

# **WILDLAND FIRES: ANALYSIS OF THE 12 AND 24-HOUR OPERATIONAL SHIFTS**

**EXECUTIVE DEVELOPMENT**

**BY: Bill Holmes, Assistant Chief  
California Department of Forestry and Fire Protection  
Chico, California**

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*Appendix B Not Included. Please visit the Learning Resource Center on the Web at <http://www.lrc.dhs.gov/> to learn how to obtain this report in its entirety through Interlibrary Loan.*

## ABSTRACT

The purpose of this research project was to analyze the two operational shifts, 12-hour and 24-hour, being used on major wildland fires by the California Department of Forestry and Fire Protection (CDF Fire). The problem was no definitive research had been conducted within CDF Fire concerning the operational shifts used on wildland fires. This study used a descriptive methodology. The research questions were:

1. Are firefighters working on the fireline getting adequate rest, a minimum of eight hours sleep, while off shift when working: A) 12-hour operational shifts? B) 24-hour operational shifts?
2. Is there a difference in resources required for a 12-hour versus a 24-hour operational shift which could affect the overall cost of the incident?
3. What are the benefits and drawbacks of both the 12-hour operational shift and 24-hour operational shift under different circumstances and when the fire is contained versus uncontained?

The procedures involved an onsite literature search at the National Emergency Training Center's (NETC's) Learning Resource Center (LRC) and CDF Fire library and an on-line search for other sources. A survey of CDF Fire Major Incident Command Team (MICT) members was conducted.

The results revealed that there was adequate scientific information and field experience available regarding both operational shifts. This applied research paper suggests that CDF Fire should consider both the 12-hour and 24-hour operational shifts, with a strong preference to the 24-hour operational shift for uncontained wildland fires and use the 12-hour shift for contained fires, or wildland fires that had no night shift. It was further recommended that CDF Fire adopt

the 24-hour shift as its preferred operational shift in all its policy handbooks and training manuals. Finally, it was recommended that CDF Fire have Firefighting Resources of Southern California Organized for Potential Emergencies FIREScope and California Wildfire Coordinating Group CWCG adopt the 24-hour shift and have it placed in the Field Operations Guide (FOG).

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## INTRODUCTION

The California Department of Forestry and Fire Protection (CDF Fire) is one of the largest fire departments in California and the nation. CDF Fire is the primary wildland fire agency responsible for protecting 31 million acres of timber, brush and grass covered watershed in California. Many of the 34 million people that live in California live in the rural and urban areas protected by CDF Fire.

On an average CDF Fire responds to 300,000 emergencies per year. Of those 300,000 emergencies 7,000 will be wildland fires. Of the 7,000 wildland fires annually only a small percentage, less than one percent, will be larger than 300 acres. Of those fires that grow larger than 300 acres only a dozen will extend for several days or a week. The focus of this paper will be to concentrate on those few wildland fires that are considered large in area, lasting several days or beyond, and the operational shift length used by firefighters working directly on the fire to contain it. An operational shift would be the number of hours each firefighter is expected to work before being relieved by another fresh crew of firefighters.

The problem is no definitive research has been conducted within CDF Fire concerning the operational shifts used on wildland fires and their effectiveness. CDF Fire, and the other large wildland fire organizations in the United States, have historically used two 12-hour shifts, day and night, with little thought to their effectiveness in suppressing the fire, cost or impacts on firefighter fatigue and safety. The changing operational requirements, safety concerns, firefighter fatigue, fiscal constraints, needs and demands on the command structure for wildland firefighting has resulted in controversy regarding the traditional 12-hour versus the more recent 24-hour operational shift. There has been no objective evaluation of these operational shifts in regards to benefits, problems, and/or when either shift might be most appropriate to use. Granted, there may

be other operational shifts to consider, but this paper will only look at the two most popular, or unpopular as the case may be, operational shifts used by CDF Fire and other wildland firefighting agencies in California and the nation.

The purpose of this research project is to examine the two main operational shifts being used by CDF Fire, and other wildland firefighting agencies, on wildland fires, the 12-hour and 24-hour operational shifts; how the operational shifts may affect the firefighters ability to get adequate rest and avoid severe fatigue over long periods of time; examine the resources required for each shift to see if there is a cost difference in terms numbers of resources required and any benefits or drawbacks of the two operational shifts under differing operational circumstances or when the fire is contained versus uncontained.

To reach a conclusion material was gathered from the United States Forest Service (USFS) that has conducted numerous research papers on the subject of operational shifts as they relate to firefighter fatigue, articles written by subject matter experts and a survey was conducted of CDF Fire's ten Major Incident Command Team (MICT) Incident Commanders (IC) and Operations Section Chiefs (OSC) with an average of 26 years of experience.

A descriptive research methodology was conducted to answer the following questions:

1. Are firefighters working on the fireline getting adequate rest, a minimum of eight hours sleep, while off shift when working: A) 12-hour operational shifts? B) 24-hour operational shifts?
2. Is there a difference in resources required for a 12-hour versus a 24-hour operational shift which could affect the overall cost of the incident?
3. What are the benefits and drawbacks of both the 12-hour operational shift and 24-hour operational shift under differing operational circumstances as well as when the fire is contained versus uncontained?

## BACKGROUND AND SIGNIFIGANCE

CDF Fire, like any other fire department in the United States, is steeped in tradition. Sometimes they don't know the reasoning behind why they do something in a particular way, they just know they have always done it that way, tradition. Going back to the 1920's most forest agencies, which included CDF Fire, United States Forest Service (USFS), Bureau of Land Management (BLM) and National Park Service (NPS), used two 12-hour operational shifts, back to back, within a 24-hour period. Traditionally one shift is referred to as the "day shift" and is thought to run from 0600 to 1800 hours while the other is the "night shift" and is thought to run from 1800 to 0600 hours. It is not known at this writing how the traditional 12-hour shifts got started or why. One may assume that it was simply a matter of splitting a 24-hour period by day and night.

One of the first documents for CDF Fire personnel on the matter of shift lengths came in 1954 from a book called, *Principles of Forest Fire Management* (Clar & Chatten, 1954). In the book Clar and Chatten talk about working 12-hour shifts, locating the fire camp close to the fire to reduce travel times to and from the fire, unless a more suitable facility is close, and locating shade for crews that must try to sleep during the day. Clar and Chatten (1954) state that:

When a number of both day and night crews have been engaged along a fire line for several days it is possible that some of the crews will have had very strenuous periods of labor. With the first lull in operations a resting break should be arranged so that the most exhausted crews may skip an entire work shift. Bodily fatigue is a cumulative thing that begins to demand more recuperative time as a man passes the point of reasonable exertion. (p. 201)



Our world has changed dramatically since 1920 when an incident base (fire camp) was out in the woods next to the fire and there was no expectation to communicate via phone or computer instantaneously. Only the home agency personnel and equipment were used and there were no labor contracts guaranteeing such things as overtime and motels. Little thought was given to firefighter fatigue and rest. There was no Occupational Safety and Health Administration (OSHA) or California-OSHA (CAL-OSHA). In today's world there is an expectation of instant communication from the incident base to a headquarters. Web pages are established for many fires in response to and demand for real time, accurate information by the agency and the public. This means the incident base has to be where there is power and phone lines putting the incident base further away from the fire and increasing travel times for operational resources going to and from the fire line. Firefighting resources from local, state, federal and private resources require such considerations as differing pay scales, working conditions and labor contracts. Firefighter fatigue must be heavily considered otherwise accidents and injuries will occur leading to civil and criminal penalties. Therefore the operational shift chosen by the fire manager may have a huge impact not only on production and the ability to suppress the fire, but on all the aforementioned issues.

Richard Mangan (1999) Project Leader, USDA Forest Service, Technology & Development Program, Missoula, Montana states in his report, *Wildland Fire Fatalities in the United States* "133 persons died while involved in fighting wildland fires in the United States from 1990 to 1998" (p. 3). The report tells us how they died, but not why.

Dr. Ted Putnam, Ph. D. Psychologist, recently retired from the US Forest Service MTDC lab in Missoula, has spent over 20 years investigating wildland fire fatalities and accidents. In a

recent email (personal communication, February 18, 2002) written for future publication titled *Fire Safety – Up In Smoke* wrote:

When looking at the fatalities, accidents, near misses and unsafe actions, fire organizations historically have focused on physical causes and ignored mental and cultural causes – the human factor. The rule of thumb among safety experts in the military and private sector is that only 20 percent of the causal factors are physical, while 80 percent are mental or cultural.

In another email written (personal communication, February 2, 2002) by Putnam titled *The Ten Standard Firefighting Orders: Can Anyone Follow Them?* Putnam sarcastically states what he thinks are some of the fire orders, the rules firefighters are suppose to live by to stay safe, are in reality. The second order is “Maximize overtime, keep other costs down”, the seventh order is “Shut up and butt up”, the eighth order is “Don’t say no” and the tenth order is “Reporting safety infractions will adversely affect your career” (p. 7). The sarcasm within the article is meant to point out what he believes are some real causal factors behind the scenes and within the firefighter culture that affect safety.

August 1994, South Canyon Fire in Colorado, 14 firefighters died yet there is little mentioned of the human factors involved. What operational shift was being implemented and was sleep deprivation an issue?

August 1999, Saddler Fire in Nevada, six firefighters burned yet there is little mention of the human factors. What operational shift were they working and how much sleep had the overhead personnel making decisions and the crew that was burned had prior to the accident?

On July 10<sup>th</sup> 2001 four US Forest Service firefighters were burned to death on the Thirtymile Fire near Winthrop Washington. In the post incident investigation report *Thirtymile*

*Fire Investigation Report, September 2001* it was noted “The single overwhelming physiological factor that impacted upon this mishap was fatigue caused by sleep deprivation” (US Forest Service, p. 80).

In the January 2002 edition of *On Scene*, a publication by the International Association of Fire Chiefs, there was an article reprinted from the Seattle Times titled *Report: Four deaths in Thirty Mile fire were entirely avoidable* by Chris Solomon and Craig Welch. In the article there were 14 significant factors listed that lead to the deaths. One very significant factor was fatigue. The article paraphrased and quoted from the official government report and states: Fatigue was rampant and “significantly degraded the vigilance and decision making” of those involved, an elite Hotshot crew leader was “incapacitated by nearly 50 hours with little sleep or no sleep”. The issue of shift lengths and firefighter fatigue suddenly came to the forefront following the Thirtymile Fire. On April 16<sup>th</sup> 2001 Dale Bosworth, Chief of the US Forest Service, issued the *Thirtymile Hazard Abatement Plan* from the Washington Office of the US Forest Service to its entire staff across the country. Item #1 in the letter states:

Incident Commanders (IC’s) shall manage fatigue and ensure firefighters comply with the FS work/rest guidelines. Incident management shall plan for and ensure crews, overhead personnel, and support personnel are provided a 2-for-1 work-to-rest ratio. This means for every 2 hours of work or travel, 1 hour of sleep or rest is provided. IC’s shall monitor compliance with these guidelines and document the following information in the daily record on all fires that exceed one operational period:

- a) Descriptions of actions taken to monitor work/rest cycles;
- b) Justifications for work shifts exceeding 16 hours with mitigation measures: and
- c) Actions taken to ensure compliance with the guidelines. (Bosworth, 2001, p. 1)

Sandy Graham wrote an article for *Safety and Health* magazine in June 2000 titled *Too Tired on the Job, Wake up to fatigue problems!* In the article Graham notes that two hours sleep lost in one night results in a 20-percent drop in memory, 30-percent drop in communications skills, 75-percent drop in attention, and a 50-percent decrease in judgment and decision making the next day. Sleep loss over days, weeks or months can make you forgetful, uninhibited, slow to react physically and mentally, fixated on simple tasks or inattentive. In extreme cases a fatigued person has the cognitive and physical abilities of a drunk. In the article Graham quotes an Australian study by Drew Dawson: "17 hours without sleep resulted in a performance level equivalent to a .05 blood alcohol level, while 24-hours equated to a .10 blood alcohol level" (Graham, 2000, p. 80).

Starting in 1977 on the Marble Cone fire in California and again in 1978, Forest Service Region 5 (California) experimented with 24-hour shifts to reduce fatigue of firefighters working extended periods of time. At the end of the 1978 fire season US Forest Service Region 5 asked the Washington office to have the MTDC lab in Missoula look into the ramifications of the 24-hour shift. Starting in 1979 and ending in 1989 the US Forest Service MTDC lab in Missoula Montana conducted extensive research on the subject of operational shifts and firefighter fatigue. An October 1989 report, *A Study of Wildland Firefighting Work/Rest Cycles*, by Arthur A Jukkala and Brian J. Sharkey, Exercise Physiologist from the US Forest Service stated:

The available literature, cost benefit analyses, and three seasons of field data support the use of the 24-hour work/rest cycles as a feasible alternative to the conventional two-shift system. While the conventional two-shift system is generally preferred, the 24-hour system is more likely to provide needed sleep/rest when portal-to-portal work time exceeds 16 hours. (p. ii)

Although the above studies recommend support using the 24-hour operational shift where appropriate to reduce firefighter fatigue, neither CDF Fire nor the USFS ever fully adopted the recommendation.

In 1990 CDF Fire Command Team Three, with Incident Commander Frank Bates, tried the 24-hour operational shift on the Campbell Fire (126,000 acres) with great success. Since 1990 the other nine CDF Fire command teams gradually adopted the 24-hour operational shift as their shift of choice on uncontained working fires. The US Forest Service national level management has steadily resisted the 24-hour operational shift, even though agency studies recommended it. Most recently CDF Fire management has raised concerns about the 24-hour shift and questioned its use. During the 2001 fire season CDF Fire management, without explanation, stopped the use of the 24-hour operational on the Martis Fire (10,000 acres in California and Nevada), which set off a tidal wave of concern among CDF Fire employees and fire managers.

This study will not only be significant for CDF Fire, but will be significant to future national fire academy executive development students, as it will aide them in understanding the issues surrounding firefighter fatigue when working extended operational shifts over days and weeks.

Firefighter fatigue is of paramount importance in regard to firefighter safety. This research correlates directly with the United States Fire Administration (USFA) Operational Objectives of saving firefighter lives. Improvements in the management of continued operational shifts on wildland fires will save firefighters lives and reduce injuries.

## LITERATURE REVIEW

In 1954 C. Raymond Clar and Leonard R. Chatten wrote a book called *Principles of Forest Fire Management*. The book was printed by the State of California and quickly adopted by CDF Fire as a way to organize and manage major wildland fires in California. Within the book Clar and Chatten discuss using 12-hour operational shifts with no discussion of other possibilities or why to use a 12-hour shift. Further in the book Clar and Chatten recognize that “working multiple shifts can be exhaustive, fatigue is cumulative and that firefighters should be allowed a shift off to catch up on sleep” (p. 201). In reference to night shift sleeping Clar and Chatten state:

If one single item were to be selected as being most important it would have to be the element of shade. Daytime sleeping for night shift crews is difficult under the best of conditions when insects, high temperatures, and noise must be tolerated. (p. 211)

Every other CDF Fire publication, training manual or internal document since 1954 has only talked about using the 12-hour operational shift with no thought given to firefighter fatigue, line production, safety, cost or effectiveness.

In 1979 USFS Region 5 (California) requested the Washington Office to have research done on alternative operational shifts for use on wildland fires, specifically a 24-hour operational shift. In March 1980 a special report came out of the US Forest Service Missoula Technical Development Center (MTDC) in Montana titled *Work, Rest and Fatigue a review of factors influencing performance and fatigue during prolonged work* by Brian J. Sharkey, Ph D. Physiologist. This was a review of scientific literature on the subject and not a field evaluation. The report stated “No significant work/rest effects were seen until the subjects were deprived of

sleep” (Sharkey, 1980, p. 5). With so many unanswered questions about the 24-hour operational shift Dr. Sharkey could not support its use, but recommended a field trial.

In 1981, James McConnell, former Operations Research Analyst for the US Forest Service MTDC lab in Missoula conducted a cost analysis of two 12-hour shifts in a 24-hour period and the 24-hour work/rest cycle. This study is cited in a 1989 report titled *A Study of Wildland Firefighting Work/Rest Cycles*. The study looked at actual cost of labor versus productivity, travel cost and any loss of natural resources or real property due to the different work shifts. The study showed a 50 percent savings in travel costs and a 21% savings in labor cost by using the 24-hour operational shift. This was due to the fact that only one shift was going out per day rather than two. Mr. McConnell could not come to any conclusion on any additional loss or damage to natural resources due to one shift or the other (Jukkala & Sharkey, 1989 p. 2).

In 1982 the US Forest Service MTDC lab in Missoula decided to try a field study, as was recommended by Dr. Sharkey, using the 24-hour Work/Rest Cycle. Some information had been collected from US Forest Service Region 5 in 1977 and 1978, but further study was needed. The purpose of the study was to record factors related to work, rest and fatigue. This field study lasted three fire seasons ending at the end of fire season 1984.

In the US Forest Service report titled *Work, Rest & Fatigue, Evaluation of their Relationships, 1982 Fire Season*, it states, while referring to the 12-hour shift, “The standard two-shift concept, involving 16 hours on the first day and 12-hours each day thereafter is realistically unattainable for fireline personnel on most large uncontrolled fires” (Jukkala & Sharkey, 1989, Appendix C, p. 1). It goes on to state in the Executive Summary “The standard concept of two shifts every 24-hours works well on simple fires of up to two days duration through control” (Jukkala & Sharkey, 1989, Appendix C, p. 1). In direction to US Forest Service

incident commanders on the use of the 24-hour shift the report asked them to consider the following scenario when using the 12-hour shift:

A fire starts in the afternoon, and escapes initial attack. The local Forest Fire Team manages the fire through early evening and cannot contain it. The forest orders a regional Fire Team, and they arrive after midnight and agree to take the fire over at the change of shift in the morning. Crews that made the initial attack and provided the reinforcements through the evening have worked all night. Whatever forces the Forest has ordered for the day shift that have arrived are available for assignment (Jukkala & Sharkey, 1989, Appendix C, p. 7).

In the scenario above firefighters have been awake since their normal wake up time in the early morning, then assigned to working on the fireline in the afternoon sometime. They will work through the night and into the next day when the next operational shift firefighters show up. They may get into the incident base mid morning to eat, cleanup and reequip before bedding down in the daylight. They will have been awake for anywhere between 28 to 30 hours and expected to be at the night shift briefing at 1800 hours fed and ready to go. Using the 12-hour shift would give them six to eight hours rest before going back on the fireline. In order to meet the 2:1 work/rest guidelines they would need 14 to 15 hours off (Jukkala & Sharkey, 1989, Appendix C, p. 3).

In 1987 Northern California and Southern Oregon experienced a severe fire season. The US Forest Service Washington Office of Fire and Aviation asked the MTDC to visit four major fire complexes and evaluate, among other items, work/rest considerations, heat stress and fluid replacement, smoke and carbon monoxide, physical fitness and nutrition and diet. The report titled *Review of Firefighter Fatigue California Fires 1987* came out in December 1987. The



authors were Arthur Jukkala and Brian Sharkey, Ph.D. of MTDC. In regards to shift lengths it was noted that most crews were working 18 hours per shift on what was suppose to be a 12-hour shift, line personnel often worked many double shifts meaning they worked at least 36 hours before rest, there was no mention by any of the management teams of planned 24 work/rest cycles however efforts were being made to provide one hour of rest for every two hours of work. Day shift crews averaged 5 to 6 hours of sleep at night while night shift crews averaged 3 to 4 hours of sleep during the day. The average tour of duty was 14 days not including travel. Particulate matter in the smoke was 1200 micrograms per cubic meter in Yreka California and higher in the incident base. Carbon monoxide (CO) levels on the Seid Complex of fires were 40 ppm. Thirty-five parts per million (ppm) of CO for 24-hours leads to CO blood levels of 7.5 %. NIOSH recommends no more than 5% CO in the blood from chronic exposure. Firefighters reported symptoms of headache, fatigue, drowsiness, impaired motor performance, impaired decision making and cognitive function. The report concluded that shift lengths, tours of duty, sleep and rest and sleeping conditions were major factors in contributing to the fatigue of firefighters. One recommendation to reduce smoke particulate and CO exposure was to place the incident base out of the heavy smoke area (Jukkala & Sharkey, 1987).

In 1989 the USDA Forest Service MTDC released a video titled, "Fatigue and Firefighter's Environment" by Dr. Brian J. Sharkey, Ph. D. Exercise Physiologist. In the video Dr. Sharkey states:

Fatigue, without adequate sleep and breaks after several long shifts digging line in the heat and smoke even the most fit get tired and it's the tired people who make mistakes. On wildfires mistakes can mean accidents and injuries. Sleep and rest are the best remedies. People can work hard for 24 to 36 hours with short sleep or rest breaks. After

that, without adequate sleep or rest fatigue becomes excessive. The brain cannot function properly without sleep. Accidents and injuries result among crews pushed too much.

The conclusion of the study that ended in 1984 came out officially in October 1989 along with the aforementioned video. Arthur A. Jukkala and Brian J. Sharkey, Ph.D. Exercise Physiologist both from the MTDC in Missoula wrote a report titled *A Study of Wildland Firefighting Work/Rest Cycles*. The report compared the 12-hour operational shift to the 24-hour operational shift. In the Summary portion of the report it recommends using the 24-hour work/rest cycle as a feasible alternative to the conventional two shift system as it will more likely provide needed sleep/rest when portal to portal time exceeds 16 hours. In the Findings portion of the report it recommends using the 24-hour work/rest shift where firefighters cannot wakeup, work on the fireline and get back into incident base early enough to eat and shower before their 16 hours is up (Jukkala & Sharkey, 1989, p. 8). The report stated that they did not have enough data collected to draw real strong conclusions either way yet in the Recommendations portion of the report recommend staying with the 12-hour, two shift system unless adequate rest could not be obtained.

In 1995 five federal wildland agencies (USDA Forest Service, USDI National Park Service, USDI Bureau of Land Management, USDI Fish and Wildlife Service and USDI Bureau of Indian Affairs) contracted with the TriData Corporation of Arlington Virginia for a four phase project titled, "Wildland Firefighter Safety Awareness Study". Phase-I was to identify the organizational culture, leadership, human factors and other issues impacting firefighter safety from inside the organization. The Phase-I report came out in October 1996 after surveys and interviews of 1000 federal, and some state, wildland firefighters from all ranks and experience were used. Firefighter fatigue was identified as a causal agent in many accidents and deaths.

Firefighters surveyed felt that they were asked to work too many consecutive hours, days or number of fires. In particular, firefighters arriving on a new fire were always considered fresh even though they may have driven all night to get to the new fire, or had left one fire to respond to another. One complication in this issue is the firefighter's desire for extra money. Among the top three fatigue issues was the concern that some crews were agreeing to work longer than required in order to make more money. The report stated: "They mask their fatigue condition to stay out longer" (TriData Corporation, 1996, p. 172). One 20 year veteran smoke jumper was quoted as saying "Overtime is what we're after, and I think a lot of people on the fireline push themselves past their workable point of fatigue. Hotshots do this for weeks at a time, then the season goes on and it accumulates" (p. 172). In addition firefighters working night shifts felt they were not getting adequate rest during the day due to noise and sleeping conditions. Night shift firefighters usually have to sleep in the heat of the sun, bothered by insects and the loud constant drone of running generators and trucks.

Dr. Ted Putnam, Ph. D. Psychologist states (personal communications, February 18, 2002) the following in his report titled *Fire Safety – Up In Smoke*: "Personal financial incentives, while necessary, too often bias firefighters to work to the point of mental and physical deterioration, making accidents more imminent. This is more likely a cause of injury and near misses than fatalities".

According to M. Terwilliger, Fire Chief for Truckee Fire Department, ex-CDF Fire command team operations section chief and current incident commander for a type-2 federal team, (personal communication, June 12, 2002) the federal pay issues dictate use of shifts, not operational efficiency and safety. The crew time report (CTR) under the federal system dictates shifts federal employees will work while assigned on an active fire and must show time off

during the shift for meal time and breaks. This adds one to two hours to the 12-hour shift, two hours before briefing and time after assignment. Crews are not allowed to show time for tool and crew preparation while off shift. Crazy system.

Phase-II of the TriData Corporation of the *Wildland Firefighter Safety Awareness Study* looked at solutions to problems identified in Phase-I and goal setting. Goal 17 on page 80 is titled *Monitor and reduce firefighter fatigue levels to safe limits*. Solutions include limiting hours, days, or fires and time in the field on fires before rest and recuperation (R&R) with a suggested limit of two weeks. Longer breaks between 14 day assignments and better sleeping conditions in bases or camps especially for day sleepers. One solution that was offered by survey respondents was to offer portal-to-portal pay for firefighters (TriData Corporation, 1997).

The April 1999 edition of *Wildland Firefighter* had an article titled, “Wildland Fire Shift Patterns – The 24-Hour Operational Period” by Michael S. Terwilliger and Ed Waggoner. The article compares the traditional 12-hour shift to the 24-hour shift being used by CDF Fire since 1990. Within the article Terwilliger and Waggoner (1999) state that:

Studies have shown that firefighters on wildland fires should receive one hour of rest for every two hours worked on the line. This has been accepted by most fire fighting agencies throughout California. This is not even remotely possible on the 12-hour shift. Personnel get out of bed at 0400 to 0500 hours to eat and attend the briefing. They are on the line until 1800 to 1900 hours, assuming travel is smooth. They may arrive in base at 2000 hours and try to eat. They must re-supply equipment and prepare for the next shift. At best, they may be in bed by 2200 to 2300 hours. This does not include time for showers. These personnel will receive four to five hours rest, not always sleep. After many days of this routine, these personnel do not perform basic hygiene, they not eat

well, and become fatigued. This is a recipe for injury and poor work production. The 24-hour shift will guarantee personnel the opportunity to complete all professional and personal tasks, and receive the sleep they require for the demanding activities of a wildland firefighter. (p. 48)

The article goes on to say that the 24-hour shift allows the incident base to be further away from the fires edge where better facilities and air are available, exposure to vehicle accidents are fewer due to half the number of vehicles to and from the fireline, production rates are higher since less time is spent changing shifts at critical times of day and crews work in a safer environment because they have seen the country they are working in during the day. Terwilliger and Waggoner (1999) make the following positive statement about using the 24-hour operational shift:

When using the 24-hour shift, line personnel receive excellent rest. They will arrive at briefings well fed, clean and rested. You will enjoy excellent eye contact with key players, and they will better understand their assignment. Contrary to past practice, well rested, clean, and alert firefighters are a safer more effective resource. (p. 46)

A National Fire Academy (NFA) Executive Fire Officer (EFO) applied research paper titled *Injury Analysis during Nighttime Operations in Wildland Firefighting* by Dan Thorpe (1999) of the Oregon Department of Forestry, states that:

Greater acceptance should be given to the 24-hour shift concept used by CDF. This tool has been successfully used to minimize injuries and increase production. Within the context of nighttime safety, crews have seen the area they are working during the day shift. (p. 31)

In January of 2002 a new report came out from the USDA Forest Service MTDC lab in Missoula titled, *Work and Fatigue During Extended Operations, A Review of Wildland Firefighters*, Steven Gaskill, Ph.D. The report admittedly is a compilation and regurgitation of all the previous work done at the MTDC between 1980 and 1989 on work, rest and fatigue of firefighters. The only new piece of information that pertains to this research paper has to do with Work Cycling. Gaskill states “The athletic world has long understood the benefit of rotating days of vigorous workouts with more moderate workouts. This cycling, or varying, of work avoids accumulated fatigue and illness allowing athletes to continue on in an alert state for long periods of time” (2002, p. 28).

## **PROCEDURES**

The first step in evaluating the 12-hour and 24-hour operational shifts for wildland fires was to do an onsite literature search at the National Emergency Training Center’s (NETC’s) Learning Resource Center (LRC) in February 2002. One magazine article centered squarely on the subject while others had various bits of information mostly related to firefighter fatigue. Several EFO research papers contained bits and pieces of information in their content, which was mildly useful, however the references contained in the back were excellent to start further research.

While teaching at the CDF Fire statewide academy in Ione during the winter of 2002, I researched the department’s library for historical information and found one very solid book, *Principal’s of Forest Fire Management* that gave some insights into the beginnings of CDF Fire in terms of incident management. CDF Fire has no research lab, research and development group or on line library.

Starting in March 2002 I conducted an exhaustive on line research for sources of information related to operational shifts on wildland fires. The most comprehensive source I found was through the USDA Forest Service Missoula Technology and Development Center (MTDC) in Missoula, Montana. The MTDC had done exhaustive research in the area of operational shifts and firefighter fatigue since 1980. In addition, the National Advanced Resource Training Center (NARTC) in Marana Arizona was helpful. Both locations had on-line listings and were quick to respond with videos and literature.

Since there was very little information on operational shifts through CDF sources I conducted an on line email survey (see Appendix A and B) of CDF Fire's 10 Major Incident Command Team's (MICT's) incident commanders, deputy incident commanders and operations section chief's, two per team. A sample, or test survey, was conducted with four instructors at the CDF Fire academy in May 2002. All four are current or past MICT members. After a review and fine tuning of the test survey a final questionnaire was sent out via email June 11, 2002. A total of 40 questionnaires were sent and 20 returned. This sample population was selected due to its experience in managing major emergencies in California where multiple operational shifts would be used. The respondents had an average of 26 years experience in the fire service with many being on MICT's for 10 years or more. All have worked both the 12-hour operational shift on CDF and federal fires and the 24-hour shift on CDF fires.

### **Definition of Terms**

#### **12-Hour Operational Shift**

A work shift on wildland fires that is usually described as the "Day Shift or "Night Shift".

Although it might be assumed that the shift is 12-

hours long, it is not. Accepted practice is to work up to, but not over, 16 hours including travel to and from the fireline, eating, showering and re-outfitting equipment. Workers are supposed to get 8 hours of quality sleep while off shift. A worker works one 12-hour shift in a 24-hour period.

**24-Hour Operational Shift**

A work shift on wildland fires that generally runs from 0600 hours one day to 0800 hours the following day. A work shift includes travel to and from the fireline, but not personal care, feeding or re-outfitting of equipment. A firefighter generally works one 24-hour shift in a 48-hour period.

**24-Hour Work/Rest Cycle**

Same as above only it implies that firefighters on the line will take rest breaks on the line equaling one hour of rest for every two hours of work. This is an accepted practice when using the 24-Hour shift.

**Contained**

For wildland fires it infers the forward progress of the fire has been stopped by whatever means. The fire still has the potential to escape containment and is not necessarily controlled.

**Fireline**

The burned edge of a wildland fire. It can be either out or still burning.



|                                           |                                                                                                                                                                                                                                                          |
|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Incident</b>                           | Any emergency that firefighters may respond to.<br>Can include wildland fires.                                                                                                                                                                           |
| <b>Incident Base</b>                      | The location where firefighters (incident workers) go to sleep, feed, shower, wash laundry and re-outfit themselves and their equipment. They will also receive their operational briefing at the incident base. Formerly known as a fire camp.          |
| <b>Operational Shift</b>                  | The period of time a firefighter will work on the fireline before being relieved by another shift of firefighters. This can vary widely in the fire service depending on the type incident. For purposes of this paper it will be either 12 or 24-hours. |
| <b>Ten Standard Firefighting Orders</b>   | Safety orders adopted by all the wildland fire agencies in the United States to guide workers on fires and other emergencies.                                                                                                                            |
| <b>18 Situations That Shout Watch Out</b> | The Watch Out Situations complement the Fire Orders and are examples of specific hazardous situations.                                                                                                                                                   |

### **Limitations and Assumptions**

The subject of operational shifts on wildland fires is a very narrow one. Very few fire departments outside the western United States have emergencies that last over 24-hours and

continue on for days and weeks at a time. Consequently very little has been researched or written about the subject.

CDF Fire has practiced the 12-hour operational shift since 1927 and 24-hour operational shift since 1990, but they have done little to document the positives or negatives of using either shift. Nor has CDF Fire documented when one shift would be advantageous over the other or costs associated with either. Fortunately, retired CDF Fire Division Chiefs Ed Waggoner and Mike Terwilliger decided to write an article, *Wildland Fire Shift Patterns, The 24-Hour Operational Period (1999)*, to document their experiences using the 24-hour shift over a ten year period. CDF Fire has done nothing in terms of research on firefighter fatigue and relies greatly on what comes out of the US Forest Service MTDC lab in Missoula or other professional sources. Consequently a survey, or questionnaire, was used to sample some of the top fire managers in CDF Fire. This limits the sample base to less than one percent of the CDF Fire total work force of 5,500. However, these are people that have been doing the job of managing California's major emergencies for many years. Whenever a survey is conducted it is limited by the number of returns, in this case 50% responded, the questions themselves and the interpretation of the questions by the respondents.

The US Forest Service is the only agency to have conducted extensive studies on operational shifts and firefighter fatigue, however those studies were very limited. The US Forest Service MTDC lab in Missoula attempted to collect field data between 1980 and 1984 with limited success. The 1987 study, *Review of Firefighter Fatigue California Fires 1987* by Arthur Jukkala and Brian J. Sharkey, Ph.D. seemed to have the most solid information from actual fires.

## RESULTS

**Research Question 1A.** Are firefighters working on the line getting adequate rest, a minimum of eight hours of sleep, while off shift when working:

A) 12-hour operational shifts?

The US Forest Service recognized it had a problem with operational shifts in 1977 when US Forest Service Region 5 experimented with the 24-hour operational shift on the Marble Cone fire to reduce firefighter fatigue. In 1979, at the request of the US Forest Service Region 5, the Washington office of the US Forest Service asked Brian Sharkey, Ph.D. Exercise Physiologist of the Missoula MTDC lab to review the factors affecting work, rest and fatigue on wildland firefighters. The report, *Work, Rest and Fatigue, a review of factors influencing performance and fatigue during prolonged work* stated “When high temperatures interacted with long work and short rest, a disproportionate decline in performance was observed” (Sharkey, 1980, p. 5). It was the first step in starting to define the problem and look for answers. A collection of data comparing the 12-hour shift and 24-hour shift on real fires in California was attempted between 1980 and 1984 but the data collection was poor.

In the US Forest Service report *Work, Rest & Fatigue, Evaluation of their Relationships, 1982 Fire Season*, it states, while referring to the 12-hour shift “The standard two-shift concept, involving 16 hours on the first day and 12-hours each day thereafter is realistically unattainable for fireline personnel on most large uncontrolled fires” (Jukkala & Sharkey, 1989, Appendix C, p. 1). It goes on to state in the Executive summary “The standard concept of two shifts every 24-hours works well on simple fires of up to two days duration through control” (Jukkala & Sharkey, 1989, Appendix C, p. 1)

In December 1987 the USFS MTDC lab in Missoula issued another report titled *Review of Firefighter Fatigue California Fires 1987* (Jukkala & Sharkey, Ph.D., 1987). The report noted that most crews on four major complexes of fires in California and Oregon were working 18 hours per shift on what was suppose to be a 12-hour shift, line personnel often worked many double shifts meaning they worked at least 36 hours before rest, there was no mention by any of the management teams of planned 24 work/rest cycles however efforts were being made to provide one hour of rest for every two hours of work. Day shift crews averaged five to six hours of sleep at night while night shift crews averaged three to four hours of sleep during the day (p. 3). Based on their own findings it doesn't appear that the 2:1 work/rest guidelines were met.

In the 1996 TriData Corporation, Phase-I report, firefighter fatigue was identified by firefighters taking the survey themselves as a causal agent in many accidents and deaths. Firefighters surveyed felt that they were asked to work too many consecutive hours, days or number of fires. One 20 year veteran smoke jumper was quoted as "Overtime is what we're after, and I think a lot of people on the fireline push themselves past their workable point of fatigue. Hotshots do this for weeks at a time, then the season goes on and it accumulates" (1996, p. 172). In addition, firefighters working night shifts felt they were not getting adequate rest during the day due to noise and sleeping conditions. Night shift firefighters usually have to sleep in the heat of the sun, bothered by insects and the constant drone of running generators and trucks. The use of the 12-hour shift creates the day shift verses night shift problems that wouldn't exist on a 24-hour shift. The federal pay issue seems to be driving the federal firefighters to stay on the 12-hour day shift although it is hard to find in any study to support such an explanation.

In the April 1999 article written by Terwilliger and Waggoner, “*Wildland Fire Shift Patterns, The 24-Hour Operational Period*” Terwilliger and Waggoner state:

Studies have shown that firefighters on wildland fires should receive one hour of rest for every two hours worked on the line. This has been accepted by most fire fighting agencies throughout California. This is not even remotely possible on the 12-hour shift. Personnel get out of bed at 0400 to 0500 hours to eat and attend the briefing. They are on the line until 1800 to 1900 hours, assuming travel is smooth. They may arrive in base at 2000 hours and try to eat. They must re-supply equipment and prepare for the next shift. At best, they may be in bed by 2200 to 2300 hours. This does not include time for showers. These personnel will receive four to five hours rest, not always sleep. After many days of this routine, these personnel do not perform basic hygiene; they do not eat well, and become fatigued. This is a recipe for injury and poor work production. (1999, p. 48)

The article does go on to say that there is a time and place for the implementation of the two different shifts. The authors recommend the 24-hour shift where night shifts are possible and the fire is still uncontained. Once the fire is contained, or there are safety problems with a night shift, a true 12-hour day shift should be used with only patrols at night (Terwilliger & Waggoner, 1999, p. 46).

In the *Thirtymile Fire Investigation Report* under Significant Management Findings, bullet point number three stated, “ Records indicated that personnel on the Thirtymile Fire had very little sleep prior to their assignments, and mental fatigue affected vigilance and decision making” (US Forest Service, 2001, p. 22). Granted, this accident occurred on the second day of the fire, but it shows the affect of fatigue on decision making and the need to be sure firefighters

are rested when they arrive to work. It also points to a major concern that came from firefighters in the TriData Corporation *Wildland Firefighter Safety Awareness Study* in 1996 where firefighters complained of being considered fresh even though they came from other fires or drove all night from their home station to the fire (p. 170).

The opinion of the CDF Fire subject matter experts surveyed indicates that 100% of them felt that firefighters did not get adequate rest on the 12-hour shift. Fifty percent of those surveyed felt that firefighters were working 18 hours per day with 6 hours sleep. Twenty five percent felt that firefighters worked 20 hours or more on a 12-hour shift. Fifteen percent felt that firefighters worked 16 hours on a 12-hour shift.

**Research Question 1B.** Are firefighters working on the fireline getting adequate rest, a minimum of eight hours of sleep, while off shift when working:

B) 24-hour operational shifts?

The following quote from *Wildland Fire Shift Patterns, The 24-Hour Operational Period* very succinctly answers the question about firefighters getting adequate rest on a 24-hour shift.

Terwilliger and Waggoner state:

When using the 24-hour shift, line personnel receive excellent rest. They will arrive at briefings well fed, clean and rested. You will enjoy excellent eye contact with key players, and they will better understand their assignment. Contrary to past practice, well rested, clean, and alert firefighters are a safer more effective resource. (1999, p. 46)

In a National Fire Academy (NFA) Executive Fire Officer (EFO) applied research paper titled *Injury Analysis during Nighttime Operations in Wildland Firefighting* Dan Thorpe states “Greater acceptance should be given to the 24-hour shift concept used by CDF. This tool has been successfully used to minimize injuries and increase production” (1999, p. 31).

In the opinion of the CDF Fire subject matter experts surveyed 100% concluded that firefighters get adequate rest when using the 24-hour shift. Fifty-five percent felt they actually worked 28 to 32 hours, but got 14 to 20 hours off shift.

The 1989 US Forest Service report titled, *A Study of Wildland Firefighting Work/Rest Cycles* states that the following as a potential benefit of the 24-hour shift, “Improved employee safety and health resulting from more rest time, more time to treat injury and illness, reduced exposure to hazardous driving or flying conditions and better informed and coordinated overhead” (Jukkala & Sharkey, 1989, p. 10).

**Research Question 2.** Is there a difference in resources required for a 12-hour versus a 24-hour operational shift which could affect the overall cost of the incident?

In the US Forest Service report titled *Work, Rest & Fatigue, Evaluation of their Relationships, 1982 Fire Season*, it states, while referring to the 24-hour shift:

The concept does not require more line workers, where both day and night shifts are manned, as in Region 5 (California). The concept may not be appropriate where no night shift is employed, as in fires in lodgepole fuel types in Montana. (Jukkala & Sharkey, 1989, Appendix C, p. 3)

Although there was little written to be found, with the exception to the above, that specifically addressed this issue the vast majority, 81%, of the CDF Fire subject matter experts surveyed responded that it would take the same number of resources on a 24-hour shift as a 12-hour shift.

This subject comes up often when comparing the two operational shifts, simple math shows they are the same. The number of resources it takes to staff two 12-hour shifts is the same

as two 24-hour shifts only the 24-hour shift is spread out over 48 hours as opposed to 24-hours with two 12-hour shifts.

### Example

#### Two 12-Hour Operational Shifts over 24-hours

10 crews day shift for 12 hrs + 10 crews night shift for 12 hrs = 20 crews

#### Two 24-Hour Operational Shifts over 48 hours

10 crews for 24 hrs + 10 crews for 24 hrs = 20 crews

**Research Question 3.** What are the benefits and drawbacks of both the 12-hour operational shift and 24-hour operational shift under different circumstances and when the fire is contained versus uncontained?

#### Contained vs. Uncontained

The following quote from *Wildland Fire Shift Patterns, The 24-Hour Operational Period* states:

In many cases, it is not necessary to staff a section of line at night. In this situation, a portion of the fire may operate on daylight 12-hour shifts only while other portions may continue on 24-hour shifts. After the fire is contained, it may become ineffective or dangerous to work at night. In this case, transition out of the 24-hour shift. (Terwilliger & Waggoner, 1999, p. 48)

The authors are recommending the use of 24-hour shifts while the fire is still uncontained, or any portion is uncontained, but switching to 12-hour shifts once contained.



Terwilliger and Waggoner go on to say that the traditional use of night shifts during mop up is ineffective and that firefighters are not that productive (Terwilliger & Waggoner, 1999, p. 48).

In the US Forest Service report *Work, Rest & Fatigue, Evaluation of their Relationships, 1982 Fire Season* states, while referring to the 12-hour shift “The standard two-shift concept, involving 16 hours on the first day and 12-hours each day thereafter is realistically unattainable for fireline personnel on most large uncontrolled fires” (Jukkala & Sharkey, 1989, Appendix C, p. 1). It goes on to state in the Executive summary “The standard concept of two shifts every 24-hours works well on simple fires of up to two days duration through control” (Jukkala & Sharkey, 1989, Appendix C, p. 1)

The 1989 US Forest Service report *A Study of Wildland Firefighting Work/Rest Cycles* concludes:

Based on the narrative reports and the crew log data, it appears that the two-shift system is the better alternative if the firefighters are provided with the 2:1 work/rest ratio recommended by the U.S. Army Research Institute for the Behavioral Social Sciences (Jukkala & Sharkey, 1989, p. 8).

This means regardless of whether the fire is contained or uncontained the US Forest Service recommends the 12-hour shift as its first choice provided adequate rest can be obtained.

The survey of CDF subject matter experts shows that 75% felt the 12-hour shift should be used while the fire is contained while 84% felt that the 12-hour shift should not be used while the fire is uncontained. It would appear that the CDF Fire subject matter experts prefer to see the 12-hour shift used during the contained period of the fire.

#### Benefits and Drawbacks of the 12-Hour Shift

The 1989 US Forest Service report *A Study of Wildland Firefighting Work/Rest Cycles* states “The current two-shift system should be the preferred work shift alternative, providing that circumstances are such that this shift system will give firefighters approximately 1 hour of sleep/rest for every 2 hours worked (2:1 work/rest ratio)” (Jukkala & Sharkey, 1989, p. 11).

In the US Forest Service report titled *Work, Rest & Fatigue, Evaluation of their Relationships, 1982 Fire Season*, it states, while referring to the 12-hour shift “The standard two-shift concept, involving 16 hours on the first day and 12-hours each day thereafter is realistically unattainable for fireline personnel on most large uncontrolled fires” (Jukkala & Sharkey, 1989, Appendix C, p. 1).

In the article *Wildland Fire Shift Patterns, The 24-Hour Operational Period* Terwilliger and Waggoner stated that on a 12-hour shift personnel were actually working 18 to 20 hours per day and resting 4 to 6 hours. This required relief drivers for most equipment since the drivers were too tired to drive. Personnel working night shifts had trouble trying to sleep during the heat of the day. Operations section chiefs have a very difficult time getting to the fireline due to the constant need to be in the incident base for planning meetings, filling out ICS-215's and operational briefings (1999, p. 46).

In the survey of CDF Fire subject matter experts drawbacks far outweighed benefits when using the 12-hour shift. Almost 100% of the CDF Fire subject matter experts felt firefighters were working much more than 12-hours per shift, there was not enough time off shift to take care of the crew, equipment and personal needs plus sleep, the 12-hour shift did not allow adequate time to travel back and forth from the fireline plus fire suppression, shift changes were being made at night when critical burnouts or control operations could be occurring, night shift personnel must try to sleep during the day and were not getting adequate rest, night shift

personnel were unfamiliar with the geography they hadn't seen in daylight causing confusion and wasting time, the 12-hour shift requires two operational briefings and planning meetings per day eating up valuable time, and lastly, the incident base had to be close to the fire line, in the smoke and in poor facilities to accommodate shorter travel times.

Some benefits of the 12-hour shift noted by the CDF Fire subject matter experts in the survey were: very little time off shift to get into trouble, the 12-hour shift allows differences in resource levels per shift and some felt it was beneficial to have a shorter work shift.

According to M. Brown, Battalion Chief for CDF Fire (personal communication, June 11, 2002), the 12-hour shift is an inefficient tradition, crude and only marginally effective when contrasted with my experiences on the 24-hour shift. The 12-hour shift reduces the opportunity of personnel to operate at their best and be highly motivated, reducing them in a few cycles to their most basic human need – sleep.

#### Benefits and Drawbacks of the 24-Hour Shift

In the article *Wildland Fire Shift Patterns, The 24-Hour Operational Period* Terwilliger and Waggoner are very much in favor of the 24-hour shift, although they concede that 12-hour shift is appropriate when there are safety concerns with a night shift of the fire, or any portion of the fire is contained. In the article Terwilliger and Waggoner list advantages of the 24-hour shift as greater rest for the firefighters, greater production in putting the fire out since firefighters are not using valuable time driving back and forth to the incident base, firefighters will always see their section of the fire during the day before the sun goes down, firefighters will be able to sleep in the dark allowing greater rest, fewer planning meetings and operational briefings allowing the operations section chief to get out on the fireline more often, travel from incident base to the fireline is cut in half saving fuel costs, wear and tear on the equipment and less exposure to

accidents, logistics only has to support one shift per 24-hour period as opposed to two, the planning section only has to produce one incident action plan (IAP) per 24-hour period and incident bases can be located further away from the fire in cleaner air and better facilities (Terwilliger & Waggoner, 1999, p. 45).

The US Forest Service in their report *A Study of Wildland Firefighting Work/Rest Cycles* states that their first option will be to use the 12-hour shift as long as firefighters meet the 2:1 work/rest requirements, however it recognizes that using the 24-hour shift will provide adequate rest for firefighters when working extended periods of time, a 50% reduction in travel time and cost due to half the necessary travel, improved productivity as workers get more rest, slightly less risk of a vehicle accident since employees have half the driving exposure. It goes on to state “The data collected in 1984 indicates that total shift production on the 24-hour work/rest cycle was judged to be greater than for the two-shift system” (Jukkala & Sharkey, 1989, p.10). In the Recommendations portion of the report it suggests using the 24-hour shift when transportation difficulties make for long travel times to and from the fireline, inadequate or dangerous access to the fireline, inadequate transportation support, logistics problems exist such as the incident base being a long distance from the fireline, safety problems exist including heat stress, smoke, rugged terrain or other conditions that require more recovery or injury treatment time (Jukkala & Sharkey, 1989, p. 11).

In the survey of CDF subject matter experts felt the benefits seemed to far out weigh the drawbacks when referencing the 24-hour shift. Very nearly 100% of those surveyed felt that there was adequate time to get to the fireline and return. There was greater production on the line since crews were not making shift changes at critical times when progress could be made in extinguishing the fire. When night came they were already familiar with the terrain and what

they were doing. Firefighters were less fatigued due to adequate rest and were less susceptible to accidents and injuries. Firefighters always slept at night which added to their quality rest. There was half the number of vehicle movements thereby reducing the exposure to accidents and saved costs in fuel and wear and tear of equipment. There were half as many planning meetings and operational briefings giving line personnel more time on the fireline and staff personnel more time to do their jobs. The Incident base can be moved further away from the fireline to better facilities and out of the smoke and carbon monoxide. There is greater time for the human body to rehydrate in extremely hot weather.

A few CDF Fire subject matter experts felt that the 24-hour shift was too long and there was too much time off for firefighters to get into trouble.

According to B. Redding, Battalion Chief, experienced command team operations and logistics chief for CDF Fire (personal communication, June 11, 2002), logistics on a 24-hour shift is less demanding particularly for evening meals. This allows time to occasionally send a hot meal to the line at night.

## **DISCUSSION**

1. Are firefighters working on the fireline getting adequate rest, a minimum of eight hours of sleep, while off shift when working: A) 12- hour operational shifts? B) 24- hour operational shifts?

Both the CDF Fire subject matter experts, the latest US Forest Service study, *Work and Fatigue During Extended Operations* done in 2002 by Steven Gaskill, PH.D. and the latest literature agree that the 24-hour shift provides at least eight hours of sleep and/or meets the 2:1 work/rest guidelines.

Where there seems to be a difference in findings is with the 12-hour shift. Almost 100% of the CDF Fire subject matter experts felt firefighters were working much more than 12-hours per shift, usually 18 hours, and firefighters were not getting eight hours of sleep or adequate rest. Firefighters were not meeting the US Forest Service guideline of 2:1 work/rest. They felt there was not enough off shift time to take care of the crew, equipment and personal needs plus sleep.

In the article *Wildland Fire Shift Patterns, The 24-Hour Operational Period* Terwilliger and Waggoner stated that on a 12-hour shift personnel were actually working 18 to 20 hours per day and resting 4 to 6 hours. Personnel working night shifts had trouble trying to sleep during the heat of the day (1999).

In the US Forest Service report *Work, Rest & Fatigue, Evaluation of their Relationships, 1982 Fire Season*, it states, while referring to the 12-hour shift “The standard two-shift concept, involving 16 hours on the first day and 12-hours each day thereafter is realistically unattainable for fireline personnel on most large uncontrolled fires” (Jukkala & Sharkey, 1989, Appendix C, p. 1). It goes on to state in the Executive summary “The standard concept of two shifts every 24-hours works well on simple fires of up to two days duration through control” (Jukkala & Sharkey, 1989, Appendix C, p. 1).

In December 1987 the USFS MTDC lab in Missoula issued a report titled *Review of Firefighter Fatigue California Fires 1987* (Jukkala & Sharkey, 1987). The report noted that most crews on four major complexes of fires in California and Oregon were working 18 hours per shift on what was suppose to be a 12-hour shift, line personnel often worked many double shifts meaning they worked at least 36 hours before rest, there was no mention by any of the management teams of planned 24 work/rest cycles however efforts were being made to provide one hour of rest for every two hours of work. Day shift crews averaged five to six hours of sleep

at night while night shift crews averaged three to four hours of sleep during the day. Based on their own findings it doesn't appear that the 2:1 work/rest guidelines were met.

It is interesting that the US Forest Service is still recommending the 12-hour shift even though there is a body of evidence within their own organization that reflects firefighters are not meeting the 2:1 work/rest guidelines. The 1989 US Forest Service report *A Study of Wildland Firefighting Work/Rest Cycles* concludes "Based on the narrative reports and the crew log data, it appears that the two-shift system is the better alternative if the firefighters are provided with the 2:1 work/rest ratio recommended by the U.S. Army Research Institute for the Behavioral Social Sciences" (1989, p. 8). This means regardless of contained or uncontained the US Forest Service recommends the 12-hour shift as its first choice provided adequate rest can be obtained. This same 1989 US Forest Service report also states that the following as a potential benefit of the 24-hour shift "Improved employee safety and health resulting from more rest time, more time to treat injury and illness, reduced exposure to hazardous driving or flying conditions and better informed and coordinated overhead" (1989, p. 10).

The conflicting comments within the US Forest Service reports might have something to do with the issues of pay and working hours issues referred by several sources. In the 1996 TriData Corporation, Phase-I report, firefighters surveyed felt that they were asked to work too many consecutive hours, days or number of fires. One 20 year veteran smoke jumper was quoted as "Overtime is what we're after, and I think a lot of people on the fireline push themselves past their workable point of fatigue. Hotshots do this for weeks at a time, then the season goes on and it accumulates" (1996, p. 172).

Dr. Ted Putnam, Ph. D. Psychologist states (personal communication, February 2002) the following in his paper titled *Fire Safety – Up In Smoke*: "Personal financial incentives, while

necessary, too often bias firefighters to work to the point of mental and physical deterioration, making accidents more imminent. This is more likely a cause of injury and near misses than fatalities”.

According to M. Terwilliger, Fire Chief for Truckee Fire Department, ex-CDF Fire command team operations section chief and current incident commander for a type-2 federal team (personal communication, June 12, 2002) the federal pay issues dictate use of shifts, not operational efficiency and safety. The crew time report (CTR) under the federal system dictates shifts federal employees will work while assigned on an active fire. Firefighters must show time off during the shift for mealtime and breaks. This adds one to two hours to the 12-hour shift, two hours before briefing and time after assignment. Crews are not allowed to show time for tool and crew preparation while off shift. Crazy system.

When the Forest Supervisor, Art Gaffrey (personal communication, August 18, 2002) for the Sequoia National Forest stood up at a close out meeting of the McNally Fire with a USFS California Major Interagency Incident Management Team (CIIMT) August 18, 2002 in Bakersfield California and said, ”The only firefighters on this fire that are rested are those on portal-to-portal pay”, I know pay and work hours are an underlying issue with the US Forest Service.

The most candid comments on this subject came from the MTDC report *Review of Firefighter Fatigue California Fires 1987*. In the report Jukkala and Sharkey make the following two statements that are very important:

Overall safety awareness appeared to be very good. However, we heard sufficient “horror stories” to indicate the Forest Service still pays too much lip service to safety rather than beginning to practice loss control management.



This cursory review of four fire complexes in northern California during September 1987 indicates that shift lengths, tours of duty, sleep and rest, and sleeping conditions were major factors in contributing to fatigue of firefighters. Regarding firefighter fatigue, one IC team member said, “We simply need to do what we know we should.” In many cases this doesn’t seem to be getting done. It’s equally as clear that many don’t know what should be done. (1987, p. 8)

The conflict in the material above seems to be within the material coming out of the US Forest Service. Many of the authors of the Forest Service reports are the same people at the MTDC lab, Jukkala, Sharkey and the latest Gaskill, yet information contradicts itself, even within the same report. The federal pay issue for the US Forest Service firefighters is clearly an underlying problem when making a choice on operational shifts.

2. Is there a difference in resources required for a 12-hour versus a 24-hour operational shift which could affect the overall cost of the incident?

Although this question seems very simple and the answer very straightforward, the question had to be asked in order to bring some closure to it.

In the US Forest Service report titled *Work, Rest & Fatigue, Evaluation of their Relationships, 1982 Fire Season*, it states while referring to the 24-hour shift “The concept does not require more line workers, where both day and night shifts are manned, as in Region 5 (California)” (Jukkala & Sharkey, 1989, Appendix C, p. 3). Although there was almost no literature to be found, with the exception to the above, that specifically addressed this issue the vast majority, 81%, of the CDF Fire subject matter experts surveyed responded that it would take the same number of resources on a 24-hour shift as a 12-hour shift.

In 1981, James McConnell, former Operations Research Analyst for the US Forest Service MTDC lab in Missoula conducted a cost analysis of two 12-hour shifts in a 24-hour period and the 24-hour work/rest cycle. This study is cited in a 1989 report titled *A Study of Wildland Firefighting Work/Rest Cycles*. The study looked at actual cost of labor versus productivity, travel cost and any loss of natural resources or real property due to the different work shifts. The study showed a 50% savings in travel costs and a 21% savings in labor cost using the 24-hour operational shift. This was due to the fact that only one shift was going out per day rather than two. Mr. McConnell could not come to any conclusion on any additional loss or damage to natural resources due to one shift or the other (Jukkala & Sharkey, 1989).

It appears, in the example below, that it takes the same number of resources to staff two 12-hour shifts is the same as two 24-hour shifts only the 24-hour shift is spread out over 48 hours as opposed to 24-hours with two 12-hour shifts.

#### Example

##### Two 12-Hour Operational Shifts over 24-hours

10 crews day shift for 12 hrs + 10 crews night shift for 12 hrs = 20 crews

##### Two 24-Hour Operational Shifts over 48 hours

10 crews for 24 hrs + 10 crews for 24 hrs = 20 crews

What the information above shows is, although there is no difference in resources required for either operational shift, there is a cost savings by using the 24-hour shift.

3. What are the benefits and drawbacks of both the 12-hour operational shift and 24-hour operational shift under different circumstances and when the fire is contained versus uncontained?

In addition to firefighter fatigue the US Forest Service has looked into the traditional 12-hour shift and the new 24-hour shift to see if one is better than the other for a multitude of reasons including meeting the 2:1 work/rest requirements.

In the article *Wildland Fire Shift Patterns, The 24-Hour Operational Period* Terwilliger and Waggoner state that CDF Fire started using the 24-hour operational shift in 1990 on the Campbell fire (126,000 acres) and have used it numerous times since (1999, p. 44). CDF Fire had the confidence to break from tradition and try the 24-hour shift because of the work that had already been done by the US Forest Service. In 2002 all ten CDF Fire type-I MICT teams prefer to use the 24-hour shift as their first choice of operational shifts for uncontained fires where it is safe to be on the fireline at night.

There seems to be very solid opinions by the CDF Fire subject matter experts, US Forest Service reports and literature cited that the 12-hour shift is the shift of choice once the fire, or any portion of the fire, is contained and/or there is a safety reason not to use a night shift.

Terwilliger and Waggoner state the following in reference to switching to 12-hour shifts: After the fire is contained, it may become ineffective or dangerous to work at night. In this case, transition out of the 24-hour shift to a 12-hour shift. Or better yet, release some resources and utilize a daytime 12-hour shift only. This will result in extremely effective mop up and maximize the resources assigned. (Terwilliger & Waggoner, 1999, p. 48)

The CDF Fire subject matter experts surveyed for this paper stated that one benefit of the 12-hour shift is that it allows one shift to be staffed heavier than the other, such as a heavy day shift and lightly staffed night shift.

In the US Forest Service report *Work, Rest & Fatigue, Evaluation of their Relationships, 1982 Fire Season*, it discusses using the 12-hour day shift only in certain circumstances

“lodgepole fuel in Montana” where a night shift would not be safe (Jukkala & Sharkey, 1989, Appendix C, p. 3).

CDF Fire subject matter experts, US Forest Service reports from 1982 to 2002 and literature cited agreed on most benefits of the 24-hour shift. There was agreement that firefighters received adequate rest and were less fatigued making them less susceptible to accidents and injuries. Firefighters slept at night in the dark adding to the quality of their rest. Another benefit that was agreed on was that rested firefighters performed at a higher level with greater production on the fireline. The US Forest Service report, *A Study of Wildland Firefighting Work/Rest Cycles* recognized that using the 24-hour shift will provide adequate rest for firefighters when working extended periods of time. Firefighters that were rested performed better with greater production on the line (1989, p. 11). The data collected in 1984 indicates that total shift production on the 24-hour work/rest cycle was judged to be greater than for the two-shift system” (Jukkala & Sharkey, 1989, p.10). In the article *Wildland Fire Shift Patterns, The 24-Hour Operational Period* Terwilliger and Waggoner state:

When using the 24-hour shift, line personnel receive excellent rest. They will arrive at briefings well fed, clean and rested. You will enjoy excellent eye contact with key players, and they will better understand their assignment. Contrary to past practice, well rested, clean, and alert firefighters are a safer more effective resource. (1999, p. 46)

Other benefits of the 24-hour shift had to do to with travel and transportation. Use of the 24-hour shift cut vehicle movement in half reducing the exposure to accidents while reducing fuel costs and wear and tear on equipment. In addition the 24-hour shift allows adequate time to travel to and from the fireline and allows the incident base to be further away from the fire in better facilities and cleaner air. The US Forest Service report *A Study of Wildland Firefighting*

*Work/Rest Cycles* notes a 50% reduction in travel time and cost due to half the necessary travel. Transportation difficulties are solved making long travel times to and from the fireline possible. Logistics problems such as the incident base being a long distance from the fireline are no longer an issue (Jukkala & Sharkey, 1989). In the article *Wildland Fire Shift Patterns, The 24-Hour Operational Period* Terwilliger and Waggoner note that travel from incident base to the fireline is cut in half saving fuel costs, wear and tear on the equipment and less exposure to accidents, logistics only has to support one shift per 24-hour period as opposed to two, the planning section only has to produce one incident action plan (IAP) per 24-hour period and incident bases can be located further away from the fire in cleaner air and better facilities (1999).

Although none of the US Forest service reports mention other benefits, the CDF subject matter experts and other literature do. Terwilliger and Waggoner, in their 1999 article *Wildland Fire Shift Patterns, The 24-Hour Operational Period* write about the fact that on the 24-hour shift crews were not making shift changes at critical times when progress could be made in extinguishing the fire. When night came they knew where they were and what they were doing. There was half the number of planning meetings and operational briefings giving line personnel more time on the fireline and staff personnel more time to do their jobs. There is greater time for the human body to rehydrate in extremely hot weather (1999). In the national and California wildland fire service arena there are *18 Situations That Shout Watch Out*. These are nationally accepted standards that all firefighters adhere to. The number two *Watch Out Situation* is “You’re fighting fire at night in country not seen in the daylight “. How can firefighters be productive and safe if they’re showing up on the fireline, after the sun has gone down, and have no clue as to the geography or where the fires edge is?

Dan Thorpe notes in his National Fire Academy (NFA) Executive Fire Officer (EFO) paper *Injury Analysis during Nighttime Operations in Wildland Firefighting*:

Greater acceptance should be given to the 24-hour shift concept used by CDF. This tool has been successfully used to minimize injuries and increase production. Within the context of nighttime safety, crews have seen the area they are working during the day shift (1999, p. 31).

There were a few negative comments made about the 24-hour shift by CDF Fire subject matter experts that need to be mentioned. Six of those surveyed felt that a 24-hour off shift was too much time to get into trouble. The US Forest Service recognizes this problem which may be one reason they prefer the 12-hour shift. US Forest service personnel that are off shift are not under the control of their agency. CDF Fire personnel, and most local government firefighters, are on portal-to-portal pay and always under the control of their agency. In the US Forest Service report *Work, Rest, Fatigue, Evaluation of their Relationships, 1982 Fire Season* the following is stated:

When crews are off-shift, or non-pay status, we cannot control their movement. This may not be any more of a concern than it is with historical shift patterns, but it is a factor to be evaluated. Base/Camp locations near metropolitan areas may be a factor in electing to utilize the 24-hour rest/work cycle. (Jukkala & Sharkey, 1989, Appendix C, p. 10)

What they are trying to say in the quote above is, if off duty problems develop you may want to keep your incident base back in the woods away from the general population, alcohol, drugs or any other distractions.

## RECOMMENDATIONS

The results of this applied research paper suggest that CDF Fire should consider both the 12-hour and 24-hour operational shifts as options to use in managing going wildland fires with a strong preference to the 24-hour operational shift. Data shows the 24-hour shift is safer, more productive, cheaper and more efficient.

The 24-hour shift clearly stands out as the shift of choice for active fires for many reasons. The 24-hour shift provides for better work production over longer periods of time by firefighters while also meeting rest and recuperation guidelines. Firefighters are more rested and less likely to have accidents or suffer injuries. Utilizing the 24-hour shift allows the incident base, if necessary, to be further away from the fire in a better facility and out of the smoke. The 24-hour shift has the firefighters on the line during critical periods of time making progress rather than trying to do shift changes. Engine companies and crews are on the fireline during the day and on into the night so they are very familiar with the geography they are in and where the fire is. Utilizing the 24-hour shift reduces the vehicle traffic going to the fireline and back in half, which also reduces the risk of vehicle accidents. Operations section chiefs (OSC) have greater opportunity to get out on the fireline and manage operations on the 24-hour shift. The workload on logistics and plans is reduced significantly since there is only one shift and shift plan every 24-hours.

There are several drawbacks to the 24-hour shift and incident commanders need to realize what those include. The 24-hour shift does not appear to be the shift of choice for fires, or portions of fires that are contained. In addition the 24-hour shift should not be used in fuel types or geography where night shifts are not safe.

The 12-hour shift is an ideal shift to use if no night shift is being utilized and the work hours are kept within acceptable work/rest guidelines. These would be fires that are contained or have no night shift for safety reasons. The 12-hour shift, although it may meet work/rest guidelines when used appropriately still has all the other drawbacks that come with it. The incident has to have two planning meetings, two operational briefings, the operations section chief has difficulty getting to the line, night shift personnel would have to sleep in the daytime heat, twice the amount of travel to and from the line, shift change at critical times when firefighting progress could be made, night shift crews are unfamiliar with their geography and section of the fireline and incident bases must be close in proximity to the fire in order to shorten travel time which keeps the firefighters in the smoke.

CDF Fire should embrace the 24-hour shift and make sure that an explanation of its preferred use is in every department handbook and/or training manual where the topic of operational shifts is addressed. The Emergency Operations Advisory Committee (EOAC) of CDF Fire should review the recommendation contained here and make a recommendation to executive staff for implementation into policy and training documents. Once approved internally by CDF Fire the department should take the 24-hour operational shift forward to the Firefighting Resources of Southern California Organized for Potential Emergencies (FIREScope) Board and California Wildfire Coordinating Group (CWCG) committee for adoption and inclusion in the Field Operating Guidelines (FOG) handbook. If CWCG approves the recommendations contained here in they should take it forward to the National Wildfire Coordinating Group (NWCG) for adoption nationally.



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## Appendix A

Chief's,

You are an important group of people who are subject matter experts on managing major emergencies in and out of California.

I am enrolled as a student in the National Fire Academy Executive Fire Officer Program. I am working on a research paper, that is due very soon, related to 12 and 24-hour operational shifts on wildland fires. I have tried to make the attached survey form very simple for you to check the boxes so it shouldn't take you very long to complete, perhaps 5 or 10 minutes. Feel free to write in any editorial comments. As a matter of fact I would appreciate some good quotes I could use in my paper. I could also use any references you may have on the subject.

You should be able to fill the form out on line and "Forward" it back. Be sure it is still attached. If you prefer you can fax it to the number below.

I know you are all very busy right now and I thank you for your precious time in advance.



"Semper Paratus"

*Bill Holmes, Assistant Chief*

California Dept. Of Forestry and **Fire** Protection

Butte Unit

2334 Fair Street

Chico CA. 95928

Office (530) 895-6620

FAX (530) 891-2827

Pager (530) 871-8301

[www.fire.ca.gov](http://www.fire.ca.gov)

[www.buttefire.com](http://www.buttefire.com)