

Impacts on Firefighter Safety of the 48/96 Schedule at the Reno Fire Department

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

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Abstract

During a period of change for the Reno Fire Department, including a reduction of area served and lay-offs of personnel, a shift schedule change was implemented. The focus of this research paper is to examine the impacts of that change in schedule.

The problem was that the Reno Fire Department was concerned that a recent change in hours of duty was impacting firefighter safety. The purpose of the applied research project was to assess if the change in scheduled hours of duty implemented by the Reno Fire Department was impacting firefighter safety by examining injury and accident data. The historical research method was used to create a framework for the data collected.

The research questions asked whether injury and vehicle accident rates had altered after the change in schedule, whether there were more severe injuries after the change in schedule, and when within the work period did injuries and accidents occur? Data was collected regarding each of these questions from databases maintained by the Reno Fire Department. Additionally, interviews were conducted and fire department personnel were surveyed about their perceptions regarding the 48/96 schedule.

It was found that injuries did not increase significantly after the change, but vehicle accident numbers did rise. Injuries and vehicle accidents were shown to be most likely to occur in the first 24 hour period of both schedules examined.

Recommendations were to continue to collect and analyze injury and accident data, disseminate data found to the fire department, look for ways to reduce fatigue, and for all fire departments to share injury and accident data.

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Introduction

Fire departments in the United States continue to experiment with different shift schedules that try to meet varying demands, including full time emergency response coverage, cost containment, employee retention, and safe working conditions. Twenty-four hour shifts are an accepted practice within the professional fire community, even as questions remain about sleep deprivation and resultant safety concerns. Questions regarding shift schedules revolve around two points. First, is 24 hours too long to be at the job, and if not, what is the most desirable and/or efficient arrangement of 24 hour shifts? A recent trend in the fire service is to extend the 24 hour shift to 48 consecutive hours at work, followed by 96 hours off duty. This is called the 48/96 schedule, and its popularity in the fire service is growing.

Like many surrounding fire departments, the Reno Fire Department recently switched to the 48/96 schedule. Prior to January 2012, the Reno Fire Department worked a 3/4 schedule consisting of 24 hour shifts worked one on, one off, one on, one off, one on, four off. There were no extra days off built into the schedule, commonly referred to as Kelly Days, and the city was covered by three shifts of firefighters working 56 hour weeks. After negotiation between the firefighters bargaining group and the City of Reno, agreement was reached to try a new schedule, the 48/96, consisting of two 24 hour shifts (48 consecutive hours at work) followed by four 24 hour shifts off (96 hours). Again, there were no Kelly Days and each shift works 56 hours per week, continuing the fire department's full time emergency response 24 hours a day, 7 days a week. The new 48/96 schedule was implemented January 1, 2012.

The problem is that the Reno Fire Department is concerned that the change in scheduled hours of duty may be impacting firefighter safety. The purpose of this research project is to

assess if the change in scheduled hours of duty is impacting firefighter safety by examining injury and accident data. The Historical Research Method was applied to examine four questions: (1) how many on-the-job injuries occurred prior to the change of schedule compared to after the change in scheduled work hours; (2) has there been a change in the severity of injuries before and after the change in scheduled work hours; (3) has there been a change in the rate of vehicle accidents involving the Reno Fire Department apparatus before and after the change in scheduled work hours; and (4) at what point in the 48 hour shift did injuries and accidents occur?

Background and Significance

The Reno Fire Department currently consists of 253 people in various divisions, including suppression, support, and fire prevention, although that number has varied in the past four years as a result of external forces. The department serves a population of over 225,000 people in an area of approximately 70 square miles. The department began operating in 1875, and currently is comprised of 14 fire stations housing fourteen type I fire engines, two 110 foot aerial ladders, and one medical rescue. Each engine and truck is staffed with four personnel, the rescue is staffed with two personnel, there are two suppression Battalion Chiefs on duty every day, and a single training/safety captain, resulting in a shift strength of 69 positions per shift, with extra firefighters for vacation and sick leave coverage. There are eight type 3 brush engines spread among the stations that have no additional staffing assigned. The fire department also supports a hazardous materials team, a water entry team, and a technical rescue team that is responsible for low and high angle rescue and confined space rescue.

From July 2000 to July 2012, the Reno Fire Department was functionally merged by way of an interlocal agreement with the Truckee Meadows Fire Protection District, which was administered by Washoe County. That merger added six companies and 24 daily positions to the Reno Fire Department. The economic downturn in 2008-2011 exposed weaknesses in the arrangement of the consolidated fire department, and the Reno Fire Department experienced layoffs of 54 personnel. On July 1, 2012, the two governing bodies that oversaw the consolidated fire department split the department into two separate fire departments, the Reno Fire Department and the Truckee Meadows Fire Protection District.

As a result of the financial conditions facing the City of Reno at the time, the fire department labor group agreed that starting July 1, 2011, they would accept a 7.5% reduction in pay and benefits. Also part of that agreement, and integral to its approval by the labor group, was an agreement that changed the work schedule from a 3/4 shift schedule to a 48/96 work schedule.

Even though there was a small economic cost to the labor group associated with the new schedule, the 48/96 schedule was desired by the bargaining group for a variety of reasons, including more full weekends off and a perception that it would help resolve home life issues resulting from lack of rest for firefighters assigned to busy companies. During discussion between representatives of the city and the labor group, there was talk of sick leave reductions resulting from the same switch in schedules at other departments, but little empirical evidence was found.

The Reno Fire Department run volume is significant, ranging from 36,918 calls for service in 2010 to 38,105 calls for service in 2013 even though the number of apparatus and

personnel had been significantly reduced as a result of deconsolidation (Reno Fire Department, 2014). Industrial injury costs also were rising, from \$892,723.90 in the 24 month period preceding the change in schedule, to \$ 943,218.13 in the 20 month period after the change in schedule. Those numbers translate to a monthly cost increase from \$37,196.83 to \$ 47,160.91 for the respective time periods (Reno Fire Department, 2014). There was a perception that there was an increase in on-the-job injuries and vehicle accidents after the change in work schedules, possibly due to increased consecutive hours at work.

Many studies of the 48/96 work schedule are based upon questionnaires that ask participants for their opinions on the benefits of the 48/96 work schedule, but few, with the notable exception of James Clack's 2003 applied research project, have hard data regarding injury and accident rates associated with them. This applied research project uses injury and accident data from the Reno Fire Department in the two years preceding and following the change in schedule to answer the research questions. Additionally, a survey of Reno Fire Department personnel and interviews with select administrators attempt to show the perception of the department concerning how the schedule change has affected safety, as compared to the actual injury and accident data.

The organizational culture of the Reno Fire Department has changed as external forces have impacted the department. The functional consolidation in 2000 of the two neighboring departments marked a high point in the organizational culture of the Reno Fire Department, and the assumptions of the leaders and employees of the department that the department would continue to grow and lead the local fire service were founded on the actual experience of those leaders and employees as they adapted successfully to the internal and external forces associated with the consolidation. The economic downturn and the inability of the City of Reno and

Washoe County to work together overseeing the consolidated department led to a myriad of problems for the department, including the breakup of the functional consolidation and layoffs of firefighters. These recent events have changed the assumptions held by the leaders and employees, and the actual experience of the hard times have re-enforced a change in the organizational culture of the Reno Fire Department, as the department has moved from a proactive to a reactive stance regarding change and future direction.

This research project aims, in addition to answering the research questions, to meet the United States Fire Administration goals of reducing risk at the local level through prevention and mitigation by looking at actual data concerning injuries and accidents and using that data to recognize trends and plan and prepare for ways to move towards safer operations at the local level. Also, by adding a focused, data-driven study to the national database of fire department studies, this study may aid future research and add to the fire and emergency services' professional status. From an organizational standpoint, by using accepted research methods to answer questions about department issues, it is hoped that the organizational culture of the Reno Fire Department can be moved from reactionary towards proactive as organizational effectiveness and efficiency is improved through data driven analysis. Completion of this project will demonstrate how research and its application can assist in efficient leadership of the organization.

Literature Review

What the safest, most efficient, and desirable work schedule is for the fire service remains an open question, and Gary Frazier (1999) of the Hutchinson Fire Department notes how each fire department's individual circumstances and the number of calls each department responds to

play an important role in what is the most efficient shift schedule for any department. The Reno Fire Department implemented a change in shift schedule in January, 2012, but questions remained about whether the new schedule was safe and efficient, and whether the majority of the employees working under the schedule preferred the new schedule two years after the change. The change in schedule was a result of negotiations between the City of Reno and the firefighters' bargaining group during the international economic downturn that started in 2007. In May 2011, the firefighters agreed to a 7.5% reduction in salary and benefits. The firefighters' bargaining group sought to make the concessions more palatable to their members by asking for a change from a 3/4 schedule to the 48/96, and the City of Reno agreed to the change in shift schedule. By 2014, enough injury and accident data existed at the department to start to analyze the possible impacts of the change.

A majority of the literature found that directly related to fire departments working the 48/96 schedule did not include injury and/or vehicle accident numbers, as authors relied on questionnaires to get opinions on how the 48/96 worked. Often, the focus of the study was to see whether the 48/96 schedule would work in the future for a fire department, so impacts to injury or vehicle accident rates as a result of a projected schedule change would be conjecture rather than reliable data. In one of the few applied research projects to look at data before and after a change in schedule, James Clack (2003) also found that few references existed in applied research projects at the National Fire Academy regarding shifts exceeding 24 hours in length. During review of applied research projects, however, it became clear that the Reno Fire Department runs a large number of calls for the manpower on duty. In 2013, with 14 stations housing 14 type 1 engines, two ladder trucks, and one two-person rescue, the RFD ran 38,105 calls for service, an average of 2,309 calls per company, or 2,721 calls per station (Reno Fire

Department, 2014). Of course, not all stations ran the same amount of calls. In downtown Reno, Station 1 ran 8,011 calls in 2013, with runs generated at a steady rate 24 hours a day due to multiple high rise casinos in the district. In Firehouse Magazine's July 2011 National Run Survey, Reno Fire Department's Engine 1 is identified as the second busiest engine company amongst the 219 fire departments that took part in the survey (Friszell-Neroulas and Roche, 2012). In the 2012 National Run Survey, with 238 departments participating, Engine 1 was the fifth busiest engine company among those reporting (Friszell-Neroulas and Roche, 2013). The perceived difference in call volume between what the Reno Fire Department and other fire departments were running led to further inquiry. Did run volume also play into injury and accident rates?

During review of available literature it became clear that occupational injury costs were a significant liability. In his study concerning the economic burden of occupational injury and illness, J. Paul Leigh (2011) found fatal occupational injuries in the United States in 2007 to number more than 5,600 at a cost of \$6 billion, while nonfatal injuries numbered over 8,500,000 and cost over \$185 billion. The price of efforts to prevent injuries is also significant, according to an August 2004 National Institute of Standards and Technology (NIST) report that estimated the costs of addressing firefighter injuries plus the cost of efforts at firefighter injury prevention to be between \$2.8 and 7.8 billion a year (TriData Corporation, 2005). Spending up to \$7.8 billion to address firefighter injuries to reduce an injury liability of \$186 billion makes sense, but how do those numbers connect to the Reno Fire Department and the possible costs (personal and economic) related to changes in shift schedule? The first step, according to the NIST report, was to gather and evaluate data specific to the Reno Fire Department, and then create an injury profile for the department without depending on national averages or industry profiles, and then

use that data to estimate the injury and accident overall loss figure for the department. (TriData Corporation, 2005).

The cost of occupational injuries was being collected and stored at the Reno Fire Department. From January 1, 2010 to December 31, 2011, the total cost of industrial injuries to the Reno Fire Department for emergency operations personnel was \$892,723.90. From January 1, 2012 to August 22, 2013, that cost was \$929,251.31, an increase of over \$36,000 even though the second time period was over three months shorter (Reno Fire Department, 2014). The injury and vehicle accident data was also being recorded by the department. The department matched the national trend of high costs associated with injuries, but even though it was understood that costs were increasing, there were questions about why, where, and when the injuries and accidents were taking place, and whether the schedule change had impacted those numbers positively or negatively. The research questions addressed how many injuries and vehicle accidents were occurring, whether they were more or less severe, and when they were occurring, as follows:

1. How many on-the-job injuries occurred prior to the change of schedule compared to after the change in scheduled work hours?
2. Has there been any change in the severity of injuries before and after the change in scheduled work hours?
3. Has there been a change in the rate of vehicle accidents involving Reno Fire Department apparatus before and after the change in schedule work hours?
4. At what point in the 48 hour shift did the injuries and accidents occur?

While Clack (2003) found that, “The second 24-hour period of the consecutive 48-hour shift shows a 44.4% increase in injuries compared to the first 24-hour period of the same shift,” other literature reviewed pointed to the reasons behind a possible change in the number of injuries after the change in schedule. In his applied research project for the National Fire Academy, Robert D. Hall studied the feasibility of 48/96 hours shifts for the Westminster Fire Department, and found that personnel exposed to heavy workloads, i.e. high run volume, and the associated physiological and psychological stressors must be assessed to safeguard them from the burden of those stressors (Hall, 2007). In her study comparing the 24/48 work schedule and the 48/96 work schedule, Dr. Susan L. Koen (2005) writes that, “the analysis of any shift schedule must begin with an assessment of the schedule’s impact on firefighters’ alertness and fatigue levels.”

The 48/96 schedule doubled the shift length for Reno firefighters. The run volume, especially at the busiest stations, is significant. How much does interrupted sleep or complete lack of sleep impact injury and accident rates? Can the effect of longer shifts be mitigated over time by employees becoming familiar with the pattern of interrupted sleep and making adjustments? In 1994, Ralph Cobb concluded that while most shift workers were able to eventually adapt their circadian rhythms with night shifts, because of the disruptions associated with calls for service, firefighters were unable to make that adjustment.

In a report describing the effects of sleep deprivation on emergency responders sponsored by the International Fire Chiefs Association, Elliot and Kuehl (2007) noted that while firefighters have a tradition of working 24 hour shifts, “firefighter alertness falls after 10 to 12 hours of work and during nighttime hours.” This loss of alertness is not dependent upon complete lack of sleep. Paley and Tepas (1994) found that changes in mood, increased irritability and fatigue, inability to

concentrate, and other behaviors associated with total sleep loss should also occur from changes in length of sleep or the interrupted sleep associated with shift work. Elliot and Kuehl's (2007) report goes on to say that the fragmented sleep associated with the episodic and unpredictable nature of responding to calls increases overall fatigue, and may relate to disproportionately higher rates of injury during the early morning hours.

Dawson and Reid (1997) compared fatigue impairment and alcohol impairment as they related to accidents and found "results underscore the fact that relatively moderate levels of fatigue impair performance to an extent equivalent to or greater than is currently acceptable for alcohol intoxication."

Injuries are not the only measure looked at in this study to determine if safety outcomes have changed as a result of the schedule change. Clack (2003) noted large difference in motor vehicle accidents after the switch to the 48/96 schedule. Reno Fire Department vehicle accidents were examined for two years before and after the schedule change. In *Managing Fire and Rescue Services*, Schamadan (2002) noted that in addition to the stress factors common to all workers, firefighters must cope with the need to always be ready to go, often without full normal sleep patterns, and that the demands on firefighters can be outside the normal scope of job stress, more physically demanding, psychologically stressful, and without a set pattern. Even so, firefighters who may be exhausted may have to respond to successive calls for service over the course of their shift. A longer duration shift adds to the likelihood that subsequent calls for service will happen. Schamadan (2002) also noted in the same article that historically one of the most dangerous parts of the firefighting job is the trip to and from an emergency incident, and while the 2003 City of Reno Fire Department Occupational Safety and Health Manual states that fire equipment operators are directly responsible for the safe operation of their vehicles, the

doctrine of law called *respondeat superior* holds that an employer is responsible for the actions of employees when those employees are performing their normal duties in a working status (Swinhart, 2007).

It is suspected within the Reno Fire Department that some crews have exhibited signs of sleep deprivation. The literature reviewed made clear that this is not an unknown phenomenon, and that it has been studied in depth:

Firefighters who experience one call during their nighttime sleep period (e.g., between 10:00 p.m. and 6:00 a.m.) typically will complete their first 24-hour workday in a state of mild sleep deprivation, depending on their ease of returning to sleep and their total sleep length that night. With a 5-hour block of restful sleep and a least one 90-minute completion sleep, sleep deprivation can be avoided. Those firefighters who average two calls during a typical on-duty night will most likely be in a state of moderate sleep deprivation, where cognitive fatigue problems will begin surfacing. Having a second 24-hour on-duty day, without any opportunity for on-shift napping or restorative sleep, could put those firefighters at risk for some safety and performance challenges. (Koen, 2005)

These performance challenges are not limited to apparatus driving and injuries involving fire fighters. They translate straight to public service in the form of efficient response to emergencies. Various experiments have found that if a sufficient number of firefighters are not operating at the scene of a fire within the critical time period, then injuries and financial loss is significantly increased. That critical time period before a flashover occurs in a structure fire with standard fuels is typically about seven minutes (Granito & Dionne, 1988). If the injury and

accident rates on the Reno Fire Department have increased after the change in shift schedule, the literature suggested that sleep deprivation may be a factor.

Why would any fire department agree to move to the 48/96 schedule if there are so many risks? Enhanced service delivery may result from improved employee morale resulting from a schedule that is perceived to be more beneficial to the employee (Kelly, 2012). Does employee convenience and improved morale weigh more heavily than safety and efficiency, and safeguarding the public? In his applied research project, Cobb (1994) writes that employers should consider firefighter safety and cost effectiveness when deciding work schedules while Poole (2012) concludes that it may be reasonable for employees to work a 48 hour shift if they are closely monitored for fatigue and measures are taken to prevent sleep deprivation.

While the majority of literature reviewed showed possible problems with shift lengths extended beyond 24 hours in busy stations, the data from the Reno Fire Department concerning injuries and accidents before and after the change in schedule needed to be analyzed prior to making any assumptions. The more data gathered about the events leading up to an injury or accident, the more clear the picture becomes. In an injury investigation, factors that might be considered include the number of hours worked prior to the injury, the events leading to the injury, and the number of runs responded to by the employee prior to the injury (Turner, 2010).

Literature review and perceptions by involved employees can only supplement actual data on injuries and accidents on the Reno Fire Department because, as others have noted, without specific analysis of that data, emotion may be used as the justification for change without regard for the actual experience (Newbold, 2012).

Procedures

The historical research method was used to examine the problem that the Reno Fire Department was concerned that a recent change in hours of duty may be impacting firefighter safety. A study of literature was conducted, starting with a narrow focus on injury and accident rate data that may show changes as a result of a similar change in schedule. The literature was very limited in that area, with few studies being conducted with hard numbers as the focus. It was found that most literature within the limited scope of the initial focus relied heavily on questionnaires and interviews, resulting in more participant-opinion driven results. This was not unexpected, and was in fact part of the reason to research this topic, as it was felt that a small study of the results of change at a single department might add to the discussion of the 48/96 schedule. As literature was reviewed, the focus of the literature review expanded to include writings concerning why accidents and injuries may increase when a change is made to an extended shift, and possible health and/or economic consequences for the employee and employer of long duration shifts.

Sleep deprivation, firefighter safety, and economic impact studies led to further research on mitigation of impacts on the employee, employer, and the general public, with texts concerning management of fire services reviewed, along with studies addressing functional and structural change to reduce fatigue and stress at fire stations.

Research of literature was conducted using the Washoe County, Nevada, public library system, and its interlibrary loan system which allowed documents from the National Fire Academy library to be accessed for review. Internal documents, manuals, and memorandums of the Reno Fire Department were also reviewed, and the internet was used to find other pertinent

documents. Industry related periodicals stored in hard copy at the Reno Fire Department were also reviewed.

Through the reading of the literature, it became apparent that the terminology can be confusing as different terms are used throughout the United States to describe shift schedules.

Three terms that need to be defined for this study are:

Shift Length - For the purposes of this paper, the length of a single shift of work at the Reno Fire Department is defined as 24 consecutive hours, starting and ending at 08:00 hours.

48/96 - A shift arrangement where the employee works two 24 hour shifts consecutively, followed by 96 hours off duty.

3/4 Schedule - A shift arrangement where the employee works one 24 hour shift, followed by 24 hours off duty, followed by working one 24 hour shift, followed by 24 hours off duty, followed by working one 24 hour shift, followed by 96 hours off duty.

The series of events which led to the present problems began in 2007 with two unrelated matters.

The first issue was a push from the Reno firefighters to the union leadership to negotiate a change in work schedule from the 3/4 schedule to a 48/96 schedule. Fire departments neighboring Reno were moving to the 48/96 during this time, and the younger members of Reno's firefighter bargaining group wanted to change schedules as well. The union leadership resisted, citing that under the worsening economic conditions being experienced at the time they

felt the city would ask for too much in return for a change in schedule. The bargaining group members continued to request the change, and a committee was formed by the union to gather information. After a period of months, the information was presented to the union's executive board, but the report lacked data to back up opinions on the benefits of the change in schedule, and the proposal was not included in negotiations between the city and the firefighters' bargaining group.

The second matter was the economic downturn that was impacting the United States beginning in 2007. The city government in Reno, Nevada found that revenues had been reduced to the point that bargaining groups in the city were asked for concessions in pay and benefits. In February 2011, the firefighters' bargaining group agreed to wage and benefit concessions with a potential cost savings to the city of \$532,003.37. In June of 2011, the firefighters bargaining group agreed to further concessions, agreeing to forgo scheduled raises. Despite these concessions, the city's economic situation did not improve, and between February 2010 and July 2012, 58 firefighters were laid off from the Reno Fire Department, and station brownouts began. The brownouts meant that fire stations would temporarily close as a result of lack of staffing due to vacation time, sick time, or on-the-job injury time lost, instead of being staffed with overtime personnel. A matrix was developed to order the shutdowns, and the slowest stations were closed first, resulting in more calls for busy stations as calls were shifted to open companies.

Reno had applied for and received approval for a Staffing for Adequate Fire and Emergency Response (SAFER) grant from the United States Federal Emergency Management Agency, and if the grant was accepted by the city, further layoffs of firefighters would be suspended for the duration of the grant, which was set at two years, but could be shortened if the city ended the terms of agreement.

Meanwhile, the labor agreement between the city and the firefighters had ended June 30, 2010, and the parties had not been able to come to agreement. Negotiations had proceeded to fact-finding arbitration, and a non-binding ruling was returned on May 13, 2011. The city was asking for a 7.5% reduction in wages and benefits, but the labor group was hesitating to agree to further concessions. The city had not accepted the SAFER grant, and there was speculation in the bargaining group that even if the grant was accepted, the terms could be violated, resulting in loss of the grant and further layoffs.

An agreement was brokered between the city and the bargaining group on May 18, 2011, to trade the 7.5% salary and benefits concession by the firefighters for a guarantee that the city would accept the SAFER grant, and if the grant was terminated early for any reason, salary and benefits would be returned from that date forward. But questions remained about whether the membership of the bargaining group would approve the agreement. In order to solidify the agreement, the change in schedule requested by the membership was incorporated into the package, and both the city and the labor group approved the deal in July 2011. The change in schedule took place on January 1, 2012.

On July 1, 2012, the City of Reno and Washoe County ended a contract for services that had functionally consolidated the fire departments of the two governments. A number of Reno firefighters chose to work for the new county department, allowing the City to avoid layoffs and possible loss of the SAFER grant, but even though the number of stations operated by the City of Reno was reduced by six, with an associated loss of positions, changes in protocols regarding response to medical emergencies led to continuing increases in the number of runs responded to by Reno Fire Department units, from 34,748 in 2012 to 38,105 in 2013 (Reno Fire Department, 2014).

The stressors that impacted Reno, including increasing run volume, a casino driven 24-hour downtown, and economic limitations on staffing were significant, and since the arguments for the schedule change had included little actual data regarding safety of the schedule, the question remained whether the 48/96 schedule was impacting the safety of Reno firefighters.

The information regarding number of injuries and accidents was found using Reno Fire Department databases. Work related injury records are mandated to be stored by the department, and were accessible through Reno Fire Department staff. The Office of Safety and Health Administration (OSHA) form 300A, Summary of Work-Related Injuries and Illnesses for each year from 2010 through 2012 was accessed, and gave an overview of department injuries. In order to filter the injuries to only include personnel who worked a 56 hour schedule and experienced the change in schedule, OSHA form 300, Log of Work-Related Injuries and Illnesses was accessed. This form provided the names of the injured employees, dates of the injuries, and a description of the injuries. This information was used to filter the employees whose injury data was to be examined. Injuries involving non-56 hour employees were eliminated. Also, injuries and illnesses that were reported on the form but were as a result of yearly physicals were eliminated. An example would be an entry for an employee who had been determined to have hearing loss at a yearly physical. Also, Battalion Chiefs were eliminated from the study, as their 56 hour work schedule had remained in the 3/4 arrangement when the firefighters changed to the 48/96.

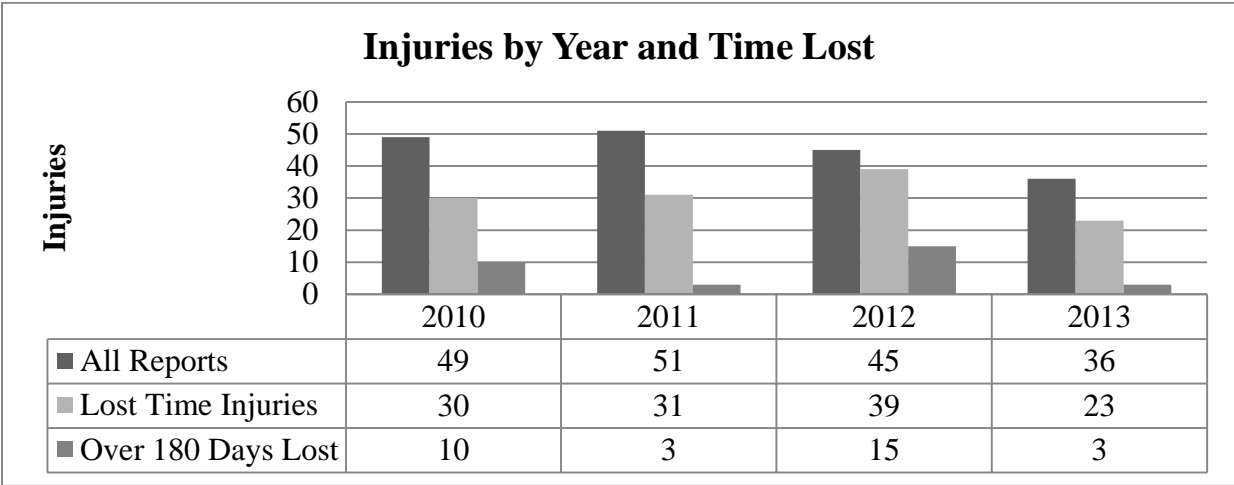
In order to see exactly when the injury occurred and track on-duty hours prior to injury and the station the employee was assigned to at the time of the injury, the OSHA form 301, Illness and Accident Report associated with each injury remaining in the study was accessed. All personnel identifiers (names, payroll numbers, etc.) were removed from the information

gathered and the information from these sources was tabulated, resulting in the information found in Appendix A.

An anomaly was found during this process that pointed to further filtering of the information. On October 15, 2012, fifteen injury reports were filled out for a single call, with no time lost. After investigation of the incident report and discussion with the responding captain, it was determined that a health department permit on the wall of a building containing a malfunctioning industrial waste burner had triggered concern among responding crews that they had been exposed to an unknown health threat. No health threat was subsequently found, but the high number of reports as a result of the incident pointed out the fact that precautionary injury reports may be more a measure of perceived injury than actual injury. The data was filtered again to remove injury reports with zero work days lost.

A final data set was refined from what was left, measuring long term injuries, defined as more than 180 days of lost work from a single injury. Figure 1 (below) summarizes Reno Fire Department injury data from 2010 through 2013.

Figure 1



Next, the injury data was separated by shift. Data from 2010 and 2011, before the change in work schedule, was separated into four categories; Day 1, Day 2, Day 3, and Off Regular Shift. These categories corresponded to the working days of the 3/4 shift schedule, and accounted for an employee who was injured while working on a shift not normally assigned. The data from 2011 and 2012 was separated into three categories; Day 1, Day 2, and Off Regular Shift. These categories corresponded to the first and second 24 hour shifts that make up the working period of the 48/96, and accounted for an employee who was injured while working on a shift not normally assigned.

Figure 2

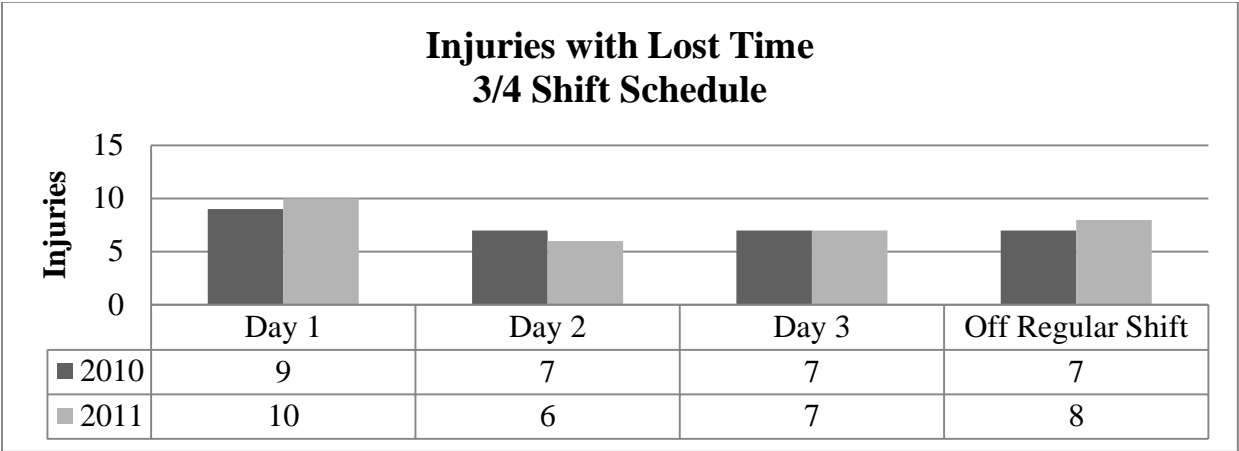
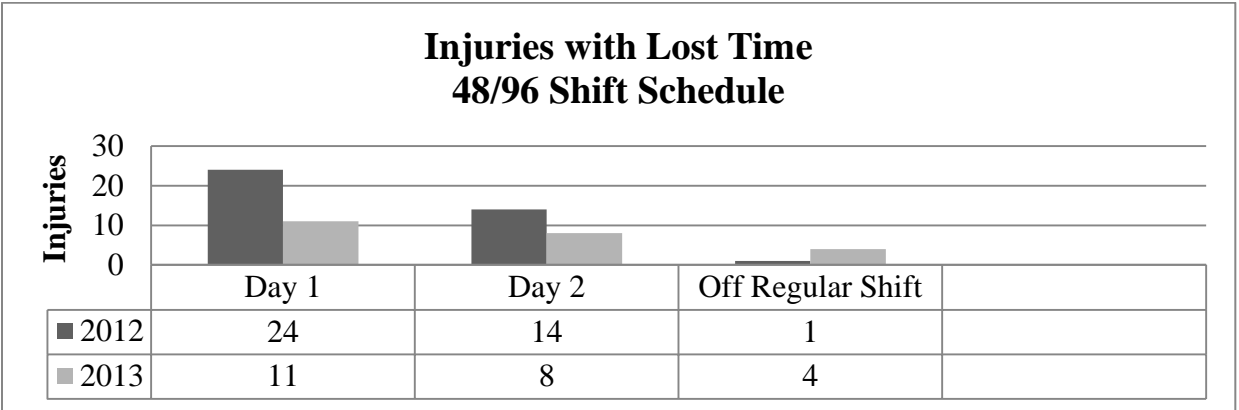


Figure 3



Year by year costs for on-the-job injuries were also found in the Reno Fire Department database. Once again, fire department staff produced information, this time from a computer data storage program called New World to measure the costs of industrial injuries on a monthly basis.

The information regarding vehicle accidents was also found using a Reno Fire Department database. The Training and Safety Division of the fire department oversees fire equipment operator training courses for the department, and the 56 hour training captain who works independently of a fire companies on the line while assigned to the training division is the fire department safety officer, and conducts accident investigations for any incident involving injury to a person or damage to a vehicle or property. A computer log is kept by the training division that details the accident date, shift on duty, accident type, time, fire department vehicle number, safety officer, a short description of the accident, the person involved, and the person's supervisor and battalion chief. The columns showing the description of the accident, the supervisor, and the shift on duty were removed for brevity, and for the final product, the names of the persons involved were X'd out. The remaining information can be found in Appendix B. By cross referencing the persons involved with the Telstaff roster files, it was determined how many hours were worked by each person involved in an accident prior to the accident and that information was recorded.

The information was again filtered. Accidents involving non-56 hour employees were eliminated. Also, accidents involving Battalion Chiefs were eliminated from the study. What were left were incidents involving fire apparatus involved in work related vehicle accidents. These were separated into the time periods 2010-2011 (3/4 shift schedule) and 2012-2013 (48/96 shift schedule). The Reno Fire Department uses the Telestaff computer program to manage the

staffing of the department, and since the accident log recorded the time of each accident, this time could be compared to the Telestaff records. The time on duty prior to an accident for each person who was involved in a vehicle accident was added into the table.

Tables 1 and 2 below, show that filtered information in table form.

Table 1

3/4 Shift Schedule - 2010 and 2011

Accident Date	Time	Hours worked prior	Day of go-round
1/1/10	5:30	21.5	3
1/3/10	16:33	8.5	3
1/18/10	10:00	2	2
2/23/10	9:00	1	3
4/30/10	10:15	2.25	3
5/11/10	8:30	0.5	1
5/31/10	12:15	4.25	2
6/16/10	17:30	33.5	Off Regular Shift
8/20/10	16:00	8	2
8/31/10	8:06	0	3
9/14/10	1:00	17	1
9/18/10	4:50	20.75	1
10/30/10	6:48	22.75	1
12/3/10	8:30	24.5	Off Regular Shift
12/25/10	0:03	16	1
1/29/11	20:24	8.5	2
2/13/11	14:50	6.75	2
4/2/11	10:10	2.25	2

4/17/11	6:30	22.5	2
4/19/11	unk	0-24	3
4/21/11	14:35	6.5	1
6/6/11	18:00	58	3
7/5/11	22:20	2.25	1
8/1/11	17:30	81.5	Off Regular Shift
10/24/11	15:33	7.5	1
11/4/11	unk	0	3
11/12/11	unk	24-48	Off Regular Shift
11/26/11	12:45	4.75	1

Table 2
48/96 Shift Schedule- 2012 and 2013

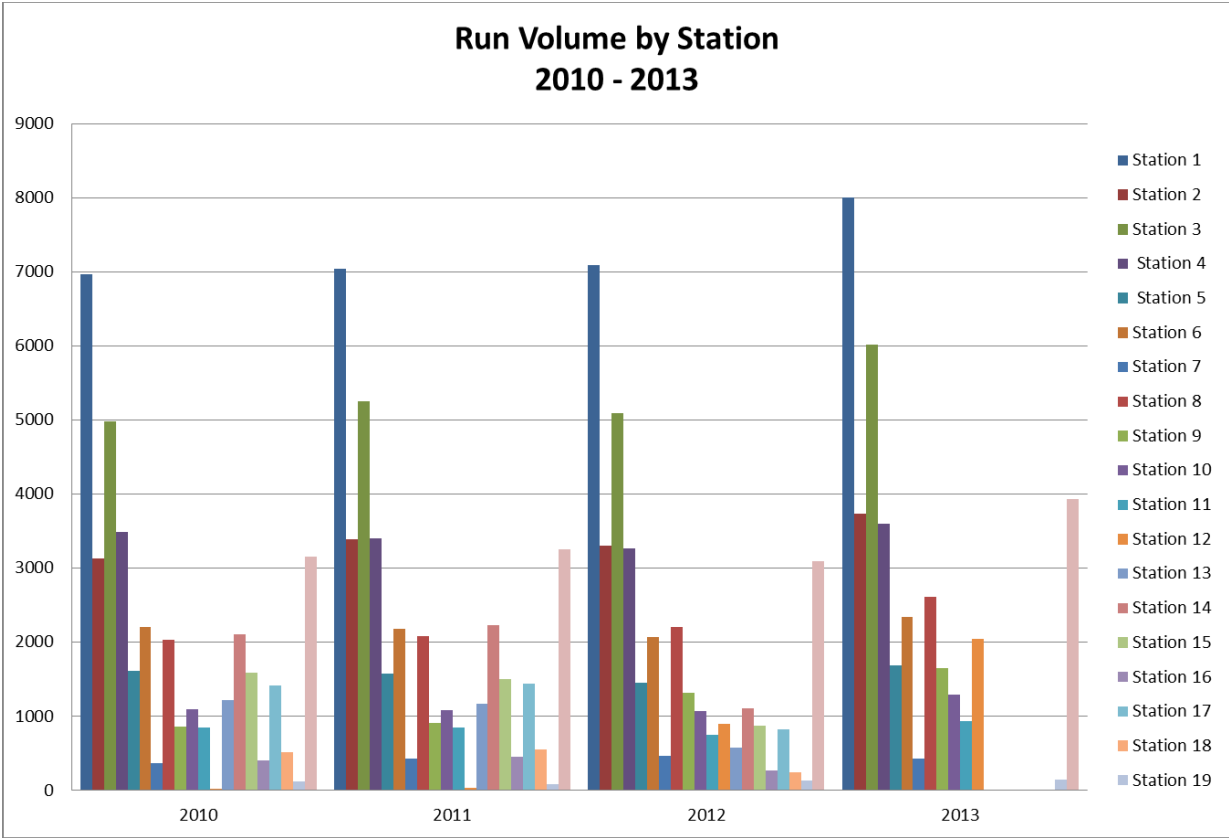
Accident Date	Time	Hours worked prior	Day of go-round
1/20/12	22:15	38.25	2
1/25/12	5:15	45.25	2
3/30/12	13:00	5	2
4/10/12	unk	0-24	1
4/13/12	1:10	17.25	1
4/29/12	4:30	44.5	2
5/3/12	11:40	27.75	2
6/2/12	7:00	23	Off Regular Shift
6/3/12	6:30	46.5	1
6/7/12	14:00	6	1
6/12/12	23:45	39.75	2
6/12/12	14:30	102.5	Off Regular Shift

Impacts on Firefighter Safety 27

6/29/12	unk	0-24	1
7/2/12	unk	24-48	2
8/5/12	12:20	28.25	2
8/21/12	15:30	7.5	1
9/5/12	19:30	35.5	1
10/23/12	14:13	6.25	1
10/31/12	unk	0-24	1
11/2/12	12:00	4	1
12/30/12	9:00	1	1
1/14/13	11:24	27.5	2
1/15/13	22:14	38.25	1
2/25/13	12:30	28.5	2
3/8/13	15:54	32	1
7/11/13	unk	168-192	2
7/18/13	8:04	0	1
7/20/13	14:06	6	1
7/27/13	19:51	35.75	2
8/8/13	15:00	31	2
9/6/13	10:45	146.75	Off Regular Shift
10/20/13	17:10	9.25	1
12/3/13	19:25	11.5	1
12/7/13	0:55	13	Off Regular Shift
12/22/13	13:00	53	2
12/23/13	20:45	1.75	1
12/25/13	18:10	10.25	1

Run totals for each station on yearly basis were found in the FireRMS reporting system used by the Reno Fire Department for incident reporting. An overall view is presented below, in Figure 4 (Reno Fire Department, 2014).

Figure 4



A table showing the percentage of calls that were run at night from July to October 2011 on the Reno Fire Department was found in a PowerPoint presentation created by department personnel who were examining alternate ways of staffing to minimize loss of service during station brownouts, and is presented as Figure 5, below (Marvel & Nachtsheim, 2011).

Figure 5

District Runs Numbers – Day, Night, Total, and Percentages

July 1, 2011 through October 15, 2011						
District	Day-Half (08:00:00 - 19:59:59)	Night-Half Total (20:00:00 - 07:59:59)	24 Hours Total	% of Calls after 20:00	% of Total RFD calls (24 Hours)	% of Total RFD night calls
1	1349	951	2300	41.35%	19.66%	21.65%
2	609	352	961	36.63%	8.22%	8.01%
3	928	576	1504	38.30%	12.86%	13.11%
4	623	435	1058	41.12%	9.04%	9.90%
5	314	165	479	34.45%	4.09%	3.76%
6	389	245	634	38.64%	5.42%	5.58%
7	82	54	136	39.71%	1.16%	1.23%
8	394	201	595	33.78%	5.09%	4.58%
9	171	88	259	33.98%	2.21%	2.00%
10	233	110	343	32.07%	2.93%	2.50%
11	181	99	280	35.36%	2.39%	2.25%
12	6	4	10	40.00%	0.09%	0.09%
13	202	118	320	36.88%	2.74%	2.69%
14	402	216	618	34.95%	5.28%	4.92%
15	284	159	443	35.89%	5.28%	3.62%
16	71	31	102	30.39%	0.87%	0.71%
17	326	201	527	38.14%	4.51%	4.58%
18	97	67	164	40.85%	1.40%	1.53%
19	24	9	33	27.27%	0.28%	0.20%
21	620	312	932	33.48%	7.97%	7.10%
Total	7305	4393	11698	37.55%		

Limitations for all the data collected included a small sample population, as the information was confined to a single fire department over four years. There were factors that made comparison difficult even within that small sample, as the number of people working for the department varied widely during the time studied, due to layoffs and the breakup of the department into two separate departments. As explained earlier, the literature review led to questions regarding run volume and sleep deprivation, and while literature on those subjects was enlightening and may lead to further study of this specific fire department, the focus of the study was returned to injury and accident rates as they may have been impacted by the change in shift

schedule. The results of the study begin to answer the question of whether there has been a change in injury and accident rates as a result of the schedule change. One question that remains is whether those injury and accident rates are abnormally high - and if so, why?

Results

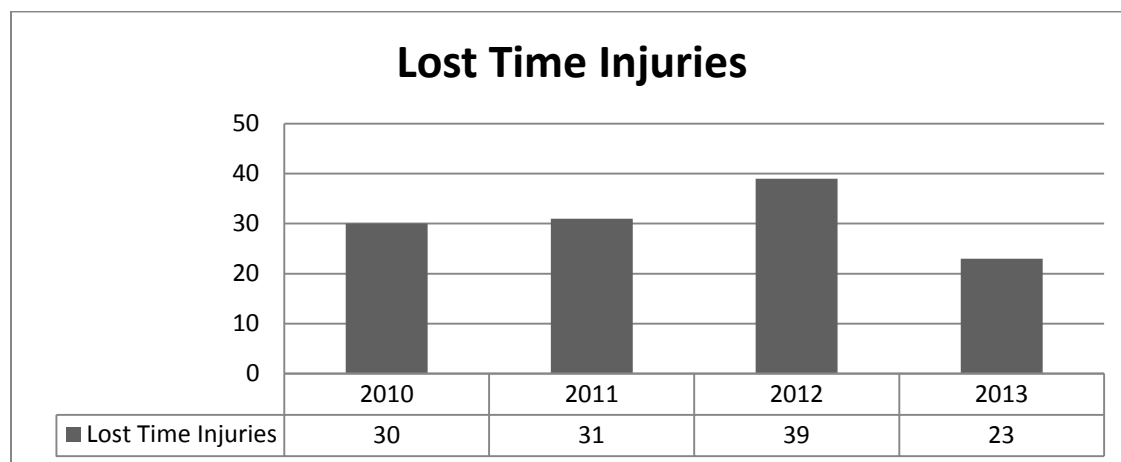
The results of the research conducted specific to the research questions follow:

Research question 1 asked, “How many on-the-job injuries occurred prior to the change of schedule compared to after the change in scheduled work hours?”

Using lost-time injuries as the measure, the answer was that in 2010 there were 30 lost-time injuries and in 2011 there were 31 lost-time injuries. The average for 2010 and 2011 was 30.5 lost-time injuries per year. In 2012 there were 39 lost-time injuries and in 2013 there were 23 lost-time injuries. The average for 2012 and 2013 was 31 lost-time injuries per year.

The increase in the average number of lost-time injuries from an average of 30.5 per year in 2010 and 2011 to an average of 31 in 2012 and 2013 does not indicate any significant trend in the number of lost-time injuries due to the change in schedule from the 3/4 shift schedule to the 48/96 shift schedule.

Figure 6



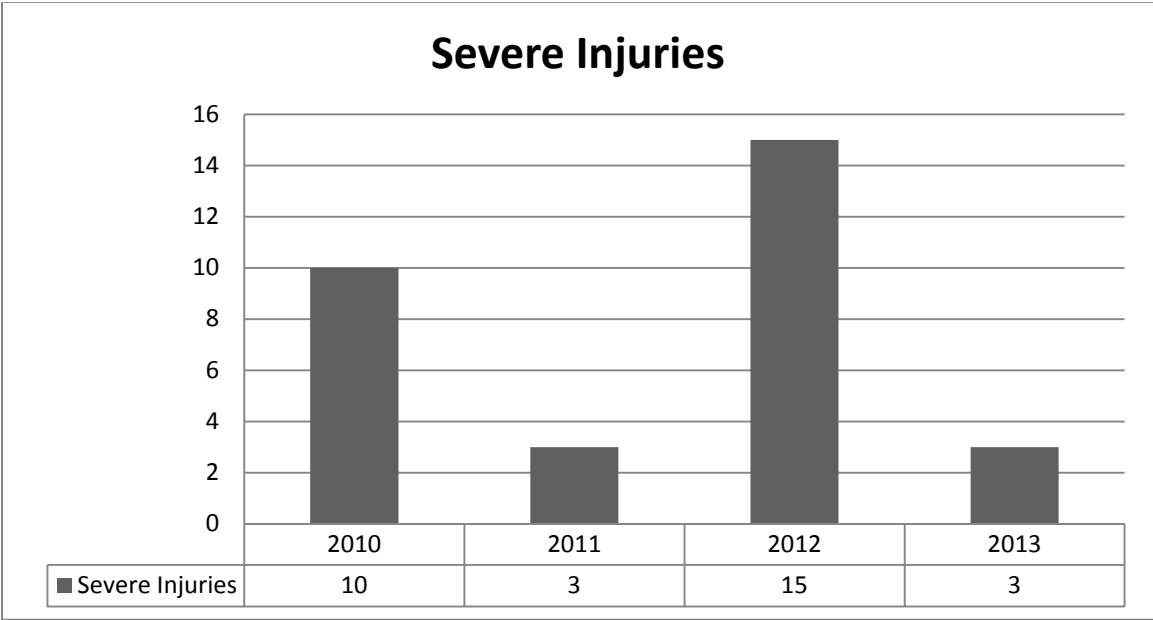
Research question 2 asked, “Has there been a change in the severity of injuries before and after the change in scheduled work hours?”

OSHA form 300, Log of Work-Related Injuries and Illnesses, classifies injuries, in part, by showing days away from work. The maximum number of days shown on the form is 180. After that number, the form records over 180 days as the default. Using the standard of over 180 days away from work as the definition of a severe injury, research found that on the Reno Fire Department in 2010 there were ten severe injuries and in 2011 there were three severe injuries. The average was 6.5 severe injuries per year. In 2012 there were 15 severe injuries and in 2013 there were three severe injuries. The average was nine severe injuries per year.

A limitation to the data is that as severe injuries were defined by more than 180 days off work due to the injury, it is possible that injuries that took place in the last half of 2013 were not counted as severe because they had not reached the 180 day threshold by the time the data was collected.

Even with that limiting factor in mind, it was found that the data was inconclusive as to whether there was an identifiable trend in the severity of injuries before and after the change in scheduled work hours, based on the observation that the number of severe injuries varied widely during the time period 2010-2013, inclusive, and the number of severe injuries both increased and decreased during the time period, without a consistent direction. As seen in figure 7, below, the highest number of severe injuries was experienced in 2012, five times the number of the previous year, only to have the number of severe injuries in 2013 return to the 2011 level, although the 2013 number, due to the limitation noted above, could move higher.

Figure 7



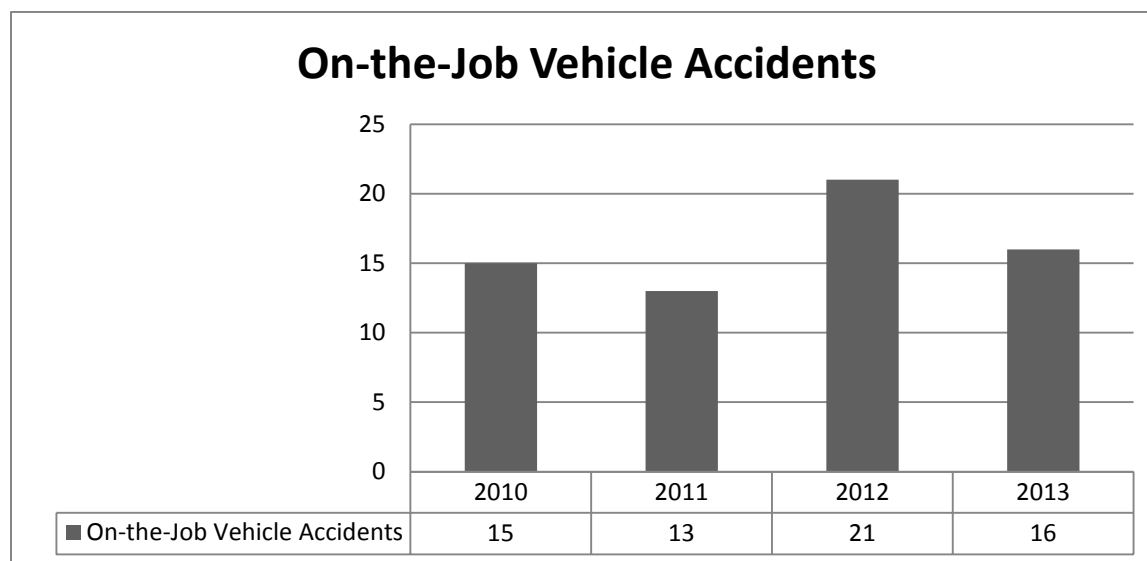
Research question 3 asked, “Has there been a change in the rate of vehicle accidents involving Reno Fire department apparatus before and after the change in scheduled work hours?”

Research showed that in 2010 there were 15 on-the-job vehicle accidents and in 2011 there were 13 on-the-job vehicle accidents. The average in 2010 and 2011 was 14 on-the-job vehicle accidents. In 2012 there were 21 on-the-job vehicle accidents and in 2013 there were 16

on-the-job vehicle accidents. The average in 2012 and 2013 was 18.5 on-the-job vehicle accidents.

The on-the-job vehicle accident average rate increased by 28.5% from 2010-2011 to 2012-2013. This may be a significant increase, but because only four years' worth of accident data was examined, confidence is only modest that the trend will continue towards higher numbers, especially on the same steep upward trajectory. More year by year numbers need to be collected to increase confidence.

Figure 8



Research question 4 asked, “At what point in the 48 hour shift did injuries and accidents occur?”

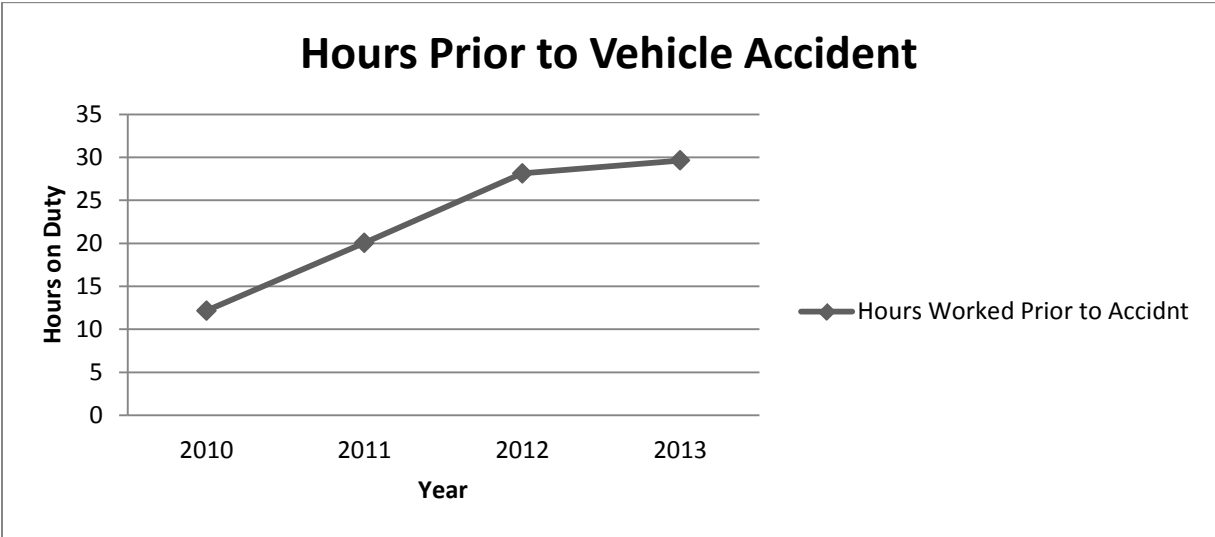
This question was broken down into two sets of data, vehicle accidents and injuries. First, vehicle accident data was used to show how many hours on duty before an accident occurs. In 2010, vehicle accidents occurred, on average, after 12.16 hours on duty. In 2011, vehicle

accidents occurred, on average, after 20.05 hours on duty. In 2010 and 2011 combined, vehicle accidents occurred, on average, after 15.32 hours on duty.

In 2012, vehicle accidents occurred, on average, after 28.13 hours on duty. In 2013, vehicle accidents occurred, on average, after 29.63 hours on duty. In 2012 and 2013 combined, vehicle accidents occurred, on average, after 28.83 hours on duty.

Limitations on a clear comparison of the data include that the opportunity to work longer hours is automatically built into the different shift arrangement. While there were times when individuals involved in a vehicle accident worked longer than 24 hours prior to the change in schedule (for example, a firefighter worked 81.5 consecutive hours prior to being involved in a vehicle accident on August 1, 2011), under the 48/96 schedule, half of all scheduled hours are beyond the previous normally scheduled 24 hour shift. If this is not taken into account, the trend illustrated in Figure 9, below, may be misleading. Another way to examine research question 4 was to ask, “During which 24 hour work period did the accidents occur in each schedule?”

Figure 9



It was expected that accidents would rise during the second 24 hour period of the 48 hour work period, and a comparison with the 3/4 shift schedule would be valid to see if a comparable rise in accident rates happened as the 3/4 shift moved through its cycle of shifts worked. The results for both schedules did not fit into preconceived expectations.

Research found that in 2010, accidents occurred five times on the first shift of the 3/4 schedule, three times on the second shift of the 3/4 schedule, five times on the third shift of the 3/4 schedule, and two times on a non-regularly scheduled shift for the equipment operator. In 2010, by percentage, the first shift had 33.3% of the accidents, the second shift had 20% of the accidents, the third shift had 33.3% of the accidents, and accidents occurring off the driver's regularly scheduled shift accounted for 13.3% of accidents.

In 2011, accidents occurred four times on the first shift of the 3/4 schedule, four times on the second shift of the 3/4 schedule, three times on the third shift of the 3/4 schedule, and two times on a non-regularly scheduled shift for the equipment operator. In 2011, by percentage, the first shift had 30.7% of the accidents, the second shift had 30.7% of the accidents, the third shift had 23.0% of the accidents, and accidents occurring off the driver's regularly scheduled shift accounted for 15.3% of accidents.

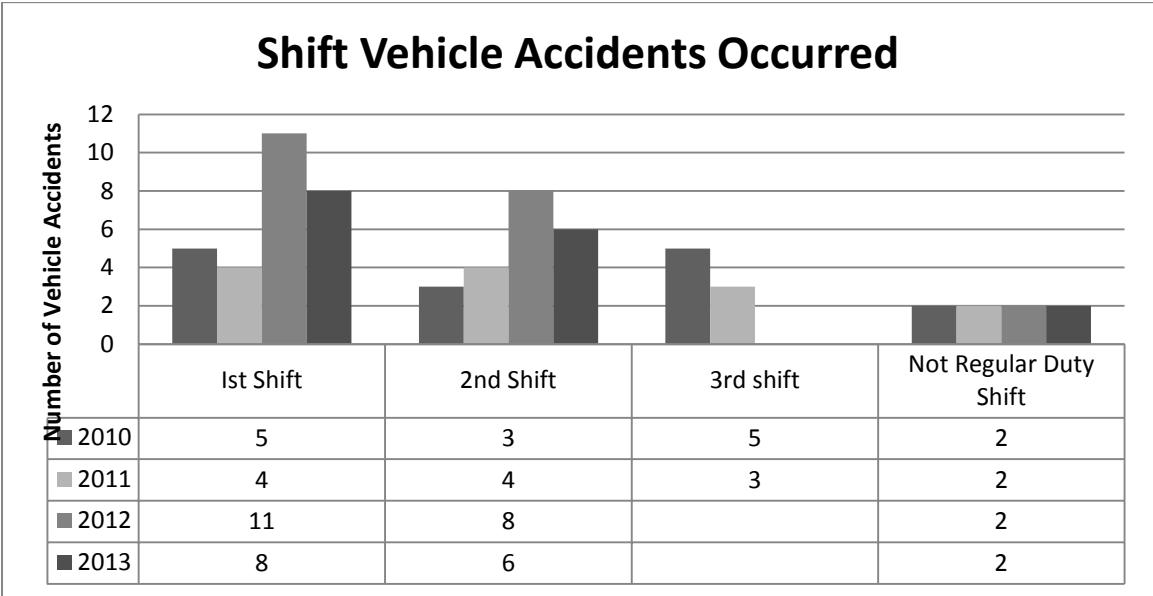
In 2012, accidents occurred 11 times on the first shift of the 48/96 schedule, eight times on the second shift of the 48/96 schedule, and two times on a non-regularly scheduled shift for the equipment operator. In 2012, by percentage, the first shift had 52.3% of the accidents, the second shift had 38.0% of the accidents, and accidents occurring off the driver's regularly scheduled shift accounted for 9.5% of accidents.

In 2013, accidents occurred eight times on the first shift of the 48/96 schedule, six times on the second shift of the 48/96 schedule, and two times on a non-regularly scheduled shift for the equipment operator. In 2013, by percentage, the first shift had 50% of the accidents, the second shift had 37.5% of the accidents, and accidents occurring off the driver’s regularly scheduled shift accounted for 12.5% of accidents.

In 2010 and 2011 combined, vehicle accidents occurred on the first shift 32.1% of the time, on the second shift 25% of the time, on the third shift 28.5 % of the time, and off the driver’s regular shift 14.2% of the time. In 2012 and 2013 combined, vehicle accidents occurred on the first shift 51.3% of the time, on the second shift 37.8% of the time, and off the driver’s regular shift 10.8% of the time.

In all four years studied, it was found that accident rates were highest or tied for highest during the first 24 hour period of a work cycle, both on the 3/4 schedule and the 48/96 schedule. This is illustrated in Figure 10.

Figure 10

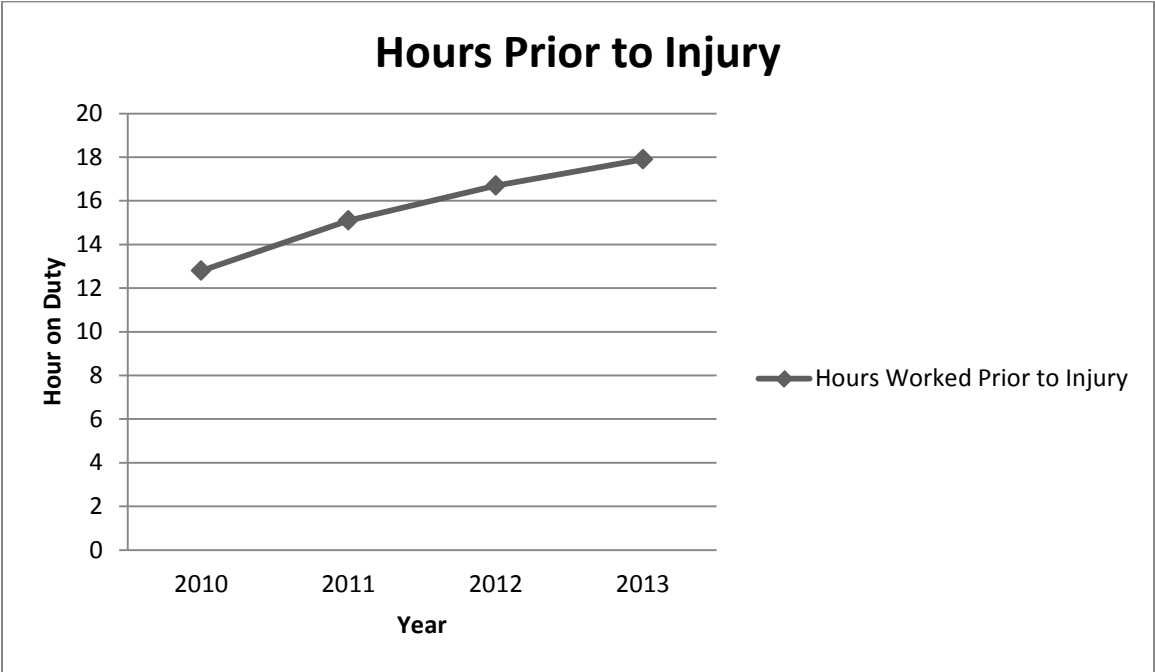


The same parameters were applied to the Reno Fire Department injury data. When looking at how many hours an employee was on duty before an injury occurred, research found that in 2010, injuries occurred, on average, after 12.8 hours on duty. In 2011, injuries occurred, on average, after 15.1 hours on duty. In 2010 and 2011 combined, injuries occurred, on average, after 13.0 hours on duty.

In 2012, after the change to the 48/96 shift schedule in January, injuries occurred, on average, after 16.7 hours on duty. In 2013, injuries occurred, on average, after 17.9 hours on duty. In 2012 and 2013 combined, injuries occurred, on average, after 17.1 hours on duty.

Again, limitations on a clear comparison of the data include that the opportunity to work longer hours is automatically built into the 48/96 shift schedule.

Figure 11



And again, another way to examine research question 4 was to ask, “During which 24 hour work period did the injuries occur in each schedule?”

In 2010, lost time injuries occurred nine times on the first shift of the 3/4 schedule, seven times on the second shift of the 3/4 schedule, seven times on the third shift of the 3/4 schedule, and seven times on a non-regularly scheduled shift for the employee. In 2010, by percentage, the first shift had 30% of the lost time injuries, the second shift had 23.3% of the injuries, the third shift had 23.3% of the injuries, and injuries occurring off the employee’s regularly scheduled shift accounted for 23.3% of accidents.

In 2011, lost time injuries occurred ten times on the first shift of the 3/4 schedule, six times on the second shift of the 3/4 schedule, seven times on the third shift of the 3/4 schedule, and eight times on a non-regularly scheduled shift for the employee. In 2011, by percentage, the first shift had 32.2% of the lost time injuries, the second shift had 19.3% of the injuries, the third shift had 22.5% of the injuries, and injuries occurring off the employee’s regularly scheduled shift accounted for 25.8% of accidents.

In 2012, lost time injuries occurred 24 times on the first shift of the 48/96 schedule, 14 times on the second shift of the 48/96 schedule, and one time on a non-regularly scheduled shift for the employee. In 2012, by percentage, the first shift had 61.5% of the lost time injuries, the second shift had 35.8% of the injuries, and injuries occurring off the employee’s regularly scheduled shift accounted for 2.5% of accidents.

In 2013, lost time injuries occurred 11 times on the first shift of the 48/96 schedule, eight times on the second shift of the 48/96 schedule, and four times on a non-regularly scheduled shift for the employee. In 2013, by percentage, the first shift had 47.8% of the lost time injuries, the

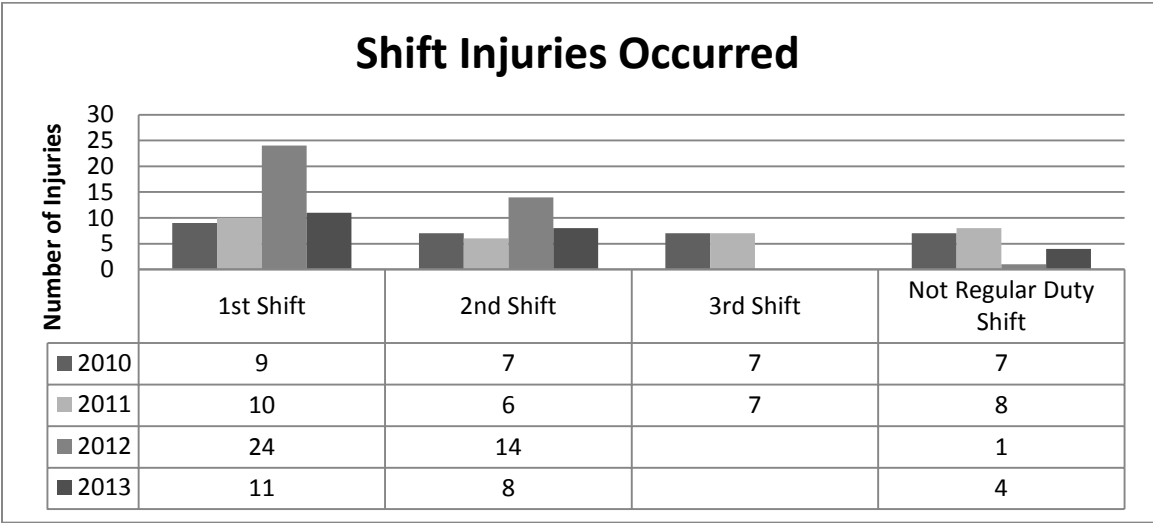
second shift had 34.7% of the injuries, and injuries occurring off the employee’s regularly scheduled shift accounted for 17.3% of accidents.

In 2010 and 2011 combined, lost time injuries occurred on the first shift 31.1% of the time, on the second shift 21.3% of the time, on the third shift 22.9 % of the time, and off the employee’s regular shift 24.5% of the time.

In 2012 and 2013 combined, lost time injuries occurred on the first shift 56.4% of the time, on the second shift 35.4% of the time, and off the employee’s regular shift 8.0% of the time.

Showing the same trend that vehicle accidents exhibited, lost time injuries were most likely to occur in the first 24 hour period of a work cycle regardless of whether the shift schedule was the 3/4 or 48/96 schedule, as shown in Figure 12.

Figure 12



While data was found to answer the four stated research questions, more general data peripherally related to the research questions was collected as part of the project. A 12 question

survey was sent to all Reno Fire Department employees asking about their feelings about the change in schedule and perceived changes in safety and quality of life away from the job as a result of that change in schedule. Additionally, two Reno Fire Department employees were interviewed and asked questions regarding their perception of how safety and quality of life had been impacted as a result of the change in schedule.

At the time of the survey, there were 253 Reno Fire Department members shown on the seniority list, and all members were sent the survey by department e-mail. One hundred thirteen Reno Fire Department employees responded to the survey. In order to check to see whether the survey sample reflected the overall demographics of the Reno Fire Department, survey questions asked about age, rank, and time in service. The survey's first question distilled the responding group down to those working a 56 hour schedule, comprising of 105 respondents.

The second question of the survey asked the respondent to identify the age category that he or she fit into. The survey showed that of those who were left in the responding group (56 hour employees), 1.9% were age 21 to 29, 19.05% were age 30 to 39, 57.14% were age 40 to 49, 20.95% were age 50 to 59, and .95% were 60 years old or older.

The survey data was compared to data retrieved from the a training database maintained by the Reno Fire Department that showed that 0.47% of RFD 56 hour personnel were age 21 to 29, 22.00% were age 30 to 39, 52.15% were age 40 to 49, 23.44% were age 50 to 59, and 1.91% were 60 years old or older (see Figure 13, below).

The third survey question asked the respondent to identify their rank, and the survey's data showed that firefighters were 49.52% of respondents, fire equipment operators were 23.81% of respondents, captains were 23.81% of respondents, and battalion chiefs were 2.86% of

respondents. Examination of the official 2014 Reno Fire Department seniority list showed the make-up of the line personnel to be 58.77% firefighters, 18.42% fire equipment operators, 19.73% captains, and 3.07% battalion chiefs (see Figure 14, below).

The fourth question of the survey looked at time in service on the Reno Fire Department. The survey's data reflected that the respondents fell into the following categories: 28.85% had less than ten years' time in service, 27.88% had 10 to 15 years' time in service, 26.92% had 16 to 20 years' time in service, 4.81% had 21 to 25 years in service, and 11.54% had over 25 years' time in service. The 2014 seniority list showed the time in service of line personnel to be 24.56% of personnel had less than 10 years' time in service, 33.33% of personnel had 10 to 15 years' time in service, 25.43% of personnel had 16 to 20 years' time in service, 5.70% of line personnel had 21 to 25 years' in service, and 10.96% had over 25 years' time in service (see Figure 15, below).

Figure 13

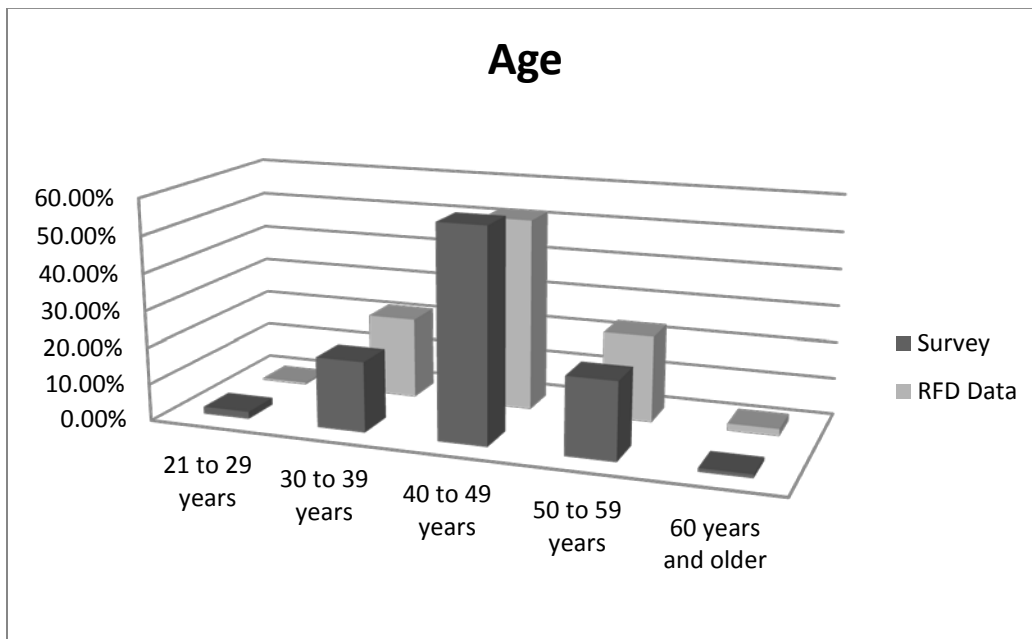


Figure 14

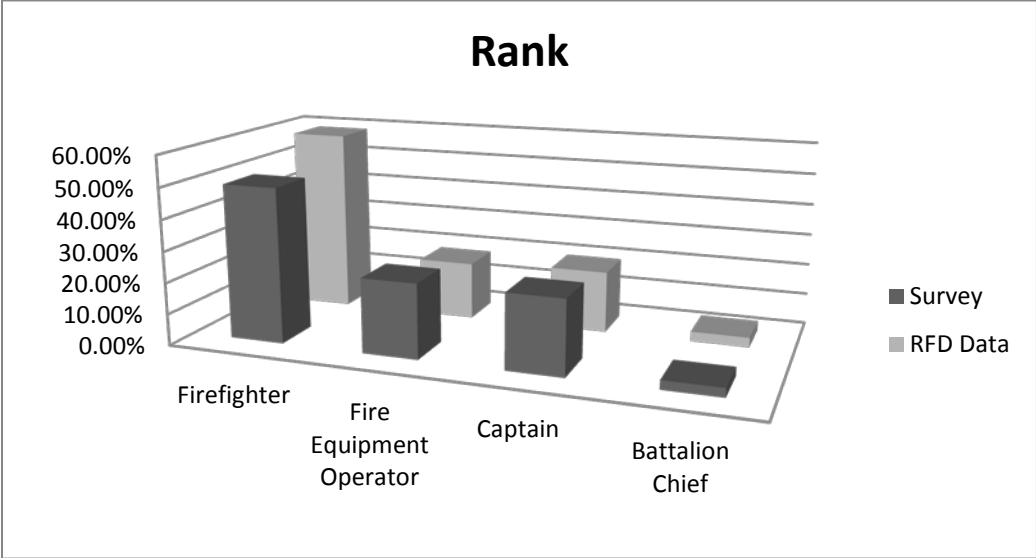
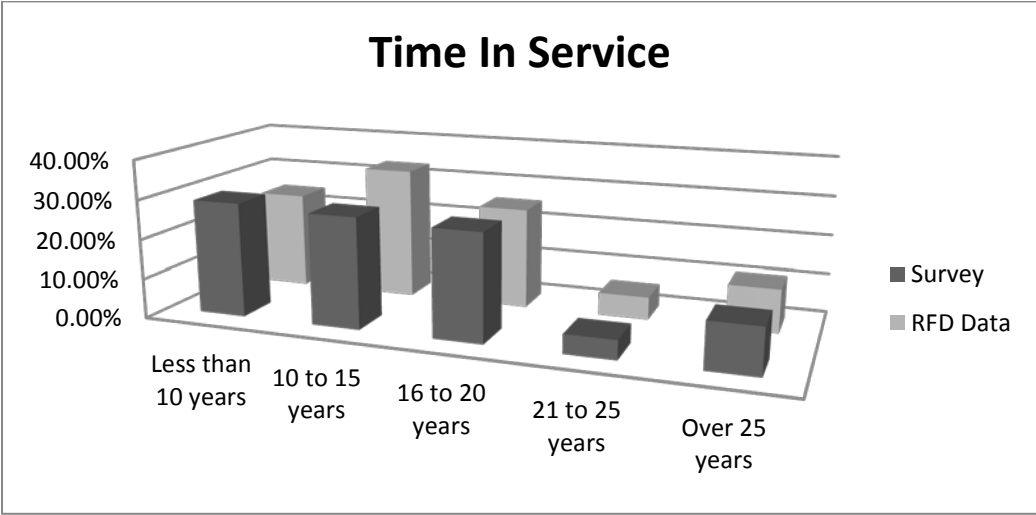


Figure 15



It was determined by the preceding survey questions that the survey sample returned to the researcher was consistent with the population demographics of the Reno Fire Department.

The remaining questions in the survey asked about the employees' feelings about the 3/4 shift schedule and the 48/96 shift schedule, how the change may have affected employee safety, and how the change in schedule affected the quality of time away from work. The survey data

showed that the 48/96 schedule was well liked by the employees, with 77.89% of respondents reporting they liked the schedule. Conversely, only 13.47% of the respondents reported disliking the 48/96 schedule. 8.65% of respondents neither liked nor disliked the 48/96 schedule.

The respondents also liked the 3/4 schedule, with 59.40% reporting liking the schedule, and 17.82% reporting disliking the 3/4 schedule.

When asked if the change to the 48/96 schedule affected employee safety, 65.71% of respondents answered no. Of the 34.29% of respondents who answered yes, 80% felt that employees are less safe as a result of the change in schedule, and 20% felt employees were safer as a result of the change in schedule.

When asked if the change in schedule affected quality of time away from work, the results were inverted, with 67.31% of respondents reporting that the quality of time away from work was affected by the schedule change. Of those who reported that the schedule change affected time away from work, 77.14% reported that time to be moderately or much improved, and 22.86% reported that time to be moderately or much worse.

When asked if they supported the change to the 48/96 schedule prior to implementation, 56.73% reported that they had supported the change to the new schedule, while 27.88% did not support the change, and 15.38% reported that they did not have an opinion on that question prior to implementation. When asked what schedule, between the 48/96 and the 3/4 schedules, that they now prefer, 74.04% reported that they prefer the 48/96 schedule and 21.15% prefer the 3/4 schedule.

As stated above, two members of the Reno Fire Department were interviewed. Both were told that the interview was part of an applied research project that was examining injury

and accident data and the shift schedule change, but they were not provided the questions prior to the interview, in order to collect general impressions rather than data driven responses. The two individuals who were interviewed were Division Chief Tim O'Brien, the operations division chief, who was assigned to a 40 hour weekly work schedule, and Captain John (Jack) Fleiner, a captain in the training division who worked the 48/96 schedule and was the shift safety officer on all B shift multiple company incidents, the safety officer for any on duty injury or illness, and the accident investigator for vehicle accidents.

Both interviews focused on the perception of whether safety of the employee or the public was impacted by the change in schedule. Captain Fleiner and Chief O'Brien both stated that fatigue was a concern. Captain Fleiner noted that, "some things I felt were changing were injuries due to fatigue." He went on to say about the fire crews, "...lifting the patient on the first shift, they were a little fresher and would be more conservative. On the second shift, where they were getting beat up, we have a lot of back strains, shoulder strains that I didn't see before." The "second shift" was the second 24 hour period contained within the 48 hour work period. Captain Fleiner also noted that it seemed like there were more long term injuries.

Chief O'Brien was more specific in his concerns. When asked if employee safety had been impacted by the schedule change, he replied that it had, continuing with, "I believe in station 1 in particular, that their fatigue level is of concern." Station 1 is the busiest station on the department, with over 6,000 calls for service per year. Chief O'Brien stated that, "It seems like we get in more vehicle accidents than we did before, since we switched."

While Captain Fleiner did not like the 48/96 schedule, stating that, "At the end of two shifts, man, I'm spent," Chief O'Brien supported the change to the new schedule, both prior to

the change and two years after the change. While the division chief had reservations concerning managerial problems with the long absences from work created by 96 hours off duty after each work period, he stated that, “From an employee standpoint, I support it. It’s better for their family life, they pick up more weekends off to be with their family, they seem to like the schedule...”

Discussion

The results of the study of the Reno Fire Department injury and accident statistics in the two years prior and after a shift schedule change from the 3/4 schedule to the 48/96 schedule yielded mixed results. The two year average number of lost time injuries remained almost unchanged. That result conflicts with the results regarding injuries obtained by collected by James Clack (2003) in his study of the Minneapolis Fire Department, who reported that, “Especially striking were the large differences in work-related injuries and motor vehicle accidents. These risk management measures convincingly demonstrate the increased costs associated with allowing firefighters to work beyond 24 consecutive hours in large emergency services organizations.” However, there was no conflict on accident rates, as both studies found an increase in vehicle accidents.

The Reno Fire Department is a relatively busy fire department, with the busiest station running over 8,000 calls in 2013, an average of almost 22 calls per 24 hour period. The city served has large casino district operating 24 hours a day, and at the busier stations sleep is interrupted more than the two times per night cited by Koen (2005) when determining sleep deprivation. She writes about the minimum work rest ratio as 3:4, and states that the 48/96 schedule has a 1:2 ratio, better than the recommended minimum ratio. The 3/4 shift schedule,

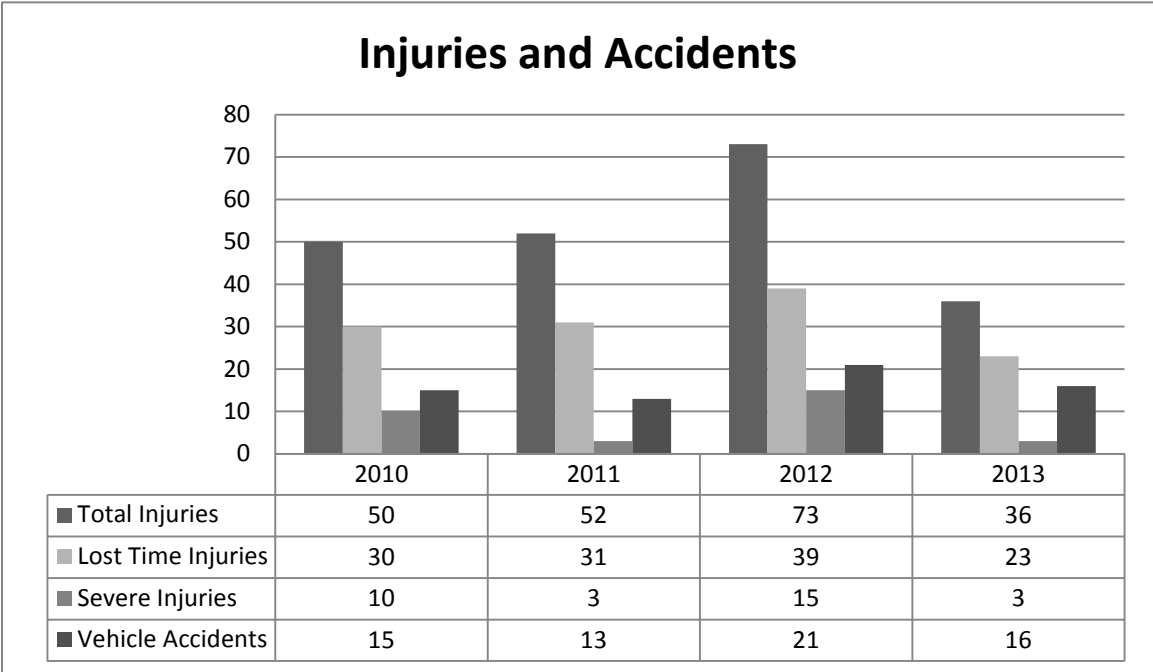
while working the same amount of hours, arranges them differently, so that in the midst of the 3/4 schedule the firefighter is working 24 hours on duty, followed by 24 hours off duty, repeated for a total of three times. The work rest ratio during the working part of the 3/4 schedule is 1:1, below the minimum recommendation of 3:4. This may account for the fact that the rate of injury did not change with the change to a longer, 48 hour work period. Specifically, Reno Fire Department firefighters may have been sleep deprived prior to the change in schedule, without sufficient off duty time to recover. If the firefighter is sleep deprived and works the same number of hours under each schedule, then it follows that injuries would remain constant. The next step might be to compare injury data from like-size departments with varying run totals, combined with a specific sleep deprivation analysis of department personnel.

The data on the number of severe accidents was less clear, as the number of severe injuries varied widely from year to year. Although the two year average of severe injuries increased after the schedule change, the number of severe injuries in each individual year varied widely, and no clear trend was clearly indicated. The time scope of study needs to be lengthened so that the data sample can produce results with confidence.

There was a 28.5% increase in the two year average of vehicle accidents from 2010-2011 to 2012-2013. Why would injuries remain constant but accidents increase under the scenario that sleep deprivation is present under both schedules? Is the answer that lost-time injuries are self-limiting by the nature of the fact that the injured person ends his or her shift at the time of the injury but those who are involved in a vehicle accident usually continue with their regularly scheduled work? It was not seen that the same person would be involved in separate vehicle accidents within the same shift, so the self-limiting nature of the injuries can be discounted as the reason for the difference in change rates between injuries and accidents.

When the overall numbers for total injuries, lost-time injuries, severe injuries, and vehicle accidents are compared, the most striking feature isn't the change from the period 2010-2011 to 2012-2013, but rather how, in all categories, 2012 has the highest number in every category. In fact, 2013 injury rates (overall, lost time, and severe) all are significantly lower than the 2010-2011 two year average, and vehicle accidents in 2013 were close to that 2010-2011 average. The year 2012 was drove the increase in the vehicle accident rate after the schedule change.

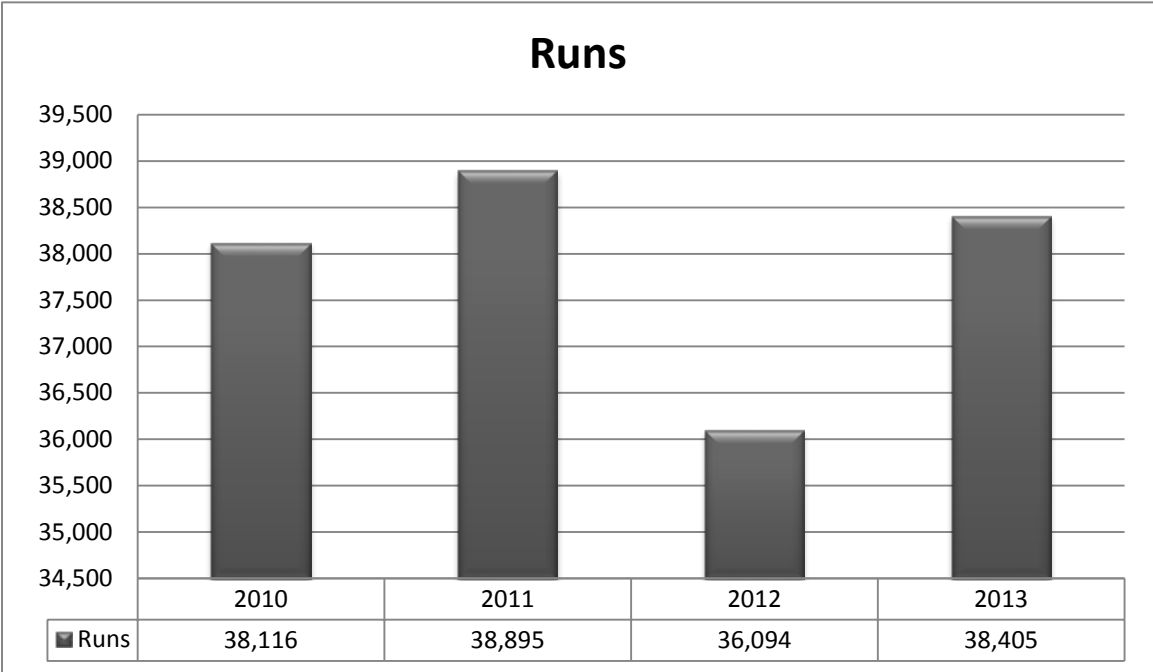
Figure 16



Is the most significant factor affecting these rates the change in schedule itself? It would be enlightening to look at a fire department who moved from a 48/96 to a 3/4 schedule, but that may be hard to find, because the survey that was part of the study found that two years after implementation of the 48/96 schedule, by a three to one margin, the 48/96 schedule was preferred to the 3/4 schedule.

Two other factors stood out. First, while the Reno Fire Department is a busy fire department, it does not appear that there is a direct correlation between run volume and accident and injury rates. As noted above when discussing sleep deprivation and injury rates, it may be that the run volume is high enough that changes in the number of yearly runs would need to be significant to impact injuries and vehicle accidents, since in 2012 the department had the lowest number of runs of the four years studied, and the highest accident and lost time injury rates.

Figure 17



Second, the last 24 hour period of the 48/96 work period did not have the highest number of injuries or vehicle accidents. The data was similar for the 3/4 schedule, where the last 24 hour period of the three shifts worked one on/one off was not the most dangerous. Again, this is a different result than the 44.4% increase in injuries in the second 24 hour period as compared to the first 24 hour period of a 48 hour shift that Clack (2003) found in his often cited applied research project. On the Reno Fire Department, in the four year period 2010 through 2013,

injuries and vehicle accidents were most likely to occur on the first day of return to work from four days off in both the 48/96 schedule and the 3/4 schedule.

Do these Reno Fire Department numbers reflect the same sort of factors that spiked the injury and vehicle accident numbers in 2012, the year after the change in schedule? Does a four day off period lead to a loss of focus and a need to readjust to the job environment upon return to work, much as the change in shift schedule required a settling in period as the firefighters became familiar with, and learned how to manage, the changed demands of the new schedule? Does it happen over four days?

In his interview, Chief O'Brien noted that the 48/96 is, from "...an admin standpoint, it's horrible, because there's too many days that go by before we see people." It may be taken for granted that firefighters will return from days off refreshed and focused, but this data shows that those "too many days that go by" may also have an effect on safety of the employee.

Recommendations

This research paper set out to find if, as a result of a change in shift schedule at the Reno Fire Department, there was a change in injury and accident rates, the severity of injuries, and when in the work period those injuries and accidents occurred. Literature reviewed for the project suggested that sleep deprivation may play a part in increased injury and accident rates in fire departments, and although none of the research questions specifically addressed sleep deprivation, the issue merits attention as part of the recommendations for the Reno Fire Department.

The results of the research undertaken for this project found that there was no significant increase in lost time injuries as a result of the change in shift schedule; however, the research did

not seek to answer the question of whether those injury rates were higher than a similar size fire department with fewer calls for service. It is recommended that lost time injury rates continue to be tabulated year by year to increase the sample size and boost confidence in the data, and that data should be compared to other departments to assess whether the Reno Fire Department has a higher than normal rate of lost time injuries.

In the case of severe injuries, more year by year data is needed before an appropriate comparison can be made with similar fire departments, and it is recommended that severe accident data continue to be tabulated and analyzed on the Reno Fire Department.

The research found that there was a 28.5% increase in the number of vehicle accidents in the two year period after the change in shift schedule, and it is recommended that the department explore more fully the reasons for the increase. One possible starting point for that exploration would be the result of the research question that asked when accidents and injuries occurred within the shift time period. In both the 3/4 and 48/96 shift schedules, the first shift after returning from four days off duty was the most likely time for an employee to experience an injury or vehicle accident. It is recommended that this information be disseminated to the department and efforts to focus upon injury and accident prevention be a priority on those days for supervisors.

Even without concrete evidence of sleep deprivation among Reno Fire Department employees, there are steps that can be taken to help mitigate the effects of a 48 hour work period. It is recommended that the fire department consider how to increase rest during night hours. This can be considered as two parts, structural and attitude. Structural change may include such things as doors on all individual sleeping units and control of the sleeping quarters' temperature

by the occupying crew. An attitude shift may be started by education for the firefighters on sleep deprivation's effects, and how to recognize it, and how to reduce or eliminate the effects of sleep deprivation.

With the overwhelming approval of the 48/96 schedule by the employees in mind, it is recommended that the Reno Fire Department continue with that schedule, while continuing to collect data and explore ways to reduce injuries and accidents as outlined above. It is recommended that any fire department that is considering a change in schedule look at hard data concerning injuries and accidents from departments that have experienced the same schedule change being anticipated, and also that departments make sure that their injury and accident data is available to be analyzed for future research. Each fire department exists in a unique situation, and there is no single shift schedule that fits all departments, but by sharing and analyzing data, fire departments can make informed choices that result in a safer and more efficient fire service.

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Appendix A

Reno Fire Department Injury Data 2010 through 2013

2010

Name Removed	Date of Injury	Days Away From Work	Over 180 Days (Y)	Time of Injury	Apparatus	Station
	1/9	14		12:43	P19	19
	1/14	19		10:00	E15	15
	1/15	21		8:00	E2	2
	1/25	0		13:00	E1	1
	1/31	62		12:20	E16	16
	2/4	69		10:00	E21	21
	2/11	0		14:00	T10	10
	2/15	0		10:00	E8	8
	2/21	0		20:50	E5	5
	3/9	27		15:40	T3	3
	3/14	54		1:08	E17	17
	3/24	3		21:10	E16	16
	4/27	180	Y	8:15	E21	21
	4/27	180	Y	10:30	T1	1
	5/1	29		19:30	E3	3
	5/7	0		10:35	E16	16
	5/16	0		18:00	E2	2
	6/7	3		19:30	E4	4
	6/9	0		11:30	E11	11
	6/11	0		14:00	E8	8
	6/14	180	Y	13:08	E1	1
	6/30	180	Y	11:35	E14	
	7/5	180	Y	17:50	E18	19
	7/10	180	Y	11:00	E1	1
	7/12	0		0:30	E11	11
	7/13	180	Y	6:30	E8	8
	7/24	180	Y	16:08	T3	3
	7/24	180	Y	11:00	T1	1
	7/26	180	Y	17:30	B14	14
	7/30	178		8:00	E1	1
	8/2	0		18:00	E17	17
	8/8	10		8:05	E14	14

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	8/16	161		15:15	E4	4
	8/21	154		11:00	E14	
	8/26	0		11:30	HZMAT 3	3
	9/4	0		9:20	P19	19
	9/22	0		14:20	E5	5
	10/11	0		16:16	E21	
	11/3	0		14:30	T3	3
	11/8	0		20:00	E2	2
	11/23	5		7:30	E15	15
	11/24	0		7:45	E15	15
	11/24	0		10:45	E5	5
	12/7	48		11:10	T1	1
	12/17	38		19:30	E8	8
	12/17	38		10:45	E6	6
	12/25	5		17:30	E3	3
	12/26	0		22:30	E13	13
	12/28	25		9:30	E16	16
	12/29	0		18:00	E2	2

2011

Name Removed	Date of Injury	Days Away From Work	Over 180 Days (Y)	Time of Injury	Apparatus	Station
	1/1	157		1:00	E1	1
	1/8	28		13:45	E8	8
	1/17	17		21:30	E16	16
	1/25	0		14:30	E16	16
	1/29	13		3:40	E15	15
	2/5	180	Y	18:32	E13	13
	2/8	0		3:20	E15	15
	3/13	1		8:00	E1	1
	3/16	40		8:15	E6	6
	4/5	2		9:30	T1	1
	4/10	17		8:00	E13	13
	4/15	0		10:00	E13	13
	4/19	10		8:00	E21	21
	4/27	11		11:30	E3	3
	5/10	0		16:35	E5	5
	5/13	0		14:00	E4	4

Impacts on Firefighter Safety 56

	5/25	0		14:00	E2	2
	5/29	10		9:15	R3	3
	6/6	130		16:15	E15	15
	6/6	7		18:00	E2	2
	6/13	0		18:45	E3	3
	6/19	0		4:50	E17	17
	7/6	0		13:00	E1	1
	7/27	4		18:45	E2	2
	7/29	0		2:00	E1	1
	7/30	0		10:30	E16	16
	8/10	19		8:00	E21	21
	8/11	0		16:30	E6	6
	8/14	0		10:00	E11	11
	8/14	0		7:20	E4	4
	8/22	53		16:30	E11	11
	8/28	0		19:00	E4	4
	8/30	8		0:25	E6	6
	9/17	135		3:30	E18	18
	9/28	0		13:30	E5	5
	9/29	91		10:00	E6	6
	10/11	0		8:00	E16	16
	10/17	38		9:00	E8	8
	10/17	180	Y	22:15	E18	18
	10/23	0		3:00	E18	18
	10/24	0		5:00	T3	3
	11/18	10		9:00	T1	1
	11/18	39		??	E15	15
	11/18	18		10:00	E6	6
	11/18	90		16:00	T3	3
	11/18	0		2:00	E3	3
	11/18	6		9:00	E16	16
	11/19	8		8:00	E11	11
	11/27	54		22:00	E11	11
	12/9	3		06::30	E8	8
	12/26	180	Y	10:45	E13	13
	12/31	0		20:45	E3	3

2012

Name Removed	Date of Injury	Days Away From Work	Over 180 Days (Y)	Time of Injury	Apparatus	Station
	1/1	180	Y	10:30	T3	3
	1/2	180	Y	18:30	E14	14
	1/6	180	Y	7:00	E17	17
	1/8	7		21:30	E8	8
	1/8	180	Y	14:00	E15	15
	1/12	180	Y	14:00	E2	2
	1/13	2		10:20	T1	1
	1/19	0		13:00	E6	6
	1/19	180	Y	20:00	E17	17
	1/19	3		15:00	E8	8
	1/19	1		17:00	E16	16
	1/20	0		18:00	B6	6
	1/24	0		17:05	E14	14
	2/1	180	Y	10:30	E13	13
	2/14	180	Y	10:30	E8	8
	2/17	7		15:00	E15	15
	2/26	180	Y	8:15	E14	14
	2/29	180	Y	6:30	E4	4
	3/1	152		12::40	E16	16
	3/8	0		13:00	E5	5
	3/12	180	Y	13:18	E5	5
	3/14	175		6:00	E2	2
	3/14	180	Y	5:45	E2	2
	3/22	0		20:00	E11	11
	4/112	17		8:00	E13	13
	4/30	180	Y	13:30	T3	3
	5/7	0		18:30	E18	18
	5/9	0		12:45	E14	14
	5/12	0		15:00	E13	13
	5/22	180	Y	13:00	E21	21
	6/9	180	Y	14:30	T3	3
	6/12	88		2:41	E11	11
	6/13	102		16:35	E13	13
	6/27	29		19:30	E13	13
	7/1	8		1:00	E15	15

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	7/2	0		14:00	E8	8
	7/3	0		21:42	E8	8
	8/13	0		11:00	E9	9
	8/18	17		15:00	E9	9
	8/23	0		14:40	E7	7
	8/30	0		13:00	E1	1
	9/20	47		10:30	E9	9
	9/21	0		1:45	E4	4
	9/23	0		12:00	E21	21
	9/26	0		18:30	E2	2
	9/26	4		11:30	E4	4
	10/15	0		23:45	E12	12
	10/15	0		23:08	T3	3
	10/15	0		23:08	E3	3
	10/15	0		23:08	E3	3
	10/15	0		23:08	E3	3
	10/15	0		23:08	T3	3
	10/15	0		23:09	E6	6
	10/15	0		23:08	T3	3
	10/15	0		23:08	T3	3
	10/15	0		23:45	E12	12
	10/15	0		23:45	E12	12
	10/15	0		23:09	E6	6
	10/15	0		23:15	E12	12
	10/15	0		23:08	E3	3
	10/15	0		23:09	E6	6
	10/16	0		11:30	E21	21
	10/17	0		13:15	E2	2
	10/19	2		11:00	E11	11
	10/27	1		15:00	E5	5
	11/24	4		16:20	E2	2
	12/1	35		8:39	E6	6
	12/12	28		8:00	E11	11
	12/17	24		16:00	E9	9
	12/19	22		8:00	T2	2
	12/21	9		18:30	E2	2
	12/26	15		8:00	E10	10
	12/28	0		9:20	E1	1

2013

Name Removed	Date of Injury	Days Away From Work	Over 180 Days (Y)	Time of Injury	Apparatus	Station
	1/4	9		16:45	E12	12
	1/25	103		13:30	E11	11
	2/6	56		10:50	E21	21
	2/11	10		19:30	E1	1
	2/13	0		11:00	E5	5
	3/6	180	Y	14:00	E9	9
	3/25	0		11:30	E9	9
	3/27	8		17:25	E4	4
	3/28	0		8:00	E1	1
	3/31	7		0:30	E5	5
	4/12	0		8:00	R1	1
	4/16	180	Y	14:00	E11	11
	4/30	0		10:00	E12	12
	5/5	21		1:00	E7	7
	5/11	0		15:20	E21	21
	5/17	0		8:45	E21	2
	6/2	0		14:00	E3	3
	6/22	137		11:00	E11	11
	6/26	34		10:15	R1	1
	6/26	16		10:00	E21	2
	6/30	0		3:10	T10	10
	7/9	180	Y	22:27	T1	1
	7/16	59		9:00	R1	1
	8/11	7		10:00	E12	12
	8/18	0		8:25	E11	11
	9/7	0		12:00	E4	4
	9/11	1		11:00	T3	3
	10/8	4		19:30	E21	2
	10/9	0		18:15	E9	9
	10/17	26		4:41	E3	3
	10/26	2		6:30	T3	3
	10/27	49		19:00	T1	1
	10/31	34		21:30	E10	10
	11/17	27		9:00	E3	3
	11/20	0		0:40	E5	5

	12/16	12		23:00	E5	5
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Appendix B

Reno Fire Department Data - Vehicle Accidents 2010 through 2013

Accident Date	Accident Type	Time	Vehicle No.	Person Involved	Apparatus	Station
1/1/10	Vehicle	5:30	FD108	XXXXXX	E4	4
1/3/10	Vehicle	16:33	E5	XXXXXX	E5	5
1/18/10	Vehicle	10:00	FD32	XXXXXX	E3	3
2/23/10	Vehicle	9:00	FD135	XXXXXX	T10	10
4/30/10	Vehicle	10:15	FD186	XXXXXX	E15	15
5/11/10	Vehicle	8:30	FD105	XXXXXX	E3	3
5/31/10	Vehicle	12:15	FD35	XXXXXX	E14	14
6/16/10	Vehicle	17:30	FD231	XXXXXX	E13	13
8/20/10	Vehicle	16:00	FD108	XXXXXX	E4	4
8/31/10	Vehicle	8:06	FD17	XXXXXX	E8	8
9/14/10	Vehicle	1:00	B14	XXXXXX	B14	14
9/18/10	Vehicle	4:50	E3	XXXXXX	E3	3
10/30/10	Vehicle	6:48	FD106	XXXXXX	E11	11
12/3/10	Vehicle	8:30	FD245	XXXXXX	E18	18
12/25/10	Vehicle	0:03	FD35	XXXXXX	E14	14
1/29/11	Vehicle	20:24	FD123	XXXXXX	E6	6
2/13/11	Vehicle	14:50	T-1	XXXXXX	T1	1
4/2/11	Vehicle	10:10	FD152	XXXXXX	T1	1
4/17/11	Vehicle	6:30	E-3	XXXXXX	E3	3
4/19/11	Vehicle	unk	T-1	XXXXXX	T1	1
4/21/11	Vehicle	14:35	E21	XXXXXX	E21	21
6/6/11	Vehicle	18:00	FD17	XXXXXX	E8	8
7/5/11	Vehicle	22:20	E5	XXXXXX	E5	5
8/1/11	Vehicle	17:30	B15	XXXXXX	B15	15
10/24/11	Vehicle	15:33	FD186	XXXXXX	E15	15
11/4/11	Vehicle	unk	FD 82	XXXXXX	B3	3
11/12/11	Vehicle	unk	FD 108	XXXXXX	E4	4
11/26/11	Vehicle	12:45	FD 128	XXXXXX	T1	1
1/20/12	Vehicle	22:15	FD104	XXXXXX	E2	2
1/25/12	Vehicle	5:15	FD108	XXXXXX	E4	4
3/30/12	Vehicle	13:00	Decon Trailer	XXXXXX	T3	3
4/10/12	Vehicle	unk	FD105	XXXXXX	E3	3
4/13/12	Vehicle	1:10	FD100	XXXXXX	T3	3
4/29/12	Vehicle	4:30	E3	XXXXXX	E3	3
5/3/12	Vehicle	11:40	FD136	XXXXXX	E8	8

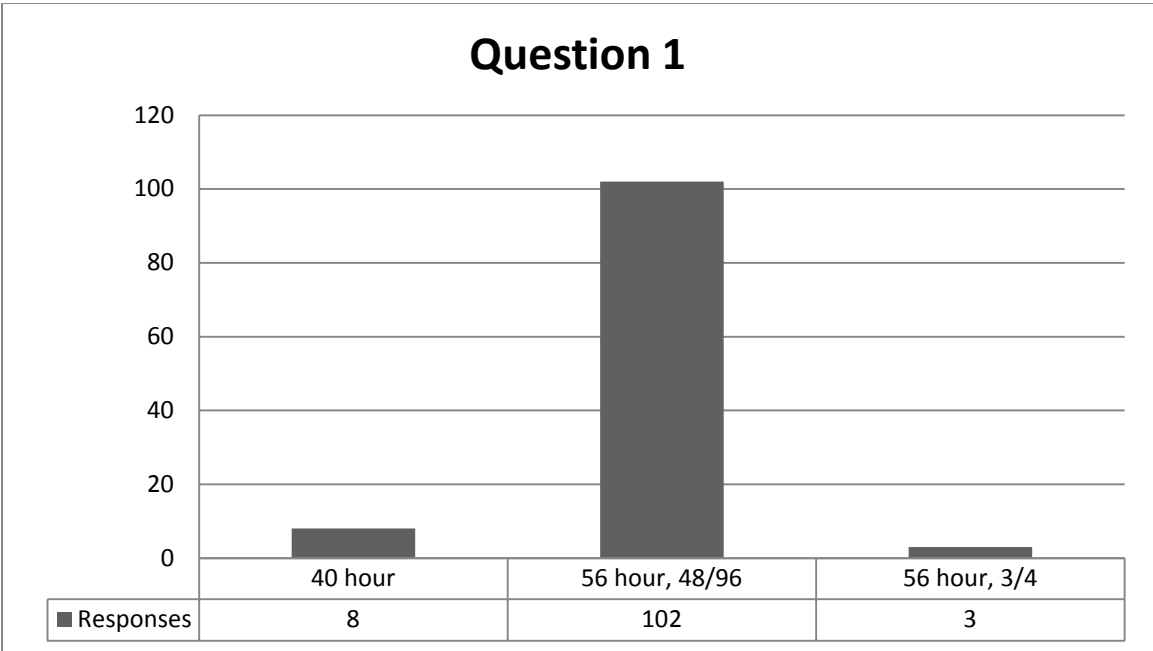
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6/2/12	Vehicle	7:00	T-3	XXXXXX	T3	3
6/3/12	Vehicle	6:30	FD100	XXXXXX	T3	3
6/7/12	Vehicle	14:00	FD103	XXXXXX	E1	1
6/12/12	Vehicle	23:45	B21	XXXXXX	E21	21
6/12/12	Vehicle	14:30	FD103	XXXXXX	E1	1
6/29/12	Vehicle	unk	FD17	XXXXXX	E8	8
7/2/12	Vehicle	unk	B-8	XXXXXX	B8	8
8/5/12	Vehicle	12:20	FD103	XXXXXX	E1	1
8/21/12	Vehicle	15:30	FD158	XXXXXX	T2	2
9/5/12	Vehicle	19:30	FD17	XXXXXX	E8	8
10/23/12	Vehicle	14:13	FD105	XXXXXX	E3	3
10/31/12	Vehicle	unk	FD11	XXXXXX	E11	11
11/2/12	Vehicle	12:00	FD18	XXXXXX	E6	6
12/30/12	Vehicle	9:00	FD11	XXXXXX	E11	11
1/14/13	Vehicle	11:24	FD212	XXXXXX	T3	3
1/15/13	Property	22:14	E2	XXXXXX	E2	2
2/25/13	Vehicle	12:30	FD158	XXXXXX	E2	2
3/8/13	Vehicle	15:54	FD100	XXXXXX	T3	3
7/11/13	Vehicle	unk	FD80	XXXXXX	B21	21
7/18/13	Vehicle	8:04	E4	XXXXXX	E4	4
7/20/13	Vehicle	14:06	FD103	XXXXXX	E1	1
7/27/13	Vehicle	19:51	FD160	XXXXXX	E1	1
8/8/13	Vehicle	15:00	FD33	XXXXXX	T1	1
9/6/13	Vehicle	10:45	FD100	XXXXXX	T3	3
10/20/13	Vehicle	17:10	FD12	XXXXXX	E5	5
12/3/13	Vehicle	19:25	FD12	XXXXXX	E5	5
12/7/13	Vehicle	0:55	FD136	XXXXXX	E9	9
12/22/13	Vehicle	13:00	E21	XXXXXX	E21	21
12/23/13	Vehicle	20:45	FD104	XXXXXX	E2	2
12/25/13	Vehicle	18:10	FD100	XXXXXX	T3	3

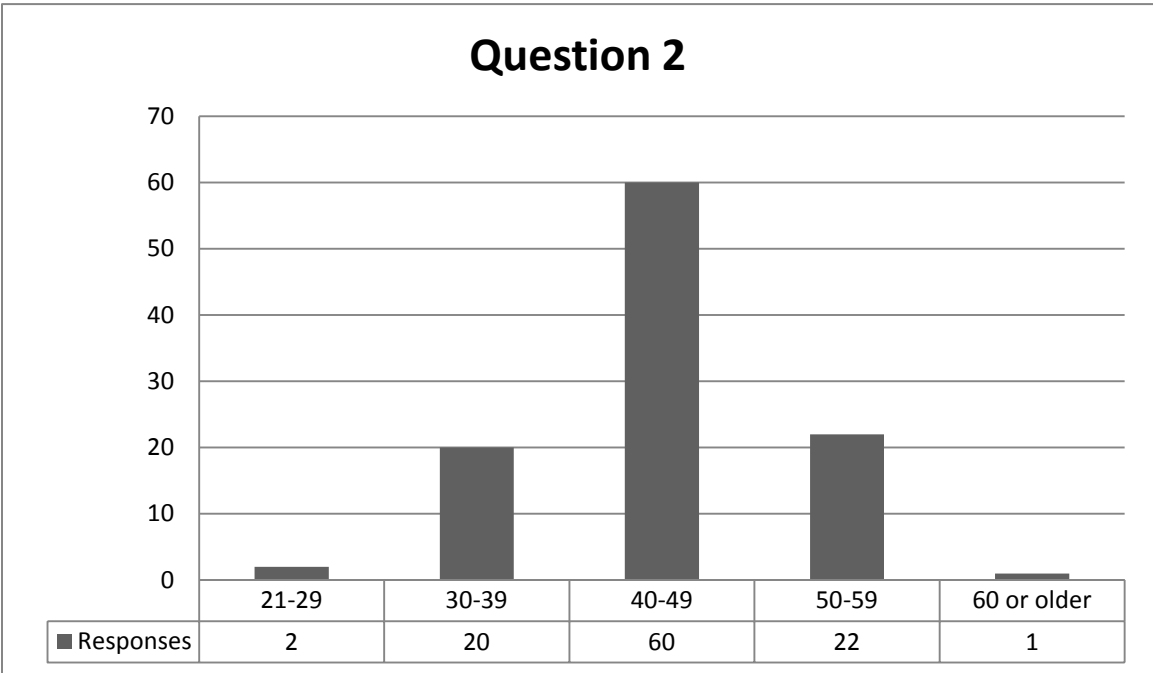
Appendix C

Survey - Reno Fire Department 48/96 Review

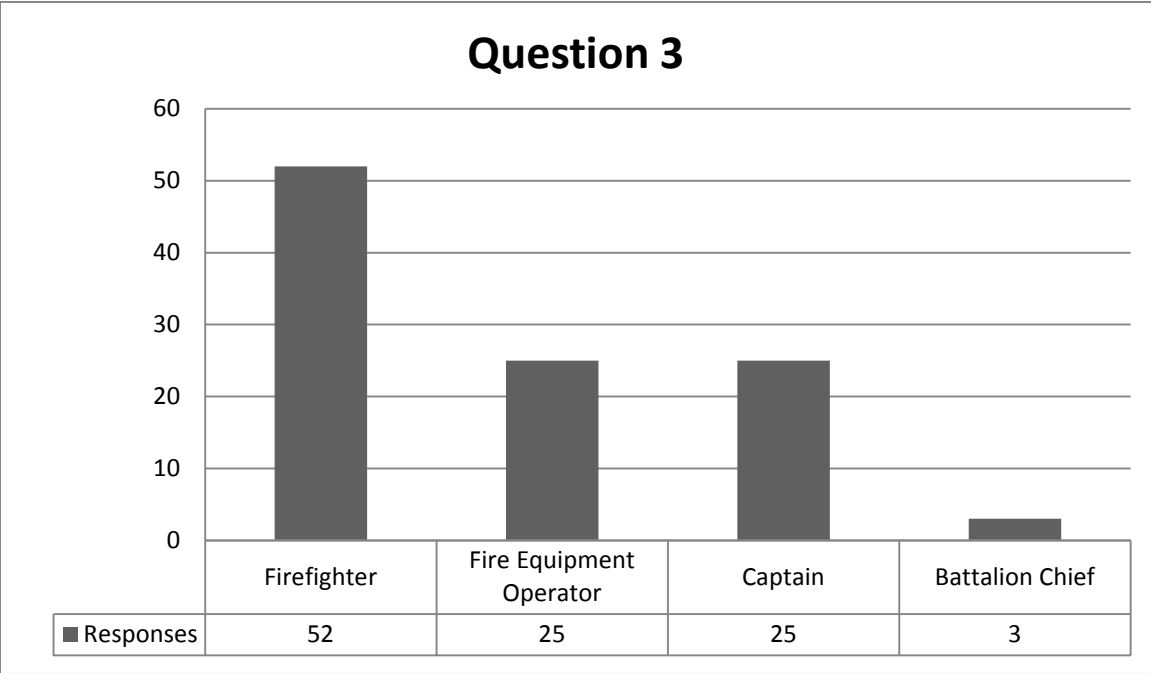
Question 1 - What is your work schedule?



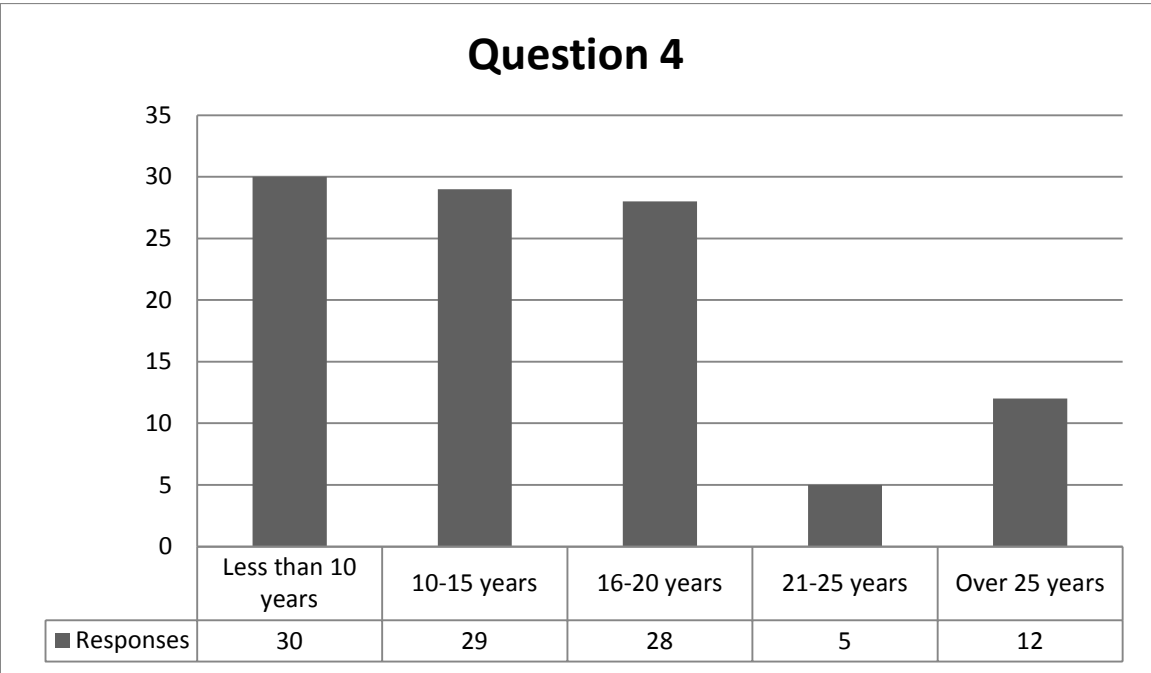
Question 2 - Which category below includes your age?



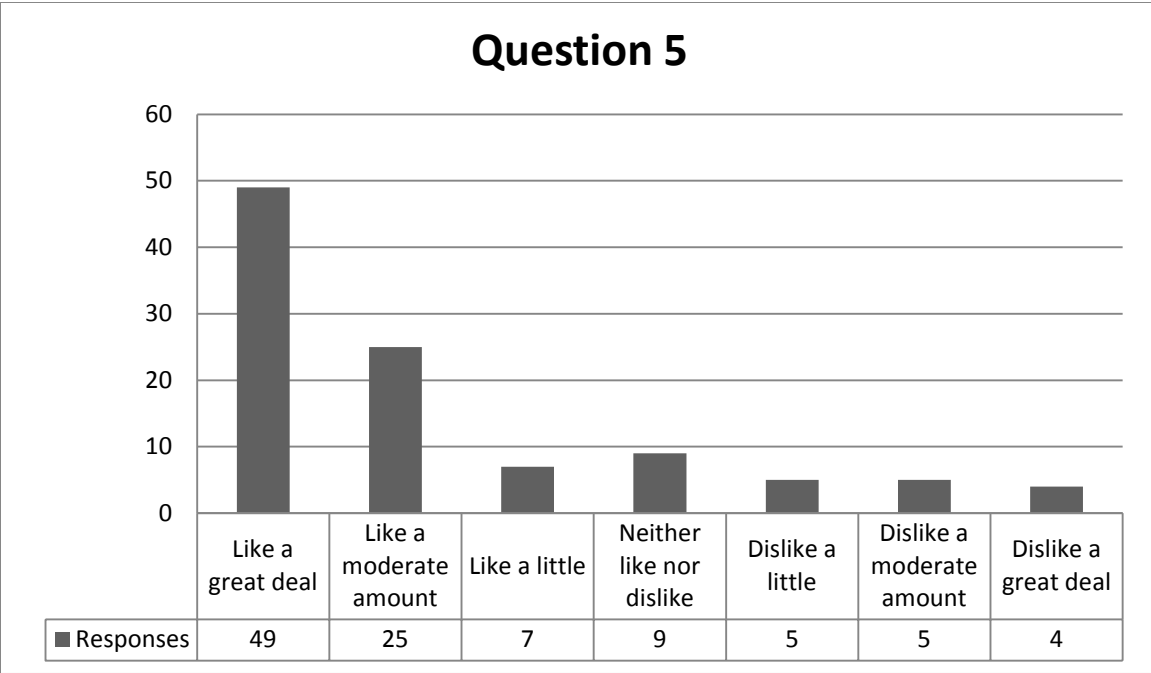
Question 3 - What is your rank?



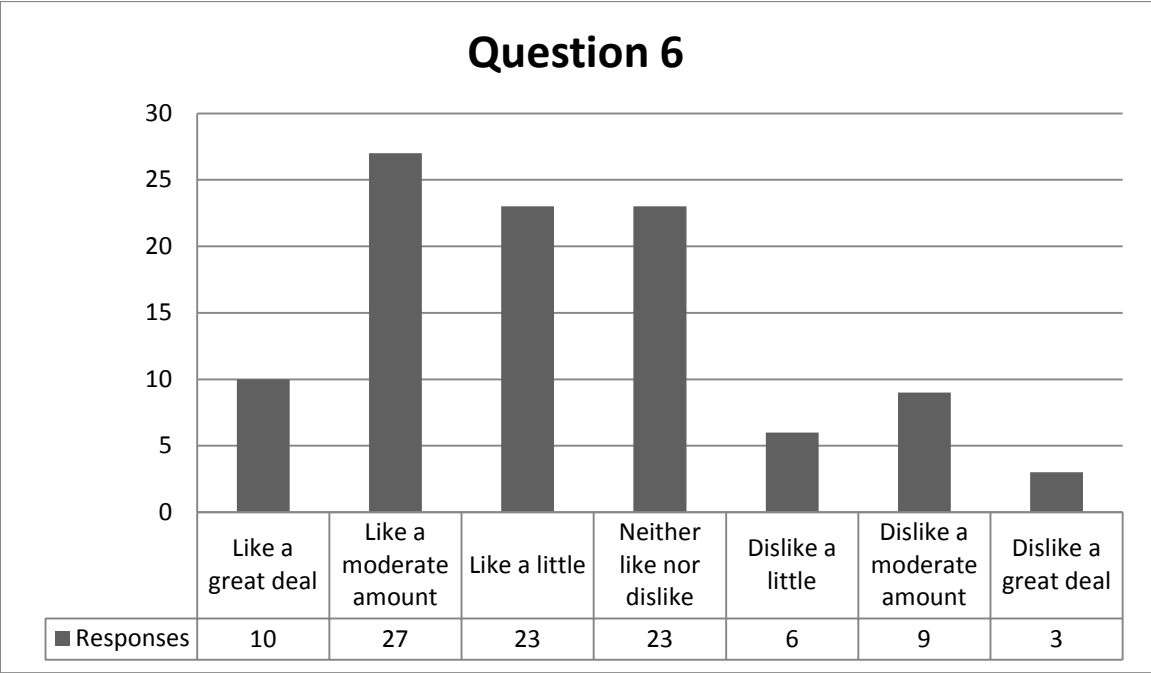
Question 4 - How many years have you been employed by the Reno Fire Department?



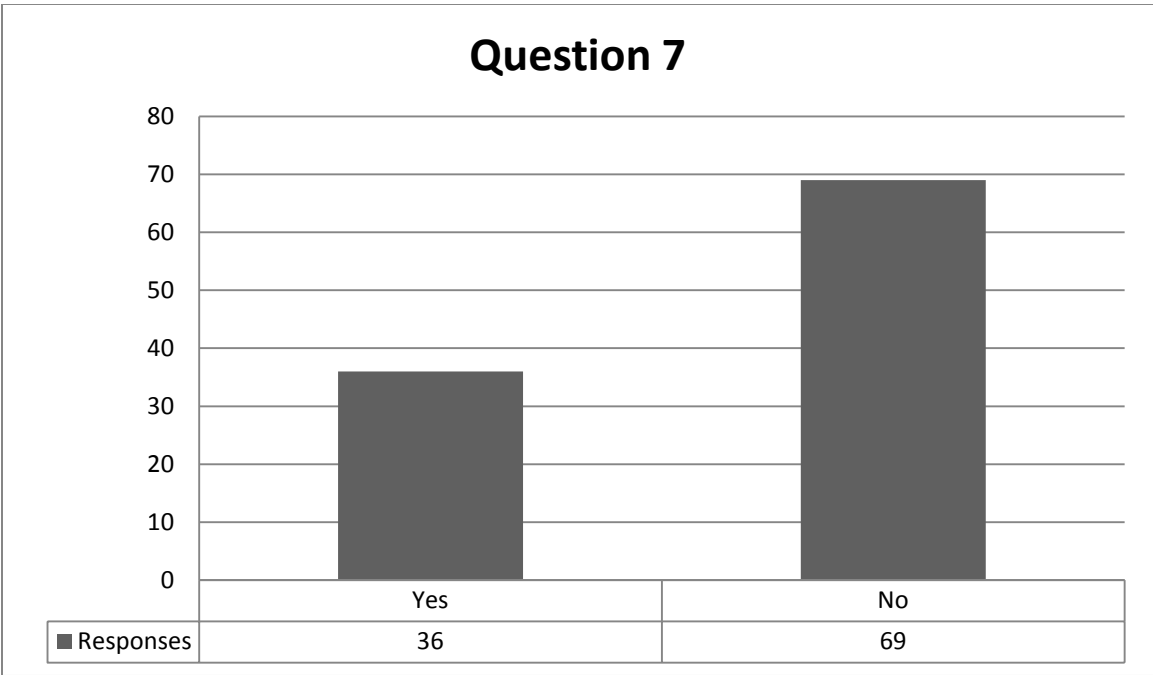
Question 5 - Do you like the 48/96 schedule, neither like nor dislike it, or dislike it?



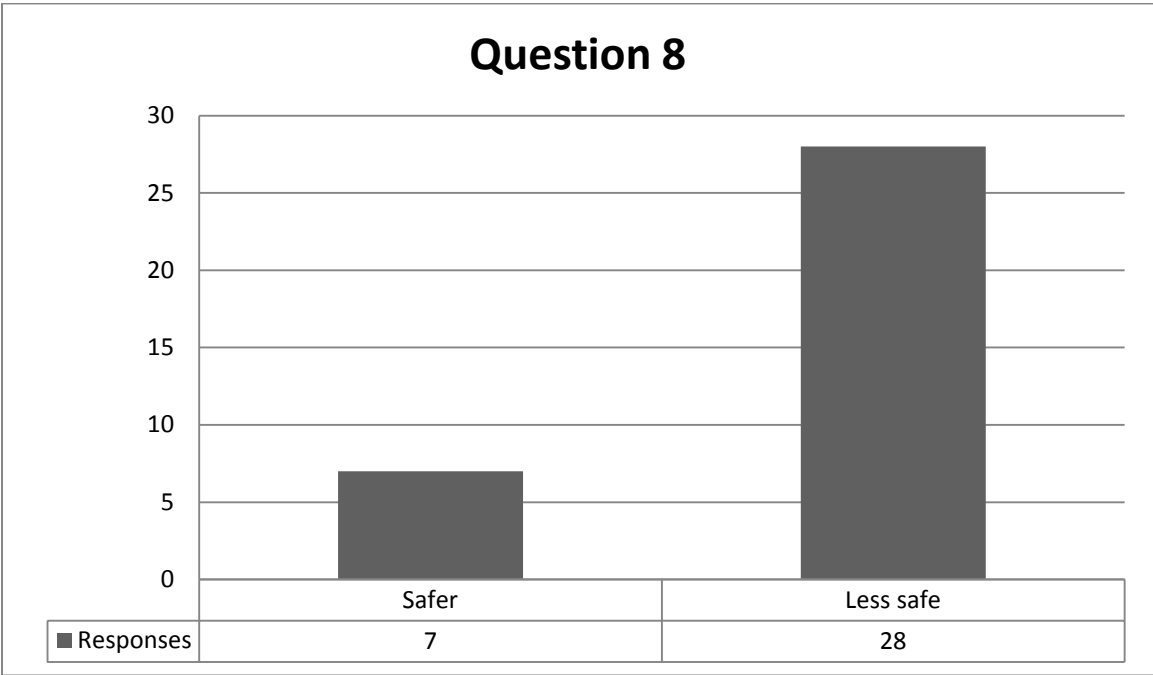
Question 6 - Do you like the 3/4 shift schedule, neither like nor dislike it, or dislike it?



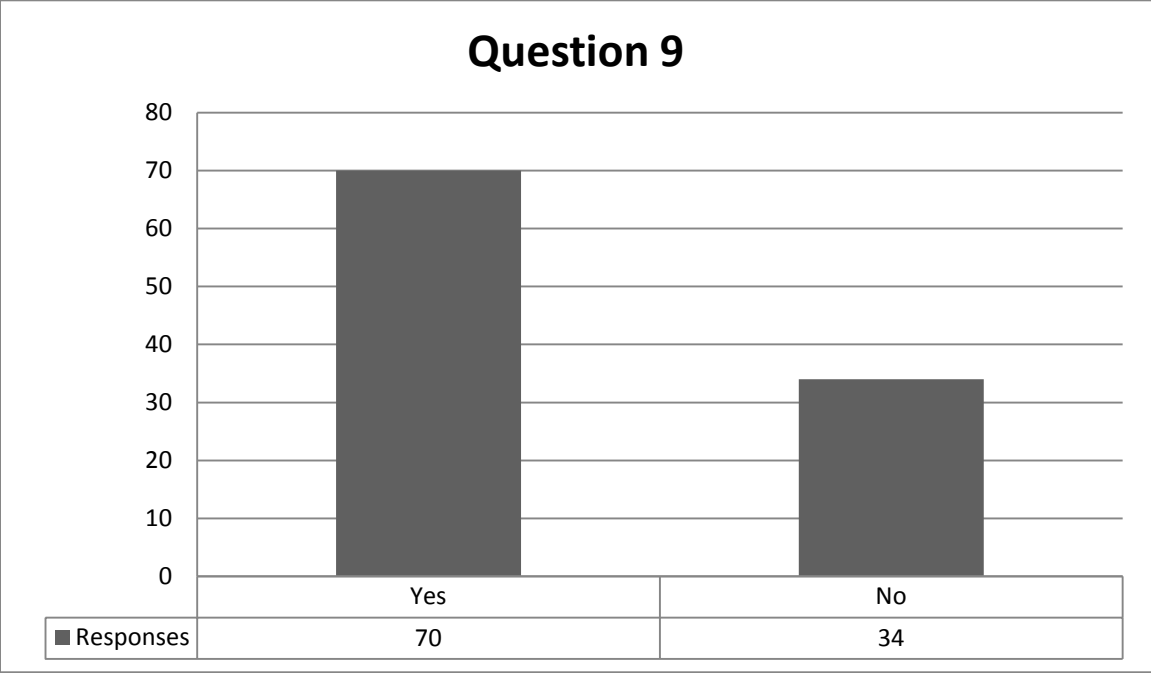
Question 7- Has the change to the 48/96 shift schedule affected employee safety?



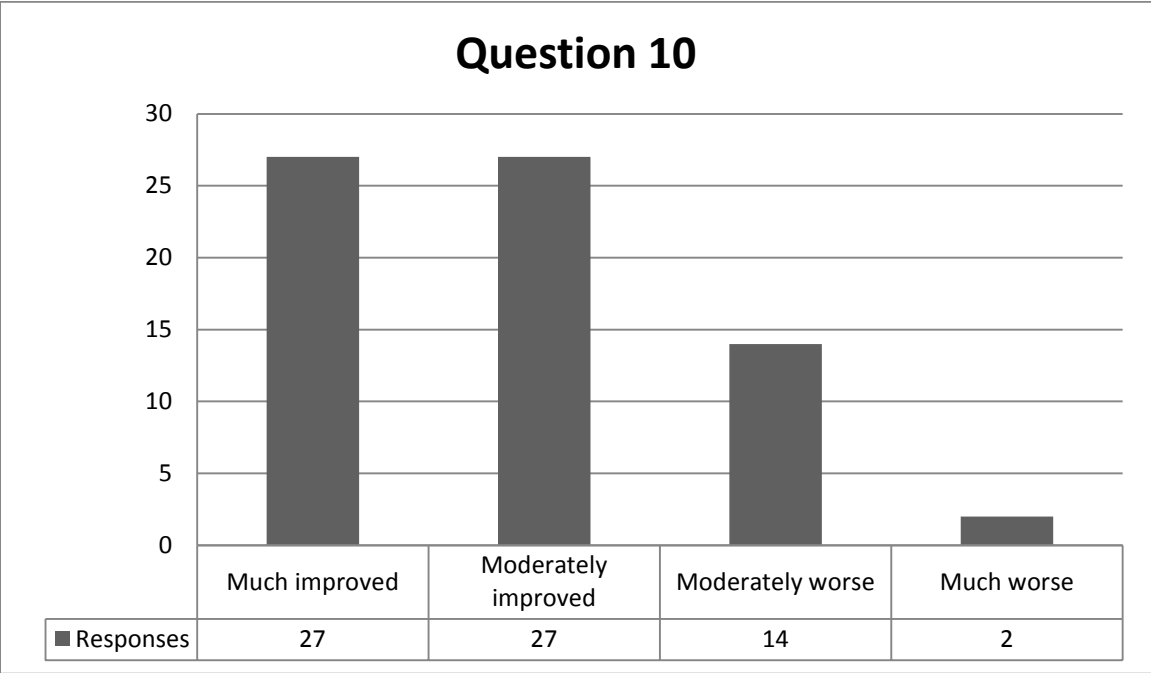
Question 8 - As a result of the change to the 48/96 shift schedule, are employees safer or less safe?



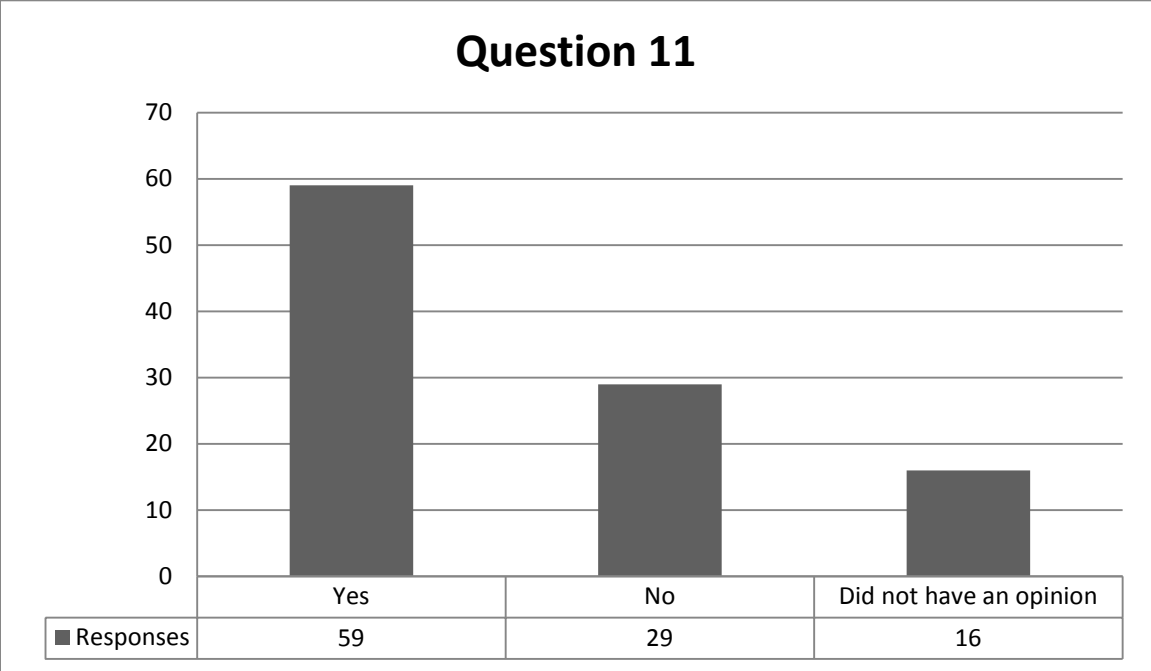
Question 9 - Has the change to the 48/96 shift work schedule affected quality of time away from work?



Question 10 - As a result of the change to the 48/96 shift schedule, what describes the change in quality of time away from work?



Question 11 - Prior to the change in work schedule to the 48/96 shift schedule, did you support changing the schedule to 48/96?



Question 12 - What shift schedule do you prefer now?

