Toward a Healthier and Safer Wildland Firefighter Workforce

Wildland fire fighting activities take place in a high-risk environment. The firefighters involved in these activities are often at risk, both in the short term and the long term, from illnesses, injuries, and sometimes infrequently even death, in the process of performing their jobs. In the United States, 133 individuals died in activities associated with wildfire suppression during the period from 1990 - 1998. Australia has also experienced numerous fire related fatalities during the same period, and other firefighters around the world have died in Greece, Mongolia, Russia and South Africa.

This paper will discuss those factors that are critical to both firefighters and fire managers to insure a safe and productive workforce. First, we will discuss such items as the work environment, the firefighter workforce, physical fitness, nutrition, work/rest cycles, lifestyle choices and job requirements. In addition, we'll review firefighter illnesses, injuries and fatalities, with the purpose of identifying mitigation measures that can be implemented to reduce and/or eliminate the risks from the fire environment. The mitigation measures suggested are applicable to both the volunteer and full-time firefighter workforce.

The Work Environment

A wide variety of environmental conditions exist in the world of wildfire suppression: from the Arctic tundra to the Florida Everglades; from the Eucalypt forest of Australia to the chaparral fields of southern California; and from the Pine forest of Montana to the Pine barrens in New York and New Jersey, the extent of ecosystems that experience fires is truly world-wide. There are numerous factors compounding the already stressful work of suppressing fires: elevations that range from sea level to over 2000 meters; steep, uneven ground; high ambient air temperatures that often exceed 35C; and above average levels of smoke and dust. All these conditions have the potential to affect the on-the-ground performance of the bushfire fighter, and may ultimately result in illness, injury or even death. These factors, especially for individuals not acclimated to them, can have a cumulative effect on a firefighter's ability to resist these exposures and risks.

The Firefighter Workforce

The individuals that participate in wildland fire fighting operations are a varied as the fuel and terrain types that they fight fire in: females and males of all racial backgrounds, at least 18 years old, but often into their 60's and 70's, weighing less than 50 kilos, but sometimes more than 100, and less than 5 feet tall to more than 6.5 feet. The fire fighters are truly a cross-section of the population that they serve. While some fire agencies have physical fitness requirements (especially among the career departments), firefighters often come to the fire environment with the same physical conditions as the general population: allergies to smoke and dust; trick knees;

sometimes overweight and out of shape; and with other untold pre-existing conditions that may surface on the fireline.

The Firefighting Job

Besides the environmental and human factors already described, the other critical factor that contributes to the illnesses, injuries and deaths that affect wildland firefighters is the actual job itself. Long hours of arduous work under difficult physical conditions, coupled with reduced sleep and dietary changes, plus working closely with a new group of individuals in a less than hygienic setting, with the potential for exposure to previously unseen infections in a period of reduced immunity: all these are prime conditions for illness and/or injury to strike the firefighter, especially on multi-day fire assignments.

Demands of the Job

Fighting wildfires has unique physical fitness requirements unlike most other jobs in the civilian workforce: both lower and upper body strength are needed to complete the necessary tasks, and endurance is essential to work the extended periods of time required to control the unwanted fires. In addition, there is always the unexpected action of responding to a flare up on the control line, or even worse, the need to make a rapid retreat when a fire threatens the firefighter's personal safety, especially after long hours on the line. Studies at the University of Montana Human Performance Laboratory have shown that aerobic fitness, as measured in max VO2, is the primary limiting factor in the firefighter's ability to sustain hard work throughout the long work shifts.

Like athletes, serious firefighters realize that physical activity and training are a year-round commitment if they are to successfully meet the demands of the job. This is often difficult to achieve, especially in a workforce that has many other conflicting demands on their available time.

Individual Factors in Firefighting Health and Safety

There are a number of factors that affect the ability of an individual to perform wildfire suppression activities in a safe and efficient manner: some are beyond the individual's ability to influence, but many are well within the individual's total control. Those factors that are inherited, or those controlled by the environment (heat, humidity, elevation), are interesting to contemplate, but are beyond the scope of our ability to affect in the context of bush firefighting.

There are, however, a number of items that the individual firefighter, whether volunteer or full-timer, can affect through their own actions and attitudes. While physical height is a genetically inherited factor, an individual has a range of options regarding their lean body weight, physical fitness level, and muscular endurance. These factors are a direct result of the firefighter's choices regarding nutritional choices, exercise regimes, and motivation to prepare themselves for the job at hand.

While these factors are generally considered as long-term in nature, there are other factors that tend to be affected more by short-term actions: acclimatization for both heat and elevation can be changed within a relatively short time frame. As temperatures heat up during the early stages of a fire season, firefighters should begin moderate levels of outside activity to prepare themselves for the inevitable fires that will require extended physical activity. Similarly, higher levels of hydration and nutrient supplements will be necessary during prolonged periods of strenuous activity during periods of high heat loads, both from the ambient air and from the fires.

Firefighter Illnesses

The illnesses that fire fighters are subjected to are not that unique from those suffered by other large groups of individuals thrown together in a close environment - such as sailors at sea, or teachers and students in a classroom - for extended periods of time. The introduction of endemic levels of infection and disease in any one individual has the potential to cause visible signs of illness among other individuals who have not had previous exposure, and the opportunity to develop an immune response. In addition to bringing a large group of individuals together, wildfires also complicate the equation by requiring long hours of hard work, coupled with a change in diet and sleep patterns. These factors, and the exposure to smoke and dust, result in a variety of illnesses among, especially as the duration of a fire assignment progresses beyond the first week.

The short-term and long-term exposure to high levels of environmental smoke from wildfires was most apparent in the 1987 and 1988 fire seasons: in those years, long duration smoke inversions plagued not only the immediate fire area, buy also impacted the incident base camps and surrounding communities for days on end. For firefighters spending multiple 21 day assignments under those conditions, the incidence of upper respiratory tract infections was wide spread, and lasted for periods as long as 3-4 months after the fire operations were over. As a result, the Health Hazards of Smoke project sponsored by the National Wildfire Coordinating Group (NWCG) was undertaken at the Missoula Technology and Development Center (MTDC). The six-year project culminated in 1997 with a Consensus Conference in Missoula, Montana that summarized the research findings, and developed mitigation measures for on-the-ground fire operations to reduce exposure to smoke.

The long duration fire season in Northern Idaho and Western Montana in 1994 offered another opportunity to look at the incidence of illness among firefighters on large fire incidents managed by fire overhead teams. An informal review of medical records conducted by Mark Vore from the Idaho Panhandle National Forest showed that nearly 40% of the visits to the Incident Medical Units were documented as respiratory problems. These findings are consistent with the problems that surfaced in 1987 - 1988, and have the potential for future occurrences as well, given the mountainous terrain and inversion potential that exist on many large wildfires and prescribed burns in the western U.S.

Another illness issue that appears to be on an upward trend on wildfire operations in the incidence of heat stress injuries. Under conditions of both high ambient air temperatures and high radiant heat flux, the firefighter can easily become dehydrated and a heat stress casualty if positive preventative measures are not implemented as a normal way of doing business on a daily basis. A recently completed Australian study on work productivity among bushfire fighters indicated that the personal protective clothing was a key factor in reducing heat stress. Project "Aquarius" noted that 2/3 of the firefighter's heat load was generated internally, with only 1/3 coming from the radiant heat of the fire. They recommended that the design of protective clothing should be to "let heat out, not keep heat out." Additionally, they recommend that wildland firefighters consider the need to consume as much as one liter of fluids per hour under high temperature and heavy workload conditions. The logistics of supporting this level of fluid replacement during a 12-hour operational period can be challenging, but is certainly essential to prevent heat stress illness. Dehydration and heat stress illness can be the result of a progressive deterioration that occurs over several days of reduced fluid intake, and can be compounded by other factors such as other illnesses or medications being taken be the individual.

Fire managers and crew leaders should take positive actions to minimize working firefighters to the point of exhaustion, or exposing them to excessive levels of smoke. Additional actions that can help reduce firefighter illness include reducing both physical and emotional stress; enhancing rest and recuperation periods, with a target of a 2-to-1 work/rest cycle (16 hours work/8 hours rest); and, providing adequate energy and nutrients to meet the special requirements of the arduous fire job. Firefighters each have an individual responsibility to insure their own ability to perform the job by getting and staying in good physical condition; making correct nutritional choices to sustain them on multi-hour and multi-day fire assignments; and making healthy lifestyle choices (such as not smoking) that will help them remain on the job during periods of reduced immunity to illnesses.

A recent paper by Dr Steve Woods from Abbott Laboratories identified "immune friendly nutrients" that enhance the function of the human immune system. They include Vitamins C and E, which both stimulate and enhance immune response; Beta carotene, which stimulates natural killer cells; Vitamin B6, which promotes white-cell proliferation; selenium, promoting anti-bacterial activity; and zinc, which promotes wound healing. All these nutrients can be helpful in reducing the risk of firefighter illness in the bushfire environment.

Firefighter Injuries

In difficult terrain, under conditions of long hours and arduous work, injuries are one of the major perils that wildland firefighters are subject to. Although no documented records exist showing trends of firefighter injuries, on-the-ground observations by experienced personnel shows several major areas where injuries occur:

- Vehicle accidents

- Tool use
- Slips/trips/falls
- Muscle strains

By inference, several of these injury areas can be related back to the casual factors of fitness levels and fatigue. As an individual fire firefighter becomes more fatigued from the long hours and arduous work, they become less attentive to the small things that prevent injuries under different circumstances: walking on steep slopes, over logs, down cut slopes; clearing obstacles and using full muscle control when swinging hand tools; failing to use proper lifting techniques for heavy objects; and not keeping full attention on driving techniques on windy, steep, unsurfaced roads.

Although these accidents are not well documented to show their rate of occurrence on fire operations, experienced personnel are well aware of these risks. Better documentation will more clearly define the problems, and lead to mitigation practices for their ultimate reduction. The MTDC publication "Fitness and Work Capacity" documents many of the conditioning techniques that can reduce firefighter fatigue by increasing work stamina.

Fitness and Injury

A number of recent studies have documented the relationship between fitness levels and injury rates. In the U.S. Army, a study of 861 female and male trainees indicated that the fittest soldiers (measured by their pushups, setups and 2 mile runs) experienced the lowest injury rates. Another study showed that the most fit individuals, as indicated by running speed, experienced the least injuries in sports training. Finally, a 1999 Australian Army study of their recruits a negative relationship between fitness and injuries. The implications of these studies to the firefighter ranks are obvious, especially in such a physically demanding activity.

Firefighter Fatalities

The first half of the 1990's decade saw two major wildfire fatality events that riveted the attention of the Nation in the U.S.: the Dude Fire in 1990 killed six (6) firefighters, and fourteen (14) firefighters died on the South Canyon Fire in 1994. Although these tragic events were horrific reminders of the risks inherent with wildfire suppression activities, they were on a portion of the total deaths that occurred in the 1990 - 1998 period. In those years, 133 fire fighters and others involved in wildfire operations died from a variety of causes. A recent MTDC Technical Report documents those causes, including aircraft accidents (30 deaths), heart attacks (28 fatalities) and vehicle accidents (25 deaths). Numerous opportunities exist to reduce firefighter fatalities off the immediate fire ground, through many of the same actions that will reduce illness and injuries. Reduction of deaths from heart attacks offers the best opportunity to reduce a sizeable number of deaths, but will require a major life style change to accomplish in many firefighters.

In the progression of events, it could be surmised that fatalities on wildland fire operation are, in many cases, the logical extension of early failures to address issues of illness and injuries that manifest themselves throughout the fire season. It is imperative that we break the chain if we are to ultimately reduce firefighter fatalities.

Toward a Safer and Healthier Firefighter Workforce

The safety and health of the bushfire-fighting workforce is critically important to the firefighters and their families, the fire management organization, and the community being served. There are numerous opportunities, both short-term and long-term, to improve the health and safety of the bushfire workforce for both volunteer and career firefighters:

- First and foremost, individual firefighters must take positive and affirmative actions to insure their own health and safety. This includes maintaining an appropriate height/weight ratio, participating in an exercise program, and minimizing high risk activities that threaten good health;
- Fire agencies have a major obligation and responsibility to provide the environment for their firefighters that fosters a safe and healthy workforce. This can include health screening programs, exercise facilities, and in some cases, work capacity testing;
- Provide specialized training in high risk activities, such as emergency vehicle operation, and create a culture that does not condone or tolerate unsafe work practices, even on a bushfire emergency;
- On multi-day bushfire operations, insure that fluid and nutritional needs are met, and that work/rest cycles are managed to prevent unnecessary fatigue among both firefighters and fire managers.
- Develop, maintain and monitor an "Illness and Injury" database, preferably at the National level, to identify health and safety trends occurring among the bushfire community.

Richard J. Mangan
U.S. Forest Service
Missoula Technology & Development Center

Missoula, Montana USA

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