A PRELIMINARY STUDY ON THE EFFECTS OF FATIGUE ON FIREFIGHTERS

Executive Analysis of Fire Service Operations in Emergency Management

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Abstract

The problem was the Laramie Fire Department (LFD) did not limit the number of consecutive hours shift personnel could work. The purpose of this Applied Research Project (ARP) is to study the effects of fatigue on firefighters. This was a descriptive research project. The research questions were:

1. What standards, laws, or regulations govern hours worked by fire/Emergency Medical Service (EMS) personnel?
2. How do other industries limit work/duty hours?
3. What are the effects of fatigue?

The procedures involved surveying a convince sample of 41 students taking Executive Fire Officer Program (EFOP) classes April 28-May 9,2003, surveying a convince sample of public safety departments in Albany County and finally testing a representative sample of LFD personnel throughout a 48 hour consecutive work period. Results show that 84% of the fire/EMS departments represented limit work hours. Thirty three percent of the Albany County Public Safety departments limit work hours. The immediate effects of fatigue on the LFD personnel were seen in strengthen loss (88%) of the subjects, increased errors in problem solving and fine motor control (88%) and gross motor control (88%) of the subjects tested.

The recommendations based on this study were for the United States Fire Administration (USFA) to recognize fatigue as a preventable health and wellness issue for firefighters. It is further recommended that the LFD develop a policy limiting the number of consecutive hours shift personnel can work.

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Introduction

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Background and Significance

Historically the LFD has adopted the National Fire Protection Association (NFPA) 1500 Standard on Fire Department Occupational Safety and Health Program. In the 1970's and 1980's LFD had a pre-entry physical test for potential employees as well as comprehensive physicals for all current employees. In the late 1990's the LFD took employee fitness and wellness a step further by incorporating a physical training policy in the policy manual.

The purpose of the physical fitness and wellness program is to promote and maintain a high level of physical fitness in all active LFD personnel, thereby, including firefighter safety and minimizing injuries. The major components of this program include firefighter task test, on duty exercise program and physical assessment by the department physician and shift fitness coordinators.

This program is supported by a medical condition screening system, time allotment for mandatory exercise, and the availability of personal fitness programs designed to help individuals achieve their fitness goals. Participating in

the program is required by all active personnel covered by firefighter pension plan, unless specifically exempt by the Chief of the LFD or the department physician. (Laramie Fire Department [LFD] Policy Manual, 1998, p. 1)

The NFPA 1500 (1993) indicates that prevention is as important as treatment when it comes to fitness and wellness.

> Much has been written about the need for preventive health care, and prevention experts. However, prevention can mean different things to different people.
>
> To some, prevention means getting fire fighters to 'live healthy' by not smoking changing their diets, wearing seatbelts, etc. often this is called controlling personal risks factors for disease." (*National Fire Protection Association* [NFPA] 1500 Handbook, 1993, p. 393)

The LFD presently encourages all employees to "live healthy". In 2000 the City of Laramie (COL) adopted a no smoking policy by all LFD employees. (Laramie Fire Department [LFD] Policy Manual, 2000, Smoking p.1)

A crucial element of NFPA Standard 1500 is mitigating occupational hazards. Prevention also means controlling occupational hazards. This might mean requiring firefighter to wear personnel protective gear, initiating a hepatitis B vaccination program, controlling diesel exhaust in the fire house, and more or improved training. (National Fire Protection Association [NFPA] 1500 Handbook, 1993, p. 393)

The LFD has addressed all these recognized occupational hazards with the addition of a hepatitis A vaccination program and annual TB testing. An

occupational hazard not addressed by either the NFPA or the LFD is firefighter fatigue.

The utilization of trades and holdovers to maintain a staffing minimum can be a fact of life for most small fire departments. The LFD is no exception. Serving a rural response district the size of a small state (4,200 square miles with three shifts of 12 people) each shift is a 24 hour tour of duty with 48 hours off. The LFD currently relies on trades and holdovers to maintain a nine person minimum. The use of trades and holdovers is so viable to the day to day operations that a policy for each has been included in the LFD Policy Manual.

Filling Holdover Vacancies

a. When the need arises for holdover, the following procedures will be used:

i. Solicit volunteers of the same grade from their own shift. This should be done under a system of rotation within qualified personnel, giving due consideration to cost

ii. If no volunteer is found, and time permits, off shift personnel of the same grade may be contacted to see if they would like the holdover. Again, cost should be considered when calling off-duty shift personnel.

iii. If no substitute volunteer is found, a person from the officer's shift will be assigned to the duty. Criteria as to who gets chosen should include cost. (LFD Policy Manual, 2003, Manning p. 3)

No where in the policy on holdovers is firefighter fatigue, maximum work hours, or consecutive hours addressed. This is also true for the policy on trades.

A. Shift Trades

1. It is permissible for LFD personnel to work for each other under the following conditions:
    a. All trades must be approved by the Shift Commander in which the trade (shift) will effect.
        1) A ‘non-scheduled Duty Form’ must be filled out, and the person to work the trade must sign the form.
        2) Trades may occur between any members qualified to perform in the other’s position, or with approval of the Shift Commander when shift personnel on duty can satisfy the qualifications of the trade.
        3) The person requesting the trade will have their Shift Commander approve the trade and initial the form. The Shift Commander will indicate approval by his/her signature at the bottom, and update the proposed manning accordingly.
            a) Trades are not considered a form of guaranteed leave. It is the responsibility of the two parties involved in the trade to cover the problems that may arise due to the trade.
            b) Individuals may not trade to relieve one of individual from department responsibilities.
        4) The completed form will be maintained on file until the trade has passed. (LFD Policy Manual, 2003, p. 1)

Of the 92 days that comprised the summer of 2002 (June 1- August 31), there were 19 shifts (20%) that did not require a trade or holdover to maintain the minimum staffing levels of nine. There were 55 shifts (59%) which had someone working over 24 consecutive hours. Fourteen shifts (15%) had two people on a trade or holdover, and four shifts (4%) had three or more people working a trade or holdover. During this time the LFD had three individuals work 96 consecutive hours, and one individual worked 120 consecutive hours. (2002 Laramie Fire Department [LFD] Manning Program June 1-August 31, 2002)

There were no accidents or injuries recorded during this time that were attributed to firefighter fatigue. However, the effect on the future health of these individuals is as of yet undetermined.

As early as January 2000 Atkinson recognized the effects of fatigue on current firefighter safety and possible future health problems.

Those involved in risk management for fire departments must often contend with chronically fatigued firefighters who may be prone to :

- have personal accidents and injuries while on duty
- cause accidents and injuries to others while on duty (especially when responding to calls) and ,
- have long-term health problems (especially heart and digestive problems). (2002 Health and Safety for Fire and Emergency Service Personnel, p. 5)

This ARP is part of the National Fire Academy's (NFA) Executive Analysis of Fire Service Operations in Emergency Management class. This ARP relates to chapters six, (Capability Assessment), and 10 (Contemporary Legal Issues For the Fire Service).

In Capability Assessment, (chapter six), eight operational combat principles are discussed. The eighth principle is safety and states the principle of safety has two points and a corollary. The first part is that safety of the force is essential to effective operations. If disaster strikes and firefighters fall, confusion will reign and all progress against the fire will halt. The second part is that provisions must be available to the force for it to remain in service. Logistical support is essential to effective operation. The corollary of the principle of safety is risk necessary to make progress with the safety of resources that will cause effective application of this principle. (National Fire Academy [NFA] SM 6-32)

The second point is that fatigued firefighters could be an unnecessary risk during fire operations. Further, fatigued firefighters could be a legal issue for many departments.

> In recent years, liability has become a major concern to firefighters and officers for a variety of reasons. The role of the fire service has been steadily expanding bringing with it a corresponding increase in exposure to liability. new hazards and assignments also increase the danger of mistakes; consequently, more people are watching and reviewing activity than ever before. Understanding the concepts of liability is the first step toward identifying the risks than can lead to a lawsuit. After identifying the risks,

corrective action can be taken to lesson the likelihood of a lawsuit affecting you. (NFA SM 10-9)

A corollary is that fire departments are encouraged to keep training records and on-duty records for all personnel. A fatigued firefighter could be a liability to a fire department when records show that he/she worked 48 consecutive hours prior to an incident or accident.

This ARP should be of interest to the United States Fire Administration (USFA) as it supports the operational objective of reducing the loss of life from fire of firefighters.

Literature Review

When looking at the effects of fatigue on firefighters three questions need to be answered: What standards, laws, or regulations govern hours worked by fire/EMS personnel? How do other industries limit work/duty hours? What are the effects of fatigue?

When looking at standards, regulations, or laws regarding maximum hours worked federal, and state laws as well as the laws governing the jurisdiction covered must be considered. The Fair Labor Standards Act (FLSA) is a federal law which most firefighters are know. Enacted in 1938 FLSA “is a federal law with broad application that contains provisions and standards on minimum wages, maximum hours allowable without overtime pay, child labor, and record keeping.” (Fair Labor Standard Act [FLSA] p. 1)

Maximum allowable work hours are discussed in FLSA Section 7.

Except as otherwise provided in this section, no employer shall

employ any of his employees who in any work week is engaged in commerce, or in the production of goods for commerce, or is employed in an enterprise engaged in commerce or in the production of goods for commerce, for a work week longer than forty hours unless such employment receives compensation for his employment in excess of the hours above specified at a rate not less than one and one-half times the regular rate at which he is employed. (FLSA 1938, As Amended, 2003, p.1)

As firefighters are not employed in an occupation that deals with commerce further review of the FLSA is required.

Public- sector (government) fire departments may establish special “7 (K) work periods” for sworn firefighters, which can increase the FLSA overtime ‘thresholds’ beyond the normal 40 hour work week. Firefighters covered by these special work periods are entitled to FLSA overtime only for hours worked in excess of a threshold set by the Department of Labor on a chart. For example in a 28 day work period, firefighters would be entitled to FLSA overtime only for hours actually worked over 212 during the 28 day period (in essence, a 53 hour work week). “7 (K)” refers to the section of the FLSA in which these special rules contained , 29 USC S 207 (K).

Most firefighters who work “platoon schedules” will be classified by their employers as ‘7 (K) eligible’ and compensated accordingly.

The special work periods and overtime rules are available only for employees who meet the statutory definition of “employees in fire protection activities” which is contained at S 203 (Y):

> Employees in fire protection activities means an employee, including a firefighter, paramedic, emergency medical technician, rescue worker, ambulance personnel, or hazardous material worker, who
>
> (1) is trained in fire suppression, has the legal authority and responsibility
>
> (2) to engage in fire suppression, and is employed by a fire department of a municipality, county, fire district, or state, and
>
> (3) is engaged in the prevention, control, and extinguishment of fires or responses to emergency medical situations where life, property, or environment is at risk. (FLSA and Firefighters p. 1)

FLSA does not limit the number of hours firefighters can work; it only defines a firefighter and the allowable hours worked before overtime compensation is required.

Operating with the premise that fatigued firefighters can be a risk management issue, *Risk Management Practices in the Fire Service* (1996) was researched. Healthy workplaces, safe work places, and NFPA 1500 were mentioned; however neither maximum hours worked or fatigued firefighters were mentioned.

The fundamental principle of occupational safety and health laws is that an employer (the fire department or emergency service organization) is responsible for providing a reasonably safe and healthy workplace for an

employee. The application of this concept to emergency operations essentially means an organization must:

- recognize, identify, evaluate the dangers inherent in performing emergency operations
- take reasonable steps to protect employees from those dangers

Determining what is reasonable in this content generally involves interrupting standards that have been incorporated by reference into regulations such as *NFPA 1500.* The exception today is that firefighters must be properly trained, supervised, and equipped to function as safely as possible, recognizing the inherent risk factors that one involved in conducting emergency operations. (Risk Management Practices in the Fire Service December 1996, p. 67)

NFPA 1500 Standard on Fire Department Occupational Safety and Health Program was examined looking specifically for maximum allowable hours worked and/or the effects of fatigue on firefighters. Viewed as the industry standard on firefighter safety, NFPA 1500 covers many aspects of wellness and health in the fire service. Fatigued firefighters and hours worked are not covered in NFPA 1500, 1581, or 1582.

NFPA 1500 has taken a complete approach to a medical and physical fitness program as an integral part of the comprehensive occupational safety and health program for fire department members, *NFPA 1500 Standard on Fire Department Occupational Safety and Health Program, NFPA*

1581,Standard on Fire Department Infection Control Program, and *NFPA 1582, Standard on Medical Requirements for Firefighters,* detail the health, medical, and safety requirements for individuals presently serving as members, firefighters, and for those who are candidates to become firefighters, *NFPA 1500* provides the medical and physical requirements for those individuals whose duties require the performance of essential fire fighting or substantially similar functions regardless of rank. *NFPA 1581* specifies the requirements for an infection control program to protect members, EMS providers, fire fighters, and patients from contagious and communicable diseases. *NFPA 1582* also details the specific medical evaluations for these individuals. (*National Fire Protection Association 1500 Handbook* [NFPA] 1993 p. 387)

Although NFPA 1500 (1993) claims to "take a complete approach to medical and physical fitness" neither sleep deprivation or fatigue is mentioned.

"Title 29 of the United States Code (USC) covers workplace safety with the enactment of the Occupational and Safety Health Act (OSHA)." (Workplace Safety: an overview p. 1) Concerned with workplace safety and health laws, OSHA covers many risks faced by fire service employees; however maximum work hours and fatigue are not among them.

After researching federal laws, and standards it appears several protect employees' rights regarding wages and hours worked. There are none limiting the number of consecutive hours worked.

The next level of laws regarding employees' rights is the individual state statute. In Wyoming title 27 of the Wyoming State Statutes (WS) covers labor and employment. The only industry mentioned in WS 27 is mining.

WS 27-5-102

(a) The lawful working day in all underground mines is eight (8) hours per day, except:

(i) In case of emergency;

(ii) By mutual agreement between an employer and employee or employees' representative for a longer period of employment, but not to exceed sixteen (16) hours in any twenty-four (24) hour period. (Wyoming State Statutes [WSS] p. 99)

In chapter 10 of the WS title 27, Collective Bargaining for Fire Fighters work hours and conditions are addressed;

WS 27-10-102 Right to collective bargaining and representation by bargaining agent. The fire fighters in any city, town or county shall have the right to bargain collectively with their representative cities, towns, or counties and to be represented by a bargaining agent in such collective bargaining as to wages, rates of pay, working conditions and all other terms and conditions of employment. (WSS p.114)

In Wyoming firefighters hours are covered by the collective bargaining agreements made between the governing agency (city or town), and the fire-fighters.

The collective bargaining agreement between the (COL) and LFD covers work hours in section 7.

> The schedules and hours of work shall consist of a basic work week of 56 hours in 24-hour shifts and on a three-platoon basis. There shall be neither additional days off (Kelly Days) granted nor shall there be any deviation from the schedule due to holidays. The city reserves the right to assign personnel to a 40-hour per week schedule. (International Association of Fire Fighters Local 946 [IAFF], 2002 p. 7)

The only regulation, standard or law governing fire/EMS maximum work hours was found in a Bureau of Land Management (BLM) instruction memorandum No WY-2003-018 (2003) from the Associate State Director Alan L. Kesterke. He addressed firefighter fatigue in the wildland setting, by setting, maximum work hours and a “work to rest ratio.”

> Regardless of time of incident, operational period, or regular work schedule, all personnel are provided a 2 to 1 work to rest ratio. Justification for work shifts exceeding 16 hours or the 2 to 1 work ratio shall be pre-approved by the agency administrator or incident commander. Under no circumstances will a pre-approved request exceed 24 hours in a single work shift. For example, after an approved 22 hour shift, the individual is required to have the

> next 11 hours off.(Bureau of Land Management [BLM] Wyoming Instruction Memorandum 2003, p. 2)

The second question that must be answered is how do other industries limit work/duty hours? Since law enforcement and the fire service are closely related maximum work hours for law enforcement officers was examined. “There is no federal standard, regulation or law limiting law enforcement work hours.” (Vila, 2000) Each agency must regulate the hours its employees work. This requires support from the collective bargaining unit in each jurisdiction.

> The State Police Association of Massachusetts (the trooper collective bargaining unit) reportedly began revamping the outdated 1974 work restriction that allows troopers to work such extraordinary hours. This restriction states that troopers cannot schedule themselves for more than 16 consecutive work hours. However, if someone else (e.g., a supervisor) schedules a trooper for overtime, or if a scheduled detail goes beyond regular work hours, then the trooper is not in violation of the 16-hour limit. The State Police Association hopes to limit the total number of hours a trooper can work per month, and penalize those who exceed this limit. (Villa 2000, p. 36)

In some jurisdictions the union may bring the chief or sheriff to arbitration over limited work hours.

> A chief of a small Massachusetts police department ran into similar problems with his officers. He has asked to remain anonymous because

> he still is in arbitration over work-hour issues. His department long had a policy limiting the hours officers could work, but it hadn't been enforced. When the Chief became concerned about excessive overtime and fatigue, and tried to enforce the policy, the union challenged the decision. After many heated meetings, the Chief even offered to obtain a substantial pay raise to help officers deal with the overtime reduction. The union still refused. (Villa 2000, p. 38)

Vila (2000) conducted his research in police fatigue by interviewing several large departments regarding overtime hours. "Most departments reportedly had no policy limiting hours how many hours an officer may work in a day, week, or month."

Although fatigue in law enforcement officers has been researched and is recognized as a serious problem, there is no national standard limiting hours worked.

The medical field was researched next. Two professions, doctors and pharmacists were looked at for maximum hours. In 2002 the American Medical Association (AMA) made history by setting work hour maximums for residents.

> The American Medical Association House of Delegates approved a wide-ranging new policy today regarding the working conditions for resident physicians, including imposing limits on the number of hours they can work. This is the first time the AMA has adopted policies with specific definitions, hours and working conditions for resident physicians.

(American Medical Association [AMA] p. 1)

Some of the major highlights of the policy include:

- Limits total residency duty hours to 80 per week, averaged over a two-week period. The AMA will work with
  graduate medical education accrediting bodies to determine if an increase of 5 percent my be appropriate for service training programs;
- Restricts scheduled on-call assignments to 24 hours, with up to six additional hours to complete transfer of care, patient follow-up and education;
- Limits scheduled on-call shifts to no more than every third night and requires one day off in seven;
- Requires that any limits on total duty hours must not adversely affect resident physician participation in the organized educational activities of the residency program. (AMA p. 1)

With EMS a major part of the fire service, fatigues' affects on medication dispensing and dosing could happen. The pharmacy profession was examined for work hour limits. There are no federal standards or regulations limiting pharmacist work hours. Individual states are trying to enact legislation limiting hours.

North Carolina became the first state to regulate pharmacist hours

> earlier this year. Spurred on by a complaint of a missfill dispensed by a pharmacist who had worked a 16-hour shift in 1997, the North Carolina Pharmacy Board's proposed a rule that would prohibit pharmacists from working more than 12 continuous hours per day. (Voice of the Injured p.6)

Although the pharmacists in North Carolina rejected the interference, some pharmacists in Maine asked to have their work day regulated.

> In late 1995, 27 Maine pharmacists – 10 from Rite Aid- submitted a petition to the Maine Board of Pharmacy asking that the board establish a regulation limiting pharmacists to a maximum 12 hour workdays. The board voted to deny the petition, noting the "potentially controversial nature and far-reaching effect of such a rule. (Voice of the Injured p. 6)

Because obtaining a Commercial Drivers License (CDL) is often a requirement of employment in the fire service, researching the hours-of-service (HOS) set by the Federal Motor Carrier Safety Administration for commercial motor vehicles (CMV) was the next step.

There is a history of HOS regulations starting in 1935 with the Motor Carrier Act. (United States Department of transportation [USDOT] p. 1)
In the past 68 years there have been many changes to the original HOS limits. There is currently a proposal in front of the Interstate Commerce Commission (ICC) to stiffen the HOS regulations as a result of driver fatigue.

This proposal would make the HOS regulations more effective by requiring motor carriers and drivers to adhere to and enforce the following six standards:

1. Promote scheduling, dispatching, and operating practices minimizing the use of potentially tired, inattentive drivers.
2. Make available for each driver a consecutive minimum off-duty period of time each workday and work week for the purpose of obtaining restorative sleep.
3. Make available for each driver an additional minimum off-duty period of time each workday, during the workday or afterwards, to allow a driver to tend personal activities and rest at the driver's discretion.
4. Empower the driver to accept or refuse dispatch or continuation a trip based upon the driver's assessment of his/her alertness level.
5. Enhance motor carriers' and CMV drivers' knowledge and use of safety techniques, devices, and practices that avoid driver impairment due to lack of sleep.
6. Require the use of automated electronic on-board recording (EDBR) technology to monitor the work-rest cycles of long-haul and regional drivers and assure compliance with the rules, as well as encourage the use of technology for other drivers. (USDOT p. 1)

Although federal regulations are in place regarding HOS many drivers ignore them.

> A recent survey reported the average number of hours reported worked exceeded 63 in the previous 7 days. Twenty-five present of the drivers reported working at least 75 hours in the preceding 7 days and 10 percent reported working more than 90 hours. (USDOT p.3)

The aviation industry was the final industry reviewed. Unlike law enforcement officers, pharmacists, and commercial drivers, the pilots association like the AMA is lobbying for tougher work hour limits.

> Pilot fatigue has long been on the National Transportation Safety Board's (NTSB) "most wanted" list of safety fixes. And the Federal Aviation Administration, which for the past six years has been trying to come up with new regulations, has weathered harsh criticism for failing to act faster. As a result, in the last few months, pilots have stepped up their fight to bring their concerns to the public. (Christian Science Monitor [CSM] 2001 p. 2)

The FAA covering pilots hours rules were vague and open to different interpretations from the pilots association and the airlines. In the fall of 2000 the Federal Aviation Administration (FAA) clarified this ruling.

> It said that in any 24-hour period, a pilot should be able to find eight hours of rest. For the pilots, it was a long overdue clarification that closed a loop hole that had kept some pilots on duty for unlimited amounts of time. The clarification, they say, set a straightforward 16-hour limit. (CSM 2000 p. 2)

The airlines were not happy with the FAA ruling and would be even less pleased should the FAA follow the pilots recommendation of 12 hour maximum work day.

The third question to be reviewed is; What are the effects of fatigue.

> "My mind clicks on and off. I try letting one eyelid close at a time while prop the other with my will. But the effect is too much, sleep is winning, my whole body argues dully that nothing, nothing life can attain is quite so desirable as sleep. My mind is losing resolution and control." Charles Lindbergh about his 1927 Transatlantic flight. (The Effects of Fatigue on Performance and Safety p.1)

There were incidents in history where fatigue was considered a contributing factor in an accident but never given the full blame.

> On January 2, 1989, the captain of a 707 tried to maneuver his plane to land in Salt Lake City after breaking his plane out of the clouds at 200 feet. He dropped his left, outboard engine on the runway, leaving a 60-foot-long gauge. Within the preceding 30 hours, he had been on duty for 19 hours, and flown 13 hours. He had been off duty for almost 12 hours, but was only able to get one hour of sleep in that time. Pilot fatigue due to disrupted circadian rhythm was cited as a contributing actor. (Pilot fatigue, Accidents and Airline Safety p. 3)

One reason for the lack of research on fatigue and its effects on humans is its relationship to other health problems.

Fatigue is closely interrelated to other problems in that it can be a

symptom of them, or it can be the cause. The most obvious cause of fatigue would be the lack of sleep, but other factors would include stress, anxiety and poor health. It can also be a cause of these problems. Furthermore, fatigue can be the symptom of other problems such as hypoxia and dehydration.

Symptoms of fatigue include a feeling of indifference to one's performance, increased reaction time, a decreased ability to concentrate on multiple tasks, fixation, short-term memory loss, impaired judgment, impaired decision-making ability, distractibility, sloppy flying skills, reduced visual perception, loss of initiative, personality changes and depression. (Pilot Fatigue, Accidents, and Airline Safety p. 3)

The first real research on the effects of fatigue on public safety personnel was done within a grant from the United States Department of Justice (USDOJ). Researching police patrol officers, Vila noted how fatigue affects all aspects of the officer's shift.

There also was general agreement among the participants that fatigue can and does degrade their interactions with the public. Specifically, this included reduced patience, increased irritability, and a diminished capacity to identify alternative responses to both specific incidents and the broader issues that might lend themselves to problem solving. Additionally they were concerned that the overall quality and quantity of work buffers as tired officers become less engaged in self-initiated activity. (Villa 2000)

In 2000 researchers in San Diego California studied sleep deprivation and the effects on the brain. They found that the brain compensates for the loss of sleep.

They concluded; ”the brain is adversely affected by sleep deprivation because certain patterns of electrical and chemical activity that occur during sleep are interrupted, impeding the brain’s ability to function normally. (Brian Activity is Visibly Altered 2000, p. 2)

The study in San Diego kept subjects awake for 35 hours, which does happen in the fire service. Even more common in the fire service is not getting six hours or more of uninterrupted sleep. Billingsley (2003) noted

> that people who sleep for six hours or less a night for two weeks responded as poorly on standard cognitive tests as do people who don’t sleep at all for three days. But they think they’re doing fine, which is the problem.

Although Billingsley does not mention if these six hours must be uninterrupted or not, research into Rapid Eye Movement (REM) sleep would have us believe these must be uninterrupted hours. In his book *Power Sleep* (1998) Maas notes the importance of uninterrupted sleep.

> Between the seventh and eighth hour is when we get almost an hour of REM (rapid eye movement) sleep, the time when the mind repairs itself, grows new connections and puts it all together. REM sleep occurs about every 90 minutes, and the periods of REM sleep get longer as the night progresses. If you’re a six-hour sleeper, you’re missing that last, important opportunity to repair and prepare for the coming day.

In a recent study by Penn State College of Medicine, Vgontzas (2003) found that sleep deprivation has long term consequences on the health and wellness of individuals.

> . . . immune systems were disrupted which could lead to an increase in the likelihood of infections and disease. Another adverse reaction was an increaser in a molecule that controls metabolism. This, in turn, could lead to obesity and on to obesity related problems such as heart disease, diabetes, and sleep apnea. In older men, slight sleep deprivation caused a decrease in testosterone levels. This study serves to emphasize the importance of getting a full night's sleep every night. Eight hours is recommended for ultimate health and well being.

In summary, based on the literature review, with the exception of the BLM memorandum 2003-018, there are no laws, regulations, or standards limiting work hours for fire personnel; however, the ICC, FAA, and AMA have work hour limits regulations in place for their personnel. Although there is no controversy with the AMA work limits both, the FAA and the ICC are finding dissention with their regulations. Fatigue and its effects on humans is a relatively new field of study. Preliminary reports show there are both short-term and long-term consequences of fatigue.

Procedures

A three part approach was taken for this ARP. The first step was to utilize a feedback form on a convince sample of National Fire Academy (NFA) students who were attending Executive Fire Officer Program (EFOP) classes from April 28, 2003 – May 9, 2003.

The six question feedback form (Appendix A) was used to discover if fire/EMS departments regulated maximum work hours. The first two questions were for

demographic purposes. The final four were posed to answer this researcher's question as to what laws, regulations, or standards govern the maximum hours worked by fire/EMS personnel. This was followed by a personnel interview with COL City Attorney Hugh McFadden to assure that no regulations, laws, or standards governing maximum work hours had been overlooked.

The second step was to interview the three local public safety agencies that LFD works with every day. "Statistical methodology assists researchers in making inferences about a large group (a population) based on observations of a smaller subset of that group (a sample)." (Helberg 1996) The Laramie Police Department (LPD), the Albany County Sheriff's Office (ACSO), and the Ivinson Memorial Hospital (IMH) Emergency Department were asked one question, Do you limit the number of hours personnel can work? If they answered in the affirmative the follow up question was, How do you mandate this?

Finally a study was conducted on LFD shift personnel at zero hours worked, 24 hours worked and 48 hours worked. Dr. Burton Clark of the NFA was consulted regarding this study which measured the subjects' fine motor control, gross motor control, listening skills, problem solving skills, and strength. Each subject was asked to complete five tasks and was timed for each task.

To limit as many human variables as possible all subjects were timed by this researcher using a Aqua Tech 1/100 second stop watch. They completed the tasks in the same order every day. The candidates were timed for each event; there was no overall time. All subjects were tested between 0800 and 0820 each morning. Before each task, all subjects were asked if they understood the task.

Upon answering in the affirmative they were told to “go.” All subjects were told they were being tested for a study on fatigue. Subjects were told they were not competing against anyone. Each subject had passed their probationary period of one year. Each subject was tested on skills required by all shift personnel. This is a representative sample (Helberg 1996).

Requirements of participating in this study were employment as a shift firefighter at LFD, scheduled to work a 48-hour shift between May 10, 2003 and July 31, 2003, and a willingness to volunteer for the study.

On May 10, 2003 LFD shift personnel numbered 36. The age break down was, twelve personnel between the ages of 20 and 29, twelve between the ages of 30 and 39, and twelve between the ages of 40 and 49. The breakdown of the subjects in this study are three between the ages of 20 and 29, three between 30 and 39, and three between 40 and 49.

To eliminate a “statistical technique” Helberg (1995) identifies as “causing problems with interpretation” multiple comparisons were not done. Subjects were not competing with each other.

The first task the subjects were required to complete was a simple friction loss equation, using the friction loss formula in the *Pumping Apparatus Driver/Operator Handbook* (Weilder 1999 p. 142). The components of the equation were changed for each of the three tests to eliminate any prior knowledge biases the subjects may have. Each equation was written out on the paper the subject used to write their answer on, thus eliminating any misunderstood verbal numerical statements. The first day they were asked to

“figure the friction loss in 200 feet of 1 ¾ inch with 300 GPM flowing”. At 24 hours worked they were asked “If 300 GPM is flowing from a nozzle, what is the friction loss in 400 feet of 2 ½ inch hose?” After 48-hours worked the subject was asked,” What is the friction loss in 250 feet of 1 ¾ inch hose when 150 GPM is flowing?” Subjects were judged on the time it took them to complete the problem and the accuracy of their answers. All candidates were supplied with a Texas Instrument TI-30X calculator to use when figuring the equations. This was used to test the subjects’ listening and problem solving skills. Time was stopped when the subjects wrote down their answers to the problem.

The second task was to fill a syringe with .5cc of saline water. The same syringe was used for all three tests and all nine subjects. A 10 cc syringe marked at .2cc intervals with a 25 gauge needle was used. Twenty cc’s pf saline water was placed in a small (20 cc capacity) container. The same container was used for all tasks and all subjects. Techniques used for drawing the saline were not outlined in the directions, however LFD EMS Protocols reference *Emergency Care Principles and Practices for the EMT-Paramedic* (1982). Subjects were judged on their accuracy and time. This task involved fine motor and listening skills.

The third task was to tie a knot. The knot chosen was the handcuff knot, a knot used in vertical rescue. All were judged on the time it took them to tie the knot and if the knot was tied properly using Norman (1998) as a reference. This tested fine motor skill and listening skills.

The fourth task was the donning of personal protective gear (PPE) . Each subject started in his station uniform and when told “go” was required to don all bunker gear, SCBA’s, helmet, face mask, and gloves. This task tested subjects’ gross motor skills, and listening skills. The task was considered complete when they had taken one complete breath on the SCBA. Standards used on this task were *Essentials of Fire Fighting Fourth Edition (*1998).

The fifth task was grip strength. They were given three chances to measure their grip strength. The Grip-o-meter (measures grip strength from 0 to 100 pounds per square inch) was used. They could chose which hand they wished to test; however once chosen that hand was used throughout the testing process. This was the only test not timed. This test measured the grip strength of each subject in psi.

Limitations and Assumptions

All respondents are assumed to have answered honestly.

It is assumed that each test subject gave 100% on each task.

It is assumed that any pre-testing knowledge was equal.

Subjects were not selected by their assignments. Some subjects were up all night and some subjects may have slept all night.

Subjects were not advised to get a good night of sleep prior to their zero hour work test, it is assumed all subjects came on duty physically ready to work.

Six months was too short of time to fully study the effects of fatigue.

This is a preliminary study, further research should take place.

All subjects in the test were make.

Definition of terms

Trade – a process by which a shift firefighter works part or all of an assignment for another firefighter.

Firefighter – any sworn shift personnel, regardless of rank, employed by a fire department.

Holdover – the working of extra hours on another shift to reach staffing minimums.

Small fire department – any fire department with fifty or less shift firefighters.

Circadian rhythm – a cycle of approximately 24 hours of biological processes.

Wellness – a state of physical and mental well being.

Results

To answer what standards, regulations, or laws govern fire/EMS maximum work hours, 41 people representing different fire/EMS agencies responded. Twenty-five of the respondents (61%) reported their agency limited work hours for their personnel. When asked if there were any exceptions to the maximum hours worked, 21 respondents (84%) answered yes.

Emergency call back was the most common exception cited by 14 respondents (66%) to the maximum hours worked followed by trades, four (20%), staffing shortages, two (10%), and one respondent, (5%) reported any work outside EMS as the only exception.

How do these 25 fire/EMS agencies regulate maximum hours? Ten departments (40%), rely on their union contract to regulate hours, six respondents (24%) reported having Standard Operating Guidelines (SOG's) that

regulate maximum hours, four departments (16%) have Standard Operating Procedures (SOP's), two respondents (8%) use Chief's orders and two (8%) use rules and regulations and one department (4%) uses an Employee Handbook.

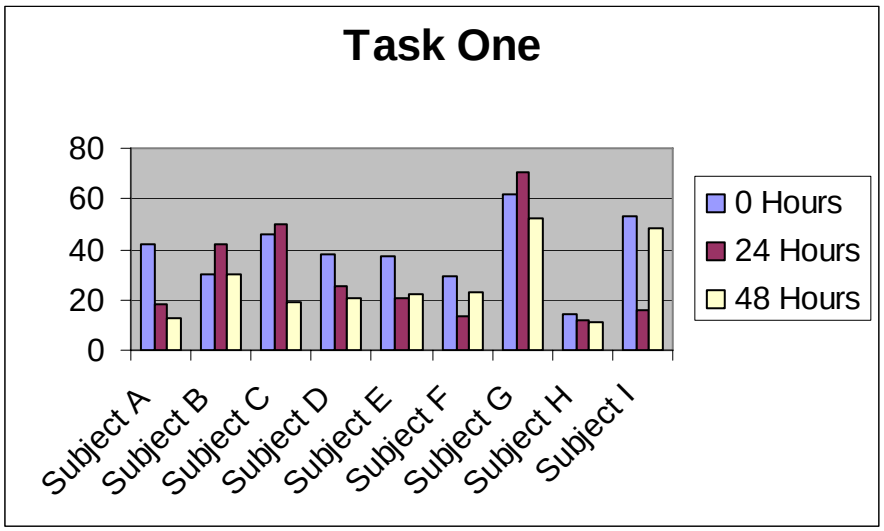
In a personnel interview with COL Attorney Hugh McFadden (personal interview June 19, 2003) he was asked "Are there any Wyoming statutes or COL laws governing maximum hours worked by fire/EMS personnel?" He answered "If there are I am not aware of any."

To answer how other industries limit work/duty hours three public safety agencies in Albany County were questioned. Only one (33%) had a policy limiting the number of hours their employees could work. (Appendix B)

Finally the effects of fatigue on the skills used everyday by the fire/EMS personnel at the LFD were recorded. Comparisons were made between zero hours and 24 hours on duty, zero and 48 hours on duty and 24 and 48 hours on duty.

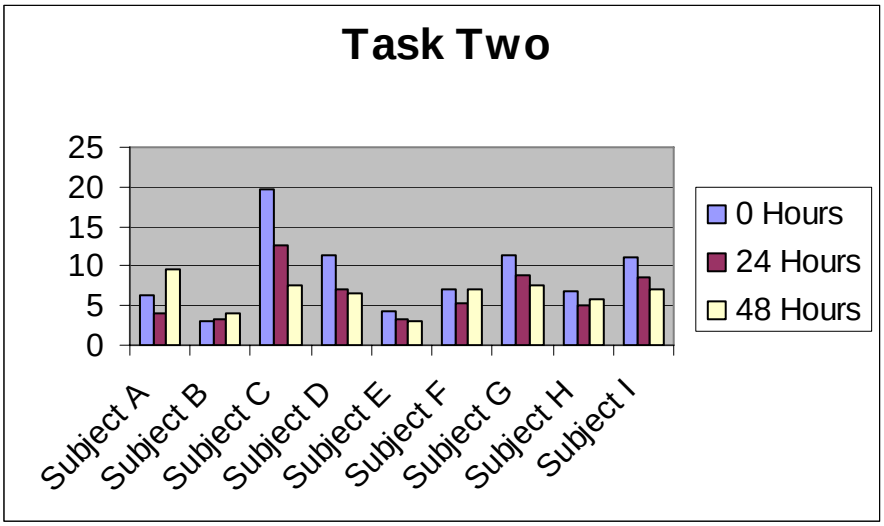
For the friction loss problem, task one, eight of the nine subjects, (88%) had no errors on the friction loss problem at 0 hours on duty. The time it took them to complete this task was used as their base line for the rest of the test. After 24 hours on duty three subjects (33%) had an increase in time; all three of these subjects showed the correct answer to the problem. Three of the remaining six subjects who showed a decrease in time had the wrong answer for the problem. Only 33% of the subjects tested had both a decrease in time and the correct answer. Comparing 48 hours on duty to the base line time, only one subject (11%) had an increase in time. Four subjects (44%) showed an improvement in

time; however they did not get the correct answer to the problem. Comparing 24 hours on duty to 48 hours on duty, three (33%) had an increase in time with one subject having the incorrect answer. Of the remaining six subjects with a decrease in time, two (22%) had a wrong answer. Two subjects (22%) showed an improvement in their time while answering all questions correctly.

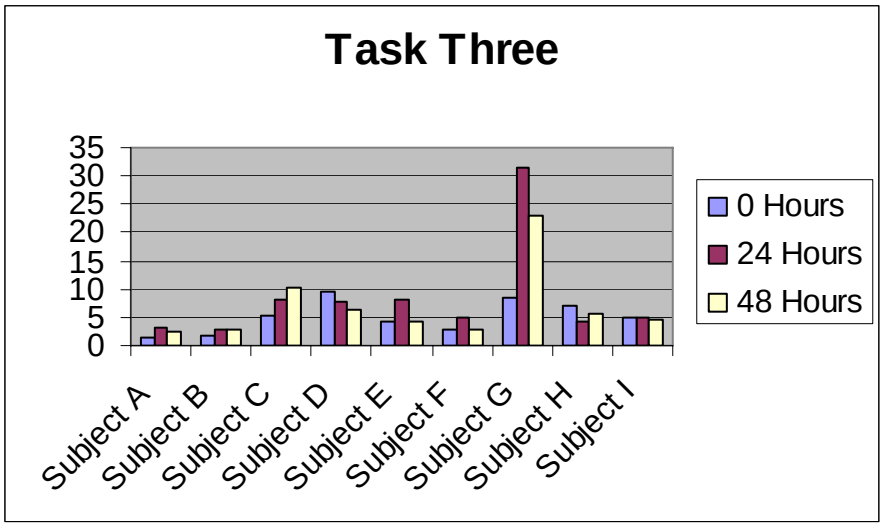


Task two, the saline draw comparisons between zero hours and 24 hours on duty showed eight subjects (88%) had a decreased time, yet five (62.5%) drew the wrong amount. The one subject that showed an increase in time drew the wrong amount of saline. After 48 hours, six subjects had a decrease in time, one-half (50%) of these drew the wrong amount of saline. One subject drew the wrong amount of saline and had an increase in time. Between 24 and 48 hours on duty, five (55%) of the subjects showed an improvement of time with three of these (60%) drawing the wrong amount of saline. Of the four subjects that had a decrease in time, two (50%) had drawn the wrong amount of fluid. Over the 48 hour period only one (11%) of the test subjects was able to improve the time

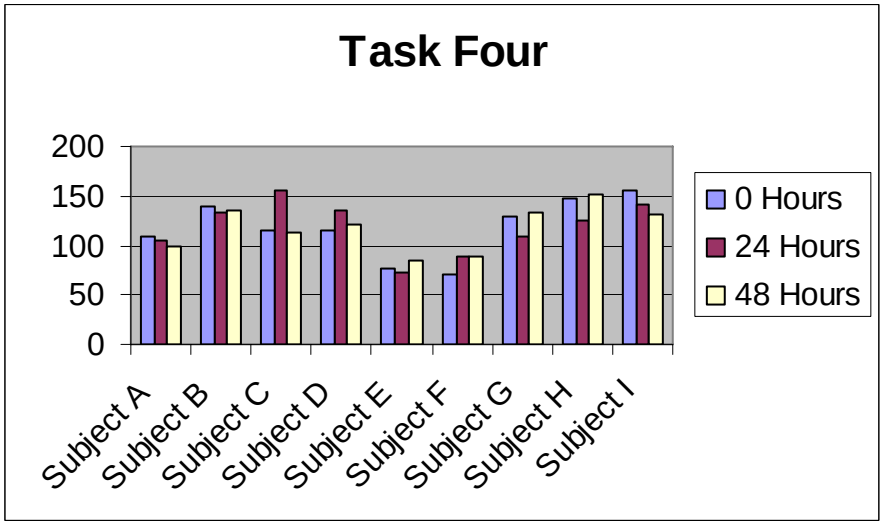
without making a mistake on the amount of saline.



Task three was the handcuff knot. Only two subjects (22%) showed a decrease in their time. Both of these knots were tied correctly. Of the seven subjects (77%) that showed an increase in time, one (11%) tied the knot incorrectly. Between zero and 48 hours four subjects (44%) had a decrease in their time. All knots tied at 48 hours were tied correctly. Comparing 24 hours on duty to 48 hours on duty, six subjects (66%) showed a decrease in time. Only one subject (11%) showed a decrease in the time while tying the knot correctly over the three test periods.



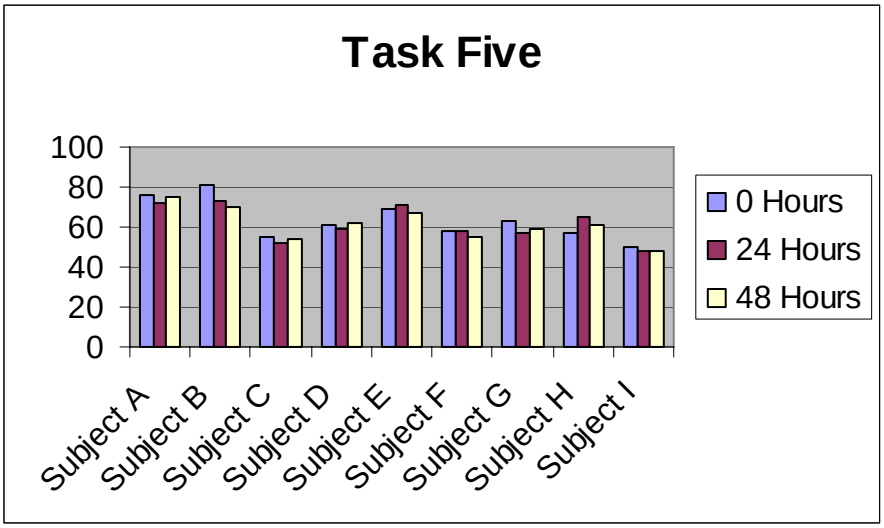
The PPE drill was the fourth task. Between zero hours and 24 hours on duty, six subjects (66%) showed a decrease in time. Between zero hours and 48 hours on duty four subjects (44%) showed a decrease in time. Between 24 hours and 48 hours on duty five subjects (55%) showed a decrease in time. Only two subjects (22%) showed a steady improvement in their times in the PPE drill.



Grip strength was measured three times each day; for comparisons the average of each day was used. Looking at zero hours to 24 hours on duty, six subjects (66%) had a decrease in strength. Between zero hours to 48 hours on

duty, six subjects (66%) showed a decrease in grip strength. Between 24 and 48 hours on duty, five subjects (55%) showed a decrease in strength. None of the subjects tested

showed steady increase in grip strength over the testing period.



Eight of the nine subjects (88%) tested had at least one error on the tasks after 24 hours on duty. Seven of the nine subjects (77%) had at least one error on the tasks after 48 hours on duty. None of the subjects showed an improvement in time without any mistakes.

Discussion

The results of this ARP show that outside of the wildland setting there are no standards, regulations or laws limiting the number of hours fire/EMS personnel can work. A relatively new issue to be recognized in the fire service fatigue can not be ignored any longer. In *Using Fatality Fire Cause Studies and a Lessons Learned Approach to Achieve Desired Changes in Firefighting* (1999) the author states;

> Fire personnel interviewed in the study also cited fatigue as a serious

> problem. US firefighting personnel are working too many consecutive hours on too many consecutive days and often on too many successive fire assignments. Additionally, firefighters are not receiving adequate rest while assigned to fire duty and many firefighters pay too little attention to adequate nutrition and hydration. (1999 p. 2).

This lack of federal regulations covering fatigue was addressed in 1992 by the National Commission on sleep disorders. In 1998 they reviewed their previous recommendations and added, “the establishment of specifically identified offices on sleep and sleep disorders within all federal departments and agencies whose programs affect or are affected by issues of sleep and sleep disorders.” (Overview of the findings of the National commission on sleep Disorders research 1998 p. 3)

Many fire service organizations are concerned with the health and wellness of firefighters. Yet none of these at this writing have specifically targeted fatigue as a health or wellness issue.

> Risk is an inherent component of the work emergency responders perform. Their ability to work in an elevated risk environment sets emergency responders apart from the general population. In order to survive, emergency responders must effectively manage their exposure to risk by recognizing danger, considering and weighing alternatives, and balancing anticipated benefits with potential consequences. (Federal Emergency Management Agency [FEMA] United States Fire Administration [USFA] 1996)

FEMA then recommends “fire departments and other emergency response organizations are expected to take every reasonable step to protect their workers from accidents, injuries, or disabling occupational disasters.” (FEMA USFA 1996)

The USFA mentions fatigue in relation to emergency incidents but does not mention fatigue caused by consecutive work hours.

> Firefighters having worked for two full 30 minute rated bottles, or 45 minutes shall be immediately placed in the Rehabilitation Area for rest and evaluation. In all cases, the objective evaluation of a member’s fatigue level shall be the criteria for rehab time. (FEMA USFA 1992)

FEMA’s retrospective study on firefighter fatalities recognizes that many fatalities are the result of a “chain of events”

> Some forces and circumstances that lead to firefighter fatalities are simply beyond human control. However, through research, study, training, improved operations, development of new technologies, the appropriate use of staffing, and other factors, it should be possible to significantly reduce the number of firefighters killed each year. Moreover, firefighter fatalities are generally the result of a chain of events, which, if detected early, may be broken to prevent many, or even most fatalities . (FEMA USFA 2002)

Further, FEMA shows the relationship between firefighters and cardiovascular health.

> Heart attacks are the leading cause of firefighter fatalities. The physical demands placed on firefighters can be very high and they often have to go from a state of deep sleep to near 100 percent alertness and high physical

exertion in a matter of minutes. Further, they must carry heavy equipment through intense heat while wearing heavy gear. Due to the physical demands of firefighting, firefighters must maintain a high level of physical fitness. (FEMA USFA 1996 p. 43)

Additionally FEMA states;

> Many factors affect a person's risk of suffering a heart attack. Some risk factors are outside of an individual's control such as increasing age, gender (male), and heredity (including race). Other risk factors, however, can be controlled or modified through diet, exercise, and personal choice. Modifiable risk factors include use of tobacco, high cholesterol, high blood pressure (hypertension), physical inactivity, obesity, and diabetes. (FEMA USFA 1996 p. 44)

Coronary heart disease has been targeted by USFA, NFPA, IAFC, and the IAFF as a major contributor to firefighter fatalities. Many studies done outside the fire service link sleep deprivation with coronary heart disease, "[The] effects of reduced sleep include increased blood pressure, heart rate variability, decreased glucose tolerance and increased cortisol levels." (Brigham and Women's Hospital 2003)

In May 2000 the International Association of Fire Chiefs (IAFC) adopted policy number 00.01 on health and safety. "A physical fitness, health and wellness program should be an objective at every fire department as a means for reducing firefighter injuries and death." (International Association of Fire Chiefs [IAFC] 2002) January 2002 saw the IAFC adopt Policy number 02.01 which states

“IAFC supports the need for the constant scrutiny and upgrade of policies/practices related to firefighter safety and prevention of firefighter injuries and deaths.” (IAFC 2002)

Dr. Eve Van Cauter at the University of Chicago has been researching the effects fatigue has on the physical wellness of humans. She shows that;

> After four hours of sleep for six consecutive nights, healthy young men had blood tests results that nearly matched those of diabetics. Their ability to process blood sugar was reduced by 30 percent, they had a huge drop in their insulin response, and they had elevated levels of a stress hormone called cortisol, which can lead to hypertension and memory impairment. (ABC News 2002)

Robert J. Koester (1997) addressed the short term effects of fatigue in emergency services.

> On May 2, 1994 Lisa Hannon (24) responded to Kirby West Virginia to function as Incident Commander in a search for a 5 year old boy. She arrived at 1300 and helped organize over 175 volunteers and other agencies into affective search teams. After running the search throughout the night, she transitioned with her replacement. She appeared alert and did not report any fatigue. Lisa departed the search at 08:00 for the 3 hour drive back home. She had not slept in the last 23 hours. At 08:22 it is presumed
> she fell asleep at the wheel of her sport utility vehicle and was killed instantly after hitting a tree. She was driving on a two-lane divided highway that had just gone from curvy and mountainous to more straight and narrow. The tree

was located at the end of a gradual curve. Lisa was wearing her lap and shoulder seatbelt, was not on any medication had a 0.0 BAC, and had no sleep disorders. (Koester 1997)

Koester associates driving fatigued with drunk driving.

After 16 hours awake (the end of a typical day) loss of reaction time in a flight-simulator is the same as someone who is at 0.05% Blood Alcohol Content. In many ways, driving home fatigued should be viewed the same as driving home drunk. (Koester 1997)

"Twenty-four hours of sustained wakefulness decreases performance to a level equivalent to a blood alcohol concentration of .10 percent – legally drunk in every US jurisdiction." (Villa 2000)

LFD policy manual covers substance/alcohol abuse while on duty. It even goes so far as to mandate "any BAC higher than 0.00 as positive." (Laramie Fire Department Policy Manual 2000) Any employee with a positive BAC will be sent home, yet employees are allowed to work after being awake for 24 hours or more.

Koester (1997) also notes the short term effects of fatigue and the types of errors typically seen in fatigued individuals.

The types of errors seen with sleep deprivation are different than most other types mistakes. The typical error is completely forgetting to perform a task as opposed to incorrect performance. Errors are not typically seen if the subject is given unlimited time. Instead, errors begin to occur when the staff member is forced to generate several tasks within a short period of time.

> Judgment and the ability to perform complex tasks remain intact. However, low-demand, self-motivated tasks often fail. In desert war games, fatigued soldiers forget to top off canteens. When medical care is being given, fatigued medics give the correct drug and dose. However, they will sometimes forget to even check the patient.

Wellness and fitness have become important issues in the fire service over the last few years. Tobacco use, alcohol use, and lack of cardiovascular training have all been cited as major contributors to firefighter fatalities. Overall wellness has become a buzz word. At the time of this research fatigue as been largely ignored as a contributor to firefighter fatalities. However, fatigue as a road block to overall wellness has been established. Even though the long term effects of fatigue has been ignored, it may be impossible to ignore the immediate effects of fatigue.

Recommendations

This researcher recommends that the LFD write a policy limiting the maximum hours all shift personnel can work. All fire service organizations with an interest in firefighter health and wellness, (USFA, NFPA, IAFC, and IAFF) must address the issue of fatigue in their standards, policies and regulations. Finally, all future readers must research the long and short term effects of fatigue and address the consequential issues.

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Appendix A

Student Feedback Form

This information gathering tool is for an Executive Fire Officer Research Paper. Please take the time to fill this out.

1) Is your department career_____? Volunteer_____?
   Combination_____?
2) Total number of firefighters in your department_____?
3) Does your department limit the hours line personnel can work_____?
4) What is the limit?_____
   _____
   _____
5) Are there any exceptions to this limit? (Please explain in detail)
   _____
   _____
   _____
6) How does your department mandate this? SOP's_____ SOG's _____
   Employee Handbook_____ Union Contract _____
   Other (please explain) _____
   _____

Thank you for taking the time to complete this information tool. If you are interested in the results include your name and mailing address and one will be sent to you.

Appendix B

Laramie Police Department Maximum Working Hours

No officer or dispatcher will work more than seventeen (17) hours in any twenty four (24) hour period, except in the event of an emergency.

1. It is the responsibility of the officer or dispatcher to inform a supervisor that this will occur.
2. The supervisor is not prevented from sending officers or dispatchers home before the 17 hour limit if the supervisor feels the officer's or dispatcher's work performance is being effected by fatigue or other factors.

Appendix C Individual Subjects Results

Subject A; 29 years of age (yoa) male

Task completed	0 hours worked	24 hours worked	48 hours worked
Problem	42.00	18.34	12.88
Saline draw	6.20	4.00*	9.69
Knot	1.56	3.29**	2.53
PPE drill	110.0	104.41	99.59
Strength	78-75-75	72-75-70	76-75-75

* represents a .3cc draw

** represents an improperly tied knot

Subject B; 28 yoa male

Task completed	0 hours worked	24 hours worked	48 hours worked
Problem	30.00	41.79	29.84
Saline draw	3.09	3.21*	3.94**
Knot	1.75	2.68	2.85
PPE drill	139.00	134.00	135.56
Strength	82-83-79	65-78-76	77-70-64

* .3cc’s drawn

** .2cc’s drawn

Subject C; 23 yoa male

Task completed	0 hours worked	24 hours worked	48 hours worked
Problem	45.84	50.06	19.03*
Saline draw	19.75	12.51	7.69**
Knot	5.47	8.25	10.22
PPE drill	116.12	154.70***	112.19
Strength	56-52-57	49-52-54	58-50-54

* wrong answer

** .4cc's drawn

*** subject had to be reminded to put on gloves

Subject D; 32 yoa male

Task completed	0 hours worked	24 hours worked	48 hours worked
Problem	37.72	25.00	20.47
Saline draw	11.29	7.05*	6.47
Knot	9.53	7.75	6.47
PPE drill	115.15	136.21	120.75
Strength	62-58-62	63-61-54	65-60-60

Subject E; 33 yoa male

Task completed	0 hours worked	24 hours worked	48 hours worked
Problem	37.00	20.82*	22.37
Saline draw	4.28	3.18	3.12**
Knot	4.34	8.09	4.17
PPE drill	76.97	73.17	85.27
Strength	66-70-70	76-76-60	66-70-65

*wrong answer

** .3cc's drawn

Subject F; 36 yoa male

Task completed	0 hours	24 hours	48 hours
Problem	29.06	13.75*	23.16**
Saline draw	7.06	5.21***	7.16
Knot	2.75	5.00	2.75
PPE drill	71.09	89.30	88.34
Strength	60-60-55	60-55-59	56-53-55

* wrong answer

** wrong answer

*** .3cc's draw

Subject G; 49 yoa male

Task completed	0 hours worked	24 hours worked	48 hours worked
Problem	61.56	70.15	52.19
Saline draw	11.25	8.90	7.59*
Knot	8.57	31.53	23.05
PPE drill	130.09	108.28	132.34
Strength	62-64-64	58-56-56	56-58-62

* .4 cc's drawn

Subject H; 42 yoa male

Task completed	0 hours worked	24 hours worked	48 hours worked
Problem	14.22	11.85	10.94*
Saline draw	6.88	4.97**	5.81
Knot	7.09	4.16	5.81
PPE drill	147.07	124.39	151.09
Strength	50-60-60	65-65-65	62-63-57

*wrong answer

**.2cc's drawn

Subject I; 44 yoa male

Task completed	0 hours worked	24 hours worked	48 hours worked
Problem	52.72*	15.84**	48.53***
Saline draw	11.00	8.53	6.97
Knot	4.88	5.05	4.63
PPE drill	154.59	142.35	130.81
Strength	50-50-49	47-48-50	48-48-49

* wrong answer

** wrong answer

*** wrong answer