



HAZARDOUS MATERIALS CLEAN UP AND CONTINUOUS OPERATIONS

INTRODUCTION

Hazardous materials recovery teams can perform for long periods of time with the right support. Civilian and military personnel have long been expected to operate at an acceptable level of efficiency in difficult, continuous, and sustained operations. This has led to a large body of studies done on operational requirements. Identified factors that may contribute to various types of performance degradation include: protective equipment and environmental demands (heat, cold, high altitude); extreme environments (undersea, polar, outer space); conditions of low stimulation inducing boredom; night operations; prolonged combat and exposure to life-threatening work; sleep deprivation; and other situations. In non-military settings, workers often have work and union rules, the freedom to quit a job, and they cannot be ordered to perform certain tasks except in very special circumstances. Failure to adhere to performance guidelines can be the result of organizational breakdown. In this way, organizational disruption can lead to sleep loss, fatigue, poor performance, accidents, psychological stress, and reduced effectiveness.

ISSUES

1. Hazardous Material Cleanup Protective Clothing for Workers

There are many levels of worker protective clothing and equipment depending on the nature of the contaminant, environmental conditions, and available support. If protective suits are required, all aspects of the clean up operation will be a significantly affected. Protective suits require special attention to hydration, temperature regulations, increased workload, and social isolation due to the inability to make eye contact. The experience of sensory input limitation caused by protective gear requires training. These suits and equipment can also impose increased ergonomic demands and may change the needed work/rest cycles.. Decreased ability to communicate clearly due to protective gear can be an increasing issue during continuous operations due to fatigue. In addition, training is needed in order to accurately monitor the performance of individuals wearing protective equipment. This may not be present in times of a disaster when many are recruited to wear protective clothing to assist in a clean-up operation.

2. Physical and Cognitive Tasks

Performance of continuous physical work produces oxygen debt. As a result, body movements are less accurate and effective as muscles become tired. Personnel who perform continuous cognitive tasks for extended periods also show predictable performance decrements. Tasks requiring ongoing attention to detailed procedures generally may be performed without degradation for periods of 4 hours or less. However, breaks are required by 4 hours. Requirements on the individual vary according to whether the monitoring task is event-driven (egg person responds to a stimulus such as signal detection) or operator driven (e.g., person initiates such as making telephone calls, entering data).

3. Sleep and Sleep Loss

Sleep is one of the most extensively studied physiological and psychological processes. It is the most important factor in sustained performance. Sleep loss degrades performance, mood, and attitude. When limited amounts of intermittent and broken sleep are obtained, it is usually of insufficient quality to restore cognitive function and performance to peak levels. When one fails to obtain the proper amount of sleep (7 to 9 hours for young adults), the individual builds up a sleep debt. When that debt accumulates, the individual feels fatigued, exhibits gradual performance degradation, and eventually performs poorly as if the person had been sleep deprived for one or more nights. Sleep loss slows biological recovery including response to muscular exercise; thus a longer recovery period is needed. The chief effects of sleep deprivation, however, are more on psychological and cognitive tasks than on physical. Sleep loss hastens the onset and increases the frequency of cognitive performance decrements, especially on vigilance (e.g., attention-requiring) tasks.

4. Restorative Sleep and Naps

Naps (brief sleep periods) during the day can supplement or replace sleep lost at night. Naps also serve as a change of pace. If a nap is long enough, it provides restorative sleep that can refresh or recharge the worker. Naps can be scheduled into continuous work-rest cycles and can help sustain performance. Continuous sleep is thought to have greater recuperative power than naps. At least 4-5 hours of sleep should be taken to prevent impaired performance. Some studies indicate that a minimum of 6 hours of uninterrupted sleep is necessary to maintain performance over a long period of time. A sleep inertia effect has been observed in people who awake from naps and try to resume performance. During this period of 15-30 minutes, the person may feel groggy or sluggish and performance deficits are likely to occur. Sleep inertia is increased by the depth of sleep. Sleep inertia should be expected if a worker is expected to wake quickly and respond immediately. In the military, it is sometimes thought that taking naps does not fit with the military image and traditions. In situations where prolonged and continuous operations are necessary, leaders should be alert to those with a critical view of napping during operations.

5. *Circadian Rhythms*

Work performance varies as a function of time of day, work schedule, and the nature of the task performed. Humans exhibit predictable physiological and behavioral rhythms with a period of about one day. On a normal day-night schedule, alertness, motivation, initiative and performance tend to be best when the body temperature is rising through the day. They decrease slightly in the late afternoon with a moderate decrease in body temperature from about 5:00 to 7:00 pm. Performance, particularly sustained cognitive performance and quick responses, are especially low in the early morning, coincident with the lowest body temperature.

6. *Rest Breaks, Work Shifts, and Work/Rest Cycles*

Rest breaks and work shifts provide novel stimuli, provide rest from sustained task, and often break the effects of fatigue. Short breaks do not reduce output on paced jobs. Rest breaks in sedentary work provide relief from boredom and subjective factors. Rest breaks in physical work can reduce some physiological effects, muscle fatigue, and cardiac strain. Optimal schedules depend on the kind of work, the health status and physical conditioning of workers, and the work conditions.

7. *Pharmacological Agents*

Pharmacological agents (e.g., medications and drugs) have been used to maintain performance in some military groups including pilots and soldiers on long-range reconnaissance patrols. Drugs can be also used to induce or enhance sleep when conditions are not conducive to sleeping. A major concern with such drugs is whether users can respond quickly and normally from a drug-induced sleep in the event of an emergency. Other concerns include lingering performance effects (such as delayed reaction time or delayed cognitive processing) and the potential for adverse health effects with prolonged and repeated use. Although stimulant drugs can prevent sleep when needed, they also temporarily mask fatigue, may lead to over-stimulation, pose addiction potential, and cause appetite changes when taken chronically. Research in this area is ongoing. Caffeine is the most commonly used and available stimulant. Like other stimulant drugs, caffeine results in disruption of sleep cycles. Non prescribed stimulant and sleep medication use, is also present in settings of high demand and continuous operations.

8. *Recognition of Degraded Performance*

Establishing specific guidelines for the duration of continuous work performance can be very difficult in new, unexpected hazardous settings. Therefore, recognition of degraded performance and monitoring and surveillance by supervisors and health care givers is important. Degraded performance can be hard to recognize. Markers of degraded performance depend on the task(s) performed. Observable markers of fatigue will vary between tasks. In physical work, lack of motor coordination including stumbling, falling, lack of coordinated motions, and accidents indicate fatigue. Supervisors should also be alert to the potential of increased accidents before

and after work as fatigued or sleep deprived workers come to work and return home. Sleep loss may lead to disorientation, dissociation, and other mental symptoms. However, these may be difficult to recognize. When a task requires maximum effort over a long period of time and the mission is critical, such as rescuing victims, people will frequently overwork. Over-dedication to task can be both a result of and a cause of degraded performance. When the task is not critical, an individual's own estimate of fatigue (e.g., ask them if they are tired) is probably the best indicator that it is time to take someone off the job.

Impaired cognitive tasks and performance are often more difficult to recognize. Monitoring measures of errors in performance, failures in logical reasoning, slowed reaction time, deterioration in mood and motivation, and mental symptoms such as dissociation, memory lapses, and disorientation can aid in detection of degraded cognitive performance. Other possible psychological disturbances that can occur with severe fatigue or sleep loss include hallucinations, illusions, and other distortions of reality. Changes in cognitive performance are also expected during the normal circadian cycle trough (for day shift people, between 3:00 – 6:00 am). The longer the task, whether physical or cognitive, the more likely are performance decrements, especially under conditions of sleep loss, lack of food and water, and rest breaks.

9. Clinical Issues and Outcomes

Sustained continuous operations and sleep deprivation may precipitate distress reactions or mental disorders. Sleep loss and sleep phase shifting may also worsen pre-operational distress or pre-existing mental disorders. Importantly, the signs and symptoms of sleep deprivation may be confused with other mental conditions. Particular attention is needed to the following disorder related issues.

- a. Mood Disorders.** Fatigue, decreased concentration, and slowed movements are among the physical signs of depression. In workers with depression (whether or not on medication), persistence of these decrements even after restorative sleep may indicate depression rather than sleep debt. Sleep shift changes, prolonged sleep deprivation, or excessive use of stimulants to continue wakefulness may at times precipitate hyperactivity, excessive talking, irritability, and impulsive or dangerous behavior (e.g. a manic episode). This requires immediate medical attention. .
- b. Anxiety Disorders.** Persons previously treated for generalized anxiety or panic disorder may experience flare-ups of their illness under the stress of prolonged continuous operations (or as a result of a disruption of their medication supply). Exposure to dead bodies or life-threatening work may cause anxiety reactions in some, or exacerbations of pre-operational illness such as PTSD. Anxiety symptoms also include poor concentration and irritability which may directly compromise mission capability.

- c. Substance Use Disorders.* Workers who abuse alcohol, use certain prescription medications or illicit substances may experience dangerous withdrawal (including seizures or delirium) if sustained operations interfere with their regular use of these agents. When combined with sleep deprivation use of alcohol or other substances results in greater cognitive impairment.
- d. Distress Reactions and Behaviors.* Anger, irritability, decreased concentration, or avoidance behavior may represent non-specific distress reactions. While these reactions are expected under the stress of prolonged continuous operations, mission leaders may benefit from consultation. Such consultation can assist in determining whether these reactions will compromise mission capability, respond to restorative sleep, or require further intervention.

TABLES

Table 1. Issues in Hazardous Materials Cleanup and Continuous Operations

Protective clothing for workers
Physical and cognitive tasks
Sleep loss
Circadian rhythms
Rest breaks, work shifts, and work/rest cycles
Pharmacological agents
Clinical issues

Table 2. Monitoring Performance Degradations/Effects of Stress

Managers and Supervisors should be alert to:

- Lack of motor coordination - stumbling, falling, accidents
 - Cognitive degradations - performance errors and slowed reaction time
 - Mental degradation – memory lapses, disorientation, psychological disturbances
 - Changes in energy levels
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Table 3. Strategies for Maintaining Performance:

Have sufficient personnel to accomplish the mission.
Modify tasks, divide workload and cross train to allow people to rest and take breaks.
Lighten mission-essential tasks to the minimum (particularly physical loads).
Create teams that will work different day-night shifts and promote sleep when possible.
Monitor each other, particularly in tasks requiring high cognitive performance.

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