times more
likely to be involved in a severe motor vehicle collision\(^5\) than CMV operators without OSA (Barr et al 2004). One of the most notable concerns regarding OSA and operator performance is the degree of difficulty in recognizing the symptoms. Performance will begin to degrade long before the CMV operator becomes aware he/she is suffering from these symptoms.

**3.4.3 Summary**

Does obesity and OSA have an impact on CMV operator performance? The information above is consistent with the argument that obesity-related OSA will impair CMV operator performance. This statement can be made because the symptoms of OSA may cause EDS, fatigue, and loss of alertness. These symptoms will impair the ability of a CMV operator to maneuver a vehicle safely. This will increase the risk of a CMV collision; a collision that may result in injury and death. The research described in the Findings and Results section will expectantly confirm this assumption.

**3.5 Prevention and Treatment**

**3.5.1 Prevention and Treatment Defined**

Awareness is crucial in preventing and treating obesity related OSA; recognizing the problem is a critical component in preventing and treating the symptoms that impair operator performance. For the purpose of this thesis the following information will consider proactive prevention through behavior modifications and lifestyle changes. This section will also discuss the importance of properly treating OSA if the condition cannot be prevented.

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\(^5\) In this study a “severe collision” was defined as a collision that resulted in multiple injuries and a towed vehicle.
3.5.2 Prevention

3.5.2.a Diet and Exercise

The key to maintaining a healthy weight is about a healthy lifestyle. This lifestyle includes proper nutrition and regular physical activity. Diet and exercise are good for health and reduce the risk of developing many diseases (Centers for Disease Control and Prevention, Division of Nutrition, Physical Activity and Obesity). As mentioned previously, there are many barriers that make it difficult for CMV operators to eat healthy and exercise while on the road. One study discovered that overweight and obese CMV operators are concerned with eating healthier and would like to have more nutritional food options at truck/rest stops (Jacobson et al 2007). Another study discovered that CMV operators were interested in having microwaves and refrigerators in the vehicle. The microwaves and refrigerators would allow them to prepare healthier meals while on the road (Wiegand et al 2009). The same study also discovered that CMV operators believed motor carriers should be more flexible with driving schedules. This would allow CMV operators time to get out of the vehicle and regularly engage in physical activity (Wiegand et al 2009).

3.5.2.b Health and Wellness Programs

CMV operators are not alone in the effort to promote healthier lifestyles. There are many programs available that encourage healthier living. Motor carriers have supported health and wellness programs to motivate CMV operators to improve their lifestyles. These programs are designed to motivate, encourage, support, and assist CMV operators to live healthier (Wiegand et al 2009). One example of a health and wellness program was created by the FMCSA and is referred to as the Gettin’ in Gear Wellness
Program. This pilot program was developed to raise health awareness and interest within the transportation industry. The program consisted of 54 participants. These Participants received information on healthy eating habits and the benefits of exercise. Overall, the participants enjoyed being involved in this program and found value in being aware of their personal health (Federal Motor Carrier Safety Administration, Design, Development, and Evaluation of Truck and Bus Driver Wellness Program).

3.5.3 Treatment

3.5.3.a General Overview

Not all instances of obesity related OSA can be prevented. If symptoms of OSA are recognized, the CMV operator should seek medical advice. Diagnosis begins with a sleep study referred to as a polysomnogram. A polysomnogram is a non-invasive, painless procedure that can be used to verify a sleep disorder, such as OSA. Physiological activity, such as brain waves and breathing, are measured via electrodes affixed to the skin (National Sleep Foundation, Sleep Studies). An initial sleep study is typically conducted to establish a diagnosis, then a second sleep study is performed to ensure the treatment is effective (Pascualy 2008).

The most common type of treatment is referred to as the Continuous Positive Airway Pressure (CPAP). A CPAP is a breathing device that holds the airway open during sleep. This device consists of a mask that is worn over the nose and/or mouth and a pump to deliver a continuous supply of pressurized air (Pascualy 2008). Although CPAP users experience an adjustment period attributed to wearing a mask while sleeping, this therapy is almost 100% effective and will eliminate the symptoms of OSA. CPAP therapy is generally preferred over surgical treatment (National Sleep Foundation, Sleep
Studies; Pascualy 2008). Surgery may be considered if CPAP devices do not effectively treat OSA. Surgery will remove tissue in the upper airway to allow a greater area for air to flow through (National Sleep Foundation, Obstructive Sleep Apnea and Sleep). Obesity related OSA can also be treated by making appropriate lifestyle changes such as a healthy diet and exercise. These lifestyle changes will help a person lose weight, open the airway, and eliminate the need for further treatment (Pascualy 2008).

3.5.3.b Undiagnosed/Untreated OSA

Undiagnosed or untreated sleep apnea is potentially the most serious situation associated with OSA. The Cambridge Health Alliance performed a study on drivers who suffer from OSA. The study consisted of 53 truck drivers who were referred to sleep studies. Thirty-three drivers ignored the sleep study referral. Twenty drivers complied with the sleep study referral and were confirmed to have OSA and only 1 of these 20 drivers sought treatment (Parks et al 2009). When sleep disorders, such as OSA, are left undiagnosed and/or untreated, drivers are at a much greater risk for motor vehicle collisions (White et al 2002). Untreated and undiagnosed OSA will contribute to daytime sleepiness, fatigue, and loss of alertness. These symptoms will progressively worsen as time passes. This presents an even greater risk of falling asleep behind the wheel and may result in life-threatening consequences to the driver and all others on the road (Gertler 2002).

3.5.4 Summary

How can CMV operators prevent the risks associated with obesity related OSA? The information above suggests ways CMV operators can prevent the risks associated with obesity related OSA. It can be assumed that awareness is the best method of
prevention; once recognized, behavior modifications and lifestyle changes can prevent the onset of obesity related OSA. If this condition cannot be prevented, treatment is essential. Minimizing and eliminating the symptoms of obesity related OSA is the only way to prevent the risks associated with the condition.

3.6 Conclusion

Based on the information in this literature review, the following assumptions can be made. (1) CMV operators are at a greater risk of being obese than standard drivers. The lifestyle of a CMV operator limits the types of foods they eat and the amount of physical activity they receive. (2) CMV operators are at risk of developing OSA because they are generally obese. Obesity is a significant contributor to the development of OSA. Since CMV operators are at a greater risk of being obese, they are also at a greater risk of developing obesity related OSA. (3) Obesity related OSA does have an impact on CMV operator performance. The daytime symptoms of OSA jeopardize the CMV operator’s ability to safely maneuver a vehicle. (4) Awareness is an essential part of the prevention and treatment of obesity related OSA. Lifestyle changes can prevent its onset and treatment can eliminate the symptoms.

4. Methodology

4.1 Problem Restatement

Obesity and OSA are growing concerns in the transportation industry. In general, CMV operators live unhealthy lifestyles. This increases the risk for obesity. Gaining weight will narrow the passages of the upper airway and cause airflow to be constricted when sleeping. This may cause the person to stop breathing for short periods of time. These pauses in breathing lead to a poor quality of sleep. Inadequate sleep will generate
daytime symptoms that will impair a CMV operator’s ability to safely maneuver a motor vehicle. This increases the risk of CMV collisions that may result in injury and death.

4.2 Research Purpose

The purpose of this research is to discover and understand the relationships between OSA, obesity, and CMV operator performance. Recognizing these relationships will emphasize the importance of prevention. Proper prevention will eliminate the symptoms associated with obesity related OSA and reduce the risk of CMV collisions. Furthermore, reduce the number of injuries and deaths related to these collisions.

4.3 Research Method

Information will be collected to establish relationships between OSA, obesity, and CMV operator performance. This information will also support recommendations that prevent the consequences of these relationships. First, the research should establish a relationship between obesity and CMV operators. Second, the research should establish a relationship between obesity and OSA. Third, the research should establish a relationship between OSA, obesity, and CMV operator performance. Finally, the research should provide the groundwork for discovering ways to encourage healthier living. The methods used to answer the following questions are listed below:

- Is obesity prevalent among CMV operators?
  - A statistical analysis was performed to determine and compare the BMI of those individuals with a valid Commercial Driver’s License (CDL) to those individuals without a CDL. This information will be used to determine if there is a difference in the BMI of CMV operators and the BMI of standard operators.
• A CMV operator survey was used to collect data and evaluate potential reasons as to why obesity may be a common problem among CMV operators.

• Professional interviews were used to obtain opinions and strengthen the arguments made above.

• Is there a relationship between Obesity and OSA?
  
  • A statistical analysis was performed on data from a sleep center. This information was used to determine if obesity contributes to the onset of OSA.

  • A CMV operator survey was used to compare the BMI of CMV operators with and without OSA. This data also included information about the number of CMV operators who have been tested, diagnosed and treated for OSA.

  • Professional interviews were used to obtain opinions and strengthen the arguments made above.

• Does obesity and OSA have an impact on CMV operator performance?

  • A statistical analysis was performed to compare the BMI of CMV operators involved in a fatigue related collision to the BMI of CMV operators involved in a vehicle related collision. This information will be used to determine if there is a difference in the BMI of CMV operators involved in these types of collision; one performance related, one non-performance related.
A CMV operator survey and professional interviews were used to obtain opinions and strengthen the arguments made above.

Three case studies were used to examine the consequences related to operating a motor vehicle while experiencing fatigue. A root cause analysis was also performed to determine if there is a relationship between obesity, OSA, and CMV operator performance within each study.

- How can CMV operators prevent the risks associated with obesity related OSA?
  - Professional interviews were used to obtain recommendations and suggestions on how to prevent the risks associated with obesity related OSA.
  - Internet Research – Internet research will be used to investigate ways to prevent the consequences of obesity related OSA.

4.4 Research Limitations

The goal of this research is to obtain the most accurate and up to date information as possible; nevertheless there are potential limitations with the resources that will be used. Below is a list of the limitations within this research:

1. The results of the statistical analysis used for building a relationship between obesity, OSA, and CMV operator performance cannot distinguish between operators with or without OSA. The presence of OSA is not a variable.

2. The conclusions made based on the responses to the CMV operator survey are dependant on honesty. Due to the private material contained in the survey, it is possible CMV operators were not truthful with all of their responses although it was anonymous.
3. Motor vehicle collisions are typically caused by a sequence of events; rarely is it the result of one root cause, especially when it results in serious injury and death. This information is taken into considerations with all of the collisions described in this thesis.

4.5 Expected Results

It is expected that the results of this research will reveal a relationship between obesity and CMV operators, a relationship between obesity and OSA, and finally a relationship between obesity, OSA, and CMV operator performance. It is also expected that this research will provide enough information to validate a health and wellness program for CMV operators. It is expected that the use of this program will reduce the risk of CMV collisions that result in injury and death.

5. Findings/Results

5.1 Introduction

The following information will use statistical data, CMV operator surveys, professional interviews, and case studies to make assumptions about the following relationships: (1) The prevalence of obesity in CMV operators, (2) the relationship between obesity and OSA, (3) and the impact of obesity related OSA on CMV operator performance. The following sections are divided by the relationship being researched, and further divided by the methods used to study these relationships. The outcome of this research will be used to persuade motor carriers to encourage wholesome living through health and wellness programs.
5.2 Obesity in CMV Operators

5.2.1 Statistical Analysis Using the Fatality Analysis Reporting System

5.2.1.a Motor Vehicle Operators With a valid CDL

In this section, the Fatality Analysis Reporting System (FARS) encyclopedia was used to identify a relationship between CMV operators and obesity. The Fatality Analysis Reporting System (FARS) is an encyclopedia that provides statistics on motor vehicle crashes in the United States. This data represents crashes that occurred on a public roadway and involved at least one fatality. A query tool allows users to select multiple variables. Although this site is typically used to evaluate fatality statistics, below it will be used to collect a large number of BMI statistics on drivers with a valid CDL. The results of this particular query do not indicate a crash cause or the responsible vehicle; these variables will be used in a subsequent section.

BMI data was collected from the year 2000 to the year 2008. The query returned the heights and weights of approximately 4,500 operators with a valid CDL. These numbers were calculated into BMI. The BMI analysis discovered 20% of the operators with a valid CDL were categorized as having an average BMI, 39% were categorized as being overweight, and 41% were categorized as being obese. See figure 5 for details.
5.2.1.b Motor Vehicle Operators Without a CDL

In this section, the FARS encyclopedia was used to compare the BMI of CMV operators the BMI of standard operators. For the purpose of this thesis, a standard operator is defined as a motor vehicle operator without a CDL. The FARS Encyclopedia will be used to collect a large number of BMI statistics on operators without a valid CDL, standard operators. Similar to the section above, BMI data was collected from the year 2000 to the year 2008. The query returned the heights and weights of over 50,000 standard operators. These numbers were calculated into BMI. The BMI analysis discovered 43% of the standard operators were categorized as having an average BMI, 34% were categorized as being overweight, and 23% were categorized as being obese. See figure 6 for details.
5.2.2 Commercial Motor Vehicle Operator Survey

In this section a CMV operator survey was used to further validate the relationship between CMV operators and obesity. See Appendix A for a template of the survey. The survey resulted in obtaining the heights and weights of 50 participants. These numbers were calculated into BMI. The survey discovered 10% of the participants were categorized as having an average BMI, 42% were categorized as being overweight, and 48% were categorized as being obese. See figure 7 for details.

The CMV operator survey was also used to understand why obesity appears to be a significant problem for CMV operators. The results of the survey revealed 70% of the
participants regularly eat\textsuperscript{6} at fast food or truck stop restaurants; and 62\% of the participants eat only one meal per day. The results of the survey also revealed 76\% of the participants do not regularly exercise\textsuperscript{7}; and 68\% of the participants work an average of 50 hours per week.

![BMI of Surveyed CMV Operators](image)

Figure 7: Percent Total Body Mass Index of Surveyed Commercial Motor Vehicle Operators.

### 5.2.3 Results

Is obesity prevalent among CMV operators? The FARS analysis and the CMV operator survey confirmed a substantial relationship between obesity and CMV operators; a majority of CMV operators have a BMI categorized as obese. In comparison, there was not a clear relationship between obesity and standard operators; the majority of standard operators had a BMI categorized as average. Evaluate both figure 5 and figure 6. The

\textsuperscript{6} In this survey “regularly eat” is defined as at least one meal per day 3 or more times per week.

\textsuperscript{7} In this survey “regular exercise” is defined as moderate physical activity at least 4 times per week.
percent total BMI of those categorized as overweight remained the same for both CMV operators and standard drivers. However, the percent total BMI of those categorized as obese were exact opposite for CMV operators and standard drivers. To further validate this argument, participants of the CMV operator survey shared their opinions.

Anonymous CMV Operator #1 with a BMI equal to 27 states “Go to any truck stop, just about everyone is walking around sporting a big gut” (2009). Anonymous CMV Operator #2 with a BMI equal to 35 states “My terminal manager said ‘big guts are the rule’… I put on an average of 5 pounds per year” (2009).

Why is obesity prevalent in CMV operators? There are many reason as to why CMV operators are at a greater risk of being obese than standard operators. It is the nature of their occupation that increases the risk of obesity. This means that due to their job, CMV operators face many barriers to healthy living. Poor diets, lack of exercise, limited food/restaurant selections, and restrictions on parking are all part of the nature of the occupation and are all problems CMV operators must deal with on a daily basis. Robert Siels states “Truck drivers do not have access to any typical restaurant… Trucks are becoming a thing that people don’t want around. They have taken away all of the parking” (2009). Anonymous CMV Operator #2 with a BMI equal to 35 states “I eat garbage to reward myself for a long day of driving” (2009). Other professionals agree that the prevalence of obesity is due to the nature of a CMV operator’s occupation. According to Michael Mencaroni, CSP, The reason for CMV operator obesity is “the nature of the occupation; they are basically sitting in a truck the majority of the day. [CMV Operators] are not active, the caloric burning is non-existent. It is a sedentary occupation.” (2009). Norman Kayler, CSP, agrees that the nature of the occupation is a
barrier to a healthy lifestyle. He adds “Truck drivers tend to get hungry or think they are hungrier than they really are.” Due to the occupation, CMV operators do not know when they will have another opportunity to eat. CMV operators typically over eat in anticipation for heavy traffic, bad weather, and other instances that will prevent CMV operators from reaching their destination (Kayler 2009).

5.3 Obesity and OSA

5.3.1 Statistical Analysis

In this section, data was collected from Sleep Insights, a sleep clinic. Sleep Insights is a medical center that provides diagnostic testing and treatment for sleep disorders. The data collected from Sleep Insights was used to identify a relationship between obesity and OSA. This data consisted of BMI and OSA information that was randomly collected from 100 patients. The analysis of this data revealed 72% of the selected patients have been diagnosed with OSA. Of these patients, 8% were categorized as having an average BMI, 18% were categorized as being overweight, and 74% were categorized as being obese. See figure 8 for details.

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8 This data does not differentiate between patients with or without a CDL.
5.3.2 Commercial Motor Vehicle Operator Survey

In this section, the CMV operator survey was used to further validate the relationship between obesity and OSA. The results of the survey revealed, out of 50 CMV operators, only 12% of the participants had undergone a sleep study to determine if they are suffering from OSA. Of these participants, 8% were diagnosed with OSA. All of the participants diagnosed with OSA had a BMI categorized as obese. To put this into a different perspective, the survey revealed 88% of the participants had never undergone a sleep study. Of these participants, 75% claimed to experience potential daytime symptoms of OSA, such as fatigue.

5.3.3 Results

Is there a relationship between obesity and OSA? Based on the information analyzed from Sleep Insights, there is a confirmed relationship between obesity and OSA.
Being obese increases the risk of developing OSA. A vast majority (74%) of the patients with OSA have a BMI categorized as obese. Amy Rama, FNP, confirms that, although obesity may not be the biggest risk factor in developing OSA, there is a definite relationship. People who are obese tend to have broader necks; a larger neck size will exert more pressure on the back of the throat and reduce airflow. Being obese may also put additional pressure on the abdomen, further reducing the flow of air (Rama 2009).

The information gathered from the CMV operator survey was inconclusive. Since most of the CMV operators have not been tested for OSA, this data cannot be used to establish a direct relationship between obesity and OSA. However, the survey did reveal, out of the CMV operators diagnosed with OSA, all of them have a BMI categorized as obese. Anonymous CMV Operator #2 with a BMI equal to 35 states “I have high blood pressure, borderline diabetes, and sleep apnea” (2009). Anonymous CMV operator #3 with a BMI equal to 30 states, “Many drivers have sugar problems, edema of the legs, smoke a pack a day, and have sleep apnea” (2009).

5.4 Obesity, OSA and CMV Operator Performance

5.4.1 Statistical Analysis Using the Fatality Analysis Reporting System

5.4.1.a CMV Operator Involved in Fatigue Related Collisions

In this section, the FARS encyclopedia was used to establish a relationship between obesity and CMV operator performance; this can be done by evaluating the BMI of CMV operators involved in fatigue related collisions. This dataset does not consider the CMV operators who have been diagnosed with OSA. However, the analysis will attempt to draw conclusions based on operator fatigue; a daytime symptom of OSA. The variables selected for this query are listed in table 2.
BMI data was collected from the year 2000 to the year 2008. The query returned the heights and weights of approximately 500 individual fatigue related collisions. These numbers were calculated into BMI. The BMI analysis discovered 21% were categorized as having an average BMI, 35% were categorized as being overweight, and 44% were categorized as being obese. See figure 10 for details.

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<tr>
<td>Drowsy Driver</td>
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<tr>
<td>Gross Vehicle Weight Rating</td>
<td>Vehicles greater than 26,000 lbs.</td>
</tr>
<tr>
<td>Vehicle Role</td>
<td>Vehicles striking other vehicles (Responsible for the collision)</td>
</tr>
<tr>
<td>Driver License</td>
<td>Drivers with a valid CDL</td>
</tr>
<tr>
<td>Driver Height</td>
<td>All</td>
</tr>
<tr>
<td>Driver Weight</td>
<td>All</td>
</tr>
<tr>
<td>Driver Related Factors</td>
<td>Drowsy, Sleepy, Asleep, Fatigued</td>
</tr>
</tbody>
</table>

Table 2: Variables and Values Selected in the FARS Encyclopedia Query Tool for Fatigue Related Collisions. Reference: http://www-fars.nhtsa.dot.gov/QueryTool/QuerySection/SelectYear.aspx

5.4.1.b  CMV Operator Involved in Vehicle Related Collisions

In this section the FARS encyclopedia was used to compare the BMI of CMV operators involved in fatigue related collisions and CMV operators involved in vehicle related collisions. The intent of this section is to determine if there is a difference in the BMI of CMV operators involved in a fatigue related collision to the BMI of CMV operators involved in a vehicle related collision. For the purpose of this thesis a vehicle related collision is defined as a collision the result of a mechanical failure of the CMV and is not considered to be a direct liability of the operator, for example failure of the vehicle brakes. The variables selected for this analysis are listed in table 4.

The query tool returned the heights and weights of approximately 160 usable vehicle related collisions; all of these collisions resulted in the death of at least one person. The heights and weights were used to calculate the BMI of the CMV operator who was responsible for the collision. The BMI analysis discovered 23% of the CMV operators were categorized as having an average BMI, 50% were categorized as being overweight, and 28% were categorized as being obese. See figure 12 for details.

<table>
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<td>Vehicle Related Factors</td>
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</tr>
<tr>
<td>Driver Licence</td>
<td>Drivers with a valid CDL</td>
</tr>
<tr>
<td>Driver Height</td>
<td>All</td>
</tr>
<tr>
<td>Driver Weight</td>
<td>All</td>
</tr>
<tr>
<td>Driver Related Factors</td>
<td>None</td>
</tr>
</tbody>
</table>

Table 3: Variables and Values Selected in the FARS Encyclopedia Query Tool for Vehicle Related Collisions. Reference: http://www.fars.nhtsa.dot.gov/QueryTool/QuerySection/SelectYear.aspx
5.4.2 Commercial Motor Vehicle Operator Survey

In this section the CMV operator survey was used to establish relationships between obesity, OSA and driver performance. The results of the survey revealed 32% of the participants had fallen asleep while driving. Of these participants, 6% were diagnosed with OSA and had a BMI categorized as obese. The results of the survey also revealed 56% of the participants believe that obesity impairs CMV operator performance and 64% of the participants believe the symptoms of OSA impair CMV operator performance.

5.4.3 Case Studies

5.4.3.a Motor Coach Run-Off-the-Road & Rollover (Case Study 1)

On January 6, 2008, a motor coach departed the roadway, struck an aluminum guardrail, descended down an embankment, rolled over, and came to rest on its wheels. The collision resulted in nine fatalities and 43 injuries ranging from minor to
serious. The National Transportation Safety Board determined the probable cause of this incident was diminished alertness due to inadequate sleep (National Transportation Safety Board, HAR 09/01). The driver of the motor coach was classified as obese and diagnosed with moderate OSA. See Appendix B for more details on this collision.

5.4.3.b  Tanker Truck Overturn and Fire (Case Study 2)

On January 13, 2004, a tanker truck departed the roadway, collided with and mounted a concrete barrier. The tanker then plummeted from the overpass onto the highway below and exploded. The collision resulted in four fatalities. The National Transportation Safety Board determined the probable cause of this incident was the driver’s failure to maintain control of his tanker truck (National Transportation Safety Board, HAB 09/01). The driver of the tanker truck was classified as overweight and was given a recommendation to undergo a sleep study for the possibility of mild OSA. See Appendix C for more details on this collision.

5.4.3.c  Motor Coach Run-Off-the-Road & Rear-End (Case Study 3)

On October 13, 2003, a motor coach departed the roadway and struck the rear end of a tractor trailer unit that was parked on the shoulder of the road. The collision resulted in nine fatalities and 7 serious injuries. The National Transportation Safety Board determined that the probable cause of this incident was a reduced state of alertness due to fatigue (National Transportation Safety Board, HAR 05/01). The driver of the motor coach was classified as overweight and diagnosed with mild OSA. See Appendix D for more details on this collision.
5.4.3.d Root Cause Analysis (RCA)

A Root Cause Analysis (RCA) is an investigative method used to identify the underlying explanation for an event that resulted to an undesired outcome. This type of analysis can be used to implement change and take preventative steps for the future. It is important to understand the complex reasoning behind RCA. In most cases, formulating a single root cause is not likely; especially when analyzing motor vehicle collisions. Motor vehicle collisions are typically a sequence of events that may result in injury and death; it is difficult to determine one reason that may have prevented the collision.

In this section, a RCA can is used to investigate the three case studies from above. The first step to an effective RCA is to identify the problem (undesired outcome). The common problem indentified in all three case studies is the serious injury and death that resulted from these collisions. Working backwards, the RCA considers specific events that took place, conditions that may have contributed to the events, and the barriers that failed to prevent the events from happening. Figures 11, 12, and 13 represent causal factor tree analyses for all three case studies. These diagrams were used to find consistency within the potential causes of these three collisions. The root cause in one case study may be more evident than the root cause in another. See table 6 for a symbol key of these diagrams.
Table 4: Root Cause Analysis Key Used to Recognize the Symbols Illustrated in Figures 11, 12, and 13.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
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<tr>
<td><img src="image1.png" alt="Image" /></td>
<td>Event</td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
<td>Condition</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td>Barrier</td>
</tr>
<tr>
<td><img src="image4.png" alt="Image" /></td>
<td>Reason Why Event/Condition/Barrier Occurred</td>
</tr>
<tr>
<td><img src="image5.png" alt="Image" /></td>
<td>Potential Reason Why Event/Condition/Barrier Occurred</td>
</tr>
<tr>
<td><img src="image6.png" alt="Image" /></td>
<td>Contributor to Severity of Event/Condition/Barrier</td>
</tr>
<tr>
<td><img src="image7.png" alt="Image" /></td>
<td>Not a Reason Why Event/Condition/Barrier Occurred</td>
</tr>
</tbody>
</table>
Figure 11: Root Cause Analysis Diagram for Case Study 1 – Motor Coach Run-Off-the-Road & Rollover. Reference: National Transportation Safety Board, HAR 09/01.
Figure 12: Root Cause Analysis Diagram for Case Study 2 - Tanker Truck Overturn and Fire. Reference: National Transportation Safety Board, HAB 09/01.
Figure 13: Root Cause Analysis Diagram for Case Study 3 - Motor Coach Run-Off-the-Road & Rear-End. Reference: National Transportation Safety Board, HAR 05/01.
5.4.5 Results

Does obesity and OSA have an impact on CMV operator performance?

Although the FARS analysis did not confirm a relationship between obesity, OSA and CMV operator performance, it did substantiate a relationship between obesity and OSA. Comparing figures 9 and 10, there appears to be a significant difference between the percent total BMI of CMV operator-related collisions and the percent total BMI of CMV vehicle-related collisions.

Although the information obtained from the analysis of the three case studies does not totally support the relationship between obesity, OSA, and operator performance, establishing a relationship is convincing. It is feasible to assume that suffering from OSA may play a role in CMV operator performance. Two of the three case studies had a confirmed presence of OSA at the time of the collision; the remaining case study presented evidence to support the potential presence of OSA at the time of the collision. Two of the three CMV operators in the case studies were categorized as overweight; one CMV operator has a BMI as 29.0. The remaining CMV operator was categorized as obese. Figures 11, 12, and 13 illustrate the complexity of RCA and determine that is reasonable to consider an unhealthy lifestyle a condition that contributed to the undesired outcomes of these collisions. Although a relationship between obesity, OSA, and CMV operator performance can not be confirmed, it is logical to consider obesity and OSA will have an impact on CMV operator performance.

Professionals agree that a relationship between obesity, OSA, and CMV operator performance does exist. Obesity and the symptoms of OSA may become detrimental to CMV operator performance. Obese CMV operators are more susceptible to
experiencing lethargy and fatigue faster than a person in good physical health. This is primarily due to the added weight the obese individuals are carrying around (Kayler 2009; Mencaroni 2009). According to Mencaroni, CMV operator fatigue is the most common underlying cause of CMV collisions; fatigue is not only a concern for the CMV operator but a concern for the overall motoring public; “The truck is basically a weapon and needs to be operated by a person who is fully alert” (Mencaroni 2009). Rama agrees that fatigue and operating a CMV is a dangerous combination, “the monotony of driving, being in a warm vehicle, and feeling the vibration of the road can contribute to sleepiness. Being tired on top of all of that can definitely result in an impaired ability to drive a motor vehicle” (Rama 2009).

5.5 Conclusion

Based on the information above, occupational related barriers limit a CMV operator’s ability to maintain a healthy lifestyle. An unhealthy lifestyle will lead to obesity. CMV operators are at a greater risk of being obese than standard drivers, in part, because of their lifestyles. There is a notable relationship between obesity and OSA; obesity increases the risk of developing OSA. Since obesity is prevalent among CMV operators, they are at a high risk of developing obesity related OSA. Although there is no confirming evidence that obesity and OSA has a direct relationship to CMV operator performance, it is credible to recognize the potential impacts of obesity and OSA on CMV operator performance.

Whether or not the conclusions based on this research validate a reason to promote wholesome living through health and wellness programs is at the discretion of the reader. Staying fit and eating healthy are detrimental to one’s overall health. Whether it is from
avoiding a fatal collision or averting a deadly side effect of an unhealthy lifestyle, preventing one premature death is the ultimate goal. This should be enough of a motive to encourage wholesome living; no matter what it costs financially.

6. Recommendations

6.1 Awareness

Awareness is crucial. Based on the research, the first recommendation is to encourage awareness. As a CMV operator or a motor carrier, it is important to recognize the risks associated with an unhealthy lifestyle. Awareness is the most fundamental method of prevention. In general, CMV operators are unaware that they may be experiencing symptoms of obesity related health problems. Drivers may attribute fatigue to working overtime or aging; unless they are tested they lack awareness (Seils 2009). Kayler agrees and adds “Drivers just don’t know. They think a McDonalds Big Mac® is just as healthy as eating fruit” (2009).

Awareness is virtually effortless. Educating CMV operators about healthy living is the simplest form of prevention. Deliver information about obesity, OSA, and other health issues to CMV operators. Recommend healthy food choices and suggestions on how CMV operators can remain reasonably active while on the road (Mencaroni 2009). Once a CMV operator is aware of these concerns, he/she can proceed accordingly. Occasionally awareness is only the first step.

6.2 Treatment

Treatment is essential. The second recommendation is to seek treatment if it is needed. This research does not conclude that obesity is the only cause of developing OSA. The onset of OSA can be attributed to many factors. The factors that contribute to
OSA include the general anatomy of the throat, large tonsils, a large tongue, narrow airway, nasal obstruction, and obesity (Medline Plus, Obstructive Sleep Apnea). In other words, a CMV operator with a BMI categorized as average can develop OSA; obesity is only one factor in the development of OSA. As mentioned above, it is important to be aware and recognize the symptoms of OSA. If a CMV operator is experiencing any of these symptoms, he/she should participate in a sleep study. If a patient is diagnosed with OSA, it is important to treat the condition accordingly. Rama states “People say they don’t feel sleepy, but after they are treated with CPAP they say they didn’t realize how sleepy they actually were (2009).

The largest struggle is getting CMV operators to see a doctor. If they are suffering from OSA they must be diagnosed and treated for the condition. Siels states “People don’t like to fess up that they may have a problem (2009). Kayler agrees and adds “Truck drivers, by nature, are not designed to see doctors… most truck drivers tend to be more of the macho type” (2009). One way to get CMV operator thinking healthy is for motor carriers to offer an incentive.

6.3 Health & Wellness Program

Health and Wellness Programs are helpful. The third recommendation is for motor carriers, truck stops and CMV operators to work together to implement a functional health and wellness program. A health and wellness program offers incentives for wholesome living; these incentives do not necessarily need to be monetary incentives. A good health and wellness program will make suggestions on how to improve diet, recommend daily exercises, and educate CMV operators on healthful living (Mencaroni
2009). Appendix E depicts an example of a functional health and wellness program that could be used to promote wholesome living.

6.4 Additional Research

Additional research is needed. The final recommendation is to continue researching this topic. This thesis paper only covers the most immediate aspect of the problem; the potential impacts of obesity and OSA on CMV operator performance. The following information contains items that may be added to this research to improve its legitimacy:

- A more in-depth statistical analysis on the relationship already contained in this thesis. A t-test can be used to determine if there is a difference between the means of two independent samples. For example, a t-test can be performed on the two datasets used to compare the BMI of CMV operators to the BMI of standard operators. A t-test can also be performed on the two datasets used to compare the BMI of CMV operators involved in a fatigue related collision to the BMI of CMV operators involved in a vehicle related collision. Performing the t-test will help determine if these variables are related and further validate the results.

- An analysis of short haul vs. long haul operations. This would include research on the differences in sleep and meal schedules for local/short haul operations vs. long haul operations. A local/short haul operation is defined as a trip of 100 miles or less from the CMV operator’s home base (Federal Motor Carrier Safety Administration, Impact of Local/Short Haul Operations on Driver Fatigue). A long haul operation is defined as travelling a lengthy distance and for an extended period of time. Local/short haul CMV operators may have the
opportunity to eat and sleep at home, while long haul CMV operators do not have the same luxury.

- Research the natural sleep stages of CMV operators. A person typically passes through 5 stages of sleep. These stages range from stage 1 sleep to Rapid Eye Movement (REM) sleep. Stage 1 is a light sleep or drifting in and out of sleep. REM sleep is a deep sleep which is characterized by vivid dreams (National Institute of Neurological Disorders and Stroke, Understanding Sleep).

- Research the natural circadian rhythms of CMV operators. A circadian rhythm is essentially the body’s 24 hour clock. During this 24 hour period a person will experience physical, mental, and behavioral changes in response to his/her environment (National Institute of Neurological Disorders and Stroke, Understanding Sleep).

- Research HOS regulations to determine if CMV operators are complying with the directive. Additional research may include whether or not this law is effectively preventing drowsy driving and reducing the number of fatigue related collisions.

- Research the menu options and nutritional value of the food at fast food and truck stop restaurants. Additional research may include portion sizes, value priced items, food convenience (whether or not it can be taken to go), and the selection of appetizing menu items.

- Research the effectiveness of Health and Wellness programs designed to improve health. Many companies (including transportation companies) have implemented a variety of health and wellness programs. Additional research may
include the differences in these programs, opinions on program details, and the reasons why programs were successful or unsuccessful.

7. Opportunities to Improve

The research and conclusions enclosed in this thesis have introduced relationships between obesity, OSA, and CMV operator performance. Combined, these relationships create a hazardous environment. The recommendations discussed in an earlier section focused on improving the lifestyle of an individual. Although very beneficial, these recommendations do not discuss ways to change the culture of the industry. In order to change the culture of the industry, management must improve. The change in management must be consistent and expectations must be standard throughout the industry. The following information will discuss the opportunities that are available to improve the management these issues.

Over the years, the FMCSA has developed many regulations to improve roadway safety. These regulations are standard procedures that the transportation industry is required to follow. These regulations provide a viable method to improve management. Currently, these regulations do not specifically highlight the problems associated with obesity and OSA. Developing new, or updating the existing, regulations to include obesity and OSA will improve management and eventually change the overall culture of the industry.

In order to obtain and maintain a CDL, CMV operators are required to take and pass a DOT physical examination every two years. This is a mandatory physical that ensures the operators ability to safely maneuver a CMV. In regards to obesity and OSA, this examination contains little to no emphasis on these issues. The examination report
provides a section for a brief description of the driver’s physical appearance and a single “yes or no” check box for the existence of symptoms that could indicate the presence of OSA. These sections do not mandate a follow-up. To improve this problem, the FMCSA could take a number of actions:

- A mandatory sleep study for all CMV operators who indicate “yes” for the presence of pauses in breathing while asleep and loud snoring.
- A mandatory sleep study for all CMV operators with a BMI greater than or equal to 30.0.
- Place greater emphasize on the importance of CMV operator’s maintaining a healthy weight. Pay special attention to excessive weight and how it contributes to health problems, such as OSA.

Creating a more significant regulation around obesity and OSA will raise the awareness of this issue. Motor carriers and CMV operators will not be able to ignore the importance of these relationships and will be, in a sense, forced to look for alternative options. Enhancing these regulations is the first step to get people to recognize the problem. In turn these regulations will encourage people to take further action and eventually change the culture of the industry.

8. Closing Remarks

To complete this paper, this section will contain the compiled results of the 4 focus questions:

- Is obesity prevalent among CMV operators? Confirmed. Obesity is prevalent among CMV operators. The statistical analysis and CMV operator surveys confirmed the prevalence of obesity in CMV operators. The statistical analysis
also confirmed that CMV operators are at a greater risk of being obese than a standard operator. The CMV operator occupation introduces a number of barriers to a healthy lifestyle. This is a disadvantage that increases the risk of obesity among CMV operators.

- Is there a relationship between obesity and OSA? Confirmed. Obesity is a risk factor in developing OSA. Although the CMV operator survey did not confirm this relationship, the statistical analysis did confirm a significant relationship between obesity and OSA. Obesity is a condition that contributes to increasing the likelihood of many health problems including OSA.

- Does obesity and OSA have an impact on CMV operator performance? Plausible. Although the research did not confirm a direct relationship between obesity, OSA, and CMV operator performance, it is possible that both obesity and OSA have an indirect relationship CMV operator fatigue. The statistical analysis established a potential relationship between obesity and OSA. One case study did confirm the presence of obesity, OSA, and poor CMV operator performance. Unfortunately the inconsistencies between all three case studies make it difficult to confirm a relationship between obesity, OSA, and CMV operator performance.

- How can CMV operators prevent the risks associated with obesity related OSA? The first step in prevention is awareness. CMV operators should be educated and aware of the health risks associated with obesity and the symptoms of OSA. The second step in prevention is treatment. If a CMV operator is experiencing any of the symptoms associated with OSA they should participate in a sleep study to
diagnose the condition and begin the recommended treatment. The final step in prevention is the implementation of health and wellness programs that promote wholesome living. Health and wellness programs will give people a motive and provide the assistance that is often needed to overcome issues such as obesity and OSA.
Appendix A

COMMERCIAL MOTOR VEHICLE OPERATOR SURVEY

Answer the following questions to the best of your knowledge. Your honesty is essential. This survey will remain anonymous and answers are confidential. Thank you for your participation!

Weight: ________ lbs.

Height: _______ ft. ________ in.

On average, how many meals do you eat while on the road driving?
- □ 1 Time/Day
- □ 2-3 Times/Day
- □ 4-5 Times/Day
- □ More than 5 Times/Day

Do you exercise on a regular basis? *Thirty minutes of moderate physical activity at least 4 times a week
- □ Less than 1 Time/Week
- □ 1-3 Times/Week
- □ 4-6 Times/Week
- □ 6+ Times/Week

How many hours a week are you on the road driving?
- □ Less than 40 Hours/Week
- □ 40-45 Hours/Week
- □ 45-50 Hours/Week
- □ 50+ Hours/Week

Do you regularly eat at fast food restaurants of Truck Stop buffets/restaurants? *At least 1 meal/day 3 or more times a week
- □ Yes
- □ No

Have you been tested for Obstructive Sleep Apnea?
- □ Yes
- □ No
- □ I don't know what sleep apnea is

Have you been diagnosed with Obstructive Sleep Apnea?
- □ Yes
- □ No

If yes, are you currently being treated for Obstructive Sleep Apnea?
- □ Yes
- □ No

Have you ever fallen asleep while operating a commercial motor vehicle?
- □ Yes
- □ No

Do you experience extreme fatigue or excessive daytime sleepiness?
- □ Yes
- □ No

Do you believe obesity impairs operator performance?
- □ Yes
- □ No

Do you believe Obstructive Sleep Apnea impairs operator performance?
- □ Yes
- □ No

Would you be interested in participating in an incentive program for promoting healthy diets/living?
- □ Yes
- □ No

If yes, what types of Incentives? (Check all that apply)
- □ Money
- □ Vacation
- □ Paid time off of work

Do you have any additional comments about this topic?
Appendix B

A Summary of NTSB Report: Motor Coach Run-Off-the-Road and Rollover

Mexican Hat, Utah
January 6, 2008

Case Study I
NTSB Report Number: HAR-09-01/PB2009-916201
Adopted NTSB on 4/21/2009
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Definitions

Acute Mountain Sickness – An illness experienced by travels at high altitudes. Symptoms include, but are not limited to, difficulty sleeping, fatigue, chest congestion, coughing.

Commercial Driver’s License (CDL) - A class of license that is required to operate a vehicle with a gross weight of 26,001 pounds or over. This includes, but is not limited to, straight trucks, tractor trailer combinations, and passenger motor coaches.

Continuous Positive Airway Pressure (CPAP) – A device used by patients for the treatment of sleep apnea.

Fatal Injury - Title 49 of Code of Federal Regulations (CFR) 830.2 defines fatal injury as any injury that results in death within 30 days of the incident.

Fore slope - A portion of the road sloping away from the roadway; the slope of the road from the shoulder edge to the ditch.

National Transportation Safety Board (NTSB) - According to their website, the NTSB is an independent Federal agency that is in charge of investigating significant accidents in various modes of transportation. The NTSB determines the probable cause of accidents and issues recommendations aimed to prevent future accidents.

Serious Injury – Title 49 of Code of Federal Regulations (CFR) 830.2 defines serious injury as any injury that requires hospitalization for more than 48 hours, commencing within 7 days from the date of injury.
General Information

Abstract:

On January 6, 2008, a motor coach departed Telluride Colorado en route to Phoenix Arizona. The motor coach was occupied by 1 driver and 52 passengers. The motor coach was travelling southbound on US Route 163 through Mexican Hat Utah. The motor coach entered a slight curve in the road. The motor coach departed the right side of the roadway, struck an aluminum guardrail, descended down an embankment, rolled over, and came to rest on its wheels. The collision resulted in nine fatalities and 43 injuries ranging from minor to serious. The National Transportation Safety Board determined the probable cause of this incident was diminished state of alertness due to inadequate sleep.

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<td>Time</td>
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<td>Route</td>
<td>Southbound on U.S. Route 163</td>
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<tr>
<td>Vehicle Information</td>
<td>2007 Motor Coach, Model J-4500, 56-Passenger, 3-axel</td>
</tr>
<tr>
<td>Number of Occupants</td>
<td>53 Occupants, 1 Driver, 52 Passengers</td>
</tr>
<tr>
<td>Weather</td>
<td>Light rain/Light snow, Light fog</td>
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<tr>
<td>Air Temperature</td>
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<td>Road Surface</td>
<td>Dry to slightly damp</td>
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<td>Road Temperature</td>
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<tr>
<td>Collision Sequence</td>
<td>Excessive speed, Run-off-road, Rollover, Ejection</td>
</tr>
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</table>
Factual Information

Narrative:

On Sunday, January 6, 2008, the driver of the motor coach awoke at 6:45 AM MST in Tulluride Colorado. He attended a driver meeting at 10:00 AM MST and was informed the planned route to Phoenix Arizona had been changed due to inclement weather. An alternate route was established. The alternate route was planned to be 556 miles. During the morning hours of January 6th, the driver complained of poor sleep due to the symptoms of a head cold to a colleague.

Fifty two passengers boarded the motor coach at approximately 2:00 PM MST. The motor coach departed Telluride Colorado at 3:15 PM MST. The driver had been awake for 8.5 hours. After crossing into Utah, the motor coach turned south on to U.S. Route 163. The driver missed the turn on to U.S. Route 191 that was the established plan to cross into Arizona. The driver remained on U.S. Route 163 (See figure 1). He later claimed that he was not aware of what route he was traveling, but knew the route would take them south toward Phoenix.

Interviewed passengers commented on the driver driving onto the shoulder of the road and swerving in the hours prior to the collision; several passengers expressed concerns of excessive speed and shouted to the driver to slow down. Approximately 6 hours into the trip, the motor coach approached a slight curve in the road. Shortly after, the motor coach gradually drifted to the right side of the road and struck an aluminum guardrail. The motor coach traveled along the guardrail for 61 feet to its end. The motor coach continued to travel approximately 350 feet along the fore slope of the roadway. As the fore slope transitioned into a ditch, the motor coach descended the embankment,
rotated in a counterclockwise direction, and rolled over 360 degrees. The motor coach came to a rest on its wheels approximately 600 feet from the initial impact with the guardrail (See figure 2).

Figure 1: Map of Collision location and planned route. Reference: Google Maps, http://maps.google.com/ (accessed October 16, 2009). Maps are not drawn to scale.
Injury Description:

As a result of the rollover, the roof of the motor coach detached from its body. Fifty of the 53 passengers were ejected from the top of the vehicle. The driver and two passengers remained inside the vehicle. Nine passengers were fatally injured. Of the nine passengers, seven were pronounced dead at the scene; two died en route to the hospital. These passengers died from blunt-force trauma to their heads and/or torsos. Thirty-five occupants (including the driver) were seriously injured. These injuries included fractures to the spine/torso/extremities and head and internal injuries. Nine passengers sustained minor injuries. These injuries included lacerations, abrasions and contusions to their faces, torsos, and/or extremities. All 52 occupants of the motor coach suffered some degree of injury (See table 1).
<table>
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<th>Total</th>
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<td>Blunt-force trauma to the head and/or torso</td>
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<tr>
<td>Serious</td>
<td>Fractures to the spine, torso, and/or extremities</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Head and/or internal chest injuries</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>9</td>
</tr>
<tr>
<td>Minor</td>
<td>Lacerations, abrasions, contusions to face, torsos, or extremities</td>
<td>9</td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>52</strong></td>
</tr>
</tbody>
</table>

Table 1: Summary of Injuries. Reference: National Transportation Safety Board, HAR 09/01

**Driver Description:**

At the time of the incident, the driver, Welland Lotan, of the motor coach was 71 years old. He held a valid Michigan commercial driver’s license (CDL) with a passenger endorsement. His motor vehicle record indicated no violations or collisions during the previous 5 years. Lotan had 7 years of experience as a CDL driver.

Lotan was 67 inches tall and weighed 235 pounds. His BMI was 36.8 and was categorized as excessively obese. Lotan was diagnosed with moderate obstructive sleep apnea one year prior to the collision. Although his personal medical records indicated a history of sleep-related conditions, Lotan’s commercial driver medical examination reported “no” for sleep disorders, pauses while sleeping, and loud snoring (See figure 3).

At the time of the incident, Lotan was being treated for obstructive sleep apnea with a continuous positive airway pressure (CPAP) device. Lotan claimed he had not been using his CPAP device properly in the days prior to the incident; claiming that his head congestion made the device ineffective.
Probable Cause:

The NTSB was notified about this incident on January 6, 2008. An investigative team was dispatched to review a number of factors. These review items included human performance, highway factors, vehicle factors and survival factors. This team was comprised of members from the Federal Motor Carrier Safety Administration, the Utah Highway Patrol, the Utah Department of Transportation, and representatives from the collision vehicle’s motor carrier (NTSB).

The NTSB determined several factors as the probable cause for this incident. The cause was determined to be the result of excessive speed and the driver’s inability to recognize lane position due to his fatigue and diminished alertness. The driver’s lack of alertness was a result of inadequate rest. The driver did not get sufficient rest due to his
failure to properly utilize his CPAP device. This device could not be used correctly because of the driver’s reported head congestion and possibly Acute Mountain Sickness.

Reference:

Appendix C

A Summary of NTSB Report: Tanker Truck Overturn and Fire

Elkridge, Maryland
January 13, 2004

Case Study II
NTSB Report Number: HAR-09-01/HWY-04-MH-012
Adopted NTSB on 7/30/09
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Definitions

**Concrete Parapet** – A low protective wall along the edge of a raised structure

**Commercial Driver’s License (CDL)** - A class of license that is required to operate a vehicle with a gross weight of 26,001 pounds or over. This includes, but is not limited to, straight trucks, tractor trailer combinations, and passenger motor coaches.

**Fatal Injury** - Title 49 of Federal Regulations (CFR) 830.2 defines fatal injury as any injury that results in death within 30 days of the incident.

**National Transportation Safety Board (NTSB)** - According to their website, the NTSB is an independent Federal agency that is in charge of investigating significant accidents in various modes of transportation. The NTSB determines the probable cause of accidents and issues recommendations aimed to prevent future accidents.

**Overpass** – A bridge, road or similar structure that crosses over another road.

**Scuff Marks** – The smudges on the road caused by vehicle tires.
General Information

Abstract:

On January 13, 2004, a tanker truck, occupied by 1 driver, was en route to deliver a load of gasoline to Bethesda Maryland. The tanker truck was traveling southbound on Interstate 895 near Elkridge, Maryland. The tanker approached an overpass. The tanker departed the right side of the roadway, traveled along the shoulder of the road, collided with and mounted the concrete parapet. The tanker then fell from the overpass onto the highway below and exploded. The collision resulted in four fatalities. The National Transportation Safety Board determined the probable cause of this incident was the driver’s failure to maintain control of his tanker truck.

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<td>Route</td>
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<td>Vehicle Information</td>
<td>2003 Freightliner Conventional Day Cab/ 2000 Heil 43ft elliptical tank</td>
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<td>Number of Occupants</td>
<td>1 Driver</td>
</tr>
<tr>
<td>Weather</td>
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<td>Road Surface</td>
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<tr>
<td>Collision Sequence</td>
<td>Lost control, Ran-off-road, Struck and mounted barrier, Fell off overpass, Exploded</td>
</tr>
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</table>
Factual Information

Narrative:

On Tuesday, January 13, 2004, the driver of the tanker truck awoke at approximately 3:45 AM EST in Finksburg Maryland. He drove to Baltimore Maryland to pick up a load of fuel and arrived 8:55 AM EST. After unloading the fuel in Landover Maryland, the driver locked his keys in his truck and phoned for help at approximately 12:40 PM EST. The driver picks up a second load of fuel in Baltimore Maryland. During the hours prior to the collision, the driver expressed his concerns about running late to his wife (over the phone) and a friend he talked to at the fuel terminal in Baltimore. At 2:25 PM EST, the driver departs Baltimore Maryland with 8,800 gallons of fuel en route to Bethesda Maryland.

Approximately 20 minutes into the trip, the tanker truck approached an overpass of Interstate 895 (See figure 1). The tanker truck drifted to the right side of the road and struck the roadside barrier/aluminum bridge rail. The tanker truck traveled along the shoulder of the road striking the barrier/rail for an undetermined distance. Scuff marks on the pavement indicated that the vehicle brakes were not locked and the driver was probably attempting to regain control of his vehicle. The tanker truck then collided with and vaulted over the concrete parapet. From the overpass, the tanker plunged 30 feet onto the northbound traffic lanes of Interstate 95. The tanker truck exploded and a large fire resulted (See figure 2). The speed of the tanker at the time of the collision was unknown; based on physical evidence it is likely the tanker truck did not exceed 49 mph.

Once the fire was extinguished, 5 vehicles were found within the burned area of Interstate 95. These vehicles included: The collision tanker truck, a tractor trailer
combination unit, a tractor trailer flatbed combination unit, a Ford sedan, and a Chevy pickup truck. Four out of the five drivers involved in this fire were fatally injured. The driver of the tractor trailer flatbed combination unit managed to escape his burning vehicle. There were no injuries reported as a result of this collision.


Injury Description:

As a result of this collision, five people suffered fatal injuries. It is unclear if the driver of the tanker trailer perished from colliding with the concrete barrier, falling from the overpass, or during the explosion/fire. Four vehicles were engulfed into the intense explosion/fire. Three of the four drivers died as a result of being caught in the flames. One driver managed to escape the fire with no injuries.

Driver Description:

At the time of the incident, the driver or the tanker truck was 64 years old. He held a valid Maryland class commercial driver’s license (CDL) with a hazardous materials endorsement. His motor vehicle record did not indicate violations or collisions. The driver had had 18 years of experience as a CDL driver.

The driver was 69 inches tall and weighed 190 pounds (Fatality Analysis Reporting System). His BMI was 28.1 and is categorized as overweight. The driver’s personal medical records indicated in 1999 the driver visited an otolaryngologist. The driver complained of snorting and snoring while asleep. It was recommended that the driver participate in a sleep study; this could be used to determine if obstructive sleep apnea was the reason for his disruptive sleep. The driver never participated in the sleep study.

Probable Cause:

The NTSB determined the cause of this collision was the tanker truck driver’s failure to maintain control of his vehicle. The reason for the driver’s inability to maintain control is undetermined. There was a lack of evidence supporting the driver’s condition, demeanor, or actions immediately before the collision. Due to insufficient information,
investigators were unable to isolate the factors that caused the driver to loose control of the tanker truck. Investigators were able to conclude the driver’s use of a cellular telephone was not a factor that contributed to this collision. Post accident drug testing confirmed that illicit drugs or alcohol were not factors that contributed to this collision. The driver’s autopsy did not indicate any evidence of any recent or past heart attacks. Since the driver declined to participate in the recommended sleep study, investigators could not determine whether or not the effects of obstructive sleep apnea contributed to this collision.

Reference:

Appendix D

A Summary of NTSB Report: Motor Coach Run-Off-the-Road and Rear-End

Tallahahassee, LA
October 13, 2003

Case Study III
NTSB Report Number: HAR-05-01/PB2005-916201
Adopted NTSB on 4/19/2005
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**Bi-level Positive Airway Pressure (BiPAP)** - A positive airway pressure machine commonly used for the treatment of Obstructive Sleep Apnea. This device is very similar to the Continuous Positive Airway Pressure device (CPAP).

**Code of Federal Regulations (CFR)** - According to the website the CRF is the codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government.

**Commercial Driver’s License (CDL)** - A class of license that is required to operate a vehicle with a gross weight of 26,001 pounds or over. This includes, but is not limited to, straight trucks, tractor trailer combinations, and passenger motor coaches.

**Fatal Injury** - Title 49 of Federal Regulations (CFR) 830.2 defines fatal injury as any injury that results in death within 30 days of the incident.

**National Transportation Safety Board (NTSB)** - According to their website, the NTSB is an independent Federal agency that is in charge of investigating significant accidents in various modes of transportation. The NTSB determines the probable cause of accidents and issues recommendations aimed to prevent future accidents.

**Pre-Trip Inspection** - This is an examination of a commercial motor vehicle prior to operating the vehicle on the road.

**Serious Injury** - Title 49 of Federal Regulations (CFR) 830.2 defines serious injury as any injury that requires hospitalization for more than 48 hours, commencing within 7 days from the date of injury.

**Supine Position** – This is a position of the body while sleeping; lying down on the back with the face up.
General Information

Abstract:

On October 13, 2003, a motor coach occupied by 1 driver and 14 passengers departed Shreveport Louisiana en route to Tuscaloosa Alabama. The eastbound motor coach was travelling on Interstate 20 through Tallulah Louisiana. The motor coach drifted to the right side of the roadway, from the travel lanes on to the shoulder of the road. The motor coach then struck the rear of a tractor trailer combination unit that was stopped on the shoulder of the road. Both vehicles traveled together in the eastbound direction for approximately 62 feet. The collision resulted in eight fatalities and 7 serious injuries. The National Transportation Safety Board determined the probable cause of this incident was “a reduced state of alertness due to fatigue”.

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<tr>
<td>Route</td>
<td>Eastbound on Interstate 20</td>
</tr>
<tr>
<td>Vehicle Information</td>
<td>1992 Neoplan USA Corporation, 49-passenger, model AN116/3</td>
</tr>
<tr>
<td>Number of Occupants</td>
<td>15 Occupants - 1 Driver, 14 Passengers</td>
</tr>
<tr>
<td>Weather</td>
<td>Cloudy</td>
</tr>
<tr>
<td>Air Temperature</td>
<td>75 degrees F</td>
</tr>
<tr>
<td>Road Surface</td>
<td>Dry</td>
</tr>
<tr>
<td>Collision Sequence</td>
<td>Ran-off-road, rear-end tractor trailer combination unit</td>
</tr>
</tbody>
</table>
Factual Information

Narrative:

On Monday, October 13, 2003, the driver of the motor coach awoke at approximately 6:00 AM EST in Shreveport Louisiana. He performed a pre-trip inspection on the motor coach with his co-driver at approximately 8:00 AM EST. The passengers boarded and the motor coach departed Shreveport Louisiana shortly after 8:00 AM EST.

The motor coach began its trip down a relatively straight and level highway. Interviewed witnesses (drivers and passengers of the vehicles traveling behind the motor coach) claimed that the motor coach repeatedly sped up, slowed down and drifted from lane to lane. One interviewed passenger claimed that the driver’s performance was fine except for the moments before the collision. The passenger claimed the motor coach drifted to the right shoulder. The passenger yelled to the driver that they were going to hit a trailer moments before the collision.

While traveling at a speed between 60 and 65 miles per hour the motor coach drifted on to the right shoulder of the road and travelled approximately 103 feet before colliding with the rear end of a semitrailer that was parked on the shoulder. After the initial impact, both vehicles remained intact. The vehicles traveled together for approximately 62 feet until they came to a rest on the outside shoulder (See figure 1). Investigators did not discover any evidence of the motor coach braking prior to the collision.

The tractor trailer combination unit was parked on the right shoulder due to the presence of smoke coming from the rear tires of the trailer. The driver of the tractor trailer pulled over to make adjustments to the trailer.
Injury Description:

As a result of the collision, eight of the 15 motor coach occupants were fatally injured. A ninth passenger died due to his injuries 35 days after the collision. According to the Code of Federal Regulations (830.2) a fatal injury is defined as any injury that results in death within 30 days from the date of the collision. Since this passenger died 35 days after the collision, the NTSB report classified eight fatal injuries. The ninth fatality is classified as serious injury. These passengers died from serious injury to the head, upper torso, internal organs, and extremities. Emergency responders reportedly found all of these passengers trapped between the seats of the motor coach.

Six occupants (including the motor coach driver) were seriously injured. These injuries included blunt force trauma to the head, torso, and extremities. Emergency responders reportedly found all of these passengers, except the driver, trapped between the seats or in the aisle of the motor coach. The driver was the only restrained occupant in
the motor coach. The motor coach driver sustained serious injuries to his left shoulder and right leg. The driver of the tractor trailer combination unit did not sustain any injuries during the collision (See table 1).

<table>
<thead>
<tr>
<th>Severity</th>
<th>Injury Type</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>Trauma to the head, upper torso, internal organs, and extremities</td>
<td>9</td>
</tr>
<tr>
<td>Serious</td>
<td>Blunt-force trauma to the head and/or torso, and extremities</td>
<td>6</td>
</tr>
<tr>
<td>Minor</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

Table 1: Summary of Injuries. Reference: National Transportation Safety Board, HAR 05/01

**Driver Description:**

At the time of the incident, the driver of the motor coach was 66 years old. He held a Texas commercial driver’s license (CDL) with a passenger endorsement. The driver of the motor coach had several years of experience as a school bus driver and claimed to have experience with multiday interstate bus trips.

The motor coach driver was 66 inches tall and weighed 180 pounds. His BMI was 29.0 which categorized as overweight (Fatality Analysis Reporting System). The motor coach driver was diagnosed with mild obstructive sleep apnea in August 2000. Although the motor coach driver was not prescribed use of Bi-level Positive Airway Pressure machine, the medical report of the driver’s sleep study recommended treatment through aerobic exercise, avoidance of sleeping in the supine position, and abstaining from the use of sedating medications during the evening.

**Probable Cause:**

The NTSB was notified about this incident on October 13, 2003. An investigative team was dispatched to review a number of factors. These review items included human performance, highway factors, vehicle factors and survival factors. This team was
comprised of members from the Federal Motor Carrier Safety Administration, the
Louisiana State Police, the Louisiana Department of Transportation, and representatives
from the collision vehicle’s manufacturer and employer.

The NTSB determined several factors as the probable cause for this incident. The
cause was determined to be the result of the motor coach driver’s poor performance in
properly operating the motor coach. This was due to the motor coach driver’s reduced
state of alertness because of fatigue. His fatigue was attributed to the motor coach
driver’s poor quality of sleep.

Reference:

National Transportation Safety Board, “HAR 05/01 – Motorcoach Run-off-the-Road Accident,” National
(accessed October 21, 2009).
Appendix E

Business Proposal:
XYZ Trucking Company Health & Wellness Program

Company Background:

XYZ Trucking Company is a large business that provides freight transportation and logistics services all across the east region of North America. XYZ Trucking Company has 100 full time commercial motor vehicle operators; each driver operates one company-owned/company-insured tractor trailer combination unit.

Problem:

Vehicle Insurance and Worker’s Compensation premiums have been steadily rising over the past 5 years. In 2009, XYZ Trucking Company paid over $500,000.00 for both vehicle and Worker’s Compensation insurance. See detailed insurance information below. In 2009, XYZ Trucking Company was legally responsible for 20 collisions. Based on statistical analysis and professional opinion it is believed that at least 7 (35%) of these collisions may have been avoided if the driver was healthy and fit. The insurance company has proposed a 10% discount on all vehicles that are operated by drivers who participate in a company health and wellness program. The insurance company is also offering a 3% discount on Worker’s Compensation Premiums for all drivers that participate in the health and wellness program.
Objective:

This proposal is a recommendation to implement a health and wellness program for XYZ Trucking Company. This health and wellness program will encourage personal wellbeing by extending awareness, supporting healthy activities, and rewarding employee participation. The goal of this program is to retain a healthier workforce and reduce the risks associated with an unhealthy lifestyle. Studies suggest that unwholesome living may increase the risk of collision. Employing a healthy workforce will reduce the risk of these
collisions, reduce the risk of the injuries resulting from these collisions, and decrease both vehicle and worker’s compensation insurance premiums.

**Scope of the Program:**

This proposed program consists of monthly newsletters, detailed training, and point-based incentives. These elements are described in more detail below.

**Monthly Newsletters** – All Commercial Motor Vehicle (CMV) operators who are actively employed with XYZ Trucking Company will receive a monthly health and wellness newsletter. See Page xl for a sample of this newsletter. This newsletter will contain a:

- Monthly Awareness topic – this is a brief description of the topic. This will include information on common symptoms, prevention, and benefits depending on the topic. The proposed training topics are listed below:

<table>
<thead>
<tr>
<th>Month</th>
<th>Awareness Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>Fatigue Management</td>
</tr>
<tr>
<td>February</td>
<td>Managing Sleep Disorders</td>
</tr>
<tr>
<td>March</td>
<td>Obesity</td>
</tr>
<tr>
<td>April</td>
<td>The benefits of a Healthy Diet</td>
</tr>
<tr>
<td>May</td>
<td>The benefits of Regular Exercise</td>
</tr>
<tr>
<td>June</td>
<td>Lowering Your Cholesterol</td>
</tr>
<tr>
<td>July</td>
<td>Work Related Stress</td>
</tr>
<tr>
<td>August</td>
<td>Drug and Alcohol Use</td>
</tr>
<tr>
<td>September</td>
<td>Tobacco Use</td>
</tr>
<tr>
<td>October</td>
<td>High Blood Pressure</td>
</tr>
<tr>
<td>November</td>
<td>Over The Counter Medication</td>
</tr>
<tr>
<td>December</td>
<td>Health Monitoring &amp; Testing</td>
</tr>
</tbody>
</table>

- Monthly Exercise Tip – this is a tip on how to exercise within the limits of the job.

- Easy Road Snack Recipe – this is a tip on how to prepare quick and easy snacks while on the road.

- Monthly Reminders – Upcoming events within the health & Wellness program.

- In the news - Current events and news articles that are related to the monthly awareness topics
• Coupons for Healthy Meals – Five coupons for a healthy meal at McFast Food Restaurants. McFast Food Restaurant is a large fast food chain located in areas all over the country. All coupons will expire on the 1st of the following month.

• Monthly Health and Wellness (H&W) Point Log – A log for program participants to track and tally their monthly H&W points.

Health & Wellness Incentive Program – Participants will receive points for being involved in the program. These points can be redeemed for a financial reward or paid days off from work.

<table>
<thead>
<tr>
<th>Points Earned</th>
<th>Award Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>$25 Gift Card to WantMore Department Store</td>
</tr>
<tr>
<td>500</td>
<td>One Floating Paid Holiday</td>
</tr>
<tr>
<td>1000</td>
<td>2 Floating Paid Holidays</td>
</tr>
<tr>
<td>2000</td>
<td>$500 Gift Card to WantMore Department Store</td>
</tr>
</tbody>
</table>

Some elements of this incentive program are largely based on employee honesty. Since activities, such as time spent working out cannot be verified, the points awarded for their completion are much lower than the activities that can be verified. The following information will provide a brief description of the activity and how many points are awarded. Points will be awarded as follows:

• Using the monthly newsletter coupons will award the employee 5 points per coupon used.

• Purchasing a healthy meal from any restaurant, truck stop, etc. will award the employee 5 points per meal. There will be a limit on 3 meals per day.

• Completing the monthly on-line training will award the employee 10 points each month.

• Completing the monthly training quiz will award the employee 10 points each month.

• Participating in a monthly weight loss plan will award the employee 1 point for every lost pound.
• Working out at the gym or at home will award the employee 1 point for each workout. A workout is considered to be a ½ hour or more of aerobic activity.

• Signing up or renewing a gym membership will award the employee 100 points each year.

• Quitting or remaining a non-smoker will award the employee 100 points each year.

• Getting screened for Obstructive Sleep Apnea and other sleep disorders will award the employee 100 points each year for five years.

**Monthly On-Line Training and Quiz** – Each month, employees will be allowed to participate in a monthly training and quiz. The topics for this training will coincide with the monthly awareness topics within the newsletters. Participants will be able to access the training by signing on to [www.xyztrucking.com](http://www.xyztrucking.com). There will be a link available to “Monthly Driver Health and Wellness Training & Quiz”. The online training will be outsourced and provided by *Outsourced Online Inc*. See a brochure from *Outsourced Online Inc.* on page xlii. As stated above, employees will receive 10 points for completing the training and 10 points for completing the quiz. This will give each employee a total of 20 points each month for the completion of these two activities.

**Annual Safety Stand-down Award Ceremony** – Each year all program participants will be invited to the Annual Safety Stand-Down Award Ceremony. At the ceremony, participants will be provided dinner, safety plaques, company logoed paraphernalia, and H&W points for the New Year.

**Responsibilities:**

**Employees** – all participating employees will be responsible for:

• Signing up for the program

• Completing the monthly H&W point log
• Submitting the log with the required documentation
• Completing the monthly online training and quiz

**Dispatchers** – dispatchers will be responsible for:

• Collecting and verifying the documentation submitted for the H&W Point logs
• Tracking of the employee’s points and submitting points the HR Coordinator monthly
• Scheduling requested days off (paid)
• Contacting the Human Resource Coordinator if an employee wishes to redeem points

**Human Resource Coordinator** – will be responsible for:

• Creating and distributing the monthly newsletter
• Keeping track of a master H&W point log throughout the year
• Ordering gift cards from WantMore Department Store
• Make arrangements for the Annual Safety Stand-Down

**Rules:**

1. Participants must join the program by January 31st of that year
2. All participants must sign an acknowledgment form stating they would like to involve themselves in the program and they have read through the program rules and procedures.
3. All participants must earn a minimum of 100 points during the course of the year to remain considered as a “participant” in the program.
4. Health & Wellness (H&W) Point Log - Documentation will be required for the following items:
   a. Receipts from the use of Monthly Newsletters coupons
   b. Receipts w/ meal description for “Healthy Meals”
   c. Monthly “weigh in” if weight loss documented
d. Documentation from signing up or renewing gym membership

e. Medical records indicating testing/treatment for sleep apnea

5. Health & Wellness (H&W) Points are redeemable at any time during the year.

6. Points cannot be carried over to the following year; all participants start with zero points on January 1 of each year.

7. Once points are redeemed the points will be deducted from the employee’s bank of points. For example, On August 1st Tommy Tandem has received a total of 350 points for the year. Tommy decides to cash in his points for a $25 dollar gift card to WantMore Department Store. Tommy will then have 100 points left in his bank for the remainder of the year. He is only eligible for additional rewards if he is able to earn the points needed for that reward.

Anticipated Costs:

The table below displays the anticipated costs of XYZ Trucking Company’s Health and Wellness Program. As noted below, the most significant costs can be attributed to the monthly coupons and the on-line awareness training. Although these costs are significant, the insurance company has proposed discounts on both vehicle and worker’s compensation premiums for all employees that are involved with the program. The costs and savings listed below represent only tangible figures and do not include the “soft” costs and savings this program will encounter.
### Anticipated Cost for XYZ Trucking Company's Health & Wellness Program

<table>
<thead>
<tr>
<th>Cost (Dollars)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$925.00</td>
<td>$25 WantMore Department Store Gift Card</td>
</tr>
<tr>
<td>$2,000.00</td>
<td>$500 WantMore Department Store Gift Card</td>
</tr>
<tr>
<td>$4,375.00</td>
<td>1 Paid Vacation Day</td>
</tr>
<tr>
<td>$2,375.00</td>
<td>2 Paid Vacation Days</td>
</tr>
<tr>
<td>$20,000.00</td>
<td>Coupons for discounted healthy meals at McFast Food Restaurants</td>
</tr>
<tr>
<td>$5,000.00</td>
<td>Outsourced Computer Based Training Through Outsourced Online Inc.</td>
</tr>
<tr>
<td>$8,000.00</td>
<td>Annual Safety Stand-Down Award Dinner</td>
</tr>
<tr>
<td>$5,000.00</td>
<td>Annual Bonus for Office Staff</td>
</tr>
<tr>
<td>($31,875.00)</td>
<td>Insurance Company Savings</td>
</tr>
<tr>
<td>($11,700.00)</td>
<td>Worker's Compensation Premium Savings</td>
</tr>
<tr>
<td>($7,000.00)</td>
<td>Potential Insurance Deductible Savings**</td>
</tr>
<tr>
<td>$2,000.00</td>
<td>Total Cost for Health &amp; Wellness Program After Savings</td>
</tr>
</tbody>
</table>

* Numbers based on the results of driver survey  
**Based on 2009 deductibles paid for collisions related to unhealthy lifestyle

**Closing:**

If accepted, this health and wellness program proposal has various benefits. (1) XYZ Trucking Company will employ a healthier workforce. This may ultimately reduce health care costs, the number of worker's compensation claims, and increase morale. (2)
Reduce both vehicle and worker’s compensation insurance premiums. (3) Give XYZ Trucking Company a way to communicate a genuine interest in employee well being. This will promote loyalty and a sense of unity among the participants. (4) Potentially save human lives. Unhealthy lifestyles predispose commercial motor vehicle operators to gain weight. This can lead to obesity and the onset serious medical conditions. The symptoms of these conditions may impair operator performance and increase the risk of collision; a collision that may result in serious injury and death.
Monthly Awareness Topic

FATIGUE

Fatigue is the Weariness and weakening from physical exertion or a physical disorder. This will cause:

- Drowsiness
- Lack of energy
- Sleepiness
- Involuntary sleep

Fatigue will impair your ability to safety operate your commercial motor vehicle. If you feel fatigued, pull over and rest. If you constantly feel fatigued, this may be a sign of an underlying health condition.

Prevent Fatigue with:

- Adequate Rest
- Managing your stress
- Improving your diet
- Quitting smoking
- Avoiding caffeinated beverages

Monthly Exercise Tip

While taking a break, perform simple stretches. Stretch your legs, arms, calves. If done correctly, this should take about 15 minutes.

Easy Road Snack Recipe

Two Celery sticks with a tablespoon of plain cream cheese on each - 150 calories

Monthly Reminders

Log on to XYZTrucking.com to do your monthly training
Record your H&W points and submit to your manager
Annual Safety Stand-Down on February 19, 2010

In The News

On November 15, 2009 a tractor trailer rear ended another tractor trailer that was stopped due to traffic. The tractor was travelling approximately 60 mph when it struck the rear of the trailer. The driver died on impact. There was no indication that the driver used his brakes or swerved to avoid the trailer. State Police believe the driver of the tractor trailer fell asleep behind the wheel due to fatigue*.

* Not an actual event. Picture Reference: NHSTA LTCCS Case 2002-073-021

FREE

DINNER SALAD & LARGE ICE TEA

50% off

DINNER SALAD & LARGE ICE TEA

25% Off

DINNER SALAD & LARGE ICE TEA
## H&W Point Log

**Driver Name**

**Driver ID Number**

**Total Monthly Points**

**Total Yearly Points**

<table>
<thead>
<tr>
<th></th>
<th>Use of Newsletter Coupons</th>
<th>Receipts for Healthy Meals</th>
<th>Monthly Online Training</th>
<th>Monthly Awareness Quiz</th>
<th>Weight Loss</th>
<th>Gym Workout</th>
<th>Sign up/Renew Gym Membership</th>
<th>Quit Smoking/Non Smoker</th>
<th>Sleep Apnea Screening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fri</td>
<td>5 Points Each</td>
<td>5 Points Each</td>
<td>10 Points/Month</td>
<td>10 points/Month</td>
<td>1 Point/1 Pound</td>
<td>1 Point Each</td>
<td>100 Points (1 Time/Year)</td>
<td>100 points (1 Time/Year)</td>
<td>100 points (1 Time/Year)</td>
</tr>
<tr>
<td>Sat</td>
<td>1-Jan</td>
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<tr>
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<td>2-Jan</td>
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<td>4-Jan</td>
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<td>Wed</td>
<td>5-Jan</td>
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<td>Thurs</td>
<td>6-Jan</td>
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<td>Fri</td>
<td>7-Jan</td>
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<td>Sat</td>
<td>8-Jan</td>
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<td>Sun</td>
<td>9-Jan</td>
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<td>10-Jan</td>
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<tr>
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<td>12-Jan</td>
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<td>Thurs</td>
<td>13-Jan</td>
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<td>22-Jan</td>
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<td>Sun</td>
<td>23-Jan</td>
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<td>24-Jan</td>
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<tr>
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<tr>
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**Column Total**
Outsourced Online Inc.

Occupational Online Training with the click of a mouse!

Over 5,000 training topics to choose from. If we don’t have it, we will create it!

Easy and secure login with customized company heading

Immediate access to current monthly topic

Comprehensive audio with action-packed, interactive pictures and scenarios!

10-20 Quiz questions that consist of Multiple Choice and True/False with immediate corrections

Printable Certificates!

If incorrect, the driver will be required to retake that portion of the training

Reference List


