# EXAMINING THE 72 CONSECUTIVE HOUR WORK LIMIT

EXECUTIVE LEADERSHIP

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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

The PCFSD had no way to determine if an employee could safely work up to or in excess of 72 consecutive hours. The purpose was to determine how many consecutive hours it is safe to work. Descriptive research discovered: industry standards for consecutive work hour limits; the correlation between call volume and work hour limits; consecutive work hour legal, medical, or other standards; and evaluation devices for fitness testing. A survey and interviews indicated PCFSD employees are safe working up to, but not more than, 72 hours. To ensure the safety of working up to 72 hours, PCFSD must increase staffing during peak seasons, rotate firefighters off of ambulance and out of busy stations, and monitor the effects of the 48/96-work schedule.

TABLE OF CONTENTS

# EXAMINING THE 72 CONSECUTIVE HOUR WORK LIMIT

## INTRODUCTION

The Park City Fire Service District (PCFSD) policy and procedure manual limits the maximum number of consecutive hours an employee may work without a minimum twenty-four hour break. The work limit is set at 72 consecutive hours. This number was set arbitrarily based on a common sense notion, that after 72 consecutive hours, an employee will probably be physically and mentally tired to a point of decreased or unsafe work practices.

The research problem is that the PCFSD has no way of evaluating whether its 72 consecutive hour work limit is unnecessarily limiting its employees from working in excess of 72 hours, or if a 72-hour work period is longer than an employee can safely work. The purpose of this research is to determine if it is safe to allow firefighters to work multiple consecutive shifts up to or in excess of 72 consecutive hours. The descriptive research method will be used to answer the following research questions. What consecutive work hour limits are in place at other fire service agencies? What is the correlation between call volume and work hour limits at other fire service agencies? What legal, medical, or other standard(s) are in place at other fire service agencies to set maximum consecutive work hour rules? What procedures or evaluation devices are other departments using to measure if a firefighter has sustained necessary physical or mental competencies prior to attempting completion of an additional consecutive shift?

## BACKGROUND AND SIGNIFICANCE

The PCFSD is a full-time, firefighting, Emergency Medical Service (EMS), transporting, and rescue agency of 72 suppression employees. The agency staffs five stations with a sixth under construction. Current minimum and maximum daily staffing is 24 firefighters. The PCFSD suppression employees currently work the Kelly schedule. The Kelly schedule consists

of three overlapping twenty-four hour platoons working the following nine-day rotation; day one on, day two off, day three on, day four off, day five on, day six off, day seven off, day eight off, and day nine off. In order to maintain minimum and maximum staffing of 24 positions, PCFSD relies on a system of voluntary callback for filling open positions. Open positions are created when an employee uses vacation, holiday, sick, work-related business, or personal leave. When open positions are created, employees are asked to fill them. In order to maximize the number of employees that are eligible to fill the open shifts, especially the open positions on day two and day four of the Kelly schedule, employees are allowed to work up to but not exceeding 72 consecutive hours. This guideline is commonly referred to as the 72-hour rule. The 72-hour rule is documented in the PCFSD standard operating guidelines (PCFSD, 2006).

Although the daily staffing has increased over the years, the policy of maintaining minimum and maximum staffing at an equal number has not changed. This policy has worked reasonably well over the years. Last year, of the 8,760 twenty-four shifts available, approximately 30 went unfilled. While the procedures used and rules governing the filling of extra shifts have not changed, the call volume has steadily increased. In the last ten years the annual call volume has increased from 1475 to 3767 (PCFSD, 2007). That equates to more than a 250% increase in call volume over the last 10 years or an approximately 10% increase every year. The increase in call volume directly correlates to fewer nights of uninterrupted sleep. As the instances of sleepless or partial sleepless nights increases, the concern over the practice of allowing employees to work 72 consecutive hour shifts increased.

Recently, the firefighter association that represents the 72 PCFSD suppression employees voted overwhelmingly to switch, from the Kelly schedule to a 48/96 schedule. The fire chief has agreed to allow this switch, and it is scheduled to begin for a one-year trial period beginning May

of 2007. With the implementation of this scheduling change, administration anticipates an increase in the number of employees working 72 consecutive hour shifts. The 48/96 schedule consists of three platoons each working two consecutive 24-hour shifts followed by 96 hours off. The rotation works in the following format; day one on, day two on, day three off, day four off, day five off, and day six off. In the Kelly schedule, employees not wishing to work 72 consecutive hours had four opportunities in every nine-day rotation, or 44% of all the available days in a year. In the 48/96 schedule, employees have only two opportunities in every six-day rotation or 33% of all the available days in a calendar year to work without placing themselves in a 72 consecutive hour shift. The logical conclusion is that there will be more instances of employees working 72 consecutive hour shifts after the implementation of the 48/96 schedule.

While the current PCFSD leave-filling configuration is a win–win situation for both the employees and administration, the administrative fear of not filling all open shifts is always present. As stated earlier, approximately 30 shifts went unfilled last year. A goal of the PCFSD is to reduce the unfilled shifts from 30 to zero without having to resort to mandatory holdover or callback. On numerous occasions employees completing a 72-hour consecutive shift have volunteered to continue for another shift. While this would help towards reducing the number of unfilled shifts, until PCFSD has a better way of determining if the employee is physically and mentally fit, such requests have been and will continue to be denied.

Evaluating whether the current policy of allowing employees to work 72-hour shifts is too long or unnecessarily not long enough relates to and supports the United States Fire Administrations third operational objective to “reduce the loss of life from fire of firefighters” (National Fire Academy, 2003). The research will accomplish this objective by evaluating currently in place rules to ensure that firefighters are fit for duty before operating in or at a

hazardous environment. The completion of this project and implementation of the recommendations is enhanced by the knowledge gleaned from the National Fire Academy Executive Leadership class. Implementation of testing devices or ensuring acceptance of modification to existing procedures will be enhanced by skills learned in the negotiation chapter of the Executive Leadership student manual (National Fire Academy, 2005).

## LITERATURE REVIEW

A literature review was completed using the Learning Resource Center, the local library, the Internet, and personal interviews. This section will disclose the body of knowledge discovered in the areas of: firefighter fatigue and shift work, the correlations between consecutive hours worked and call volume, shift work and its effect on firefighter circadian rhythms, and fitness evaluation devices.

### *Firefighter Fatigue and Shift Work*

The nature of providing emergency services requires personnel to be available twenty-four hours per day every day of the year (Glazner, 1996). In order to provide this service to the public, emergency service agencies are challenged to balance the needs of the community with the expense of firefighter salaries. Firefighting, like other professions, requires twenty-four hour service. Doctors, nurses, long haul pilots, and emergency medical service workers are also required to work shifts. Glazner (1996) defines shift work as working outside the normal daytime hours of 9am to 5pm. An alternate definition provided by Glazner (1992) is awake and working during a time frame when the human body would rather be asleep. A typical firefighting shift schedule is the “10-14”. This schedule requires two crews per day. One crew works the ten-hour day shift and one crew works the fourteen-hour night shift. A total of four

crews are required to maintain twenty-four hour coverage seven days a week 365 days a year (Glazner, 1996).

Another common crew schedule is the 24-hour schedule. This schedule requires firefighters to work 24-hour shifts. Typically three crews are required to maintain year-round coverage. The shifts are arranged in a variety of configurations. Some of the more popular schedules include the one on and two off, the two on and four off, and the Kelly schedule. The Kelly schedule is based on an every other day for three and then four off rotation. Various variations of the Kelly schedule are also in use (Schedule Me, 2007).

When reviewing the effects of fatigue on shift workers, one important differentiation must be made between firefighters and most other professions. Most shift workers are required to perform the same duties at night as they are during the day. For instance, airline pilots must perform the same flight procedures on a night flight as they do during a day flight. Factory workers on swing or night shift must perform the same tasks as factory workers on day shift. Conversely, firefighters working the night shift most always are sleeping unless there is a call for service (Glazner, 1992). In addition to sleeping at night, napping is common at many if not all fire agencies in the United States. Many agencies recognize the importance of a quick nap to the health and safety of the individuals. Many departments officially condone the practice of napping, and many more allow it albeit not officially (Firehouse, 2007). Chief Tingley (personal communication, Oct. 15, 2006) of the Hermosa Beach Fire Department claims his employees leave the station more rested than when they arrive. He attributes this to getting better sleep and the practice of napping at the fire station, which many firefighters won't or can't do while at home. The body's natural circadian rhythm hits a lull in the early afternoon. The most beneficial nap is taken in the early afternoon (Lambert & Smolensky, 2001, p. 72).

Studies of resident doctors working as many as 120-hour workweeks have shown them to perform adequately provided they only perform tasks of short duration. Fatigued EMS workers have also been shown to perform well during pre-hospital tasks (Fazackerley & McCallion, 1991). The danger for fatigued EMS workers is not in mistakes or omissions of care, but of falling asleep during transport. This was highlighted in the Midwest when an EMT responding lights and siren fell asleep at the wheel causing a serious accident (Fazackerley & McCallion, 1991). In response to a death attributed to an oversight by a fatigued resident doctor in New York, the state passed legislation limiting residents and interns to an eighty-hour workweek. Similar legislation failed in California. California is also home to some of the laxest consecutive work hour rules in the United States. The San Francisco Fire Department has no limits to consecutive work hours, and the Los Angeles Fire Department will allow firefighters to work up to 120 consecutive hours (Fazackerley & McCallion, 1991). The Hermosa Beach Fire Department has no limit to the number of consecutive shifts an employee may work. According to Chief Tingley, the current record is 27 consecutive 24-hour shifts (personal communication, Oct. 15, 2006). On the other side, the American Ambulance Association has numerous private members who have limited consecutive work hours through contract negotiation. A typical contract limits consecutive work hours to 36. The same contracts also dictate the amount of rest between shifts (Fazackerley & McCallion, 1991).

Human error has been shown to play a role in as much as 90 percent of all workplace accidents. The significant factors in human error leading to work place accidents are drugs, alcohol, and lack of or insufficient sleep. The U.S. Department of Transportation estimates 200,000 accidents annually are related to drivers falling asleep at the wheel. Semi-truck drivers are ten times more likely to wreck between 4 a.m. and 6 a.m. In a survey of police, officers 80

percent admitted to falling asleep at least once every week when working night shifts (Fazackerley & McCallion, 1991).

The negative effect of shift work can be classified into three interrelated areas. The three areas are medical, biological, and social. Shift work leads to both objective and subjective medical problems. Previous studies suggest there are more subjective problems than objective ones. The biological problems can almost always be traced to the disruption of circadian rhythms. The firefighter schedule will almost always conflict with family and social schedules that are based on the more traditional Monday through Friday 9-5 workweek (Glazner, 1992).

Shift workers, especially those working 24-hour shifts, are prone to severe physiological and psychological reactions. These reactions manifest themselves in decreased productivity, decreased overall happiness, and a decrease in physical health. These side effects also manifest themselves at home where firefighters report family and social problems as a result of 24-hour shifts. The cumulative effect of these reactions is a reduction in the employee's overall quality of life (Boudreaux, Brantley, Jeffries, and Mandry, 1997). In research performed by Glasner (1992), about 10-20 percent of firefighters working 24-hour shifts suffer from adaptation problems including health problems. The health problems include eating, sleeping, and social disorders. Glasner (1992) contributes the fairly low rate in firefighters to the strong physical and mental nature of people that gravitate toward the firefighting profession.

In a research paper submitted to Prehospital and Disaster Medicine, the authors explored whether the number of calls received per day was correlated to the overall stress experienced by the EMS worker. The research revealed two significant correlations. The largest single portion, 46%, of a worker's stress was directly related to caring for patients. The workers who cared for the most patients or went on the most runs experienced the most stress. Interestingly, the authors

found stress to be cumulative and also found work stress often led to increased stress at home (Boudreaux, Brantley, Jones, & Mandry, 1996).

In many professions like nursing or piloting, the danger of fatigue is the increased probability of a mistake. Several studies have shown worker mistakes increased during evening and graveyard shifts. Some of the largest disasters of all time occurred after midnight. These disasters include the Bhopal India chlorine leak, the Three Mile Island and Chernobyl nuclear reactor meltdowns, and the Exxon Valdez oil spill (Fazackerley & McCallion, 1991).

The danger of an error by firefighters is much less. This is due to the release of adrenalin into the bloodstream upon receipt of an alarm. It does not matter if the alarm is false or real. The adrenaline starts releasing at the time the bell sounds. The duration of adrenaline release will routinely match the duration of the call. A false alarm may only release a small amount of adrenaline. A working fire will keep the adrenaline flowing for many hours. The release of adrenaline combats the effects of fatigue in firefighters (Glazner, 1992).

While some literature has shown there to be little danger to firefighters working long shifts, other literature shows the exact opposite for civilian companies. Fazackerley & McCallion (1991) quote Marty Klein, president of a company that specializes in setting up shift and staffing schedules for companies that routinely require their employees to work shifts. According to Klein, shift work will lead to “burnout, chronic stress, and increased workers compensation claims”. These factors result in high turnover and increased operational costs.

In a study of injuries to shift working firefighters, Glazner (1996) attempted to show that firefighter injuries were related to shift work. The results of the study did not fully support the theory. Instead, the results show that injuries were more closely related to calls regardless of the time of day. Firefighters were most often injured while fighting fires. The rate of injuries during

daytime fires closely matched the rate of injuries for fires occurring at night. The study also attempted to correlate the number of hours worked in a week and demographic characteristics to the rate of injuries. The study found no measurable relationship between injury rates and a person's age, socio-economic, marital status, job title, or hours per week worked. Interestingly, the disruption of metabolism due to adrenaline stopping the digestive process was a bigger factor in the rate of injuries. It seems hungry firefighters are more likely to get hurt fighting a fire than tired ones.

In agencies that don't limit consecutive work hours, employees will often trade shifts, or snatch up extra shifts, putting themselves into 72 consecutive hour work situations. Sleep research suggests these firefighters will perk up for critical patients, but may become uncaring or irritable to frequent flyers, town drunks, or patients with minor injuries or conditions. The risk of a tired firefighter becoming irritable or uncaring may lead to complaints, poor medical care and, if bad enough, a lawsuit. The author suggests limiting trading and overtime if it causes the employee to work too many consecutive hours (Fazackerley & McCallion, 1991). Rynning (1997) examined shift trading in an applied research project (ARP) for the National fire Academy (NFA). He concluded that shift trading that puts firefighters in multiple shift situations should be limited. He summarized that all departments should limit hours worked and have requirements for minimum rest periods between shifts. Rynning recommends limiting consecutive shifts to a maximum of two with a minimum of one rest shift before returning to work.

An organization's decision to allow employees to work numerous consecutive or extremely long shifts should not be taken lightly. Case law has held that the employer can be held liable when a fatigued employee causes an accident after leaving the workplace. An Oregon

jury held McDonalds liable when a teenager caused a fatal accident after working three shifts in a 48-hour span. The last shift started at midnight and ended at 07:30 in the morning. The fatigued worker fell asleep at the wheel while driving home and collided with another vehicle. The worker was killed and the driver of the other vehicle suffered serious injuries. The injured driver sued McDonalds for allowing the worker to work unreasonably long hours. An Oregon court of appeals upheld the verdict and awarded the injured driver damages (Flaherty & Shoemaker, 1995). According to Fazackerley and McCallion (1991), several other cases have led to similar results. These decisions lead to numerous implications for emergency service organizations. Should emergency service agencies limit consecutive hours worked? Should emergency service workers be allowed to work when they are extremely fatigued? How does an agency know when a worker is extremely fatigued? Should fatigued workers be allowed to drive themselves home when they are fatigued (Flaherty & Shoemaker, 1995)? The implications from this case closely resemble the focus of this research paper.

The single greatest challenge to changing a scheduling pattern, or limiting consecutive work rules, often comes from the employees themselves (Fazackerley & McCallion, 1991). Schedule change is controversial; human nature is to stay in a comfort zone. Employees tend to resist change for no reason other than fear of the unknown. Employees are reluctant to give up a perceived great schedule even at the expense of their personal health. Employees are unwilling to give up the ability to trade themselves into long consecutive work sessions, because they have come to rely on them for supplementing their vacation and holiday periods (Meirovitz, 1991).

### *The Correlations Between Consecutive Hours Worked and Call Volume*

Firefighter shift schedules have evolved over the years. It was not uncommon in the early part of the last century for firefighters to work 24 hours on and 24 hours off (May, 2006).

The 24-on 24-off schedule mostly disappeared many years ago partially due to changes in federal work laws. More recently, firefighter work schedules change due to call volume. According to Benson (1993), most agencies change work schedules due to rising call volume. The direct result of rising call volume is chronically fatigued workers. According to one source quoted in the Benson article, Emergency Medical Service (EMS) workers who average 18 calls per 24-hour shift or more and are awake most of the night should no longer work 24-hour shifts. At the time of the Benson (1993) article the author lamented about the complete lack of research on the affects of scheduling, stress, and fatigue on emergency workers. The author's own literature review revealed a similar lack of research 14 years later.

In some areas of the country, most notably California, 48-hour shifts are the standard. The Boise City Fire Department web site lists over 70 departments in the Western United States that have switched to the 48/96 Schedule (Boise, 2007). In many of these departments, high call volume is a way of life. On a ride-along at the Long Beach Fire Department, Meirovitz (1991) ran 23 calls in 24 hours. Many departments have busy stations and slow stations. Typically the younger firefighters enjoy the high call volume. The firefighters that do not like the high call volume bid out of the busy stations before they get burned out (Meirovitz, 1991). In a survey of 23 departments in California, Division Chief Forest Craig (2005) of the Novato Fire Protection District examined the relationship of consecutive shifts and injuries. Of the 23 departments, 11 had no limit to the number of consecutive shifts a firefighter could work. Five departments limited consecutive shifts to three. Four departments limited consecutive shifts to four. None of the departments had limits less than three. Of all the departments surveyed, only one reported an increase in injury rates subsequent to the completion of the first consecutive shift. In a similar study, Division Chief James Clack (2003) examined safety during the second half of a 48-hour

shift. Clack's research showed a 44.4% increase in injuries in the second 24-hour period. His research also showed a 112.9% increase of accidents from 24-hour shifts to 48-hour shifts. Motor vehicle accidents increased 11.9% in the second half of the 48-hour shift.

Boudreaux et al. (1997) echo the idea that consecutive work hour limitations are determined by call volume. In departments with steadily increasing call volume, there will become a point when 24-hour shifts will become unmanageable. In their study, call volume had increased steadily over a fifteen-year period with no ensuing increase in staffing. The point when call volume became unmanageable was when employees suffered from severe emotional exhaustion and feelings of burnout.

*Shift Work and its Effects on Firefighter Circadian Rhythms*

The term circadian is derived from the Latin words circa for "around" and the word dies for "days". The literal translation is "about a day". A circadian rhythm is a roughly 24-hour cycle in the physiological processes of animals (Wikipedia, 2007). The human animal performs at its optimum level during the day. The scientific term for active by day and resting at night is diurnal. Scientists are not sure if the day-oriented phenomenon is genetic or developed through natural adaptation. Either way humans perform at their peak during the daylight hours that parallel the earth's spin on its axis around the sun every 24-hours. The functions of active by day and resting at night is the natural human circadian rhythm of work sleep (Glazner, 1992).

Previous research shows that shift workers routinely sleep less than workers on normal Monday thru Friday 9-5 schedules. Shift workers fight the body's natural circadian rhythm. They are constantly deprived of sleep. Workers who try to make up for lost sleep by sleeping during the day typically never get more than four or five hours of sleep before the body fooled by daylight wakes up for good (Benson, 1993). The effect of short sleep patterns is cumulative. In

her study on firefighter fatigue, Ann Pond (2003) of the Laramie Fire Department noted that after two weeks of less than six hours a night sleep, subjects scored the same on cognitive tests as people who don't sleep at all for three days. From a medical standpoint, Pond (2003) reported that blood drawn from workers sleeping for four hours a night for four consecutive nights matched those of diabetics. After consecutive shifts the body becomes chronically tired. The sleep patterns of emergency workers in busy locations often resemble the sleep habits of a 70-year old. When the body is ready for sleep it is also less likely to want to perform. The result is workers on the night shift are not only naturally tired, but they are performing at a lower level. The result is documented in one study at an agency working 24-hour shifts. The incidence of vehicle accidents, employee injuries, and medical accidents and omissions were higher late at night (Benson, 1993).

Emergency room doctors, in an attempt to share the unpopular graveyard and swing shifts, will rotate schedules often. Unfortunately, rapid rotation of shifts does not allow the body to adjust to the effects of circadian rhythm disruption. Kuhn (2001) recommends spending at least a month on each shift before attempting to rotate. Spending a month allows the body to adapt to the new schedule. The technical term for circadian rhythm adjustment is entrainment. The key to success in the entrainment of a new circadian rhythm is the level to which the emergency room physician devotes to shutting out environmental factors in his or her personal habits. According to Kuhn (2001), disruptions of circadian rhythms can lead to significant medical problems. Cardiac arrest due to heart disease and other fatal medical conditions are 60 percent higher from 2 a.m. until 8 a.m. Unfortunately, these peak rates of fatal conditions occur when emergency room doctors are themselves the most tired.

While the PCFSD is scheduled to change from 24-hour shifts to 48-hour shifts many agencies are reducing from 24-hour shifts to 14/10 or 12-hour shifts. The reason for this change is to allow employees to work hours more consistent with their natural circadian rhythms. In a study of one large urban fire department, employees who switched from a 24 to a 12-hour schedule felt less exhausted and reported feeling less burnout. The employees felt less exhaustion and fatigue due to the reduction in sleep deprivation. The disruption of sleep deprivation was a direct result of employees allowing their bodies to enjoy the benefits of a more natural circadian rhythm (Boudreaux et al., 1997). However, other research shows the rotating schedule of day and night shifts plays havoc with the body's circadian rhythm. The cumulative effect of fatigue on workers rapidly switching between day and night shifts is more difficult to recover from than a rotating schedule of 24-hour shifts (Frazier, 1999). Scientists recommend a minimum of twenty-one consecutive days of night shifts before the body will become adjusted to the new schedule (Benson, 1993). Benson goes on to say the body never fully adjusts to night shifts.

Martin (1995), in his research on circadian rhythms of air medical crews, found pilots were having a tough time adjusting to shift changes. Pilots would find themselves awake when they should have been sleeping and very sleepy at times they should be wide-awake, such as while piloting an aircraft. Interestingly, pilots working 24-hour shifts reported higher morale, lower burnout, and less stress than those working rotating day-night schedules. Martin suggested that 24-hour schedules for pilots only worked well when the pilot had few if any ancillary duties and low flight volumes. This allowed the pilots nap time to offset the disruptions in circadian rhythms.

*Fitness Evaluation Devices*

Fitness evaluation devices are designed to test for impairment. The creation of these devices has been driven primarily by the need to ensure that workers in safety sensitive positions are not impaired by alcohol, drugs, or sleep deprivation. According to a study by the National Workrights Institute (NWI) (2007), only three manufacturers are currently producing a product for workplace use. The manufacturers are Bowles Langley Technology (BLT), Eye Dynamics Incorporated, and PMI Incorporated. The three devices use one of two different technologies to test for impairment. Two of the devices are passive in that they only require the subject to peer into a device that assesses the papillary response to light stimulus, and tracks the eyes' ability to follow light. The third test is a computer graphic with a keyboard input that measures a variety of performance functions including reaction time, decision-making, hand-eye coordination, and spatial orientation.

An extensive search of the Internet could only identify seven additional manufacturers of fitness evaluation devices. Of the seven, three are no longer in business and three do not manufacture a product suitable for the workplace. The seventh company Systems Technology Incorporated (STI) manufactures a device that tests psychomotor functioning to detect impairment of eye-hand coordination and continuous response in a controlled activity (STI, 2007). The test, called the Critical Tracking Task (CTT), takes approximately one minute to perform and measures impairment from fatigue, illness, alcohol, medications, or illegal drugs. The National Highway Traffic Safety Administration sponsored research into the CTT and certified its use for testing alcohol impairment.

BLT manufactures an interactive alertness test. The National Institutes of Health and the National Institute of Occupational Safety and Health both work closely with BLT through grants

and joint research. The test requires the subject to identify if all the shapes on a screen are the same or different. If the shapes are the same, the subject presses the right arrow key; if one shape is different, the subject presses the left arrow key. The test can be administered on any personal computer with web access. The test measures a variety of performance functions including reaction time, decision-making, hand-eye coordination, and spatial orientation. According to the company these are good indicators of general alertness (BLT, 2007).

PMI is the developer of technology used to measure fitness for duty and human impairment. Its stand-alone or mobile device can assess whether fatigue, sleep deprivation, legal or illegal drugs, or alcohol has significantly impaired a person. The device cannot differentiate between the different causes of impairment. The device functions by measuring individual papillary reaction against the subject's previously established personal baseline (PMI, 2007).

Eye Dynamics Incorporated manufactures the SafetyScopeTM Ocular System. SafetyScopeTM uses a 90-second test to record pupil diameter and eye movement parameters. The device was originally developed for drug impairment testing. Recently it has been validated for use in evaluating impaired alertness levels (Eye Dynamics Inc., 2007).

An alternative to a fitness evaluation device is to evaluate call volume to work time. At what number of calls per day will the emergency services worker still get enough sleep time during a 24-hour shift so that he may continue to work successive 24-hour shifts safely? Unit per hour utilization (UHU) measures the average time each unit spends on responses per year as a percentage of on-duty time. The UHU is determined by dividing total annual call volume by the product of 8,760 (total hours in a year) multiplied by the number of 24-hour equivalent units available. According to an article written for Fire International by Alan Saly (2000), assistant to the president for EMS command at the Fire Department of New York, in excess of .50 UHU will

lead to worker fatigue and burnout in less than five years. Saly theorizes that there is a difference between firefighters and EMS personnel. He suggests that EMS workers are busier than firefighters; therefore, EMS workers will need more time to rest, recuperate, and train than firefighters.

Approximately 5 to 10 percent of the population is early risers or night owls. In her study of emergency room physicians Kuhn (2001) states: "To date there does not appear to be a standardized method for (1) predicting which workers are more tolerant to shift work or (2) preventing increased intolerance to variation in work schedules." However, she does recognize that some individuals tolerate shift work better than others. The night owls have shown better ability to adapt to shift schedules. According to Kuhn, measuring a person's ability to tolerate shift work is not practiced when screening an individual for emergency room or emergency service employment.

As a result of this literature review, the author identified that fatigue is induced in several different ways. Various authors have theorized that fatigue can be induced among shift workers by excessive consecutive work hours or by rotating work schedules. According to literature, fire departments that have switched to a rotating day and night 10/14 schedule are solving one problem while creating another. The body never adjusts to the constant rotation, creating cumulative sleep deprivation problems. Conversely, an acute sleep deprivation problem is created when excessive call volume during a 24-hour shift prevents sleeping. Much of the research concerning shift work and fatigue is centered on a non-fire related industry. The comparison is not usually equitable, as firefighters have the distinct advantage of sleeping on the job or napping. The amount of sleep or quality of the naps is different for every agency and

different every shift. The reason is call volume. Call volume has a distinct part in ascertaining whether a schedule is appropriate in each jurisdiction.

The literature review identified several companies that manufacture fit for duty evaluation devices. All of these devices would seem to measure whether a firefighter is acutely or chronically fatigued. Each machine has the added benefit of determining all types of impairment. The original research will attempt to locate departments that have used one of these technologies and determine whether one is suitable for PCFSD.

## PROCEDURES

A review of existing material to evaluate previous research conducted about similar subjects started with a search of all material available at the Learning Resource Center (LRC) at the National Fire Academy (NFA) in Emmitsburg, MD. The LRC search was performed during October of 2006. The search at the LRC revealed several applied research papers on the subjects of fatigue, fitness for duty, the effects of 48-hour shifts on safety, accidents, and injuries, and shift trading into multiple consecutive shifts. A similar search of periodicals provided the author with additional information on circadian rhythms, shift schedules, and the effect on fatigue, legal issues, and similar problems associated with other professions.

Additional background information was downloaded from the Internet over the course of the project. An extensive search of the Internet was used to locate manufacturers of fitness for duty measuring equipment. Interestingly, the best sources of information on fitness for duty test equipment came from web sites primarily concerned with worker rights over illegal drug testing. While the specific information on drug testing was not of interest, the links to the manufacturers of the test equipment were invaluable.

The survey instrument was developed to provide information necessary to answer the research questions. The answer to question 1-5 allowed the author to determine where the PCFSD 72-hour rule stands in relation to the fire industry as a whole. If all the research into fitness for duty testing equipment conducted for this report proves inconclusive, PCFSD will have ascertained whether its arbitrary 72-hour rule is in-line with industry standards. This determination will be made by using the information in questions 1-5 to determine the UHU for each department. The UHU will be compared to the consecutive hour work limitation (or lack thereof) to determine if PCFSD's consecutive hour work rule is in line with departments with similar UHU's.

The purpose of questions 6-8 was to determine if the surveyed departments had a written policy, procedure, or other document stating a consecutive work hour limit, and if the consecutive work hour limit was based on any legal, medical, or other standard. The discovery of a written regulation based on a legal, medical, or other standard would assist in justifying or modifying the existing rule in place at the PCFSD. Questions 9 and 10 were intended to discover if a mechanical or electrical device is being used to test for fitness for duty in the fire service, and what those devices were. The purpose of determining if agencies are using a device and what device they are using is to assist in the evaluation and suitability of devices for PCFSD.

The survey was conducted via phone of all the full-time departments in Utah and by e-mail to a representative sample of full-time agencies of both large and small departments in both large and small cities from around the United States. In order to ensure a representative sample of departments other than those in Utah was achieved, the author chose the same criteria used by the National Fire Academy (NFA) to select students for individual Executive Fire Officer (EFO) classes. The NFA, in an attempt to provide a diverse learning environment,

regularly mixes individuals from small and large departments from small and large towns from all across the United States. The survey was sent to students from full-time agencies in all four of the author's EFO classes. Each class had twenty-five students for a total of 100. After subtracting duplicate students and students from volunteer agencies, 52 agencies received surveys. Of the 52 agencies that received e-mails, 19 responded to the survey. This corresponds to a response rate of 36.5 percent.

The phone survey of full-time Utah departments achieved a 100% success rate. There are over 30,000 fire departments in the continental United States (Firehouse, 2007); ideally, the author would have surveyed all of the full-time agencies. A survey of every full-time agency was not within the resources or time limitations imposed by the Executive Fire Officer Program. The response rate to the survey was less than expected. Each individual received a personal e-mail. The author only received two notifications of incorrect e-mail address. Those addresses were corrected and the survey was resent successfully in both instances.

The literature review discovered several manufacturers of impairment testing devices and software. Each of the manufacturers was contacted via telephone during late February and early March of 2007. The customer service department was contacted, and from there the author was referred to the appropriate person. The purpose of the interview was twofold. The author attempted to discern if the product was appropriate and available to emergency service agencies for fitness for duty testing. The research attempted to determine if the product had been sold to or tested with an emergency services department. Each manufacturer was asked questions related to the purpose, and upon receiving affirmative responses, was asked to provide references to emergency services agencies that are using or had used their products. Follow-up information was received from two manufacturers via e-mail following the initial telephone interview.

The telephone interviews with impairment testing companies led to two references. The two references were contacted via telephone in mid March of 2007. Both references were asked to relate the reason for implementing the device in their department. Additionally, they were asked to relate if the device performed as advertised, how well it was received by the work force, and if they would recommend it. Discussion about consecutive work hour rules with Chief Tingley in October of 2006 took place while both he and the author were attending the Executive Leadership class at the National Fire Academy.

## *Definition of Terms*

Adrenalin: A hormone produced by the adrenal glands that elevates heart and respiration rates; also called epinephrine.

Circadian Rhythm: The inborn, genetically programmed, self-sustaining rhythm in behavior, physiology, and metabolism, developed over evolutionary time that enables living organisms to cope with the 24-hour daily rotation of the earth around the sun.

Demographic: A statistic characterizing human populations, or segments of human populations, broken down by age or sex or income, etc.

Endogenous: Something produced by the brain or body.

Entrainment: The matching of the endogenous circadian rhythm to environmental timing clues.

Fitness Evaluation Device: A piece of equipment used to determine if workers in a safety sensitive position puts themselves and others at risk by directly measuring the workers' current fitness for duty.

Impairment: The condition of being unable to perform as a consequence of physical or mental unfitness.

Physiological: Being in accord with or characteristic of the normal functioning of a living organism.

Psychological: Mental or emotional as opposed to physical in nature; "give psychological support".

## RESULTS

Research Question 1: What consecutive work hour limits are in place at other fire service agencies?

The results of the consecutive work hour limitation questionnaire are listed in Appendix B. Departments with the shortest consecutive work hour limitations are listed at the top and descend in order to the departments with the longest limitations. Approximately 35% or 13 of the agencies that replied to the survey have no limit to the number of consecutive hours an employee may work. Approximately 27% or 10 of the agencies that replied to the survey limit consecutive hours worked to 48. Approximately 22% or eight of the agencies that replied to the survey limit consecutive hours worked to 72. Four agencies that replied to the survey or approximately 11% limit consecutive work hours to 38 or less. One department limited consecutive work hours to 96 hours.

Research Question 2: What is the correlation between call volume and work hour limits at other fire service agencies?

The results of the consecutive work hour questionnaire are organized in Appendix C by unit per hour utilization. The slowest units are listed at the top and the busiest units are listed at the bottom. There does not appear to be any correlation between how busy units are and how

many consecutive hours the department will allow an individual to work. Departments that have no limit to the amount of consecutive hours worked are spread evenly from the slowest departments all the way down to the busiest departments. The second most common consecutive work hour limit, 72-hours, is also spread evenly throughout the results. If anything, the departments with 72-hour limitations are skewed slightly towards the busier departments.

Research Question 3: What legal, medical, or other standard(s) are in place at other fire service agencies to set maximum consecutive work hour rules?

Twenty-four of the departments that responded to the survey have consecutive work hour limitations. Of the 24 departments, 10 reported the rule was in writing. Six of the departments reported the rule was issued as a directive or policy from the fire chief or from senior fire administration. Two of the rules cited health or safety concerns as a reason for adopting the rule. Maximum consecutive work hour rules were negotiated as part of union or labor agreements by two departments. Two departments reported the rule as being in place for so long that no one could remember who put it in place or for what reasons it was put in place. The Wilmington Fire Department, whose consecutive work hour limitation policy listed health concerns, did not elaborate on what health issues they were concerned about. The Memphis Fire Department administrative work rule limiting consecutive work hours is based upon personal safety issues and legal liability. This rule does not state specifically what legal liabilities Memphis is concerned about or what the specific safety issues are.

Research Question 4: What procedures or evaluation devices are other departments using to measure if a firefighter has sustained necessary physical or mental competencies prior to attempting completion of an additional consecutive shift?

Not one single department that responded to the survey has implemented a procedure, or is using an evaluation device, to evaluate whether an employee is physically or mentally competent to work in excess of their normal work period. However, the author through personal interviews with the manufacturer representatives of fit for duty evaluation devices located two emergency departments who are or have tried using a fitness evaluation device. The Alameda City Fire Department (AFD) in California at the request of the manufacturer voluntarily participated in a study of the BLT alertness test for six months in early 2001. The trial study was intended to discover if the test could accurately discover diminished alertness in firefighters prior to beginning their normally scheduled work period. Keystone Quality Transport (KQT), a private ambulance company with operations in Philadelphia, Pennsylvania, is using the PMI Fit 2000 to test employees for impairment due to fatigue.

Alameda Fire Department Deputy Chief Chris Riley (personal interview, March 19, 2007) recalled how the AFD agreed to participate in a trial of the BLT alertness test in 2001. BLT, who is located in Alameda County, initiated the trial. Chief Riley recalled the BLT alertness test as being "well received" and he reported the "employees were into it," even though participation in the program was voluntary. Chief Riley did not recall if the results of the testing revealed any significant issues with reduced alertness during the trial period. At the conclusion of the trial, testing with the BLT alertness test stopped, and no further action was ever taken by the AFD. Chief Riley recalled the trial was part of design testing for the BLT alertness test and assumed it was not yet ready for sale to the public.

Mary Kopishke (personal interview, March 19, 2007) related KQT uses the PMI Fit 2000 to test for fatigue within their employee ranks. An accident involving a fatigued driver precipitated the purchase and subsequent implementation of the PMI Fit 2000. The device was

purchased to ensure ambulance drivers were not fatigued at the start of their shift. Every employee is required to take the test to prove they have come to work rested. The device has been in operation for over four years. Employees who receive low scores are sent home and told to come back to work when they are sufficiently rested. KQT requires employees to submit to testing as a condition of employment.

The discovery of the Unit per Hour Utilization formula in the literature review led to a comparison of PCFSD to each of the departments surveyed. PCFSD's UHU, as shown in Appendix C, is extremely low in comparison to not only the departments surveyed, but also to the benchmark established by Saly (2000). Saly's benchmark of a UHU of .5 is more than ten times the level of current PCFSD operations at .046. PCFSD UHU ranked second to lowest in comparison to the departments surveyed.

## DISCUSSION

The results of the survey reveal mixed consecutive work hour rules; however, over a third of departments listed no limits whatsoever. This discovery, tied to the trend in the fire service towards the adoption of the 48/96 work schedule (BFD, 2007), leads the author to believe there is a discrepancy between published research and actual problems with fatigue in the fire service. These results are in direct conflict with the majority of literature available. The results of the literature review suggest that many authors are concerned about the effects of fatigue on shift workers and firefighters working rotating schedules and long shifts. This is emphasized when legislation is passed to support such concerns. The legislation passed in New York limiting residents and interns to 80-hour workweeks is an example (Fazackerley & McCallion, 1991). Another example is labor unions whose members often negotiate contracts limiting workweeks. The American Ambulance Association reports typical contracts limit consecutive work hours to

36 (Fazackerly & McCallion, 1991). Supporting the trend to limit consecutive work hours in the fire service are Pond (2003) and Rynning (1997). Pond in her ARP recommends all fire departments address the issue of fatigue and its consequences. Rynning in his ARP suggests shifts be limited to two consecutive. However, the author is unaware of any legislation limiting firefighter workweeks.

The research attempted to show a correlation between call volume and consecutive hour work limitations. Several authors postulated that rising call volume leads to chronically fatigued workers including Benson (1993). Benson argued that units that exceed 18 calls in a 24-hour shift or are up most of the night should no longer work 24-hour shifts. Boudreaux et al. (1997) echoed similar sentiments. Their research suggested that employees experiencing severe emotional exhaustion and feelings of burnout were the signal to switch to shorter work periods. Glazner (1992) expressed concerns that 24-hour shift workers are prone to objective and subjective medical problems, and physiological and psychological reactions. The results of the survey did not support their findings. Twenty-three of the busiest twenty-four departments surveyed were still working some form of a 24-hour shift. The recent switch to 48/96 shift schedules among many departments (Boise, 2007) suggests firefighters, whether they know the reason why or not, feel better than when working 24/48 or Kelly schedules. It also suggests that many administrations have seen the benefits of the extended off time and agreed with the employees. Although I have no scientific argument to support it, I suspect the four-day off of a 48/96 schedule allows the body to reset its cumulative sleep deficit to zero. In the words of a posting on the Boise (2007) web site, short-term fatigue may increase but long-term fatigue goes to zero. Staying with one schedule and giving the body time to adapt is a notion supported by

Kuhn (2001) who suggests avoiding entrainment. Frazier (1999) also is a proponent of avoiding rotating schedules with few days off between shifts.

Only two departments whom responded to the survey included any mention of a legal or medical reason for limiting consecutive work rules. The Wilmington Fire Department mentions health concerns, and the Memphis Fire Department lists legal liabilities and safety issues. The lack of concern for legal action against fire departments resulting from fatigued firefighters is concerning. Employers may be held liable for injuries caused by fatigued employees. The case law, although not specific to a firefighter, was established in Oregon (Flaherty & Shoemaker, 1995). Unfortunately, it will take a similar incident involving a fatigued firefighter before the fire service will give the issue the importance it deserves. A downside of 48/96 work schedules is it encourages employees to live further from their places of employment (Boise, 2007). The firefighter suffering short-term fatigue will not have the adrenaline boost of an alarm bell to keep him awake on the extended drive home (Glazner, 1992). Allowing the employee to trade into or pick up extra shifts may only compound the problem.

The technology exists to test employees before allowing them to accept extra shifts or even before they get in their own cars to drive home. The four companies discovered for this ARP all are heavily funded by federal agencies, including the National Highway Traffic Safety Administration (STI, 2007). One key area of focus is on fatigued drivers on the nation's roads and highways. The difficulty will be in marketing the program to the firefighters. The greatest innovations will often founder when not marketed properly. The testing technology for firefighters is just now in its infancy and will be a difficult sell until an agency suffers a tragic incident related to fatigue.

The implications of this research to the PCFSD are similar to the implications to the fire service as a whole. The danger of a fatigued firefighter making a mistake that causes injury during a response is low due to the powerful effects of adrenaline. However, the danger of firefighters becoming fatigued and causing an accident in non-emergent situations is significant. This research has shown that the Park City Fire Service District is currently doing several things correctly. Staffing levels have increased proportionately so that UHU is staying well below the suggested threshold. The 72-hour rule, although implemented arbitrarily, is well within the standards of the industry. The organization attempts to minimize cumulative sleep deprivation by rotating the firefighters in the busiest stations from the engine to the ambulance, and seasonal staffing is brought in during the peak winter season. The anticipated switch to a 48/96-work schedule should contribute to the prevention of cumulative sleep deprivation. The idea that it might be safe to allow employees to work past the 72-hour limit to reduce the number of unfilled shifts is not supported by this research. The PCFSD will have to find another way to ensure 100% of all shifts get filled. The results of this research project support the continuation of the PCFD 72-hour rule.

## RECOMMENDATIONS

The results of this research are static in time. In order to ensure the results are still accurate in coming years, the organization must continue to monitor resource utilization. The Unit per Hour Utilization formula used in this research can be improved upon. The UHU formula focuses on the number of calls. The author recommends a continued study that expands on the variables associated with a call. A routine EMS call may last significantly longer in one organization than another. Followup research should modify the formula to include actual time

spent on calls as opposed to just the number of calls. This data could easily be culled from dispatch logs.

The monitoring of fatigue and the exploration of different ways to measure fatigue must continue especially with the implementation of the 48/96-work schedule. This researcher did not factor injuries or accidents into the measurement of fatigue. The PCFSD must keep accurate statistics of injuries and accidents in the future. An accurate continuous evaluation of accidents or injuries per employee will reveal trends resulting from increased fatigue. The PCFSD must continue exploring the technology available for measuring fatigue. When fatigue-measuring technology becomes more mainstream and accepted in the fire service, opportunities for implementation must be exploited. Simultaneously, administration must continuously educate employees about the benefit of fatigue testing and continue to look for an opportunity to implement fatigue testing when there might be a high probability of success.

As with many issues facing the fire service, continued involvement with local, state, and national organizations along with review of trade journals and Internet sites will lead to prompt notification of pertinent case law and recent studies. The rulings and publications must be examined continuously in order for the PCFSD policies and procedures manual to reflect guidelines that will prevent a fatigued firefighter from harming him or herself or others.

REFERENCE LIST

Benson, K. (1993). Rapid shift movement: EMS agencies work to outsmart the sandman. *Emergency, 25(1),* 28-32.

Boise Fire Department (2007). *Departments on 48/96.* Retrieved March 5, 2007, from http://www.48-96.com/Other%20Departments.htm

Boudreaux, E., Brantley, P.J., Jeffries, S., & Mandry, C. (1997). From 24 to 12: The benefits of shift modification. *Journal of Emergency Medical Services, 22(3),* 86-87.

Boudreaux, E., Brantley, P.J., Jones, G.N., & Mandry, C. (1996). Patient care and daily stress among emergency medical technicians. *Prehospital and Disaster Medicine 11(3),* 189-194.

Bowles Langley Technology (2007). *Industrial safety: alertness testing.* Retrieved March 6, 2007, from http://www.bowles-langley.com/indsafety.html

Clack, J. (2003). *The management effects of firefighters working a consecutive 48-hour shift.* Executive Fire Officer program applied research project. Emmitsburg, MD: National Fire Academy.

Craig, F.M. (2005). *Impact of the 2 x 4 work schedule and consecutive shifts worked on firefighter safety.* Executive Fire Officer program applied research project. Emmitsburg, MD: National Fire Academy.

Eye Dynamics Incorporated (2007). *Safety Scope.* Retrieved March 8, 2007, from http://www.eyedynamics.com/SafetyScopeGEN.htm

Firehouse forums (2007). *Nap time anybody?.* Available from Firehouse.com web site, http://forums.firehouse.com/

Fazackerley, J., & McCallion, R. (1991). Burning the EMS candle: EMS shifts and worker fatigue. *Journal of Emergency Medical Services 16(10),* 40-47.

Flaherty, M., & Shoemaker, D. (1995). Employer liable for tired worker's MVA. *Emergency Medical Services Insider 22(5),* 2-3.

Frazier, G. (1999). *Alternate work schedules – is the answer to increased efficiency, safety, and productivity?* Executive Fire Officer program applied research project. Emmitsburg, MD: National Fire Academy.

Glazner, L.K. (1992). Shift work and its effects on fire fighters and nurses. *Occupational health and Safety, 61(7),* 43-57.

Glazner, L.K. (1996). Factors relating to injury of shift working firefighters in Northeastern United States. *Safety Science, 21,* 255-263.

Kuhn, G. (2001). Circadian Rhythm, shift work, and emergency medicine. *Annals of emergency medicine, 37(1),* 88-98.

Lamberg, L. & Smolensky, M. (2001). The body clock guide to better health (2nd ed.). New York: Henry Holt Company.

Martin, T.C. (1995), Adverse effects of rotating schedules on the circadian rhythms of air medical crews. *Air Medical Journal, 14(2),* 83-86.

May, B. (2006). Fire service history. *Firehouse, 31(12),* 72-74.

Meirovitz, A. (1991). Why do paramedics work those long 24-hour shifts? *Journal of Emergency Medical Services 16(10),* 45.

National Fire Academy (2003). Executive Fire Officer Policies and Procedures – Applied Research Guidelines. Emmitsburg, MD: pp. II-2

National Fire Academy (2005). *Executive Leadership:* Student Manual. Emmitsburg, MD

National Workrights Institute (2007). *Impairment testing – does it work?* Retrieved March 6, 2007 from http://www.workrights.org/issue_drugtest/dt_impairment_testing.html

Park City Fire Service District (2007). PCFSD Web page, *About Us, Statistics, 10-year incident-by-situation summary*. Retrieved February 11, 2007 from http://www.pcfd.org/pdf%20files/10-Year%20Comparison%20Data-2005.pdf

Park City Fire Service District (2006). Standard Operating Guidelines, *General/Daily Operations*. pp. 1-7

PMI Incorporated (2007). *Fitness for duty impairment screeners.* Retrieved March 8, 2007, from http://www.pmifit.com/

Pond, A.B. (2003). *A preliminary study on the effects of fatigue on firefighters.* Executive Fire Officer program applied research project. Emmitsburg, MD: National Fire Academy.

Rynning, N.B. (1997). *An examination of shift trading in the fire service.* Executive Fire Officer program applied research project. Emmitsburg, MD: National Fire Academy.

Saly, A. (2000). The dangers of fatigue. *Fire International, 173(3),* 28.

Schedule Me. (2007). Firesched, The scheduling experts. Retrieved February 25, 2007, from http://www.schedule-me.com/fire.htm

Systems Technology Incorporated (2007). The critical tracking task (CTT) and fitness-for-duty testing. Retrieved March 8, 2007, from http://www.systemstech.com/content/view/29/39/

Wikipedia (2007). The free encyclopedia, *Circadian Rhythm.* Retrieved March 5, 2007, from http://en.wikipedia.org/wiki/Circadian_rhythm

APPENDIX A

## Consecutive Work Hour Limitation Questionnaire

Name:

Agency:

City & State:

Contact Phone #:

1. How many suppression employees are on duty each day?

2. How many units are staffed each day?

3. What was the total call volume of your department in 2006?

4. What is your department shift schedule?

5A. Does your department limit the number of consecutive shifts or hours an employee may work?

5B. What is the limit?

6. If your department has consecutive work hour rules, does your department have a policy, procedure, etc. stating the rule?

7. If your department has a policy, procedure, etc. limiting consecutive work hours, is it based on a legal, medical, or other standard?

8. If the answer to question 7 is yes, please describe or attach the legal, medical, or other standard.

9. Has or does your department use an evaluation device(s) to evaluate whether an employee is mentally or physically competent to work in excess of their normally scheduled work period?

10. If the answer to question 9 is yes, please describe the device, attach a description, or provide a link to the manufacturer.

# Appendix B

## Consecutive Work Hour Limitation Questionnaire Results Organized by Consecutive Work Hour Limits

| Consecutive work hour limit | Schedule | UHU | Department | # of platoons | # of Units | 8760 x # of units | Total call volume |
|---|---|---|---|---|---|---|---|
| 24 | 14/10 | 0.097 | Mt. Lebanon Fire Department | 4 | 2 | 17,520 | 1,698 |
| 36 | 24/48 | 0.048 | Memphis Fire Department (Fire) | 3 | 86 | 753,360 | 36,000 |
| 36 | 24/48 | 0.242 | Memphis Fire Department (EMS) | 3 | 33 | 289,080 | 70,000 |
| 38 | 24/72 | 0.166 | Wilmington Fire Department | 4 | 11 | 96,360 | 16,000 |
| 48 | 24/48 | 0.095 | Atlanta Fire Rescue | 3 | 84 | 735,840 | 70,000 |
| 48 | 24/48 | 0.12 | Tarpon Springs Fire Department | 3 | 4 | 35,040 | 4,220 |
| 48 | 24/48 | 0.123 | Miramar Fire Rescue | 3 | 10 | 87,600 | 10,800 |
| 48 | 24/48 | 0.148 | Palm Beach County Fire Rescue | 3 | 82 | 718,320 | 106,000 |
| 48 | 24/48 | 0.304 | Floorence Fire/EMS | 3 | 3 | 26,280 | 8,000 |
| 48 | Kelly | 0.057 | Bluffdale City Fire Department | 3 | 1 | 8,760 | 500 |
| 48 | Kelly | 0.09 | West Jordan City Fire Department | 3 | 7 | 61,320 | 5,500 |
| 48 | Kelly | 0.1 | South Jordan City Fire Department | 3 | 4 | 35,040 | 3,500 |
| 48 | Kelly | 0.128 | West Valley City Fire Department | 3 | 8 | 70,080 | 9,000 |
| 48 | Kelly | 0.183 | South Salt Lake Fire Department | 3 | 3 | 26,280 | 4,800 |
| 72 | 24/48 | 0.135 | Fort Walton Beach FD | 3 | 3 | 26,280 | 3,554 |
| 72 | 24/48 | 0.74 | Ocala Fire Rescue | 3 | 10 | 87,600 | 65,000 |
| 72 | 48/96 | 0.1 | Provo City Fire Department | 3 | 5 | 43,800 | 8,700 |
| **72** | **Kelly** | **0.046** | **Park City Fire Service District** | **3** | **10** | **87,600** | **4,002** |
| 72 | Kelly | 0.091 | Orem City Fire Department | 3 | 6 | 52,560 | 4,800 |
| 72 | Kelly | 0.097 | Sandy City Fire Department | 3 | 6 | 52,560 | 5,100 |
| 72 | Kelly | 0.14 | City of Newport News Fire Dept. (Fire) | 3 | 10 | 87,600 | 12,402 |
| 72 | Kelly | 0.174 | Murray City Fire Department | 3 | 4 | 35,040 | 6,100 |
| 72 | Kelly | 0.195 | City of Newport News Fire Dept. (EMS) | 3 | 14 | 122,640 | 23,895 |
| 96 | Mod. Kelly | 0.124 | Ogden City Fire Department | 3 | 12 | 105,120 | 12,996 |
| None | 14/10 | 0.092 | Fire Department New York (Fire) | 4 | 341 | 2,987,160 | 275,557 |
| None | 14/10 | 0.095 | West Hartford Fire Department | 4 | 6 | 52,560 | 5,000 |
| None | 14/10 | 0.33 | Fire Department New York (EMS) | 4 | 450 | 3,942,000 | 1,300,000 |
| None | 24/24 | 0.018 | Air Force Academy Fire & Emerg. Services | 2 | 8 | 70,080 | 1,246 |
| None | 24/48 | 0.073 | Sioux City Fire Department | 3 | 9 | 78,840 | 5,779 |
| None | 24/48 | 0.095 | Coral Gables Fire Department | 3 | 9 | 78,840 | 7,493 |
| None | 24/48 | 0.124 | McMahan Fire Protection District | 3 | 1 | 8,760 | 1,087 |
| None | 24/48 | 0.133 | Lubbock Fire Department | 3 | 18 | 157,680 | 21,000 |
| None | 48/96 | 0.082 | Greater Salt lake Unified Fire Authority | 3 | 28 | 245,280 | 20,000 |
| None | Kelly | 0.109 | Monroe Fire Department | 3 | 3 | 26,280 | 2,863 |
| None | Kelly | 0.12 | Midvale City Fire Department | 3 | 4 | 35,040 | 4,200 |
| None | Kelly | 0.199 | Salt Lake City Fire Department | 3 | 17 | 148,920 | 29,571 |
| None | Mod. Kelly | 0.04 | Weber Fire District | 3 | 5 | 43,800 | 1,765 |

## Appendix C

### Consecutive Work Hour Limitation Questionnaire Results Organized by Unit per Hour Utilization

| UHU | Consecutive work hour limit | Department | Schedule | # of pla-toons | # of Units | 8760 times # of units | Total call volume |
|---|---|---|---|---|---|---|---|
| 0.018 | None | Air Force Acad. Fire & Emerg. | 24/24 | 2 | 8 | 70,080 | 1,246 |
| 0.04 | None | Weber Fire District | Mod. Kelly | 3 | 5 | 43,800 | 1,765 |
| **0.046** | **72** | **Park City Fire Service District** | **Kelly** | **3** | **10** | **87,600** | **4,002** |
| 0.048 | 36 | Memphis Fire Department (Fire) | 24/48 | 3 | 86 | 753,360 | 36,000 |
| 0.057 | 48 | Bluffdale City Fire Department | Kelly | 3 | 1 | 8,760 | 500 |
| 0.073 | None | Sioux City Fire Department | 24/48 | 3 | 9 | 78,840 | 5,779 |
| 0.082 | None | Salt lake Unified Fire Authority | 48/96 | 3 | 28 | 245,280 | 20,000 |
| 0.09 | 48 | West Jordan City Fire Dept. | Kelly | 3 | 7 | 61,320 | 5,500 |
| 0.091 | 72 | Orem City Fire Department | Kelly | 3 | 6 | 52,560 | 4,800 |
| 0.092 | None | Fire Department New York (Fire) | 14/10 | 4 | 341 | 2,987,160 | 275,557 |
| 0.095 | 48 | Atlanta Fire Rescue | 24/48 | 3 | 84 | 735,840 | 70,000 |
| 0.095 | None | Coral Gables Fire Department | 24/48 | 3 | 9 | 78,840 | 7,493 |
| 0.095 | None | West Hartford Fire Department | 14/10 | 4 | 6 | 52,560 | 5,000 |
| 0.097 | 24 | Mt. Lebanon Fire Department | 14/10 | 4 | 2 | 17,520 | 1,698 |
| 0.097 | 72 | Sandy City Fire Department | Kelly | 3 | 6 | 52,560 | 5,100 |
| 0.1 | 48 | South Jordan City Fire Dept. | Kelly | 3 | 4 | 35,040 | 3,500 |
| 0.1 | 72 | Provo City Fire Department | 48/96 | 3 | 5 | 43,800 | 8,700 |
| 0.109 | None | Monroe Fire Department | Kelly | 3 | 3 | 26,280 | 2,863 |
| 0.12 | 48 | Tarpon Springs Fire Department | 24/48 | 3 | 4 | 35,040 | 4,220 |
| 0.12 | None | Midvale City Fire Department | Kelly | 3 | 4 | 35,040 | 4,200 |
| 0.123 | 48 | Miramar Fire Rescue | 24/48 | 3 | 10 | 87,600 | 10,800 |
| 0.124 | None | McMahan Fire Protection District | 24/48 | 3 | 1 | 8,760 | 1,087 |
| 0.124 | 96 | Ogden City Fire Department | Mod. Kelly | 3 | 12 | 105,120 | 12,996 |
| 0.128 | 48 | West Valley City Fire Department | Kelly | 3 | 8 | 70,080 | 9,000 |
| 0.133 | None | Lubbock Fire Department | 24/48 | 3 | 18 | 157,680 | 21,000 |
| 0.135 | 72 | Fort Walton Beach FD | 24/48 | 3 | 3 | 26,280 | 3,554 |
| 0.14 | 72 | Newport News Fire Dept. (Fire) | Kelly | 3 | 10 | 87,600 | 12,402 |
| 0.148 | 48 | Palm Beach County Fire Rescue | 24/48 | 3 | 82 | 718,320 | 106,000 |
| 0.166 | 38 | Wilmington Fire Department | 24/72 | 4 | 11 | 96,360 | 16,000 |
| 0.174 | 72 | Murray City Fire Department | Kelly | 3 | 4 | 35,040 | 6,100 |
| 0.183 | 48 | South Salt Lake Fire Department | Kelly | 3 | 3 | 26,280 | 4,800 |
| 0.195 | 72 | Newport News Fire Dept. (EMS) | Kelly | 3 | 14 | 122,640 | 23,895 |
| 0.199 | None | Salt Lake City Fire Department | Kelly | 3 | 17 | 148,920 | 29,571 |
| 0.242 | 36 | Memphis Fire Department (EMS) | 24/48 | 3 | 33 | 289,080 | 70,000 |
| 0.304 | 48 | Floorence Fire/EMS | 24/48 | 3 | 3 | 26,280 | 8,000 |
| 0.33 | None | Fire Department New York (EMS) | 14/10 | 4 | 450 | 3,942,000 | 1.3 mil. |
| 0.74 | 72 | Ocala Fire Rescue | 24/48 | 3 | 10 | 87,600 | 65,000 |