Chapter 9

Case Study: The Military

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As Operation Desert Storm illustrated, technological advances have dramatically increased the ability of the military to carry out operations at night. In addition, many military situations demand that personnel engage in operations that require 24-hour manning and around-the-clock work. These operations can lead to circadian rhythm disruption, sleep loss, and other stressors (13). Many military settings that require continuous manning (e.g., command and control, medical, security, communications, ship navigation and propulsion, most transportation system operations) have civilian equivalents; others do not. For the most part, military work that has no direct civilian counterpart is performed on a continuous basis. This case study focuses on operations and work settings that are unique to the military and examines the typical duty schedules employed by the U.S. armed forces for carrying out those operations.

THE NATURE OF MILITARY OPERATIONS

An important characteristic of military activity is the context in which operations and tasks are being carried out. That context determines the tempo at which tasks are to be performed and the nature of the stressors associated with job performance. A task being performed during routine operations or in training can be very different when performed under actual or simulated combat conditions. Routine operations are those that are characteristic of peacetime and usually involve regular duty and rest schedules for continuous reaming of tasks. In continuous operations, work is unceasing, but the demands on the individual are not; in sustained operations, the individual has to maintain performance for long periods (usually more than 12 hours). Sustained operations are characteristic of combat or high-alert conditions and are often characterized by sharply increased tempo (surge conditions). As a result, in sustained operations individuals have inadequate opportunity for rest, making sleep loss and fatigue limiting factors in an operation. In sustained operations, sleep loss often results from the need for an individual to perform some vital function almost continuously for an extended period of time. The amount and tempo of work (especially mental work requiring attention and concentration) and the availability of nonsleep rest periods will determine the rate at which performance degrades, with faster work tempos causing faster degradation of performance (l). Although this report is concerned with the factors limiting personnel endurance, other factors, such as having enough materiel (munitions, fuel, other supplies), equipment (servicing and repair requirements), or information (command and control decisionmaking, communication limitations, or intelligence and situation assessments) can also limit the duration of fast-paced combat or training activities.

The nature of work and rest schedules can also be altered when military units are transported to different areas. The extra tasks involved in relocation operations disrupt individual schedules, and transmeridian relocations add jet lag to other disruptions. Rapid aerial deployment of military units overseas results in jet lag, and the first day or two at sea often involves extra tasks. Relocation of forces can also occur under surge conditions (the beginning of combat operations, combat reinforcement operations, and major training exercises), in which case disruptions and stressors associated with both normal relocation and surge conditions are present.

Various disruptions of biological rhythms and stressors that lead to performance decrements are associated with these situations. Short-term desynchronization of circadian rhythms can result from changes in operations (e.g., relocation overseas) or changes in operating tempo (e.g., at the onset of hostilities or at the start of a major operation). As in shift work in the civil sector, chronic disruption of circadian rhythms may result from constantly shifting schedules and schedules that require daylight rest and night duty, such as the 18-hour duty cycle often found in submarines, the 12-hour duty cycle often used on ships, or the deployment of night-fighter teams on the battlefield. Both acute and chronic sleepiness may occur in these situations, especially under sustained operating conditions, and these, in concert with circadian disruption or on their own, can lead to degradations in performance.

Training and operational readiness exercises are a constant fixture in the military. These exercises are

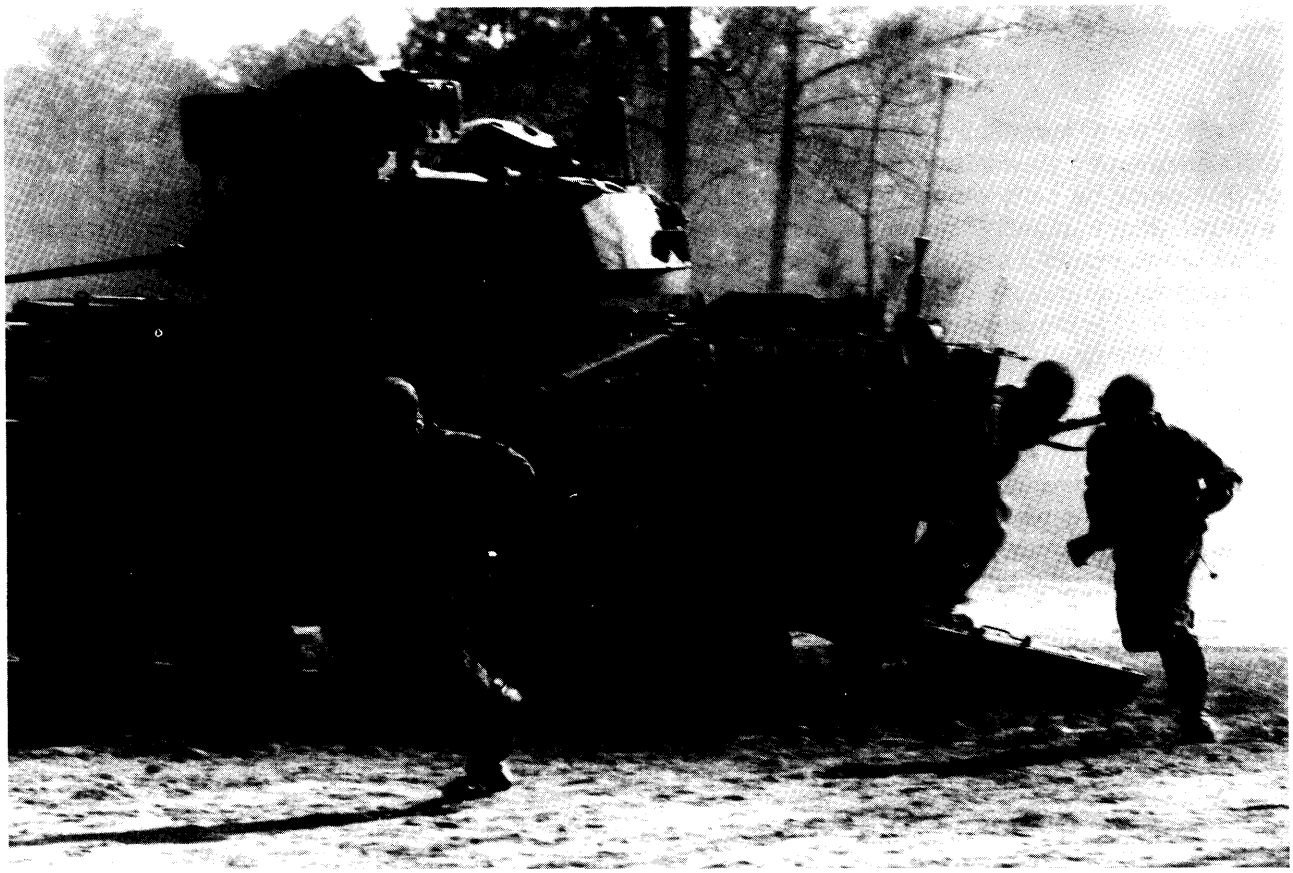

Photo credit: U.S. Army

Soldiers engaging in combat exercises.

as realistic as possible, replicating as closely as possible the conditions and schedules that would be encountered during combat. Although training exercises cannot duplicate the stress and fear encountered in actual combat, they do mimic the nature and tempo of such operations. As a result, military personnel are routinely and repeatedly exposed to the various conditions described.

Activities that occur in conjunction with combat or combat training are usually marked by an increased tempo and sustained hours of duty. Another factor which can impinge on military duty hours are manpower limitations. For example, in the Navy there are manpower documents that outline the level of manning of a ship necessary for a given operation. A loss of manpower due to casualties or sickness will result in a mismatch between manpower resources and mission requirements. This situation would require that the available crew work extended duty hours to successfully complete the mission (21).

There are few specific regulations or guidelines in the military related to hours of service and scheduling. Regulations limit flight hours and length of duty for aviators in all the services; however, decisions regarding hours of duty and work schedules for all other military personnel are generally left up to commanding officers, who base their decisions on their knowledge of mission requirements and on the condition and limitations of their personnel. Under routine post, camp, and station operating conditions, in which service members can go home to their families at the end of each workday, military work schedules tend to resemble civilian work schedules. For personnel deployed in the field or at sea, work schedules tend to be about 70 hours per week. In training and operational readiness exercises, work often continues until individuals are unable to go on. The existing guidelines for rest requirements in peacetime are not binding in combat (29,38,40) and are frequently relinquished in order to accomplish the mission (3,16).

Military Tasks

A variety of tasks have to be carried out at any time, day or night, and are therefore susceptible to the effects of disrupted biological rhythms and sleep loss. Since sustained operations are integral to modern military operations, some of the most salient problems for an individual are sleepiness (inclination for sleep) and fatigue (weariness due to physical or mental exertion). Both sleepiness and fatigue affect performance. As with studies of task performance in a civilian setting, studies of the effects of around-the-clock operations in military settings have revealed that the nature of the task determines its sensitivity to circadian disruption, sleep loss, and fatigue. For example, studies of sustained operations over several days with little or no opportunity to sleep show that vigilance, memory, and cognitive task performance of infantry soldiers, tank crews, and artillery fire direction teams are degraded (13). Although most people need 6 to 8 hours of sleep daily to maintain normal levels of alertness and performance, 4 hours of sleep can offer some protection from the deleterious effects of sustained operations (13).

Tasks that require physical activity and effort (e.g., infantry marches, preparing fortifications, handling supplies) are not significantly affected by the time of day, moderate sleep loss, or other circadian disruptions (2,8,26,41) However, the perceived effort required to do a physical task is sensitive to the time of day the task is performed, with greatest fatigue perceived between 2 a.m. and 6 a.m. (11). If personnel are quite fatigued, as they often are during sustained operations, their ability to perform physical tasks can be reduced (2,10,13). Physical conditioning is important in all the services, because fit personnel have more endurance in the performance of physical tasks, even though physical fitness does not protect against the effects of sleep loss.

Military operations also involve many tasks that require constant vigilance, often under conditions not conducive to alertness. These include air defense radar and electronic surveillance, sonar, sentries, pickets, and so on. The performance of many tasks requiring vigilance (sonar operation, for example) degrades-measurably after less than an hour of duty (13,24). Performance is also degraded by sleep loss and being required to work at inappropriate times during the circadian cycle, regardless of amount of rest **(13,18-20,22).** When vigilance is required in sustained operations, naps can be effective, especially if taken during the predawn period, from 2 a.m. to 6 a.m. (13); however, relief from the task (i.e., simple rest) and sleep are the most effective means of combating decrements in vigilance.

The operation and control of vehicles is also a common characteristic of military operations. Studies of the effects of fatigue on the performance of aircraft pilots indicate that physical coordination seems little degraded, even in conditions of extreme sleepiness (15); however, judgment degrades fairly quickly with the onset of fatigue (7,12,42). This effect is compounded when tasks are performed near the nadir of the circadian alertness cycle. There are regulations to guide aircraft operations (described later) but no crew rest guidelines for land or water vehicle operators. The use of pharmacological agents to enhance performance in aircraft operations, especially after long flights or during sustained operations, is being investigated (5).

The performance of other types of tasks associated with military operations, such as the maintenance, preparation, and operation of equipment (e.g., weapons systems, communication systems, construction equipment), may also be affected by circadian, fatigue, and sleepiness factors associated with time and duration of duty. As with the other tasks described, this is especially true in the case of sustained operations (13,23).

Finally, the task of commanding, which involves judgment and planning, is vulnerable to performance degradation caused by sleep loss and biological rhythm disruption. In fact, judgment is usually the first faculty to be degraded, and it is a very difficult one for the individual to monitor (2,9,12). There are no regulations or guidance regarding the duty hours associated with command. Leaders and command and control personnel generally stay awake and are involved during continuous and sustained combat operations to see to their responsibilities. However, since effective leadership depends on unimpaired judgment, and fatigue, sleep loss, and other biological rhythm disruptions impair judgment, avoiding or minimizing such effects is critical to successful combat leadership and command and control. The implementation of sleep discipline plans, a relatively new military innovation, is critical for combat leaders (14).

OPERATIONS REQUIRING 24-HOUR MANNING

Military operations that could be affected when personnel are exposed to biological rhythm disruption or sleep loss include combat operations (immediate involvement in fighting) and combat support (supply, communications, or medical aid), as well as combat training exercises. This includes all aspects of land combat (in-place, reinforcement, and expeditionary), support logistics operations, air operations (tactical and logistic), high-readiness operations of strategic forces, and the operation of naval vessels at sea. The most salient disruption in such cases is fatigue and sleep loss, exacerbated by various kinds of stress. Circadian disruption can also occur in combat operations: events such as strikes and assaults are often planned for the time at which the enemy is expected to be least effective. Momentum is very important in offensive operations (especially in land combat), and sustaining it for days or weeks entails many human endurance problems. Also, some element of surprise is always desirable in combat actions. The conduct of extended combat operations (over days and weeks) tends to be more effective if there is no discernible routine to the action. The need to carry out operations in which routines and predictability are minimized will have a negative effect on personnel duty-rest schedules.

Army Operations

With the exception of Army Aviation, there are no specific guidelines for work schedules and duty hours for most Army activities and operations. In their planning of operations, it is the responsibility of individual commanders to ensure that the personnel under their command are rested and fit for duty.

Deployment

Most military units are based in the United States; military units outside the United States are usually deployed for some limited period and then replaced. This deployment is usually scheduled well in advance. Individual jet lag can best be mitigated by allowing for recovery periods at the destination.

Surge deployment is usually in response to some new military requirement (e.g., the need to show force to support foreign policy in a time and place of tension) and is done on short notice. It usually involves transmeridian movement by aircraft, so jet lag effects would be present. The requirement to pack up, load, unload, and set up at a destination causes additional transient disruptions. Since these temporary tasks are not part of what is usually thought of as combat or mission tasks, they are not included in the planning of operations (35,38).

Reinforcement

Reinforcement is adding more personnel and equipment to units already deployed. Usually, reinforcement would be more urgent than relocation and would require new personnel to begin operations immediately on arrival at the same operating tempo as existing forces. Reinforcement is most likely to occur under surge conditions. The same disruptions in biological rhythms that would be encountered during initial troop deployment could also occur during reinforcement operations.

Special Operations

Special operations are difficult to characterize, given their inherent irregularity and classified nature. Special forces can be subjected to unpredicta-

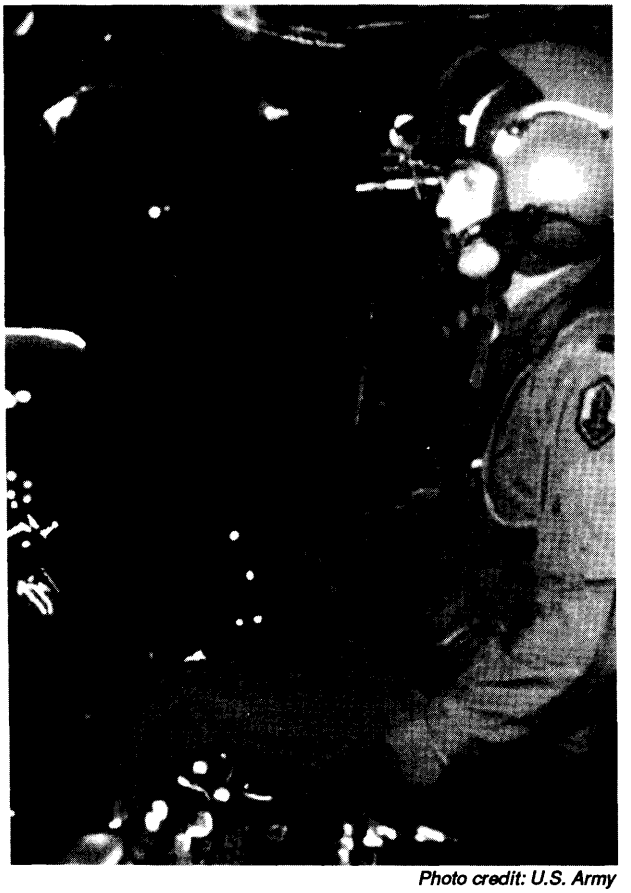

Photo credit: U.S. Army

Helicopter pilot wearing night goggles.

Table 9-l-Crew Endurance Guide for Flight Operations, U.S. Army

Time period (hours)	Maximum duty period (hours)	Maximum flight time (hours)	Environmental factor	
24	16	8	Day	1.0
48	27	15	Day contour/low level	1.3
72	37	22	Instrument	1.4
168 (7 days)	72	37	Night	1.4
720 (30 days) (peacetime)	288	90	Day NOE	1.6
720 (30 days) (mobilization)	360	140	Night terrain	2.1
			Night vision devices	2.3
			Chemical MOPP	3.1

EXAMPLE: The stress and fatigue experienced in 1 hour of day nap-of-the-Earth (NOE) flight (e.g., extreme low-level, Contour flight) is equal to 1.6 hours of standard day flight. If a crew member flies day NOE in chemical mission-oriented protective posture (MOPP), the larger factor (3.1) will be used. The flight time shown in column 3 will be adjusted by the factors in column 4.

SOURCE: U.S. Department of the Army Regulation AR 95-3, Aviation, *General Provisions, Training, Standardization, and Resource* Management.

ble and unanticipated requirements and must respond on short notice to anything from military search and rescue missions to counterterrorism. Frequently these situations require rapid deployment and the crossing of time zones. Planned or programmed duty-rest schedules usually are difficult to implement in such situations (17). Special operations forces tend to train at a continuous operations tempo, interspersed with periods of sustained operations, combined with relocations on short notice (often involving transmeridian travel).

Combat

For planning purposes, Army regulations specify that combat personnel (those doing the fighting) should have 6 hours each day for rest (35). In actual combat situations, as in the reinforcement and special operations outlined above, the nature and scheduling of rest periods would be dictated by the conditions of the moment.

Army Flight Operations

Army regulation 95-3 (36) governs scheduling limits for flight operations of both fixed-wing and rotary aircraft. These regulations provide guidance for duty period and flight time limits for air crews (table 9-l). The limits are adjusted for the conditions under which the operations occur. For example, flying 1 hour at night is considered the same as flying 1.3 hours during the day. In addition, the regulations recommend that commanders consult the unit's flight surgeon and aviation safety officer when setting limits for specific operations or time periods.

Air Force Operations

Tactical and Transport Forces

Air Force tactical and transport flight operations are guided by a number of regulations that provide requirements for scheduling (27-29,32,33). Tactical forces engage in air combat, support land warfare (close air support, interdiction of enemy supply lines, surveillance), and consist largely of fighters, bombers, and helicopters. Transport forces carry personnel and materiel from the United States overseas and from overseas supply depots to more remote distribution points. These aircraft consist primarily of tanker and transport craft. Exercises are conducted routinely to provide experience with various combat and readiness scenarios.

Rest and flight duty limitations for all personnel who operate Air Force aircraft are delineated in several Air Force regulations (29-31,33). These regulations specify:

- maximum allowable flight duty periods for basic and augmented crews,
- maximum monthly and quarterly flying hours for aircrews,
- minimum crew rest periods, and
- conditions necessary to waive the requirements.

The maximum allowable flight duty period is the maximum number of hours crew can fly in a certain type of aircraft in a 24-hour period (table 9-2). Total flying time for tactical forces is limited to 75 hours per 30 consecutive days and 200 hours per 90 consecutive days (31). A minimum rest period of 12 hours is mandated between flights and must include 8 hours of uninterrupted, continuous rest. If a crew

Table 9-2—Maximum Flight Duty Periods, U.S. Air Force

Aircraft	Basic aircrew	Augmented aircrew
Fighter, attack or reconnaissance		
Single control	12	
Dual control	12	16
Bomber or reconnaissance		
Single control	12	
Dual control	24	30
Transport	16	
Sleeping provisions	16	24
Tanker	20	
Sleeping provisions	20	30
Trainer	12	16
Rotary wing (no automatic flight control system)	12	14
Rotary wing (automatic flight control system)	14	18
Utility	12	18

SOURCE: U.S. Department of the Air Force Regulation AFR 60-1, *Flight Management.*

member is interrupted and cannot get 8 hours of rest, he or she must be afforded 8 more hours of uninterrupted rest plus reasonable time for other activities (e.g., dressing, eating, traveling) (31). These regulations also specify that the relationship between crew rest and limitations on flight duty hours be considered when planning and scheduling missions. For transport crews, total flying time is limited to 125 hours per **30** consecutive days and 330 hours per 90 days (33). Based on the timetable established for a deployment operation, a unit's commander and flight surgeon may develop a schedule prior to departure that will adjust crew members' body clocks (6). Finally, the regulations authorize commanders to waive maximum flight duty periods for high-priority missions and during impending or actual hostilities.

Nonflight Air Force support units (airfield operations, communications facilities, logistic support, aircraft repair) are generally operated on a continuous basis. The factors affecting their operating tempo and conditions are similar to Army combat support activities.

Maximum limits on duty hours for all Air Force personnel (i.e., flight and nonflight) in a wartime setting have been set at 247 hours per month (10 hours per day, 6 days a week) during continuous operations and ***309*** hours per month (12 hours per day, 6 days a week) for a maximum of 30 days during sustained operations (6).

Strategic Forces

Strategic forces are the nuclear deterrent intercontinental bomber and missile forces. These forces operate on a routine carefully designed and controlled to sustain operations without decrements in performance. The primary concern is to ensure that personnel with access to nuclear weapons are reliable and can carry out their duties without impairments to their judgment or performance.[1]

Flight operations are guided by the general Air Force flight regulations previously described and others specific to strategic forces operations (30). These regulations include the requirement that, when possible, missions with late-night departures (which cause the crew to fly through normal sleeping hours and to rest during normal working hours) be scheduled for less than maximum duty periods. Also, the regulations stipulate that crew members who cross more than three time zones on route to a permanent location should normally not be required to perform any additional flight duty for the first 48 hours after arrival at their destination (30).

The crews manning intercontinental ballistic missile silos are on alert duty for 24-hour periods. Regulations stipulate that the minimum rest-sleep period for each crew member is 6 hours (34). In general, these crews are on duty every third day. When relieved of duty, a crew member will have a minimum rest period of 12 hours.

Navy Operations

Nonshipboard operations are similar to Army or Air Force nonflight operations as far as scheduling is concerned. Ships in port maintain duty-rest schedules very much like those of activities ashore, nominally modeled on a 40-hour workweek, with limited personnel standing watch around the clock (see later discussion). When deployed, there is a transition to the at-sea routine, which typically consists of a 70- to 80-hour workweek (38).

[1]Each service has a tightly controlled Personnel Reliability Program which covers all persons who have duties involving access to nuclear weapons (from the technicians who put them together and do maintenance on them, to the crews who prepare them tfire or be dropped, to the crews who fire or drop them). The program involves background checks, regular reviews by medical officers and comma riders, and annual certification of behavioral reliability for each person in the program.

Shipboard operations require that some tasks be performed on a continuous basis. Unlike land-based facilities, where there may be local resources to draw on, each ship must be entirely self-sufficient. The crew must not only carry out the mission of the ship but also perform all housekeeping and maintenance tasks associated with it. Thus, normal operations on a ship have the character of continuous operations. Typically, jobs on board ship are divided into two types. Work that is general in nature, such as maintenance and repair tasks, is routinely carried out on board ships at sea using a 12-hour shift schedule (12 hours on, 12 hours off') (38,39). Tasks that require an individual to operate a specific piece of equipment or be at a specific station (sonar, radar, communication operators, engine room personnel) are manned using a watch schedule. A person who is on watch is at his or her station for a certain period of time and is then relieved by the next person standing watch. The specific watch schedules for submarines and surface ships are described later; however, they often result in personnel constantly changing the hours they are active and the hours that they are sleeping. Thus, these schedules cause substantial circadian disruption. A study that examined the effects of watch schedules on merchant ships has shown that these schedules are associated with sleep disturbances, decreased alertness, and decreases in measures of performance (4,25).

Several conditions of readiness modulate a ship's work schedule. Condition I Battle Readiness is the equivalent of sustained operations; all systems are manned and operating, and no maintenance is conducted except maintenance associated with keeping watch and urgent repairs. The crew does not have any rest period and is expected to be able to endure Condition I for 24 continuous hours. Condition II Battle Readiness means that required operational systems are continuously reamed and operating, but the crew does have 4 to 6 hours of rest per person per day. Urgent preventive maintenance and support functions are carried out. Other conditions are Wartime Cruising Readiness, Peacetime Cruising Readiness, and Inport Readiness, as well as readiness for specific types of ships (e.g., mine countermeasures, amphibious operations, supply ships) (21).

Submarines

The essence of submarine operations is to remain undetected, and that, in turn, depends on maintaining a very high state of vigilance. Undersea is a significantly more hostile environment than the surface, with much less time available to respond to mechanical problems that arise, so propulsion and control (and related systems) vigilance must be high and sustained as well. There are two types of submarines, ballistic missile and attack submarines. Ballistic missile submarines carry nuclear missiles and operate in a mode that is essentially a combination of independent operations and Air Force strategic forces operations. Their task is to remain in their assigned area, undetected, and be ready to launch their missiles if so ordered. Attack submarines have more varied tasks, including defense of a group of surface ships, information gathering, and attacks on enemy shipping. Both ballistic and attack submarine operations at sea use 18-hour watch schedules, consisting of three sections of personnel rotating 6 hours on, 12 hours off. Generally, the 6-hour on period is the time an individual is engaged in his or her specific job (e.g., sonar operator, radio operator). The 12-hour off period is used for sleep and rest as well as other activities, including meals, maintenance, training, and administration. Typically, a crew member averages 4 hours of sleep during an 18-hour cycle, depending on the tempo of the operations, training, and maintenance, with each sleep period occurring 6 hours earlier than the previous one (37). Analogous to a rotating shift schedule, watch scheduling results in individuals who will always be active and sleeping at different times of the day and whose sleep periods will generally be shorter than normal.

Surface Ships

Naval surface ships include combat vessels and supply ships. During routine operations at sea, the watch schedules depend on the size of the crew, which will determine how many sections of personnel are used. Usually, schedules are based on duty cycles of 12 hours (two sections with 6 hours on watch, 6 hours off; three sections with 4 hours on watch, 8 hours off), 16 hours (four sections with 4 hours on watch, 12 hours off), or 18 hours (three sections with 6 hours on watch, 12 hours off). The on period is the time when the crew member is engaged in a specific job, while off time is divided among other tasks, eating, and sleeping. Crew members on

surface ships average 6 hours of sleep per 24 hours (37), and their watch schedules require them to constantly change their hours of activity and rest.

Supply ships replenish combat ships with fuel, foodstuffs, parts, and munitions. Replenishing supplies while at sea can upset the duty-rest routine of a large portion of the crew on the ship being supplied because of the extra tasks required (e.g., tending lines, standing extra lookout watches, stowing supplies). The frequency of underway replenishment depends on the activity of the ship, but replenishment every 3 or 4 days is not uncommon, principally because combat ships are maintained as nearly full of fuel and other supplies as possible all of the time.

Under combat conditions, when the crew of a ship is at general quarters for extended periods, acute fatigue can become a problem. In combat there is a constant threat of attack from the air, submarines, and other ships. The entire crew is on duty without relief in order to carry out all of the defensive and other operations required. Activity under these conditions is fast-paced and continuous; sleep and rest are often sporadic and irregular.

Aircraft carrier operations involve the same tasks as other combat surface vessels but include tasks involved in flight operations. These tasks include moving aircraft around, preparing them for flight, operating catapults and arresting gear, air traffic control, and all other operations that support air combat mission preparation and control. Generally, aircraft carriers carry enough personnel to make up one complete shift to operate the equipment and do the tasks required to conduct flight operations. During continuous flight operations, this shift is split; thus, flight operations do not involve the kind of rotating work-sleep schedules so common on other ships. Crews ordinarily work about 14 to 16 hours each day; during periods of sustained activity, they may work nearly continuously (20 hours or so each day) for several days. Operating for extended periods at general quarters is even more disruptive aboard an aircraft carrier than other surface combat ships because of the far greater amount of movement of men and materiel from one part of the ship to another in conducting flight operations. Crew members are effectively in a sustained operations mode (none returns to sleeping quarters).

Table 9-3--Maximum Accumulated Individual Flight Times, U.S. Navy

Aircraft	Maximum hours		
	30 days	90 days	365 days
Single-piloted	65	165	595
Multipiloted (pressurized, ejection seat)	80	200	720
Multipiloted (nonpressurized)	100	265	960
Multipiloted (pressurized)	120	320	1,120

SOURCE: U.S. Department of the Navy, "Military Planning and the Impact of Circadian Rhythms on Military Operations," briefing materials provided to D. Liskowsky, Office of Technology Assessment, Washington, DC, 1989.

Flight Operations

The Navy's flight crew regulations are similar to the Air Force's in that they may not constrain operations in wartime (40). These regulations specify maximum hours of flight time: 6.5 hours per day for single-seat aircraft and 12 hours for other aircraft. They also specify that flight personnel should not be assigned to flight duty on more than 6 consecutive days. The regulations indicate that 8 hours of sleep time should be made available every 24-hour period and that flight personnel should not be scheduled for continuous alert or flight duty (which requires the person to be continuously awake) for more than 18 hours. If the 18-hour rule is exceeded, 15 hours of continuous off-duty time must be provided to the individual. The maximum number of accumulated hours of flight time for various aircraft is also specified (table 9-3). Finally, the regulations state that if the tempo of operations requires an individual's flight time to exceed any of the guidelines, that person should be closely monitored and specially cleared for flight by the commanding officer, with the advice of the flight surgeon. In situations where jet lag might occur (changing local sleep-awake periods, transmeridian flights), flight crews are not grounded, but the guidelines suggest that closer observation of the individuals by the flight surgeon may be warranted (37,40).

Marine Corps Operations

Amphibious Assault

The opposed landing (coming ashore against armed opposition) is the essence of Marine Corps operations. It is a very intense period of sustained operations that changes to continuous operations in a day or two. Although seas and tides are important factors in the timing of amphibious assaults, most

operations are planned to begin before dawn, when the enemy is expected to be least vigilant and effective. As with Army combat operations, there are no specific guidelines regarding duty hours for Marine combat units. The planning of operations and the monitoring of the condition of troops are left to the discretion of commanding officers. The Marine air forces, which provide air support for amphibious assaults and other Marine ground operations, are governed by the same flight crew duty-rest cycle regulations as Navy flight crews (40). Under actual combat conditions, the limitations on flight hours imposed by these regulations may be exceeded. For example, in the case of amphibious assaults, which tend to be fairly short in duration, these limits may be exceeded for the first 36 to 48 hours of the operation.

SUMMARY AND CONCLUSIONS

The nature of many military operations requires that personnel be engaged in activity at all hours and often for extended periods of time. Within the context of these operations, personnel are required to carry out a variety of tasks, the performance of which can be degraded as a result of disruptions in biological rhythms, sleep loss, fatigue, and other factors. Decisions concerning the schedules used and the duration of duty are generally left to commanding officers, who base their judgments on their knowledge of the limitations of their personnel under various conditions. There are few specific regulations or guidelines in the military related to hours of service and scheduling. An exception is the regulations that direct flight operations in all services. These regulations specify maximum allowable hours of flight duty and may include stipulations regarding transmeridian flight, minimum necessary rest periods, and the scheduling of flight operations. In the Navy there are specific guidelines, which have a long-standing tradition, for the scheduling of watches on board ships. They require that personnel standing watch constantly vary their hours of activity and sleep, which results in a constant state of circadian desynchronization.

Finally, the overriding priority in all military operations is the successful completion of the mission. As a result, regulations regarding duty hours are generally waived in wartime operations. There may be battle circumstances in which all available forces are needed, even if they will not be functioning at optimal levels and even if their effectiveness in the near future will be even more degraded. Decisions concerning the disposition and activities of personnel are guided by the demands of a given situation, and the effects of performance decrements due to biological rhythm upset, fatigue, and other factors may be accepted rather than mediated in some wartime circumstances. A better understanding of those decrements and their effects will ultimately aid military commanders in balancing the various factors that go into making such decisions.

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