NRT

Volume I

Guidance for Managing Worker Fatigue During Disaster Operations

Technical Assistance Document

April 30, 2009

THE NATIONAL RESPONSE TEAM

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Acknowledgements

The National Response Team (NRT) acknowledges the NRT member agencies, and state and Federal agencies participating on the Regional Response Teams (RRTs), for their contributions in preparing this document. We invite comments or concerns on the usefulness of this document in all-hazard planning for responses. Please send comments to:

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Executive Summary

This Technical Assistance Document (TAD) the first of two documents created by the National Response Team (NRT) to address worker fatigue during large-scale disaster operations, such as those following the Oklahoma City bombing, the 9-11 attacks, anthrax contamination, the Columbia Space Shuttle Recovery, and Hurricanes Katrina, Rita, and Wilma. This document is intended to serve as a hands-on manual to assist organizations with the development of programs and plans to address fatigue issues among disaster workers. The second document, "Volume II: Guidance for Managing Worker Fatigue During Disaster Operations: Background Document," summarizes the essential information compiled and reviewed by the NRT while developing its recommended approach.

After a large-scale disaster, workers often work longer shifts and more consecutive shifts than they would typically work during a traditional 40-hour work week. The fatigue and stress that may arise from strenuous work schedules can be compounded by the physical and environmental conditions in the affected area after a disaster: non-existent, damaged, or limited critical infrastructure (roads/traffic signals, utility lines, transportation/distribution of basic necessities, etc.); vegetative, construction, and hazardous debris; flooding; hazardous material releases; and displaced pets, indigenous wild animals, and snakes or other reptiles. The relationship between exposure to disaster conditions and strenuous work schedules has not been studied for disaster workers. Thus, there is limited data on the resulting effects on disaster workers' physiological capabilities and risks of injury. Available literature focusing on non-disaster workers, however, suggests that working longer hours increases the risk of occupational injuries and accidents and that this risk also may be affected by the nature of the work and the characteristics of the individual worker. Therefore, it is of critical importance for the NRT and other disaster organizations to take a proactive approach to addressing worker fatigue during disaster operations.

The NRT recognizes that disaster workers represent a unique population, and one on whom relatively little attention has been focused. Because of the broad variety of activities in which disaster workers may be engaged, as well as the widely varying circumstances in which they may be working, the NRT recognizes that there is no simple solution or one-size fits all approach to dealing with disaster worker fatigue issues. Instead, the NRT is recommending an approach that will assist organizations with the development of their own fatigue management efforts specifically targeted at the nature of their activities and the needs of their workers. This recommendation calls for a comprehensive, two-pronged approach that will result in the development of an organization-wide fatigue management program, which the organization will then use to construct incident-specific fatigue management plans to meet the circumstances and needs of individual incidents.

The TAD identifies four essential components for the development of fatigue management programs and plans – assessment, risk factors, controls, and evaluation – and discusses the kinds of information needed for each component. Dealing with these four components will require that organizations assess the types of activities they can expect to conduct during a disaster operation, estimate the conditions under which these activities may be performed, identify the factors

typically present at a disaster site that can result in fatigue (i.e., fatigue risk factors), define controls that target these risk factors, and establish evaluation schedules to assess the effectiveness of the controls. In addition, the TAD provides an example of an incident-specific fatigue management plan. The document also provides users with a fatigue management risk assessment tool (see Appendix A), which has been developed to assist with the formulation of fatigue management plans and the identification of resources that each organization should have in place in preparation for responding to major emergencies.

The recommendations in this document can be applied throughout a disaster. But, they are targeted primarily at the operations occurring once rescue efforts have been concluded. The Incident Commander (IC)/Unified Command (UC) will make the decision to transition to the next phase of operation. Once the transition occurs, risk-benefit decision making must be re-evaluated to reduce the level of risk to workers. It is important to recognize that during a large-scale disaster this transition may not occur in all areas affected by the incident at the same time; rescue operations may be continuing in one area while life-sustaining activities may have begun in another.

1.0 Introduction

Concerns about disaster worker fatigue issues have been growing over the past several years, but really became a focus of NRT attention after the massive devastation of the 2005 hurricane season. The NRT found that available literature does not address the question of how strenuous work schedules combine with the unique hazards and exposures associated with disaster operations to impact worker fatigue. Rather, existing literature and work practices generally focus on the effects of shift work and/or extended work hours on employees working normal, non-disaster-related employment and focus on reducing or limiting work hours. While this approach may be appropriate for employees who are performing routine tasks/operations in a controlled environment, it does not address the full range of factors that are likely to be associated with disaster operations and that may present fatigue risks for disaster workers.

The purpose of this TAD is to fill this gap and provide an approach for dealing with the unique needs of disaster workers. This TAD guides organizations step by step through the process of developing their own individual fatigue management programs from which they can then develop incident-specific fatigue management plans. To do this, organizations need to assess the types of activities they expect to conduct during a disaster, estimate the conditions under which these activities may be performed, identify the factors typically present at a disaster site that can result in fatigue (i.e., fatigue risk factors), define controls that target these risk factors, and establish evaluation schedules to assess the effectiveness of these controls. While the recommendations in this document can be applied throughout a disaster operation, they are primarily targeted at the operations occurring once rescue efforts have been concluded.

1.1 Phases of Disaster Operations

When a disaster occurs, the initial focus is responding to the event – rescuing people, saving lives, ensuring that the injured receive treatment, and providing shelter and food for the victims. During initial response operations, decisions and actions are time sensitive because site conditions often are uncontrolled and can change rapidly, as in the cases of fires, explosions, or hazardous substance releases. The availability of responders and response equipment may be limited, and options for controlling emergency responder exposures may be restricted. During this phase of an operation, the risks to emergency responders from higher and more hazardous exposure levels and longer work shifts must be balanced against the very real need to save lives, protect the public, and control the emergency. Risk management principles must be integrated into the IC/UC decision-making process to ensure that emergency responders are adequately protected and able to perform their operations safely.

Once the initial rescue activities have been accomplished, however, the pace of operations and operational objectives stabilize, and decisions about acceptable risks, exposure controls, and work shifts should be re-evaluated and revised. Site conditions are better characterized and controlled, and additional resources may begin to arrive on site. At this time, the focus has shifted to life-sustaining operations, such as providing temporary housing, restoring utilities (electrical, gas, water, sewer, and communications), tarping roofs, and removing debris. Although the hazards associated with extended work shifts, work weeks, and work rotations should be evaluated and addressed during all phases of an incident, it is even more important to focus on them once the rescue phase has concluded and workers may already be experiencing fatigue from their rescue efforts.

The IC/UC makes the decision to transition from the rescue phase to the next disaster operations phase based on incident-specific circumstances. This transition decision impacts how operations are prioritized and conducted, and where resources will be used. Once the transition occurs, risk-benefit decision making must similarly shift to reduce the level of risk to workers. During this phase, the IC/UC should re-evaluate reliance on extended work shifts, work weeks, and work rotations; assess fatigue risk factors; and implement appropriate fatigue management recommendations. It also is important to recognize that this transition may not occur in all areas affected by the incident at the same time, because there are likely to be variations in the extent of the damage, thus rescue operations may be continuing in one area while life-sustaining activities may have begun in another.

1.2 Fatigue Risk Factors

For the disaster worker population, there are many factors that can lead to increased risk of fatigue, reduced alertness and productivity, and increased risk of accidents and injuries in the workplace. Chief among these is the length of work shifts. Research indicates that as work shift length increases, the risk of accidents and injuries also increases (see “Volume II: Guidance for Managing Worker Fatigue During Disaster Operations: Background Document” at www.nrt.org). This risk further increases if the shifts are night shifts rather than day shifts and if the length of the work week also increases. Additional factors increasing the risk of fatigue include disrupted sleep patterns; exposure to environmental, physical, and/or chemical hazards; limited sanitation facilities; poor living conditions; and limited access to nutritious meals. These and numerous other factors can be present during most disaster operations in varying degrees. In addition, because site conditions, operations, and available resources will differ among disasters, the contribution of each of these risk factors to overall fatigue and fatigue-related accidents and injuries will vary, as will the appropriate controls for reducing responder risk.

This broad range of factors that can result in fatigue (i.e., fatigue risk factors) leads to the conclusion that the most effective way to reduce disaster worker fatigue is to adopt an approach that assesses and controls for each of these risk factors in proportion to the hazard it presents at a given disaster. The initial step in this approach is to identify and assess the fatigue risk factors associated with likely operations and incident conditions so that appropriate control measures—such as work scheduling, rest breaks, planning for temporary living conditions, access to recreational/exercise equipment, and reducing worker driving time—can be implemented efficiently and effectively for individual incidents. One tool for conducting this assessment is a Risk Factor Assessment Tool included in Appendix A.

The situations listed below can be additional “fatigue risk factors” that should be considered when developing policies and procedures to manage worker fatigue during disaster operations:

- Insufficient or fragmented sleep (less than 7-8 hours of uninterrupted sleep)

- Shift work/rotating shifts/night shift work
- Sleeping during the day
- Sleep debt with no possibility to make-up lost sleep
- Lack of/limited rest breaks
- Physically and mentally demanding work
- Exposure to temperature and other environmental extremes
- Exposure to chemical and physical hazards, particularly if these are in a mixture or are not well characterized
- Use of Personal Protective Equipment (PPE)
- Limited access to recreational/fitness equipment
- Exposure to psychological stressors (e.g., close contact with injured or dead victims)
- Unfamiliar work environment and/or work task/operations
- Temporary or communal living conditions (which may contribute to psychological stress and result in insufficient or fragmented sleep)
- Limited access to nutritious meals
- Travel time to work site

2.0 Recommendations

Because of the broad variety of activities in which disaster workers may be engaged, as well as the widely-varying circumstances in which they may be working, the NRT is recommending an approach that will assist organizations with the development of their own fatigue management efforts specifically targeted at the nature of each organization's activities and the needs of its workers. This recommendation calls for a comprehensive, two-pronged approach that will result in the development of an organization-wide fatigue management program, which each organization will then use to construct incident-specific fatigue management plans to meet the circumstances and needs of individual incidents.

The fatigue management program should reflect the experiences of the organization (i.e., nature of incidents with which the organization has previously been involved), the conditions to which workers previously have been exposed, and the efforts previously made to deal with the effects of these experiences. The program also should reflect the lessons the organization has learned from those experiences. It broadly describes the practices, procedures, and resources the organization has in place to assess and manage fatigue. The incident-specific fatigue management plan, which is tailored to meet the particular conditions of the incident, identifies the fatigue risk factors associated with the disaster operations being performed[1] and the controls that will be used throughout these operations to manage worker fatigue. In addition, both the program and the incident-specific plan should identify roles and responsibilities (i.e., who in the organization is going to do what) for the implementation of each section of the program's and plan's provisions. The organizational program and the incident-specific plan each should have the following four components, which also are summarized and compared in Table 1:

[1] **It should be noted that although this document focuses on fatigue management for post-rescue operations, organizations are urged to apply fatigue management techniques throughout all phases of an operation.**

- **Assessment** – This component describes the nature of incidents to which the organization responds and the types of work performed.

- **Identification of Risk Factors** – This component identifies and describes the range of risk factors to which the organization's workers can be exposed.

- **Controls –** This component describes the organization's policies, procedures, and work practices that are applied to mitigate the various risk factors identified in the previous component.

- **Evaluation –** This component identifies and describes the process that will be used to assess the effectiveness of the controls in mitigating worker fatigue.

Table 1 compares provisions of the organizational fatigue management program with those of the incident—specific fatigue management plan.

Table 1: Summary and Comparison of Fatigue Management Program and Plan Components

Component	**Organizational Fatigue Management Program**	**Incident-Specific Fatigue Management Plan**
Assessment	Describes the types of events to which the organization has responded in the past and anticipates responding to in the future, the types of work performed, conditions to which disaster workers were exposed; identifies individuals responsible for overseeing this component of the program.	Describes the event, the types of work to be performed, conditions under which workers will be operating, and identifies individuals responsible for conducting the initial assessment and providing updates; describes how initial information will be obtained and updated, depending on the level of infrastructure damage.
Risk Factors	Describes fatigue risk factors workers have experienced in the past and can anticipate experiencing in the future.	Identifies fatigue risk factors likely to be present at the current event and individuals responsible for providing initial and updated information.
Controls	Describes fatigue management controls the organization has used in the past and/or anticipates using in the future.	Identifies specific fatigue management controls to be implemented during this event and the individuals responsible for implementing

Component	Organizational Fatigue Management Program	Incident-Specific Fatigue Management Plan
		this section of the plan.
Evaluation	Describes evaluation methods used in the past and those currently available for use to assess the effectiveness of the organization's fatigue management efforts.	Describes the specific evaluation methods to be used at this event and the schedule for their application.

2.1 Organizational Fatigue Management Program: Step-by-Step Guide

This section outlines the steps to be taken in developing the components of an organizational fatigue management program.

Assessment

This component lays the foundation for the development of the organization's fatigue management program. Preparing for the future involves incorporating lessons learned from the past.

- Review the organization's history over a specific time frame (e.g., the last five years) to determine the nature of the incidents (e.g., floods, hurricanes, earthquakes, wildfires, and/or large-scale explosions) to which the organization has deployed personnel for disaster operations, the types of work performed, the physical conditions (e.g., levels of devastation and infrastructure damage, working and living conditions, and logistical challenges) to which workers were exposed, the duration of deployments, and the lengths of work shifts. This component also should include information on the types of conditions to which workers were exposed that may have contributed to emotional reactions or the development of any mental health-related issues (e.g., posttraumatic stress disorder).

- Review the response histories of similar organizations over a specific time frame and incorporate this information to augment the information obtained from the initial organizational review.

- Based on the historical review, and taking into consideration any recent organizational mission changes, estimate the nature of likely future disaster operations in which the organization may become involved.

- Identify potential mechanism(s) for obtaining information on site conditions, particularly when there may have been significant communications disruptions and infrastructure damage in the affected area (e.g., flyovers, alternative communications methods such as satellite phones, shortwave radios, and walkie-talkies).

Identification of Fatigue Risk Factors

Identifying potential risk factors to which the organization's workers may be exposed also will require a historical review of risk factors to which workers in this and similar organizations have been exposed. The historical review can be helpful in encouraging organizations to focus on lessons learned after previous disasters and modify their plans based on those lessons.

In general, risk factors can be assigned to six categories. For each of these categories, after describing previous experiences, also include modifications expected to be made for future operations based on any lessons learned from past disaster operations. The organization's process for assessing the significance of each risk factor and setting priorities for the use of resources and controls also should be included in this component. Appendix A provides a tool for conducting this assessment.

- **Work Hours and Rest Periods –** Describe the work hours, work rotations, and rest periods that are characteristic of types of operations the organization has conducted in the past and anticipates conducting as part of future disaster efforts. For example, a policy might state that workers have a minimum of 10 hours rest time in a 24-hour time period, with as much of that in consecutive hours as possible; and 48 hours time off after 14 consecutive days of work

- **Site Conditions –** Describe the range of conditions previously encountered by the organization's responders while performing disaster operations and that are likely to be encountered in the future (e.g., extent of devastation, including infrastructure damage, population displacement, and security of worksite).

- **Living Conditions** – Describe the nature of accommodations generally provided for the organization's workers during previous disaster operations (e.g., hotel/motel, trailers, tents; food service or MREs; sanitary facilities; and recreational opportunities).

- **Nature of Work** – Describe the various types of work (e.g., collection of orphaned containers, tarping roofs, collection of white goods, and oil spill cleanup) performed by the organization in previous disaster operations and, considering any mission changes, likely to be performed by the organization at future disaster operations.

- **Management and Administrative Support** – Describe the management and administrative support functions and services provided at previous disaster operations (e.g., contracting, financial services, and clerical support).

- **Emotional Stress –** Describe the types of stressful situations previously experienced by the organization's disaster workers and likely to be experienced at future events (e.g., exposure to bodies or seriously injured people, severe devastation, and/or homeless victims).

The contribution of each fatigue risk factor to the overall fatigue risk will vary among incidents and should be assessed when developing an incident-specific plan. The organization's process for assessing each fatigue risk factor should be described in this component of the operational program. The Risk Management Assessment Tool in Appendix A can be used to evaluate the potential contribution of each risk factor to the overall risk for workers. This also allows the organization to identify the work practices, policies, and resources it should have in place to address the most significant risk factors in anticipation of a major disaster and a likely deployment of disaster workers.

<u>Controls</u>

For each of the control categories listed below, review lessons learned from previous disaster operations to ensure that past omissions or deficiencies have been remedied. A fatigue management program should include information for the seven categories listed below. Examples of controls are provided in the discussion that follows; a more complete list of potential controls can be found in Appendix B.

- **Education –** Describe the education program that the organization has in place to ensure that disaster workers are prepared, as much as possible, for whatever they will face when on site and how to take care of themselves. Educational topics can include information on such issues as signs, symptoms, and health effects of fatigue, as well as disaster deployment preparedness training. The educational component of this section of the program should address the process used to educate/inform workers on how the organization deals with each of the topics that follow.

- **Advance Planning** – Describe organizational components already in place to ensure contingency planning for incident mobilization and identify who does what and when (e.g., roles of advance incident management teams). Many of the support services that are critical for managing fatigue require advanced planning. This section should describe the organization's policies regarding the assignment of personnel to positions for which they are specifically trained and medically cleared, the provision of PPE when needed, considerations for additional medical requirements (e.g., unique vaccinations), and the typical procedures in place for checking workers in and out so that workers' locations are tracked throughout the incident effort. This section should also address base camp/site security if these services will be used to control access to worksites or base camps. In addition, efforts should be made to ensure that the organization's disaster workers practice advance planning themselves (e.g., have "go kits" ready, have alternatives in place for child care, pet care, and bill paying).

- **Work Hours and Rest Periods** – Describe the organization's policies regarding duration of deployments, work hours, work shift rotation (if applicable), and rest breaks during the specific phases of a disaster operation, including time off after a pre-determined number of consecutive days of work (e.g., minimum of 10 hours rest time in a 24-hour time period, with as much of that in consecutive hours as possible; and 48 hours off after 14 consecutive days of work). Describe how this policy will be managed and enforced during disaster operations (e.g., provisions in place to ensure that sufficient personnel who are properly trained and medically qualified will be available for deployment).

- **Transportation –** Describe the range of transportation method(s) generally used by workers to reach IC/UC during disaster operations, as well as transportation modes potentially available for moving disaster workers from base camps to work areas. This section should include a variety of options to reflect the various situations the organization's workers will face and should recognize the potential for worker impairment and potential driver impairment from long work hours.

- **Living Conditions** – Describe the range of lodging options utilized by the organization in the past (e.g., commercial hotels/motels, trailers, tent cities), as well as the options for providing meals, privacy, quiet sleep areas, sanitation facilities, security, and laundry facilities. If new options will be considered, these also should be described.

- **Recuperation Provisions** – Describe organizational policies regarding provision of access to facilities and opportunities for exercise and recreation (e.g., local community college has made gym available), recognizing that recreational opportunities help to maintain worker functionality.

- **Health Care Services** – Describe the full range of medical, mental health, and stress management services that can be provided by the organization during disaster operations.

<u>Evaluation</u>

Evaluating the effectiveness of the organization's fatigue management efforts ensures the continued effectiveness of the organization's workforce over time.

- Describe the organization's policy for conducting evaluations during a disaster operation to enable quick course corrections, as needed. If the organization has not previously had such a policy in place, consider developing one. Examples may be available from other similar organizations.

- Describe the organization's policy for conducting evaluations at the end of a response for incorporation into a "lessons learned" report that will be used to make systemic program changes. Also describe policies and procedures in place for implementing lessons learned. If none exist, consider developing such policies and procedures.

2.2 Incident-Specific Fatigue Management Plan: Template

The incident-specific fatigue management plan includes the same components as the organizational program described in Section 2.1, but targets all of the information at the specific incident. The information in the organizational program provides a menu of options to be used in the development of the plan. The template below presents an optional format for an incident-specific fatigue management plan. A sample of a completed incident-specific fatigue management plan can be found in Appendix C.

Name of Incident **Location:** **IC/UC Personnel:** **Description of Event & Site Conditions:** **Fatigue Risk Factors Present:** • **Work Hours & Rest Periods –** • **Living Conditions –** • **Nature of Work –** • **Management & Administrative Support –** • **Emotional Stress –** **Controls to Be Implemented:** **Evaluation Schedule:**

3.0 Conclusion

Disaster workers represent a unique population, and one on whom relatively little attention has been focused. Because of the broad variety of activities in which workers may be engaged, as well as the widely varying circumstances in which they may be working, the NRT recognizes that there is no simple solution or one-size-fits-all approach to dealing with disaster worker fatigue issues. Instead, the NRT is recommending a comprehensive, two-pronged approach that will result in the development of an organization-wide fatigue management program, which the organization will then use to construct incident-specific fatigue management plans to meet the circumstances and needs of individual incidents.

The NRT recognizes the impossibility of preparing for every conceivable contingency in disaster operations. Given the current dearth of guidelines for protecting disaster workers, however, the recommendations presented in this TAD represent a constructive first step in raising awareness of the need to better ensure the health and well-being of these workers. The health effects, both physical and mental, of participating in operations following the 2001 terrorist attacks and the 2005 hurricanes are now recognized. It is the goal of the NRT to provide organizations that participate in disaster operations with a menu of options that can reduce the detrimental effects of this essential work on their workers and ensure the continued availability of workers to help this country meet the challenges of future disastrous events—whether natural or human-caused.

Appendix A: Fatigue Management Risk Assessment Tool

This tool for evaluating risk factors and quantifying risk can be used to assist in developing the plans and procedures and identifying the resources each organization should have in place in anticipation of a major emergency response. As noted previously, this document and tool are primarily for use during the post-rescue phase of a long-term emergency response operation.

The tool identifies "risk factors" and "stressors" within each "risk factor" using the concept of Operational Risk Management and aspects of risk assessment tools used by Department of Defense (DOD) agencies and the United States Coast Guard (USCG). The Fatigue Management Risk Assessment Tool is loosely based on the USCG Green-Amber-Red (GAR) Assessment Model. Instead of the standard elements of GAR, fatigue risk factors or stressors have been identified (Column 1). These five (5) major factors that contribute to or are affected by fatigue and their associated sub-factors, or "stressors" (Column 2), are identified in the research on fatigue and extended work hours.

The risk factor or stressors include:

- Major Factor A - Time – Sub-factors: long hours (more than 8 hours/day), extended hours per week (greater than 40 hours per week), and extended weeks (more than two weeks);
- Major Factor B - Living Conditions – Sub-factors: quarters, food, sanitation, and recreation/leisure opportunities;
- Major Factor C- Nature of Work – Sub-factors: phase (rescue, response, or demobilization), activity, level of PPE, shift work, security, familiarity with area, and familiarity with emergency and disaster work;
- Major Factor D - Site Conditions – Sub-factors: chemical hazards, multi-chemical hazards, ionizing radiation, and other WMD; and
- Major Factor E - Emotional Stress – Sub-factors: potential for encountering casualties (wounded or deceased) and people who have lost relatives, friends, property, pets, etc.

The tool lists suggested stressors for each risk factor listed above in Column 2. Each of the stressors has been assigned a **weight factor** (the relative value of these weight factors was determined based on experience of the authoring agencies of this document [Department of Defense, United States Army Cops of Engineers, Department of Labor, Environmental Protection Agency, National Institute for Occupational Safety and Health, AIHA/Engineering Industry-SIG and Center for Construction Research and Training]). The stressors identified and the weighting factors suggested are subjective in nature and are provided as a guideline only; they may be customized based on the experience of a specific organization.

Within the table, each stressor is aligned with several increasing exposure levels (found in Columns 4, 6, 8, and 10). Each exposure level is associated with an **exposure factor**. The relative weight of the exposure factors is based on the literature reviewed and the experience of the authors. They are subjective in nature and are provided as a guideline only; they may be scaled differently based on the experience of a specific organization. **By multiplying each weight factor by the appropriate exposure factor, a numerical value for risk can be developed**.

Appendix A: Fatigue Management Risk Assessment Tool

Columns 5, 7, 9, and 11 are scoring columns. Once a stress factor is identified, its weighted value in column 2 is multiplied times the exposure factor identified (in column 4, 6, 8, or 10) and the score is placed in columns 5, 7, 9, and 11. An example calculation is provided below:

Operations will extend three weeks after the rescue phase. Work will be accomplished in 10 hours per day; 40 – 50 hours per week, and will continue for three weeks. The weight factor associated with the stressor *Long Hours* (1) would be multiplied by the exposure factor associated with the exposure level of 10 hours per day (2, as identified in Column 6) resulting in a risk value of 2 (1 x 2 = 2). In the Extended Time/Week row the score in Column 7 would be (2 x 2=) 4 and the score in Column 6 would be (3 x 2 =) 6.   By adding these three scores, the total score for *Major Risk Factor A. Time* would be (2+4+6=) 12. This score would be placed in Column 12 in the *A. Totals* row.

This process is repeated until all applicable major stressor factors have been assessed.

Column 13 lists the risk value range for each major stressor factor. As the calculated risk number increases, so does the need for controls. These controls can be included in the incident-specific fatigue management plan. Column 14 lists suggested corrective actions for each risk factor in a major factor. Note each risk number and corrective action needs to be looked at as an individual factor and should be addressed in the incident specific plan along with the other major contributing factors identified in the assessment.

Like the GAR Assessment Model, as the total scores within major factors and as a whole increase, decisions and responsibilities pertaining to risk management strategies fall on higher levels of management. In the Corrective Action column there are four levels of risk for each Major Factor. No action and increasing awareness action decisions can be made at the field level. As scores increase, the decision to develop Site-Specific Fatigue Management Plans, Level 3, or to implement all or portions of the Agency fatigue management program, Level 4, will lie with senior Response Management and Agency Senior Management, respectively. If corrective actions are implemented effectively, the risk numbers would be adjusted and there would be no “unacceptable” score. With respect to individual factors, agencies may set risk numbers that, when reached, are considered “unacceptable,” e.g., allowing worker to work for more than 72 hours per week for more than 4 weeks or allowing workers to be exposed to radiation at levels > 5 rem /year.

Acronyms:

- WMD - Weapons of Mass Destruction
- HASP - Health and Safety Plan
- AHA - Activity Hazard Analysis
- APP - Accident Prevention Plan
- HAZWOPER - Hazardous Waste Operations and Emergency Response
- SSHP - Site Safety and Health Plan
- CIH - Certified Industrial Hygienist
- CSP - Certified Safety Professional
- CHP - Certified Health Physicist

- CISM – Critical Incident Stress Management
- mrem - milliroentgen equivalent man
- rem - roentgen equivalent man

Appendix A: Fatigue Management Risk Assessment Tool

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Risk Factor	Stressor	Weight Factor ↓	Exposure Factor 1		Exposure Factor 2		Exposure Factor 3		Exposure Factor 4		Total	Risk #	Corrective Action Plan
A. Time	**Long Hours**	1	**≤ 8 hrs/day**		**> 8 < 10 hrs /day**		**> 10 <12 hrs/day**		**12 hrs/day**			**0 - 6**	**No action (unless required by assessment of Stressors B-E)**
	Extended Time/Week	2	**≤ 40 hrs/wk**		**> 40 < 50 hrs/wk**		**> 50 < 72 hrs/wk**		**> 72 hrs/wk**			**7 - 12**	**Increase awareness + actions based on assessment of Stressors B-E**
	Extended Weeks Without A Full Day Off	3	**2 weeks**		**3 weeks**		**4 weeks**		**> 4 weeks**			**13 - 18**	**Develop fatigue management plan as part of HASP (AHA) + actions based on assessment of Stressors B-E**
												19 - 24	**Implement pre-approved fatigue management plan + actions based on assessment of Stressors B-E**
	A. Totals												
B. Living Conditions	**Quarters**	1	**Home**		**Typical Business Travel**		**Recreational Vehicles (RVs)**		**Makeshift Shelter**			**0 - 8**	**No action unless assessment of Stressors A, C, D, or E indicates need**
	Food	1	**Home**		**Typical Business Travel**		**Mass Dining Facilities**		**Improvised**			**8 -12**	**Increase awareness and monitoring by managers; address in separate AHA or actions based on assessment of Stressors A, C, D, or E**
	Sanitation	1	**Home**		**Typical Business Travel**		**Mass Washing Facilities**		**Improvised**			**12 - 16**	**Address in Pre-approved Living Condition Management Plan or actions based on assessment of Stressors A, C, D, or E**
	Recreation/ Leisure Opportunities	1	**Home**		**Typical Business Travel**		**Limited**		**None**				
	B. Totals												
C. Nature of Work	**Phase**	2	**Demobilization/ Report Writing**		**Recovery**		**Response**		**Rescue**			**0 - 16**	**No Action unless assessment of Stressors A, B, D, or E indicates need**
	Activity	1	**Office Admin**		**Front Line Admin (MASH)**		**Field Oversight**		**Field Worker**			**17 - 32**	**Increase awareness, address in separate AHA or actions based on assessment of Stressors A, B, D, or E**
	Level of Protection	3	**Level D**		**Modified Level D/C**		**Level B**		**Level A**				
	Shift Work	4	**Normal Day**		**Normal night**		**Swing**		**12am:12pm; 12pm;12am**			**33 - 48**	**Site-Specific Management Plan for nature of work to include a security plan + plans based on assessment of Stressors A, B, D, or E**
	Security	4	**Normal Day**		**Normal Night**		**Limited**		**Sporadic**			**49 +**	**Address in Pre-approved Management Plan for nature of work + plan based on assessment of Stressors A, B, D, or E**
	Familiarity with Area	2	**High**		**Moderate**		**Slight**		**None**				
	Familiarity with Emergency Response (ER) Work	4	**High**		**Moderate**		**Little**		**Training Only**				
	C. Totals												
D. Site Conditions	**Chemical**	1	**Controlled**		**Controlled and Predictable**		**Controlled but Unpredictable**		**Uncontrolled**			**0 - 11**	**(APP) + actions based on assessment of Stressors A, B, C, and E**
	Multi-chemical	2	**Controlled**		**Controlled and Predictable**		**Controlled but Unpredictable**		**Uncontrolled**			**12 - 22**	**APP + HAZWOPER SSHP + actions based on assessment of Stressor A, B, C, and E**
	Ionizing Radiation	4	**Background (BKG)**		**> BKG < 100 mrem/hr**		**> 100 mrem/hr < 5 rem/yr**		**> 5 rem/yr**			**23 - 33**	**APP + HAZWOPER SSHP CIH, CSP or CHP Program Manager + actions based on assessment of Stressors A, B, C, and E**
	Other WMD	4	**None**		**Potential**		**Known Levels**		**Unknown Levels**			**34 +**	**APP + HAZWOPER SSHP CIH, CSP or CHP Site Safety Officer + actions based on assessment of Stressors A, B, C, and E**
	D. Totals												
E. Emotional Stress	**Potential for Encountering Casualties (wounded or deceased)**	4	**Unlikely**		**Some potential but unusual**		**Very Likely**		**Probably will encounter**			**0 - 6**	**No Action**
												7 -12	**Employee Assistance Program (EAP) Counseling Available + actions based on assessment of Stressors A, B, C, and D**
	Potential for Encountering Casualties (those who have lost relatives, friends, property, pets, etc.)	2	**Unlikely**		**Some potential but unusual**		**Very Likely**		**Probably will encounter**			**13 - 18**	**CISM or Resilience Counselors visit frequently + actions based on assessment of A, B, C, and D**
												19 +	**CISM or Resilience Counselors on-site + actions based on assessment of Stressors A, B, C, and D**
	E. Totals												

Appendix B: Potential Controls for Mitigating Fatigue Risk Factors

The following lists identifies suggested controls that may be used to reduce fatigue risk factors, including: educating disaster workers to recognize the signs and symptoms of fatigue, limiting work shift durations, including rest breaks, increasing recovery time, reducing drive time to/from site, providing recreational resources, and conveniently locating and designing base camps for optimal recovery. These methods should be used in combination to modify work schedules and improve off-hour living conditions.

As discussed, site conditions and operations will vary among incidents, as will the resulting fatigue risk factors and the contribution of each factor to the overall fatigue risk. Once an organization has evaluated the risk factors using a tool such as the Risk Management Assessment Tool, it is in a better position to select the work practices, policies, and resources needed to address the most significant risk factors. Different patterns of work and variations in workload will impact cumulative fatigue over a single shift and throughout a work rotation. In some cases, a single control, such as limiting work shifts to 10 hours, will be feasible. In other cases a combination of controls, such as monitoring for fatigue signs and symptoms, providing transportation services, including rest breaks, and rotating workers through jobs during a work shift, may be used to offset the physical demands of the task and an operational need to operate using 12-hour shifts.

Educational Topics

- Health Impacts, Signs, and Symptoms of Fatigue
- Strategies for Preventing Fatigue during Disaster Operations
- Recognizing Operational Fatigue and Stress in Employee (training for supervisors)
- Common Fatigue Risk Factors during Disaster Operations
- Information on Organization's Employee Assistance Program
- Tips/Checklist on Preparing for Deployment to a Disaster Site – Personnel and Supervisors
- Information for Disaster Workers and their Families on what to expect during deployments (http://www.osha.gov/SLTC/emergencypreparedness/resilience_resources/predeployment.html)
- Work Zone Safety and Defensive Driving Techniques
- Sleeping Strategies for Night-shift Workers
- Critical Incident Stress Management Team and Employee Assistance Program services availability
- Information on organizations' policies and procedures related to work hours and rest periods
- Job Aid providing clearly defined job tasks and duties
- Pre-deployment training, resources, and other tools covering listed topics for employees and for supervisors
- Site orientations, daily briefings, and safety meeting(s) that review fatigue related information (signs, symptoms, prevention) and reinforce reporting of signs/symptoms to supervision or health care providers

Advance Planning

- Approved list of hotels that have fitness facilities, continental breakfast, and dining facilities;
- Contracts with transportation services for shuttling employees to/from job sites
- Helpful checklists of personal preparedness tasks for personnel likely to deploy
- Preassembled "go-kits" with PPE and other equipment for shipment when deployed
- Mobile trailer outfitted as office space for deployment with personnel
- Reasonable estimate of resource needs (equipment and personnel) to support disaster deployment for duration and breadth anticipated
- Information for responders and their families on what to expect during deployments: (http://www.osha.gov/SLTC/emergencypreparedness/resilience_resources/predeployment.html)

- Mechanism for reporting fatigue (self, co-worker)
- Existing employment/medical screening programs include evaluation for likely disaster conditions/operations

Work Hours and Rest Periods
- Criteria for setting a maximum work shift duration or minimum amount of time off during a 24-hour period (e.g., 10 hours rest time in a 24-hour time period, with as much of that in consecutive hours as possible)
- Consideration for how work shift duration may change based on the use of controls to mitigate fatigue (e.g., use of transportation)
- Time off between work rotations (e.g., 48 hours off after 14 consecutive days of work.)
- Rest breaks throughout a work shift to address fatigue, PPE limitations, and/or temperature extremes (heat and cold-related illnesses)
- Rotation of personnel during longer shifts requiring strenuous and/or detailed tasks
- Scheduling day/night shift rotations to reduce fatigue (e.g., clockwise rotation with several days off before new shift assigned)
- Limiting early morning shift start times (e.g., before 6:00 am)
- Procedures for monitoring personnel for fatigue signs/symptoms
- Procedures for enforcing work/rest and rotation schedules for employees and supervisors
- Provisions (e.g., job rotation, extended lunch/breaks, additional time off) for personnel and crews exhibiting signs/symptoms of fatigue
- Mechanism for employees to request additional time off and encouragement to do so when experiencing signs/symptoms of fatigue

Transportation and Living Conditions
- Transportation service or an assigned staff member as the “designated driver” to shuttle personnel to/from the site
- Food service at staging areas and base camps; storage/cooking utilities for personnel with special diets
- Use of hotels/motels with access to recreational facilities and dining facilities
- Separation of day and night shift sleeping areas and provision of areas for socializing in base camps
- Reimbursement for personal calls to home during deployment
- Scheduling complex/hazardous tasks for periods of higher alertness
- Lighting for night-shift operations
- Provision of security for base camp and night-time operations
- Encouraging family visits during rest periods/off-hours once the affected area is stabilized

Recuperation Provisions and Health Care Services
- Subsidized health club memberships at local facilities
- Encouraging visits by family members during off-duty hours and time-off.
- Basic recreational equipment included in supplies deployed with personnel
- Incentive programs and other forms of positive reinforcement
- Employee Assistance Program (EAP) and other health services at base camps and staging areas; access to these services during off-hours (in-person or via telephone)

Appendix C: Sample Incident-Specific Fatigue Management Plan

Incident Name: New Madrid Earthquake

Location: New Madrid, MO

IC/UC Personnel:

- **Incident Commander – Mary Jones**
- **Deputy Incident Commander – Bob Smith**
- **Safety Officer – Joe Johnson**
- **Public Information Officer – Peggy Greene**
- **Liaison Officer – Larry Brown**
- **Operations – Ken Jackson**
- **Planning – Betty Baxter**
- **Logistics – Joan Black**
- **Finance – Brian Clark**

Description of Event & Site Conditions:

- The incident is a massive earthquake that occurred two weeks ago and affected a 3,000 square-mile area in three states, resulting in major destruction to the infrastructure.
- Lifesaving operations have ended, and there is an urgent need to begin rebuilding the destroyed infrastructure.
- Airports and railroad facilities are still inoperable and major highways as well as many smaller roads are still impassible. Work groups will be transported via helicopter wherever roads are inadequate.
- There is major structural damage of buildings, and those that are habitable are being used to care for the injured and homeless. Workers will have to carry in their own shelters.
- There is no potable drinking water, and public waste disposal systems are still inoperable. Drinking water supplies will be carried in, and sanitation needs will likely initially be port-a-jons.
- Communications in the area all have been disrupted.
- Work groups will deploy for 3-week periods.
- Although the response has moved to the post-rescue phase, workers can expect to see scenes of extreme destruction that may be emotionally disturbing to many.

Fatigue Risk Factors Present:

- **Work Hours & Rest Periods –**
  - Long work hours – possibility of 12+ hour days initially.
  - 3-week deployment, with no time off.
- **Living Conditions –**
  - No housing available – responders will be sleeping in tents; limited sanitation facilities available initially.
  - Food initially will likely be military style "meals ready to eat."
  - Communications will be difficult; power lines and cell phone towers are still down; responders will be out of touch with families initially.
  - Community has been totally devastated; few buildings left standing.
- **Nature of Work –**
  - Begin assessing hazardous materials situation. Specific assignments will be made on site

- **Management & Administrative Support –**
  - Administrative support will be lacking initially.
- **Emotional Stress –**
  - Personnel may be exposed to scenes of major and widespread destruction and a severely affected population, which may have emotional or psychological consequences.
  - Because of the lack of communication infrastructure, workers will not be able to contact family/friends, so normal systems will not be available.

Controls to Be Implemented:

- **Education –** Fact Sheets on preparing for this deployment and what workers should bring with them.
- **Advance Planning –** The advance Incident Management Team (IMT) has already deployed and is initiating readiness for incoming responders. Sleeping and mess tents and latrine facilities are being set up.
- **Work Hours and Rest Periods –** During this phase of the incident, workers will be working 12+ hours/day (which may not include commuting time, depending on the location). Efforts will be made to provide a minimum of eight consecutive hours off for rest. Work hours will be tracked daily and the Safety Officer will coordinate with the Logistics Section to ensure that personnel are provided 48 hours off after each 21-day work rotation.
- **Transportation –** Because of the damage to road and highway systems and shortage of gasoline in the affected area, efforts are being made to reduce the number of vehicles needing gasoline. When practical, vans will be used to transport work teams, which also will help to reduce potential driver fatigue. This may also reduce the likelihood of accidents due to fatigued drivers. Where roads are inadequate, helicopters will transport disaster work groups with their equipment to their work areas.
- **Living Conditions** – Be prepared for considerably less privacy than one normally has. Initially, disaster workers will be living in a tent city, which means that there will be a minimum of privacy.
  - Meals will be served in a food area.
  - As soon as water is available, shower tents and laundry tents will be set up.
- **Recuperation Provisions –** Initially, because of the devastation, no formal recreation facilities will be available. Workers should bring easy-to-carry recreational materials with them (e.g., playing cards, balls, and/or strength bands).
- **Health Care Services –** The advance IMT has set up a medical tent staffed by Public Health Service personnel.
  - Representatives of the organization's Critical Incident Stress Management Team also are on site to assist with stress-related issues.

Evaluation Schedule:

- The effectiveness of the organization's fatigue reduction policies and procedures will be reviewed on a daily basis and modified as needed.
- At the end of the response, a hot wash will be conducted. Comments will be incorporated into an after action report and integrated into organizational policies and procedures for use during future responses.

Appendix: D Completed Risk Assessment Tool

Appendix D is an example of the Evaluation Tool completed for this scenario.

Using the Assessment Tool, our risk factors and stressors are:

A: Time – 12 + hours per day (1X4=4), 7 days per week (2X4=8) for 3 weeks without a break (3x2=6. Total score for Time Risk factor = 4+ 8 + 6 = 18.

B: Living Conditions – Make shift shelter (1X4 =4); Mass Dining Facilities (1X 3 = 3); Makeshift Sanitation (1X3=3); and no recreation available (1X4=4). Total score for Living Conditions Risk Factor Assessment = 4 + 3 + 3 + 4 = 14

C: Nature of Work – Disaster (2X2=4); Field work (1X4=4); Level B (3X3=9); Day Shift (4X1=4). During this phase of a response to a disaster of this magnitude, security would be limited (3x4 = 12). The first wave of disaster workers are generally going to be familiar with the area and ER work, so we can assume they would be moderately familiar with the area (2X2=4) and moderately familiar with ER work (4X2=8). Total score for the Nature of Work Risk Factor Assessment = 4 + 4 + 9 + 4 + 12 + 4 + 8 = 45

D: Site Conditions – Likely to encounter uncontrolled single and multiple uncontrolled chemical situations so, single uncontrolled chemicals (1X4=4) and multiple uncontrolled chemicals (2X4=8). Potential for encountering radiation sources is probable, levels > 100 mrem/hr - < 5 REM/yr (4X2=8). Other WMD may not be intentionally released but given the scope of this incident the potential to encounter explosives, disease, etc. as in a WMD event would be highly likely (4X4=16) Total score for Site Conditions Risk Factor Assessment = 4 + 8 + 8 + 16 = 36.

E: Emotional Stress – In this instance, even in the post-rescue phase, disaster workers will have potential for encountering remains from impacted graveyards, morgues, funeral homes or casualties of the event (4X3+12) and will be affected by the devastation and. (2X3=6). Total score for emotional stress Risk Factor Assessment = 12 + 6 =18.

Based on the scores for the individual risk factors assessments, controls would be:

- **Time – Risk Score 18 = Develop a site specific fatigue management plan as part of HASP (AHA) as well as actions based on assessment of Stressors B-E.**
- **Living Conditions – Risk Score 14 = implement the Pre-approved Living Condition Management Plan portion of the Organization's Fatigue Management, as well as actions based on assessment of Stressors A, C, D or E.**
- **Nature of Work – Risk Score 45 = Site Specific Management Plan for nature of work to include a security plan as well as plan based on assessment of Stressors A, B, D, or E.**
- **Site Conditions – Risk Score 36** = **APP + HAZWOPER SSHP CIH, CSP or CHP Site Safety Officer as well as actions based on assessment of Stressors A, B, C, and E.**
- **Emotional Stress – Risk Score 18 = CISM or Resilience Counselors visit frequently as well as actions based on assessment of Stressors A, B, C, and D.**

Appendix: D Completed Risk Assessment Tool

Based on this evaluation, this Organization would be implementing their Organizational Fatigue Management Plans as related to Living Conditions and Site Conditions, and a Site- or Response-specific Fatigue Management Plan based on scores for Time Stress, Nature of Work Stress, and Emotional Stress would be incorporated into HASPs.

Appendix: D Completed Risk Assessment Tool

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Risk Factor	Stressor	Weight Factor ↓	Exposure Factor 1		Exposure Factor 2		Exposure Factor 3		Exposure Factor 4		Total	Risk #	Corrective Action Plan
A. Time	Long Hours	1	≤ 8 hrs/day		> 8 < 10 hrs /day		> 10 <12 hrs/day		12 hrs/day	x	4	0 - 6	No action (unless required by assessment of Stressors B-E)
	Extended Time/Week	2	≤ 40 hrs/wk		> 40 < 50 hrs/wk		> 50 < 72 hrs/wk		> 72 hrs/wk	x	8	7 - 12	Increase awareness + actions based on assessment of Stressors B-E
	Extended Weeks Without A Full Day Off	3	2 weeks		3 weeks	x	4 weeks		> 4 weeks		6	13 - 18	Develop fatigue management plan as part of HASP (AHA) + actions based on assessment of Stressors B-E
												19 - 24	Implement pre-approved fatigue management plan + actions based on assessment of Stressors B-E
A. Totals											18		
B. Living Conditions	Quarters	1	Home		Typical Business Travel		RVs		Makeshift Shelter	x	4	0 - 8	No action unless assessment of Stressors A, C, D or E indicates need
	Food	1	Home		Typical Business Travel		Mass Dining Facilities	x	Improvised		3	8 -12	Increase awareness and monitoring by managers, address in separate AHA or actions based on assessment of Stressors A, C, D or E
	Sanitation	1	Home		Typical Business Travel		Mass Washing Facilities	x	Improvised		3	12 - 16	Address in Pre-approved Living Condition Management Plan or actions based on assessment of Stressors A, C, D or E
	Recreation/ Leisure Opportunities	1	Home		Typical Business Travel		Limited		None	x	4		
B. Totals											14		
C. Nature of Work	Phase	2	Demobilization/ Report Writing		Recovery	x	Response		Rescue		4	0 - 16	No Action unless assessment of Stressors A, B, D or E indicates need
	Activity	1	Office Admin		Front Line Admin (MASH)		Field Oversight		Field Worker	x	4	17 - 32	Increase awareness, address in separate AHA or actions based on assessment of Stressors A, B, D or E
	Level of Protection	3	Level D		Modified Level D/C		Level B	x	Level A		9		
	Shift Work	4	Normal Day	x	Normal night		Swing		12am:12pm; 12pm;12am		4	33 - 48	Site Specific Management Plan for nature of work to include a security plan + plans based on assessment of Stressors A, B, D or E
	Security	4	Normal Day		Normal Night		Limited	x	Sporadic		12	49+	Address in Pre-approved Management Plan for nature of work + plan based on assessment of Stressors A, B, D or E
	Familiarity with Area	2	High		Moderate	x	Slight		None		4		
	Familiarity with ER Work	4	High		Moderate	x	Little		Training Only		8		
C. Totals											45		
D. Site Conditions	Chemical	1	Controlled		Controlled and Predictable		Controlled but Unpredictable		Uncontrolled	x	4	0 - 11	Accident Prevention Plan (APP) + actions based on assessment of Stressors A, B, C and E
	Multi-chemical	2	Controlled		Controlled and Predictable		Controlled but Unpredictable		Uncontrolled	x	8	12 - 22	APP + HAZWOPER SSHP + actions based on assessment of Stressor A, B, C and E
	Ionizing Radiation	4	Background (BKG)		> BKG < 100 mrem/hr	x	> 100 mrem/hr < 5 rem/yr		> 5 rem/yr		8	23 - 33	APP + HAZWOPER SSHP CIH, CSP or CHP Program Manager + actions based on assessment of Stressors A, B, C and E
	Other WMD	4	None		Potential		Known Levels		Unknown Levels	x	16	34 +	APP + HAZWOPER SSHP CIH, CSP or CHP Site Safety Officer + actions based on assessment of Stressors A, B, C and E
D. Totals											36		
E. Emotional Stress	Potential for Encountering Casualties (wounded or deceased)	4	Unlikely		Some potential but unusual		Very Likely	x	Probably will encounter		12	0 - 6	No Action
												7 -12	EAP Counseling Available + actions based on assessment of Stressors A, B, C and D
	Potential for Encountering Casualties (those who have lost relatives, friends, property, pets, etc.)	2	Unlikely		Some potential but unusual		Very Likely	x	Probably will encounter		6	13 - 18	CISM or Resilience Counselors visit frequently + actions based on assessment of A, B, C and D
												19 +	CISM or Resilience Counselors on-site + actions based on assessment of Stressors A, B, C and D
E. Totals											18		

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NRT

Volume II

Guidance for Managing Worker Fatigue During Disaster Operations

Background Document

April 30, 2009

THE NATIONAL RESPONSE TEAM

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Acknowledgement

The National Response Team (NRT) acknowledges the NRT member agencies, and state and Federal agencies participating on the Regional Response Teams (RRTs), for their contributions in preparing this document. We invite comments or concerns on the usefulness of this document in all-hazard planning for responses. Please send comments to:

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1.0 Executive Summary

This document is the second of two documents created by the National Response Team (NRT) to address worker fatigue during large-scale disaster operations, such as those following the Oklahoma City bombing, the 9-11 attacks, anthrax contamination, the Columbia Space Shuttle Recovery, and Hurricanes Katrina, Rita, and Wilma. This document summarizes the essential information compiled and reviewed by the NRT while developing the recommended fatigue management approach detailed in *Volume I Guidance for Managing Worker Fatigue During Disaster Operations: Technical Assistance Document (Fatigue Technical Assistance Document).* This Background Document discusses many of the issues and challenges that may arise during a large-scale disaster and how they may impact worker fatigue. It also summarizes current literature on the effects of working extended work shifts/work weeks and the practices used by federal agencies and other organizations to control them.

After a large-scale disaster, workers often work longer shifts and more consecutive shifts than they would typically work during a traditional 40-hour work week. The fatigue and stress that may arise from strenuous work schedules can be compounded by the hazards and impediments created by the physical and environmental conditions in the affected area after a disaster: non-existent, damaged, or limited critical infrastructure (roads/traffic signals, utilities, transportation/distribution of basic necessities, etc.); downed power and communication lines; vegetative, construction, and hazardous debris; flooding; and hazardous material releases.

Available literature does not provide extensive findings about how strenuous work schedules combine with the unique hazards and exposures associated with disaster operations to impact worker fatigue. Although existing literature generally focuses on the effect of shift work and/or extended work hours on employees working normal, non-disaster-related employment, it is the best available information at this time. For example:

- Numerous studies indicate that accident rates tend to increase when work shifts extend beyond 12 hours per day or 60 hours per week. (Folkard & Lombardi, 2006, 2004; Dong, 2005; Barger, et al, 2005; Editorial, 2005; Dembe, 2005; Caruso, et al, 2004; Feyer 2001; Horne & Rayner, 1999.)
- A recent study (Allen, Slavin & Bunn, 2007) acknowledges the findings of Dembe (2005) and cautioned that additional factors, such as the characteristics of the employee (e.g., age, gender, and prior health problems) and the type of work, should be considered when characterizing the risk of injury/illness.
- Sleep deficits, particularly when they accumulate over a period of time, may lead to performance deficiencies, as well as contribute to increased accident and injury rates. (Fryer, 2006; Johnson, 2006; Dahlgren, et al, 2005; Belenky, 1997; Jones & Smith, 1992; OTA, 1991.)
- The longer and more stressful the work shift/week, the greater the need for recuperative time off. (Sonnentag & Zijlstra, 2006; Johnson, 2006; Totterdell, et al, 1995; USDA/Forest Service.)
- Numerous studies identify the effectiveness of regular rest breaks, particularly during long work days. (Baxter & Kroll-Smith, 2005; Dong, 2005; Dembe, 2005; Jackson, et al, 2004; Tucker, et al, 2003.)

- Several articles identify the negative effects of night shifts and/or extended work hours on family relationships. (Pressler, 2000; ACTU, 2000; White & Keith, 1990.)

Multiple agencies and organizations have recognized the potential effects of fatigue in the workplace and enacted regulations or developed voluntary guidelines and operating practices to address some of the fatigue risk factors mentioned above. Most focus on reducing long work hours to address worker fatigue, maintain alertness and productivity, and reduce fatigue-related accidents and injuries for employees who are performing routine tasks/operations in a controlled environment. While this approach may be appropriate for employees who are performing routine tasks/operations in a controlled environment, it does not address the full range of fatigue risk factors that are likely to be associated with disaster operations.

Because of the broad variety of activities in which disaster workers may be engaged, as well as the widely varying circumstances in which they may be working, the NRT recognizes that there is no simple solution or one-size fits all approach to dealing with disaster worker fatigue issues. Instead, the NRT recommends an approach that will assist organizations with the development of their own fatigue management efforts specifically targeted at the nature of their activities and the needs of their workers. This approach, which is detailed in *Volume I Guidance for Managing Worker Fatigue During Disaster Operations: Technical Assistance Document,* involves developing an overall **organizational fatigue management program** and, at the time of an incident, an **incident-specific fatigue management plan:**

- The **organizational fatigue management program** identifies the range of disaster operations, site conditions, and risk factors that employees may experience and provides the overall strategy, work practices, and other controls (including those addressing length of work shift and work rotation) that the organization may use to reduce incident-related fatigue.

- The **incident-specific fatigue management plan** describes the nature of the incident and incident conditions, lays out the risk factors and control measures for a specific incident, and identifies the evaluation schedule.

2.0 Introduction and Scope

Disaster personnel often work extended work hours in stressful environments, which can lead to added fatigue and injuries. Disaster workers are also exposed to a wide variety of chemical, physical, and mental stressors, potentially compounding the stress and fatigue created by working strenuous work schedules. Although the relationship between length of work shift/work week, fatigue, and workplace injury has been examined in peer reviewed literature, and several industry sectors have established regulations and guidelines to address the hazards, there are limited data and few resources addressing worker fatigue during disaster operations. Experience from large-scale disaster operations, such those following the Oklahoma City bombing, the 9-11 attacks, anthrax contamination, the Columbia Space Shuttle Recovery, and Hurricanes Katrina, Rita, and Wilma, prompted the NRT members to examine the potentially detrimental health and safety effects associated with working extended work hours and work rotations.

This Background Document discusses many of the issues and challenges that may arise during a large-scale disaster and how they may impact worker fatigue (Section 3.0). It also summarizes current literature on the effects of working extended work shifts/work weeks and the practices used by federal agencies and other organizations to reduce the risks to workers (Section 4.0). This Background Document should be used in conjunction with the NRT's *Volume I Guidance for Managing Worker Fatigue During Disaster Operations: Technical Assistance* to better understand the roots of the **organizational fatigue management program** and the **incident-specific fatigue management plan** recommended therein.

The hazards associated with extended work shifts, work weeks, and work rotations should be evaluated and addressed during all phases of an incident. However, the information in this document and in *Volume I* is most applicable following the completion of the initial emergency operations.

3.0 Background Information

Operations after a large-scale disaster often necessitate that workers work longer shifts and more consecutive shifts than they would typically work during a traditional 40-hour work week. For the purposes of this document, extended work shifts are shifts that extend beyond a traditional 8- or 10-hour work day. This document also addresses extended work weeks or rotations, in which workers may work successive shifts beyond a more traditional 5-day work week.

Extended work shifts can be a contributing factor in creating and/or exacerbating health impacts caused by hazardous working conditions at a disaster site. The most evident effects associated with working extended workdays are sleep loss, fatigue, stress, and prolonged exposure to chemicals and other hazards (Harrington, 2001). Fatigue and stress may also increase the risk of other accidents, injuries, and illnesses in the workplace. In a recent report, the National Institute of Occupational Safety and Health (NIOSH) concluded that "a pattern of deteriorating performance on psychophysiological tests as well as injuries while working long hours was observed across study findings, particularly with very long shifts and when 12-hour shifts combined with more than 40 hours of work a week." (Caruso, et. al, 2004.) These findings suggest that employees working longer shifts combined with longer work weeks, which are typical during disaster work, may be at a higher risk of injury and reduced performance due to fatigue.

3.1 Site Conditions and Other Potential Hazards

Disasters create uniquely challenging physical and environmental conditions for workers, including: non-existent, damaged, or limited critical infrastructure (roads/traffic signals, utilities, transportation/distribution of basic necessities, etc.); downed power and communication lines; vegetative, construction, and hazardous debris; flooding; hazardous material releases; limited temporary housing (for victims and workers); and damaged or collapsed commercial structures and homes. In addition to these conditions, the volume of resources needed to restore the area after a large-scale disaster will likely exceed those available in the affected communities. Resources, including workers, will need to be brought in from outside the local area, creating a host of logistical issues (e.g., locating, staging, and housing goods and workers; credentialing for out-of-state professionals; and training critical skilled workers unfamiliar with disaster work). These site conditions and circumstances affect workers' physiological capabilities, influencing their performance and impacting their safety and health decision-making.

The following subsections highlight some of the hazards and challenges that the Incident Commander/Unified Command (IC/UC), Incident Safety Officer, and other incident decision makers may confront when addressing worker fatigue and implementing the approach outlined in *Volume I Guidance for Managing Worker Fatigue During Disaster Operations: Technical Assistance Document*. NIOSH identifies very similar issues as challenges to safety and health management as a whole during large-scale disasters in the report *Protecting Emergency Responders: Safety Management in Disaster and Terrorism Response*. The following subsections provide brief summaries; a detailed accounting of each topic is included in Appendix A.

3.1.1 Phase of Disaster Operations

Operations, resources, and site conditions change throughout the response to a disaster. During rescue operations, decisions and actions are time sensitive. Site conditions are often uncontrolled and may change rapidly, as in the case of a fire, explosion, or hazardous substance release. Responders and response equipment may be limited and options for controlling exposures to emergency responders may be restricted by these limitations. During this phase of an operation, the risks to emergency responders are often balanced against the very real need to protect the public, control the emergency, and save lives. Emergency response personnel may be acclimated to this intense activity, the higher level of personal protective equipment (PPE), and alternative work practices required; they are familiar with the site conditions that frequently exist in the immediate aftermath of an incident.

Once the IC/UC declares the initial rescue phase over or complete and the immediate threat has been stabilized, operations move into the next phase. As this transition occurs, risk-benefit decision making must similarly shift to reduce the level of unnecessary risk to workers. Reliance on extended work shifts, work weeks, and work rotations should be reevaluated; the fatigue risk factors should be assessed; and the applicable fatigue management recommendations in *Volume I*

Guidance for Managing Worker Fatigue During Disaster Operations: Technical Assistance Document Section 2.0 should be implemented.

3.1.2 Exposure to a Wide Range of Health and Safety Hazards

Conditions after a disaster can create additional risk for many reasons, including the loss of basic infrastructure (e.g., power, roads, water, and food/hotel services), the large amount of debris in roads and work areas, the large number of workers who are not familiar with the area, and the volume and wide range of operations conducted at close proximity to one another. These conditions may result in exposure to chemicals (e.g., silica and asbestos from collapsed building materials; carbon monoxide from generators; oil, gasoline, and other hazardous materials from storage tanks or chemical facilities), heat/cold stress, contact with contaminated water, noise, falls from elevated surfaces, electrocution risks, fires/explosions, motor vehicle accidents, and confined space entry hazards.

Skilled support personnel (SSP) who become involved in disaster operations are often familiar with the hazards of their jobs under normal work conditions, but may not be familiar with the additional hazards posed by disaster conditions. In addition, the PPE and other exposure controls routinely used to perform their jobs under normal work conditions may need to be augmented to provide adequate protection under disaster conditions. This may require modification to work practices, additional training, and medical monitoring.

Workers at a disaster site often come from communities outside the disaster area and may be unfamiliar with it. This can create challenges in navigating the disaster area, particularly if road signs and traffic lights were destroyed during the disaster. It also poses challenges to understanding the risks associated with indigenous plants and animals. Workers may also be assigned work tasks for which they have minimal or no training. The unfamiliarity factor is similar to hiring a new employee for a job; the greatest chance for an accident occurring is during the first 6 to 12 months.

3.1.3 Exposure to Multiple Agents Simultaneously

Disasters like the World Trade Center, where many different agents are mixing in the workers' breathing zone, pose great challenges for establishing acceptable exposure criteria, given the real possibility of synergistic effects. All of the Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values are established for single chemical exposures with an underlying assumption that employees will recover for 16 hours before being re-exposed. This assumption normally is not representative of the conditions at a disaster site.

3.1.4 Personal Protective Equipment (PPE) Use

Most PPE and the organizational operating procedures for employee use are not designed for multiple hazards and prolonged periods of use. The selection and use of PPE may need to be adjusted to provide adequate protection during disaster operations when site hazards are varied and work shifts are extended. For example, a cartridge change schedule designed for routine use during a standard 8-hour shift will need to be reevaluated for use during a 12-hour shift (assuming the same level of exposure). If exposures are anticipated to be higher during the extended period and/or additional chemicals will be present, respirator cartridges may need to be changed more frequently, a different set of cartridges may be necessary, or a more protective respirator may be required. Similar adjustments may be necessary for other types of PPE, particularly chemical protective clothing. Additionally, PPE use and, in particular, the use of respiratory protection, poses a physiological burden under normal working conditions during traditional working hours. This burden will likely be increased if the PPE or respiratory protection is used for extended work shifts/rotations.

3.1.5 Shift Work

Shift work may be used during large-scale disaster operations to address time-critical operations. It may also be combined with extended hours. Shift work can make employees tired and sleepy. Being excessively tired increases the possibility of errors and accidents. The stress of shift work can also have health effects, such as digestive disorders or aggravating heart disease. Working at night makes it difficult to get enough sleep. Sleep after night work is usually shorter and less refreshing or satisfying than sleep during normal night time hours. Body and brain functions slow down during the night time and early morning hours. The combination of sleep loss and working during the body's low point can cause excessive fatigue and sleepiness. This makes it more difficult to perform well, which increases the risk of accidents. Frequent rotations between day and night shifts can further fatigue employees and the separation from family and friends can add additional stress. These stresses can be harmful to health (Plain Language About Shiftwork, DHHS (NIOSH) Publication No. 1997-145).

3.1.6 Psychological Impacts

Responders can be exposed to a variety of experiences that may potentially cause psychological and emotional effects. Job demands and fatigue can exacerbate these effects and intensify the need for recovery periods. Whether workers are dealing with natural disasters, technological disasters, or terrorist events, they may experience fear, anxiety, grief, and guilt. They may become extremely irritable and/or emotional, experience mood swings, and have memory problems. Persistent and severe reactions may lead to posttraumatic stress disorder (PTSD). For example, approximately 20% of the 1,138 World Trade Center disaster workers studied by the Centers for Disease Control and Prevention (CDC) met the symptom threshold for PTSD (CDC, 2004).

3.1.7 Use of Skilled Personnel that are not Traditional Disaster Workers

Heavy equipment operators and other construction trade workers who are called into a disaster operation often have limited experience with performing routine tasks under disaster conditions and working typical disaster work schedules. They generally are unfamiliar with the physical, chemical, and psychological stressors routinely encountered during disaster operations. They may have limited or no training about the physical and chemical hazards present at a specific disaster site, the work practices, and the PPE used for protection. In addition, they may not be prepared for the nature of their working or living conditions while deployed. OSHA has created the Disaster Site Worker training course specifically to address the vulnerabilities of construction workers during disaster response operations. Information about this course is available at: http://www.osha.gov/fso/ote/training/disaster/disaster.html.

3.1.8 Temporary Living Conditions and Other Considerations

- Use of Base Camps for Temporary Housing: workers may have to deal with primitive, communal living conditions in spaces that were not originally designed as living quarters. They may have to share sleeping and bathroom facilities. This can be stressful in itself, but may be even more difficult when the other workers are not on the same work schedules. In addition, temporary housing usually has very limited facilities for recreational activities, and may not have food service or amenities for preparing and storing food.

- Potential for long travel times to and from work site and base camp or other temporary living spaces: Long travel times further reduce the amount of time a worker has to relax, sleep, and recover after a work shift, which increases the risk of worker fatigue. It also may increase a worker's risk of an automobile accident. According to a 2002 National Transportation Safety Board press release, research shows that about 100,000 crashes per year involve "drowsy driving" and 1,500 (1.5 percent) of those crashes are fatal.

- Medical Considerations: Medical sources indicate that in situations where personnel are under stress and tired, the risk of staphylococcus or other infections increases as the body's immune system is compromised. Additionally, psychological stress has been demonstrated to delay wound healing and decrease immune/inflammatory responses required for normal bacterial clearance.

4.0 Highlights of Research on Extended Hours

Although a significant amount of literature was reviewed as part of this effort, only one document actually focused on the safety and health needs of responders and disaster workers: *Protecting Emergency Responders: Volume 3: Safety Management in Disaster and Terrorism Response* (Jackson, et. al., 2004). The subject of disaster operational work hours was touched on only briefly under the topic of response sustainability in this joint RAND/NIOSH report. All of the other documents reviewed focused on the effect of shift work and/or extended work hours on employees working normal, non-disaster-related employment. More scientific evaluation is needed to understand and address the effects of both extended work hours and shift work for emergency responders and disaster workers, particularly in the case of extended duration operations, such as those associated with the 2005 hurricanes and the World Trade Center and Pentagon attacks.

A review of the literature on the effects of shift work and extended work hours suggests that the following findings should be considered by the IC/UC, Incident Safety Officers, and other incident management decision makers during the planning and development of incident-specific policies regarding extended work hours for disaster workers:

- Numerous studies indicate that accident rates tend to increase when work shifts extend beyond 12 hours per day or 60 hours per week. (Folkard & Lombardi, 2006, 2004; Dong, 2005; Barger, et al, 2005; Editorial, 2005; Dembe, 2005; Caruso, et al, 2004; Feyer, 2001; Horne & Rayner, 1999.)
    1. According to Dr. Charles A. Czeisler, Professor of Sleep Medicine at Harvard Medical School, people who go without sleep for 24 hours or who sleep only four or five hours a night for a week are impaired at the equivalent of a blood alcohol level of 0.1% - which is the equivalent of being legally drunk (Fryer, 2006).
    2. In an effort to model the effect of the components of long work hours on injuries and accidents, researchers found that "risk increased in an approximately exponential fashion with time on shift such that it was more than doubled in the 12th hour relative to the average for the first 8 hours." Thus, if the risk for an 8-hour shift was set at 1, the risk increased to 13% for a 10-hour shift and to 27.5% for a 12-hour shift (Folkard & Lombardi, 2004).
    3. Evaluating risk across three different shifts and using pooled data from five studies, Folkard & Lombardi (2004) reported that "incident risk increased in an approximately linear fashion, with an increased risk of 18.3% on the afternoon shift, and of 30.4% on the night shift, relative to that in the morning shift." Relative risk of incidents over successive night shifts was about 6% higher on the second night, 17% higher on the third night, and 36% higher on the fourth night in comparison to the first night (Folkard & Lombardi, 2004).
    4. Working at least 12 hours per day was associated with a 37% increased risk of injury and working at least 60 hours per week was associated with a 23% increased risk of injury in an analysis of more than 100,000 work records over a 13-year period (Dembe, et al, 2004).
    5. Construction workers working more than 8 hours per day had a 57% higher injury rate than those working 7 or 8 hours per day (Dong, 2005).
    6. Work schedules with both very long shifts and more than 40 hours per week were associated with reduced performance, decreased alertness and cognitive function, and both increased fatigue and injury levels (Caruso, et al, 2004).
- A recent study (Allen, Slavin & Bunn, 2007) acknowledged the findings of Dembe (2005) and cautioned that additional factors such as the characteristics of the employee (e.g., age, gender, and prior health problems) and the type of work should be considered along with the number of hours worked when attempting to assess accident and health risks from extended work hours.

- Sleep deficits, particularly when they accumulate over a period of time, can lead to performance deficiencies, as well as contribute to increased accident and injury rates (Fryer, 2006; Johnson, 2006; Dahlgren, et al, 2005; Belenky, 1997; Jones & Smith, 1992; OTA, 1991).
- There can be serious physical and mental health effects from working shifts more than 12 hours a day (Pietroiusti, et al, 2006; Dembe, et al, 2006; Salzman & Belzer, 2006; Caruso, 2004; Liu & Tanaka, 2002; Ettner & Grzywacz, 2001; Harrington, 2001; Kawakami, et al, 1999; Sokejima & Kagamimori, 1998; Sparks, et al, 1997; Tucker, et al, 1996; Sauter, et al, 1990).
- The longer and more stressful the work shift/week, the greater the need for recuperative time off (Sonnentag & Zijlstra, 2006; Johnson, 2006; Totterdell, et al, 1995; USDA/Forest Service).
- Engaging in social activities and/or athletic activities can enhance recovery (Dahlgren, et al, 2005; Fritz & Sonnentag, 2005; Westman & Eden, 1997).
- A study of offshore and onshore oil industry workers found greater job satisfaction among the offshore workers because they had around-the-clock resources available to them (meals, recreation, supervisory support) regardless of what shift they worked in comparison to the onshore workers who worked night shifts (Parkes, 2003).
- Numerous studies identified the effectiveness of regular rest breaks, particularly during long work days (Baxter & Kroll-Smith, 2005; Dong, 2005; Dembe, 2005; Jackson, et al, 2004; Tucker, et al, 2003).
- Several articles identified the negative effects of night shifts and/or extended work hours on family relationships, indicating that some consideration needs to be given to both supporting responders in the field and reaching out to family members (Pressler, 2000; ACTU, 2000; White & Keith, 1990).
- A small laboratory study evaluated the combined effects of work schedule and task factors on upper-extremity fatigue. The study noted that fatigue was observed more quickly with increased time on shift and during night shifts compared with day shifts. (Rosa, Bonnet, & Hale, 1998).

5.0 Existing Regulations and Work Practices

Multiple agencies and organizations have recognized the risk associated with fatigue in the workplace and enacted regulations or developed voluntary guidelines and operating practices to address it. A subset of regulations and guidelines/operating practices is highlighted below; a full discussion of each is presented in Appendix C.

Transportation Industry

Regulations limiting the hours of service and specifying a minimum interval for recovery have been set for the transportation industry:

- Long-haul Truck Drivers: 11 hours of driving time (up to a 14-hour work day) after 10 hours of off-duty time; 60-70 hours per week (7- or 8-day interval) with requirement of 34 hours off before restarting this clock. (49 CFR, Part 395)
- Federal Aviation Administration (FAA) regulations (14 CFR 121.471) impose an eight-hour limit for flight time during a 24-hour period, provided the pilot has at least eight

continuous hours of rest during the 24-hour period. The rules do not address the amount of time that the pilot can be on duty (stand-by time).
- Locomotive engineers/railroad signalmen: 8 hours of rest between each shift worked under 12 hours and 10 hours of rest between each shift worked of 12 hours or more. (49 USC §21101 et seq.)

Nuclear Power Industry

The Nuclear Regulatory Commission's (NRC) proposed rule requires standard working hour limits of 16 hours in a 24-hour period, 26 hours in a 48-hour period, and 72 hours in a week, excluding shift turnovers. Breaks of at least 10 hours between shifts, a 24-hour break in any 7 days, and a 48-hour break in any two weeks are required (NRC, SECY-05-0074).

Wildland Firefighting

Firefighters generally plan for and ensure that all personnel are provided a minimum 2:1 work/rest regimen (for every two hours of work or travel, provide one hour of sleep and/or rest) with work shifts that may be up to 16 hours/day. Standard assignment length is 14 days with two mandatory days off following an assignment. The Incident Commander or Agency Administrator must justify work shifts that exceed 16 hours and those that do not meet 2:1 work to rest ratio. (National Wildfire Coordinating Group, Interagency Incident Business Management Handbook, Chapter 10, 2004)

Healthcare Industry

The Accreditation Council for Graduate Medical Education (ACGME) set guidelines limiting on-call activities to 24 consecutive hours (plus six additional hours for continuity of care follow-up) and total weekly hours were limited to 80 hours (ACGME, Common Program Requirements, Resident Duty Hours and Working Environment, 2003). With similar intent, the Committee on the Work Environment for Nurses and Patient Safety recommended that state regulatory bodies prohibit nursing staff from providing patient care in any combination of scheduled shifts, mandatory over-time, or voluntary overtime in excess of 12 hours in any given 24-hour period and in excess of 60 hours per 7-day period. (Committee on the Work Environment for Nurses and Patient Safety. Ed. Page, A. (2004). Keeping Patients Safe: Transforming the Work Environment of Nurses. Washington, D.C.: The National Academies Press)

Recent legislation in the U.S. Congress proposed prohibiting health care facilities from requiring nurses to work more than a scheduled work shift or duty period, more than 12 hours in a 24-hour period, or more than 80 hours in a consecutive 14-day period, absent an emergency declared by Federal, State, or local governments.

Numerous States have enacted bans on mandatory overtime, generally considered more than 40 hours per week, for healthcare workers. The American Nursing Association website identifies fourteen states that currently prohibit the use of mandatory overtime for nurses and fourteen states that introduced similar legislation in 2007. As one example, New Jersey's law covers hourly workers who are involved in direct patient care activities or clinical services and are employed by a health care facility. It states that no health care facility shall require an employee to accept work in excess of an agreed to, predetermined and regularly scheduled daily work shift, not to exceed 40 hours per week. Covered workers may do so voluntarily.

U.S. Coast Guard (USCG)

USCG has developed a "Guide for Managing Crew Endurance Risk Factors" that outlines the steps for implementing a Crew Endurance Management Program. A crew endurance risk assessment is conducted by a crew endurance work group made up of trained personnel in the unit/operation. The risk assessment is conducted for the unit/operation using a standard risk factor assessment form. A crew endurance management plan is then developed for the unit/operations to address the risk factors identified. Risk factors include items such as: less then 7-8 hours of uninterrupted sleep daily, poor sleep quality, main sleep scheduled during the day, work hours exceeding 12 hours, high workload, poor diet, lack of control over work environment, exposure to extreme environmental conditions, no opportunity to exercise, isolation from family. (See Appendix B for addition information.)

U.S. Army Corps of Engineers (USACE)

USACE provides information on work scheduling during disaster operations in its Engineering Manual EM 385-1.1, Safety - Safety and Health Requirements, in Appendix B (Emergency Operations), Paragraph 8 (Duty Schedule). In this document, USACE restricts on-duty hours for operations lasting longer than two weeks as follows:

- 12 hours per day, 7 days per week
- 84 hours per week
- 24 hours rest after 14 days and 48 hours of rest after 21 days (provided, optional to employee)
- 24 hours rest required after 29 days and at least 24 hours required every two weeks thereafter
- Travel time to be minimized; if more than 180 minutes roundtrip, then work hours will be shortened by travel in excess of 180 minutes

6.0 Conclusion

Large-scale disasters create site conditions, hazards, and operations that are unique in their combination, proportion, and duration. To restore a community that has been devastated, workers will often work strenuous work schedules under dangerous conditions (e.g., collapsed building, scattered debris, uncharacterized hazardous substance releases) and with limited access to critical local infrastructure (e.g., communications, power, transportation, etc.). For disaster workers, the relationship between exposure to disaster conditions and strenuous work schedules has not been studied; there is limited data on the resulting impacts to a worker's physiological capabilities and risk of injury. However, available literature focusing on non-disaster workers suggests that working longer hours increases the risk of occupational injuries and accidents and that this risk may be dependent on the nature of the work and the characteristics of the individual worker. It is therefore critical for the NRT and other organizations to proactively address worker fatigue during disaster operations.

Multiple agencies and organizations, recognizing the potential effects of fatigue, have enacted regulations or developed voluntary guidelines and operating practices to address it. Most regulations and guidelines set limits on work hours, work weeks, and overtime to address worker fatigue, maintain alertness and productivity, and reduce fatigue-related accidents and injuries. While this approach may be appropriate for employees who are performing routine tasks/operations in a controlled environment, it does not address the full range of fatigue risk factors that are likely to be associated with disaster operations. Fatigue risk factors are more fully discussed in *Volume I Guidance for Managing Worker Fatigue During Disaster Operations: Technical Assistance Document* and can include:

- Long work hours
- Insufficient sleep (less than 7-8 hours of uninterrupted sleep)
- Fragmented sleep
- Shift work/rotating shifts/night shift work
- Sleeping during the day
- Sleep debt with no possibility to make-up lost sleep
- Lack of/limited rest breaks
- Physically and mentally demanding work
- Exposure to temperature and other environmental extremes
- Exposure to chemical and physical hazards, particularly if these are in a mixture or are not well characterized
- Use of PPE
- Limited access to recreational/fitness equipment
- Exposure to psychological stressors (e.g., close contact with injured or dead victims)
- Unfamiliar work environment and/or work task/operations
- Temporary or communal living conditions (which may result in insufficient sleep, fragmented sleep, etc.)
- Limited access to nutritious meals
- Travel time to work site

Because of the broad variety of activities in which disaster workers may be engaged, as well as the widely varying circumstances in which they may be working, the NRT recognizes that there is no simple solution or one-size-fits-all approach to dealing with disaster worker fatigue issues. Instead, the NRT is recommending an approach that will assist organizations with the development of their own fatigue management efforts specifically targeted at the nature of their activities and the needs of their workers. This recommendation is detailed in *Volume I Guidance for Managing Worker Fatigue During Disaster Operations: Technical Assistance* and calls for a comprehensive, two-pronged approach:

- Developing an **organizational fatigue management program** that identifies the range of disaster operations, site conditions, and risk factors that employees may experience and provides the overall strategy, work practices, and other controls (including those addressing length of work shift and work rotation) that the organization may use to reduce incident-related fatigue.
- Developing an **incident-specific fatigue management plan** that lays out the risk factors and control measures for a specific incident.

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Appendix A: Occupational Hazards, Psychological Impacts, and Other Considerations

This appendix provides an expanded discussion of the hazards associated with working extended shifts and work rotations identified in Section 3.0 of the document.

Fatigue

Fatigue can be defined as a state of physical and mental exhaustion that results from overexertion and lack of sleep (USCG, 2004). Signs and symptoms include sleepiness, irritability, depression, giddiness, loss of appetite, digestive problems, and an increased susceptibility to illness, though these symptoms can vary among workers. According to the Department of Transportation's (DOT's) Fatigue Resource Directory, fatigue can be caused by sleep loss and circadian rhythm disruption, and both may be associated with working extended work shifts (DOT).

It is difficult to assess with precision the effects of fatigue on worker safety and health and quantify fatigue's exact contribution to workplace accidents. However, it is known that processes like sleep/wake patterns, body temperature, hormone levels, and digestion are regulated by the body's internal circadian clock over a 24-hour period (DOT). These internal rhythms affect how alert a worker feels and can impact how the worker performs tasks. Fatigued workers may react more slowly, fail to respond or respond incorrectly, and show poor logic or judgment. Fatigued workers are also less able to concentrate, and may be less motivated and more forgetful (Alberta Human Resources and Employment, 2004; Elliot and Kuehl, 2007).

Performance is best when the body is alert and the internal body activity is high. During the normal day-work, night-sleep pattern, people work when the circadian rhythm is high and sleep when it is low (Rosa, 1997). This schedule is best for performance and for a worker's safety. When employees work extended hours they may be working during hours that their internal circadian rhythm is low, potentially impairing their performance (Harrington, 2001; Rosa, 1997).

The DOT's *Fatigue Resource Directory* indicates that extreme fatigue can cause uncontrolled and involuntary shutdown of the brain, and an individual who is extremely sleepy can lapse into sleep at anytime despite the potential consequences (DOT). According to a 2002 National Transportation Safety Board press release, research shows that about 100,000 crashes per year involve "drowsy driving" and 1,500 of those crashes (1.5 percent) are fatal. Although these statistics address the effects of fatigue on driving, it is likely that they also indicate the level of risk fatigue may pose while performing other tasks that require similar levels of concentration.

Several studies have examined the relationship between work shift duration and risk of injury. These studies are summarized in Appendix D, Tables 1 and 2. Although the data vary, many of these studies conclude that there is an elevated risk of injury associated with working extended shifts and performing shift work. With respect to fatigue, Dembe, Erickson, Delbos, & Banks (2005) found that "long working hours indirectly precipitate workplace accidents through a causal process" by inducing fatigue or stress (p. 592). After reviewing 52 recently published studies, the National Institute of Occupational Safety and Health (NIOSH) concluded that overall, "a pattern of deteriorating performance on psychophysiological tests as well as injuries while working long hours was observed across study findings, particularly with very long shifts and when 12-hour shifts combined with more than 40 hours of work a week." (Caruso, et. al.,

2004) These findings suggest that disaster workers, who frequently work longer shifts combined with longer work weeks and night shifts, may be at a higher risk of injury and reduced performance.

Shift Work

Shift work is a function of work scheduling that is often critical during the early phases of a response and may be necessary during disaster operations. NIOSH defines shift work as working outside the normal daylight hours, considered by NIOSH to be 7 a.m. to 6 p.m. Shift workers may work in the evening, during the middle of the night, overtime or extra-long workdays, and they may rotate from one shift to another during response and throughout disaster operations. Shift work schedules can be demanding and are likely to produce stress and fatigue (Rosa, 1997).

Many studies have shown that night shift workers get the least amount of sleep. This sleep loss affects a worker's ability to perform safely and efficiently. "If a worker also has lost sleep, fatigue could combine with the circadian low-point to double the effect on one's ability to perform. Studies of errors and accidents at different times of day show an increased risk at night when the circadian rhythm is low and sleep has been lost." (Rosa, 1997)

Additional references that include information on circadian rhythm, fatigue, and their relation to extended work shifts and shift work are included in Appendix D, Table 2.

Occupational Safety and Health Hazards

Hazards are not well characterized at a disaster site. Dependent upon the type of disaster, a variety of hazards may be present at the site. The following is a partial list of potential hazards:

Safety Hazards

- Falls from elevation
- Slips, trips, falls on the same level
- Electrocutions
- Striking/Being struck by vehicles, falling objects, heavy equipment
- Fire/explosives
- Confined space hazards
- Moving vehicles
- Musculoskeletal injuries
- Contact with power tools
- Eye injuries
- Cuts and punctures from materials handling
- Drowning
- Trenching

Health Hazards

- Atmospheric and dermal chemical hazards
- Carbon monoxide from generators/other combustion sources
- Heat or cold stress
- Insect/animal bites
- Contact with contaminated water (biological/chemical)
- Contact with bloodborne pathogens
- Exposure to building materials, such as silica, lead, fiberglass, and asbestos
- Exposure to fire, smoke, and toxic byproducts
- Excessive noise
- Radiation
- Chemical/biological weapons/hazards

Appendix A: Occupational Hazards, Psychological Impacts, and Other Considerations

Physical Hazards

During all phases of disaster operations, physical hazards will be present. Many physical hazards are similar to typical construction worksite safety hazards, but intensified. At every disaster site, there will be an increased urgency as compared to normal workplaces, due to community and other external pressures to complete work as quickly as possible.

Because disasters can occur in any season, particular attention should be paid to heat and cold exposure. The use of personal protective equipment in hot climates will add to workers' overall body heat burden. Employers should ensure that an adequate supply of water is available and encourage hydration. Employers should also implement a heat stress program in the workplace with proper work/rest regiments to avoid heat-related illnesses, (Henshaw, Letter to C. Terhorst, 10/17/01; OSHA Quick Card on Heat Stress, 2005; OSHA Safety and Health Topics Webpage on Heat Stress.)

Physical hazards can include falls, electrocutions, being struck by equipment, fires and explosions, confined space hazards, musculoskeletal injuries, and lacerations, among others. As described in the section on fatigue, some studies have found that changes in the length and schedule of work shifts may be associated with increased injury rates. (Dong, 2005; Caruso et. al., 2004; Dembe, 2006, 2005; Editorial, Scand J Work Environ Health, 2005.)

Prolonged Exposure to Chemicals and Other Agents

OSHA PELs are usually expressed as 8-hour time weighted averages (TWAs). Many PELs were developed based on the assumption that employees will typically work for an 8-hour work shift and will recover for 16 hours before being re-exposed. OSHA requires an adjustment of the PEL for lead during extended work shifts in its construction and general industry standards. In both standards, the PEL is reduced for extended shifts according to the following formula:

PEL (ug/m3) = 400/hours worked in the day.

OSHA has adopted two sampling approaches when quantifying worker exposures to other hazards during extended work shifts. The first approach requires sampling what is believed to be the worst continuous 8-hour work period of the entire work shift. The TWA calculated for this period is used for comparison with the PEL. The second approach requires collecting multiple samples over the entire extended work shift. Using this approach, multiple personal samples are collected during the first 8-hour period, and additional samples are collected over the extended work period. Exposure is calculated based upon the worst eight hours of exposure during the entire extended work shift. (Fairfax, Memorandum on OSHA policy regarding PEL adjustments for extended work shifts, 11/10/99.)

Other organizations identify the use of mathematical models for adjusting occupational exposure limits. The American Conference of Governmental Industrial Hygienists (ACGIH) refers to the use of the Brief and Scala method to adjust Threshold Limit Values (TLVs) (ACGIH, 2008).

The Brief and Scala method reduces exposure limits based on the hours worked per 24-hour day and the time period between exposures. NIOSH also notes the use of this method for adjusting exposure limits (NIOSH, 2001).

None of these methods deals with the very real issue of exposure to more than one agent during the course of an incident. Incidents like the Graniteville, South Carolina derailment in January 2005 routinely expose responders and the community to potentially deadly gases, but often to only one agent at a time. At Graniteville, the chlorine released from a tank car killed nine people, but the toxicology, physical properties and measurement of chlorine have been understood for a long time, and – despite some initial difficulties – responders were able to measure the gas appropriately and provide well-founded recommendations to the incident commander, eventually establishing three rings of real-time monitoring stations around the damaged railcar that sent data to a dedicated computer well-removed from the disaster (personal communication, C. Staton, 8-25-05).

Disasters like the World Trade Center, where many different agents mixed in the breathing zones of workers, pose much greater challenges for establishing acceptable exposure criteria, given the real possibility of synergistic effects. All of the OSHA PELs and ACGIH TLVs are established for single chemical exposures. The ACGIH and OSHA have the same approach to dealing with the mixing of chemicals vapors. If chemicals act on the same organ system, their combined effect should be given primary consideration. Without any data to the contrary, however, one assumes the effects to be additive and uses the mixture formula, where C is the measured concentration, and T is the threshold limit for that chemical. Any result greater than unity indicates that the limit has been exceeded:

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \cdots \frac{C_n}{T_n}$$

Unfortunately, for nearly all of the chemicals in use there are no data on synergistic effects because the research is not being done, given the costs and scope. A search of Toxline, which contains over 3 million citations, found only 110 hits when searching research over the last fifteen years for the key words "synergism and chemical and human" (8-27-05). The AIHA clearly indicates that its Emergency Response Planning Guide (ERPG), "with only a few exceptions, is devoted to one chemical or substance." OSHA currently has PELs for roughly 500 chemicals. The Chemical Abstract Service (CAS) registry includes 30,011,521 organic and inorganic substances, as of October 1, 2006, (available at: http://www.cas.org/cgi-bin/regreport.pl). Despite the limited knowledge of synergistic effects from multiple chemicals, it is intuitive that extending work shifts will increase these multiple exposures and any concomitant synergistic effects from those agents.

Appendix A: Occupational Hazards, Psychological Impacts, and Other Considerations

Impact of PPE Use in Disasters

Wearing PPE is often necessary during disaster operations; frequently, it is the only exposure control feasible for reducing employee exposures to the physical or chemical hazards present at the work site. It is important that disaster workers, particularly those who are assigned to work for extended hours, understand the limitations of the PPE they use and are aware of how long it will provide protection in a hazardous environment.

It may not be practical or protective to wear some forms of protective equipment for the entire extended work period. Most PPE and employer operating procedures are not designed for multiple hazards and prolonged periods of use. For example, respirator cartridges must be changed when they reach their "end of service life" (i.e., before the absorbent material become saturated) to ensure that the selected respirator continues providing adequate protection. An employer's cartridge change schedule may state that one set of cartridges is sufficient for the chemical exposure present over a standard 8-hour shift. However, if employees begin working 12-hour shifts with the same level of exposure, the cartridge change-out schedule must be reevaluated to ensure it is adequate for the extended work period. If exposures are anticipated to be higher during the extended period or additional chemicals will be present, the cartridges may need to be changed more frequently, a different set of cartridges may be necessary, or a more protective respirator may be required.

Using chemical protective clothing is also frequently necessary during disaster operations. Coated and tightly woven materials used in protective garments provide protection for a specific set of chemicals for which they have been tested. This test data is available from the manufacturer and should be consulted when selecting the type of chemical protective clothing for a specific incident. The chemical protective clothing selected must provide protection for the range of chemicals potentially present at each incident site. Test data should also be used to help determine how frequently individual garments should be changed during a work shift.

Chemical protective clothing made from coated and tightly woven materials can block the evaporation of sweat. Wearing this type of garment may increase an employee's risk of developing a heat-related illness. Extended work shifts require employees to use this type of PPE for longer periods of time, potentially increasing this risk. When designing a work-rest schedule or implementing other controls to reduce heat-related illnesses, it is important to ensure that the extended work period is also taken into account. Like chemical exposure guidelines, some temperature exposure guidelines may not be designed for work beyond a standard 8-hour day. Modifications may be necessary to apply the exposure guideline to work shifts that exceed eight hours.

It is also important to note that the use of PPE and, in particular, the use of respiratory protection, may pose a physiological burden under normal conditions. The burden on the worker's body will vary with the type of PPE and respiratory protection worn, the job and worksite conditions in which the PPE or respirator is used, and the medical status of the worker. Workers who use PPE and respiratory protection must be medically evaluated to ensure they are fit to use the required equipment while performing their assigned jobs. If workers are likely to work extended work shifts/rotations, this should be considered during the medical evaluation.

Ergonomic Considerations

Fatigue and discomfort may result from working in awkward postures or with excessive effort. These factors also may be associated with "musculoskeletal disorders" or "MSDs." These types of injuries are generally controlled using ergonomic principles.

Factors to consider may include, but are not limited to:

- Force - the amount of physical effort required to perform a task (such as heavy lifting, pushing, pulling) or to maintain control of the equipment or tools.
- Repetition - performing the same motion or series of motions frequently for an extended period of time.
- Awkward and prolonged static postures - assuming positions that place stress on the body, such as repeated or prolonged reaching above the shoulder height, bending forward or to the side, twisting, kneeling, or squatting.
- Contact stress - pressing the body or a part of the body (such as the hand) against hard or sharp edges, or using the hand as a hammer.
- Vibration - using vibrating tools, such as sanders, chippers, drills, grinders, or reciprocating saws, may result in fatigue, pain, numbness, increased sensitivity to cold, and decreased sensitivity to touch in fingers, hands, and arms. Exposure to whole body vibration may damage the joints of the skeletal system.
- Cold temperatures combined with the risk factors above may increase the risk of musculoskeletal disorders.

Not all of these risk factors will be present in every job, nor is the existence of one or all of these factors necessarily sufficient to cause injury. However, it is important to examine these factors when screening and analyzing jobs, operations, or workstations to determine which risk factor(s) is present. Jobs and tasks that have multiple risk factors have a higher probability of causing MSDs (OSHA, 2007).

Guidelines, analysis tools, and observation of the task help evaluators identify ergonomic hazards in the workplace. Examples of analysis tools include: Occupational Safety and Health Administration (OSHA) Evaluation Checklists at: http://www.osha.gov/SLTC/ergonomics/index.html; and Washington State Department of Labor and Industries Evaluation checklists at: http://www.lni.wa.gov/Safety/Topics/Ergonomics/default.asp. General solutions include administrative and work process modifications. Administrative approaches could include job rotation, job enlargement, rest breaks, and employee discussions. Work process modifications could include rearranging, modifying, redesigning or replacing: tools, equipment, workstations, packaging, parts, or products.

Appendix A: Occupational Hazards, Psychological Impacts, and Other Considerations

Occupational Psychological Impacts

Relatively little is known about the psychological effects of extended work hours on disaster workers. A literature review found that studies conducted on the effects of work schedules tend to focus on such issues as health effects and accident rates for shift workers, effects of shift work on family relationships, and necessary recovery periods to maintain efficient and effective workers. Using this research, however, it is possible to make some inferences about the psychological effects of extended work hours. For example, Dembe, Erickson, Delbos, & Banks (2005) found that "long working hours indirectly precipitate workplace accidents through a causal process" by inducing fatigue or stress (p. 592). The use of the term "stress" can be inferred as an indication of psychological effects. Harrington (2001) posed a "chicken or the egg" question by considering shift workers to be a largely "self-selected population," making it difficult to know whether to attribute their increased anxiety and depression to shift work or to consider it to be a pre-existing condition. Tucker, Folkard & MacDonald (2003) also found overtime to be more harmful than working compressed work shifts, because working more than the standard number of hours per week denies workers sufficient time for recovery between shifts. This was particularly the case for workers who had low schedule autonomy and low social support. In addition, psychological effects can be inferred from studies (i.e., Salzman & Belzer, 2006; Pressler, 2000; Sparks, et al, 1997; White & Keith, 1990) that found negative effects on family relationships from either shift work or extended working hours. Troubled marriages and/or divorces are known to have major psychological impacts on those involved.

A significant number of studies focused on the necessary time frames needed to recover from either extensive work hours or from extremely stressful work, which also has implications for psychological effects. For example, Sonnentag & Zijlstra (2006) and Dahlgren, Kecklund, & Ackerstedt (2005) found that the more intense the work day, the longer it takes a worker to unwind. Job demands (e.g., time pressure, role ambiguity, situational constraints, and long working hours) combined with low job control (e.g., control over work schedule, breaks) can result in fatigue symptoms that include disturbed mood and impaired cognitive functioning. This increases the need for recovery. The types of activities engaged in off the job predict the level of recovery (e.g., time spent in social or physical activities such as sports facilitates recovery). They conclude that recovery opportunities are important for worker functionality, particularly with work that makes high demands on people's physical and psychological resources through exposure to hazards, situational constraints, or extended working hours. In addition, Fritz & Sonnentag (2005) also found that having to deal with nonwork-related struggles during time off impedes recovery, whereas participation in social activities and sports enhanced recovery. In a slightly different vein, Baxter and Kroll-Smith (2005) suggested benefits from introducing naps into the workday schedule, citing positive results from studies on airline pilots and train crews.

There is another body of literature that can be used to infer psychological effects from extended work hours—the literature that examines the psychological effects of emergency response work, whether by traditional emergency responders (e.g., fire fighters, police, EMTs) or by the workers who are called on to assist during and after emergency operations. Emergency responders, whether they are those traditionally viewed as first line emergency responders or those in the second line who are called in to assist shortly after a disaster occurs (e.g., members of the construction industry) can be exposed to a variety of experiences that may potentially cause psychological and even traumatic effects. Responders can face a number of known and unknown risks, hazards, and dangers, some of which may be life-threatening or have future physical health implications. They may be working in physically unsafe conditions (e.g., collapsed buildings). They may be exposed to toxic substances. They may be confronted with dead bodies or severely injured victims. Some of their colleagues may become victims as a result of their response work. All of these difficulties can be compounded by the extended working hours and rotating shifts frequently encountered in emergency response work and disaster operations. In these circumstances, the physical stresses, often accompanied by skipped or inadequate meals, can tax the responder's physical and emotional resources, making it difficult to deal with the psychological distress. Those in the traditional emergency response professions may have built up a certain amount of tolerance to such exposures; in their case, however, the effects can be cumulative, and serious effects are not uncommon. For those in such fields as construction, the reactions may be more acute and immediate.

Whether responders are dealing with natural disasters, technological disasters, or terrorist events, they may experience fear, anxiety, grief, and guilt. They may have difficulty sleeping and/or eating. They may have nightmares or flashbacks. They may become extremely irritable and/or emotional, experience mood swings, and have memory problems. If these problems persist, the responder could be diagnosed with PTSD. For example, approximately 20% of the 1,138 World Trade Center rescue/disaster workers studied by the CDC met the symptom threshold for PTSD (CDC, 2004).

For these reasons, it is important that supervisors monitor their workers and provide assistance at the first indication of need, rather than waiting until a worker's symptoms multiply and become potentially incapacitating. Such assistance can be in the form of psychological first aid provided by peers or mental health professionals in the field or through the organization's employee assistance program. When possible, this assistance should include an educational component that presents information on healthy ways to manage stress and an opportunity for counseling if the worker desires.

Other Considerations Impacting Work Environment

Other factors associated with the overall work environment at a disaster site (e.g. travel time, base camp conditions, limited familiarity with the area, and sanitation) can affect how site hazards and exposures impact workers. Disaster workers should be briefed so that they are aware of the overall conditions and challenges that they will face once on site. They should also be medically evaluated to ensure they are physically and mentally fit for successful deployment given the likely work and living conditions at the site.

Travel Time and Road Conditions

Travel time to and from the work site should be factored into the length of the workday. Excessive travel time can lengthen the workday considerably, creating additional fatigue and stress. Workers may have limited pre-incident knowledge of the affected area and maps may be rendered useless by the incident. Both can create challenges for navigation. If road signals are destroyed and roads are covered with debris and utility lines, then driving conditions become increasingly hazardous, particularly for workers that have little knowledge of the area. All of these circumstances could lead to an increase in vehicular accidents. Consideration should also be given to the type of vehicle that will be provided. Disaster conditions may warrant the use of larger, more rugged vehicles. Workers should be familiar with and have the proper skills to safely operate the vehicle provided.

Base Camps

Base camp conditions and layout are also an important consideration. Since it is likely that there will be shift work and scheduled days off throughout an incident, base camps need to be set up in a manner that will provide dark, quiet areas for resting and sleeping at all times of the day. Sleeping areas should be isolated from dining facility, bathrooms, etc., to minimize noise. Early in an incident, when resources and supplies are stretched to their limits, adequate housing and eating facilities may be scarce. Supervisors must ensure that no one is deployed into the area without guaranteed adequate housing and eating facilities.

Sanitation Provisions

Medical sources indicate that in situations where personnel are under stress and tired, the risk of staphylococcus or other infections increases as the body's immune system is compromised. Additionally, psychological stress has been demonstrated to delay wound healing and decrease immune/inflammatory responses required for normal bacterial clearance. Sanitation is an extremely critical health and safety element that needs to be adequately addressed to safeguard the wellbeing of disaster workers.

Drinking Water

Consideration must be given the providing and adequate supply of drinking water. Cool water must be provided during hot weather. Drinking water must be provided according to the requirements of the Safe Drinking Water Act, as amended, and all applicable Federal, State, and local regulations. Facilities classified as suppliers of water—

(1) Must comply with substantive and procedural requirements pursuant to 40 CFR 141;
(2) Must meet any State and local regulations that are more stringent than the Federal regulations; and
(3) Shall ensure that the sanitary control and surveillance of water supplies and that the chlorination and fluoridation are conducted according with applicable guidelines.

- Drinking water must be dispensed by means that prevent contamination between the consumer and the source.
- Potable drinking water dispensers must be designed, constructed, and serviced to ensure sanitary conditions; must be capable of being closed; and must have a tap.

- Containers must be clearly marked as "DRINKING WATER" and must not be used for other purposes.

- Do not dip cups or ladles into container to get water - use containers with spouts.
- Fountain dispensers must have a guarded orifice.
- Use of a common cup (a cup shared by more than one worker) is prohibited unless the cup is sanitized between uses. Disposable cups are preferred.
- Employees must use cups when drinking from portable water coolers/containers.
- Unused disposable cups must be kept in sanitary containers and a waste receptacle must be provided for used cups.
- Outlets dispensing non-potable water must be conspicuously posted "**CAUTION - WATER UNSAFE FOR DRINKING, WASHING, OR COOKING**."

Toilets

When sanitary sewers are not available, one of the following facilities, unless prohibited by local codes, must be provided: chemical toilets, recirculating toilets, combustion toilets, or other toilet systems as approved by State/local governments.

- Each toilet facility must be equipped with a toilet seat and toilet seat cover. Each toilet facility - except those specifically designed and designated for females - must be equipped with a metal, plastic, or porcelain urinal trough. All must be provided with an adequate supply of toilet paper and a holder for each seat.
- Toilet facilities must be so constructed that the occupants will be protected against weather and falling objects; all cracks will be sealed and the door will be tight-fitting, self-closing, and capable of being latched.
- Adequate ventilation must be provided and all windows and vents screened; seat boxes must be vented to the outside.
- Toilet facilities must be constructed so that the interior is lighted.
- Cleaning of construction site-type portable toilets usually can not wait for routine weekly maintenance. These facilities must be inspected at least once per shift and cleaned as appropriate to maintain the interior surfaces as sanitary as possible.

Washing Facilities

Washing facilities must be provided at toilet facilities and as needed to maintain healthful and sanitary conditions. Washing facilities for persons engaged in the application of herbicides, insecticides, or other operations where contaminants may be harmful must be at or near the work site and shall be adequate for removal of the harmful substance.

Each washing facility must be maintained in a sanitary condition and provided with water (either hot and cold running water or tepid running water), soap, and individual means of drying. However, where it is not practical to provide running water, hand sanitizers (e.g., Purel) may be used as a substitute.

Showers must be provided in accordance with the following:

a. One shower shall be provided for every ten employees (or fraction thereof) of each sex who are required to shower during the same shift;
b. Body soap or other appropriate cleansing agent convenient to the shower shall be provided;
c. Showers shall have hot and cold running water feeding a common discharge line; and
d. Employees using showers shall be provided with individual clean towels.

Shower facilities should be sanitized between uses (sprayed with hypochlorite solution and must be inspected at least once per shift and cleaned carefully with disinfectant daily).

Living Quarters

When temporary sleeping quarters are provided, they must be heated, ventilated, and lighted.

Bedding and common areas must be picked up daily and sprayed with a disinfectant (e.g., Lysol). Additionally, workers must decontaminate their boots when returning from a work site before walking into the facility or to bunk areas to decrease the chance of cross contamination.

Food Preparation

All employees' food service facilities and operations must meet the applicable laws, ordinances, and regulations of the jurisdictions in which they are located.

All employee food service facilities and operations must be carried out in accordance with sound hygienic principles. In all places of employment where all or part of the food service is provided, the food dispensed shall be wholesome, free from spoilage, and shall be processed, prepared, handled, and stored in such a manner as to be protected against contamination.

Food storage containers must be clearly marked as such and segregated to the extent possible to prevent contamination.

Food preparation surfaces must be cleaned with disinfectant frequently. Utensils, pots, pans, and containers must be washed between uses with hot water and antibacterial soap and stored to prevent contamination between uses.

First Aid

All injuries that result in breaks in the skin must be cleaned and treated with appropriate antibiotics (e.g., over-the-counter triple antibiotic/Neosporin) and injuries must be monitored by first aid personnel.

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Appendix B: Federal Agency Operating Practices and Other Standards Addressing Work Hours and Work Rotations

Agency	Background & Applicability	Hour Limitations	Rest Periods & Rotation Length	Source
Federal Agency Operating Practices Related to Work Hours and Work Rotations for Federal Employees				
USACE	USACE Employees During Emergency Response Operations	Should not work in excess of 84 hours per week (usually 12 hours per day, 7 days a week, during emergency response). *Note: If travel time to and from work exceeds 90 minutes one way, work hours shall be shortened by the travel time in excess of the 180 minute round trip travel time.*	Employees provided opportunity for 24 hours rest after working 14 days and 48 hours of rest after working 21 days. Employees required to take at least 24 hours off for rest after continuous 29-day period of work and at least 24 hours off every 2 weeks thereafter.	Duty Schedule defined in EM 385-1-1, App B Par 8.
Department of Interior (DOI)	National Interagency Fire Fighters	National interagency fire fighters work up to 16-hour days. *Note: Travel time is included in the 16 hour per day limit. There is also a 10-hour limit of behind the wheel driving time (this is consistent with the policies summarized in "Voluntary Standards" under National Wildfire Coordinating Group).*	14 days on, 2 days off schedule. This constitutes a 2:1 work to rest ratio.	Chapter 10 Objectives, Policy, and Scope of Operation, 2006 National Interagency Mobilization Guide from the National Interagency Coordination Center at the National Interagency Fire Center.
USCG	USCG personnel on vessels conducting maritime operations	The Crew Endurance Management System (CEMS) provides a system of proven practices for managing endurance risk factors that affect	A crew endurance risk assessment is conducted by a crew endurance work group made up of trained personnel and individuals involved	Crew Endurance Management System

Agency	Background & Applicability	Hour Limitations	Rest Periods & Rotation Length	Source
		operational safety and crewmember efficiency in the maritime industry. It is a cyclical, continuous-improvement process, which allows an organization to make improvements at a level and pace appropriate to its operation, focusing efforts towards those factors that are most feasibly mitigated and present the greatest possible reduction of risk. The system does not specify hour limitations; it is a process designed to evaluate and mitigate specific risk factors that USCG has identified as critical for crew endurance during marine operations.	in the unit/operation. The risk assessment is conducted for units/operations using a standard risk factor assessment form. A crew endurance management plan is then developed for the unit/operation to address the risk factors identified. Risk factors include items such as: less then 7-8 hours of uninterrupted sleep daily, poor sleep quality, main sleep scheduled during the day, work hours exceeding 12 hours, high workload, poor diet, lack of control over work environment, exposure to extreme environmental conditions, no opportunity to exercise, isolation from family. Rest breaks and controlling work shift/work rotation durations may be part of the endurance plan to mitigate the risk factors identified.	(December, 2005) www.uscg.mil
NIOSH	CDC staff involved in preparedness exercises	The recommended work shift is 9hrs/day; the recommended work week is 40hrs/week. The recommended number of continuous work days is 4.	The recommended work shift (9hrs/day) includes travel time.	Official agency policy
	CDC staff deployed in response to a health incident	During the first 3 days of an incident, the recommended work shift is 12hrs/day and the recommended work week is 36hrs/week. Beginning on the 4th day of an incident the recommended work	After the first 3 days, staff should be given a mandatory day off. Beginning on the 4th day of the incident, the work rotation should shift to 5 days on with two days off. The recommended work shift, in all	Official agency policy

Appendix B: Federal Agency Operating Practices and Other Standards Addressing Work Hours and Work Rotations

Agency	Background & Applicability	Hour Limitations	Rest Periods & Rotation Length	Source
		shift/work week changes to: 9 hour work shifts and 45 hour work weeks.	cases, includes travel time.	
Standards and Guidelines that address Work Shift and Work Week Durations for a Regulated/Covered Population of Workers				
DOT	Commercial Motor Vehicle Drivers DOT recognized the potential hazards of working extended hours and the likely dangerous results of fatigue in commercial truck driving as early as 1939. In April 2003, DOT issued the first revisions to the Hours of Service rule in over 60 years.	11-hour limit on the length of time a long-haul truck driver can drive after 10 consecutive hours off.	May not drive beyond the 14th hour after coming on duty, following 10 consecutive hours off duty. May not drive after 60/70 hours on duty in 7/8 consecutive days. A driver may restart a 7/8 consecutive day period after taking 34 or more consecutive hours off duty.	DOT website. www.fmcsa.dot.gov/Home_Files/revised_hos.asp
Federal Aviation Administration (FAA)	Pilots/Flight Crews	Crew members cannot accept an assignment if they will exceed any of the following: • 1,000 hours in any calendar year • 100 hours in a any calendar month • 30 hours in any seven consecutive days • 8 hours between required rest periods.	Specific rest requirements between flights range from 8-11 hours (based on total flight time during a 24-hour period). Exceptions made to these rules require that flight crew members receive the proper amount of compensatory rest time during the next rest period. Rules do not address the amount of time flight crew members can be on duty (standby time). Airline rules may be even stricter than FAA regulations if the issue is part of a collective bargaining agreement.	Pilot Flight Time and Rest, FAA, Fact Sheet (2006) http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=6762
Nuclear Regulatory Commission	Nuclear Power Plant Personnel	Proposed rule requires standard working hour limits of 16 hours in a 24-hour period, 26 hours in a 48-	Proposed rule requires breaks of at least 10 hours between shifts, a 24-hour break in any 7 days, and a 48-	http://ruleforum.llnl.gov/cgibin/downloader/Part26

Appendix B: Federal Agency Operating Practices and Other Standards Addressing Work Hours and Work Rotations

Agency	Background & Applicability	Hour Limitations	Rest Periods & Rotation Length	Source
(NRC)	The NRC has proposed regulations on fitness for duty, including managing fatigue. This regulation may become final rule in 2007.	hour period, and 72 hours in a week, excluding shift turnovers.	hour break in any two weeks are required. Some exceptions to these limits can be made in the first 8 weeks of outages.	_risk_lib/1054-0155.htm?st=risk (downloaded 11/28/2006) and personal communication with NRC personnel
ACGME	For Medical Residents Voluntary accreditation program, which sets standards that restrict the number of work hours for residents.	Guidelines limited on-call activities to 24 consecutive hours (plus six additional hours for continuity of care follow-up) and weekly totals to 80 hours.		ACGME *Resident Duty Hours Language: Final Requirements.* February 24, 2003. http://www.acgme.org/DutyHours/dutyHrsLang.pdf
National Wildfire Coordinating Group (NWCG)	Personnel from Participating Agencies (U.S. Department of Agriculture (USDA) Forest Service, Bureau of Land Management (BLM), National Park Service (NPS), Bureau of Indian Affairs (BIA), Fish and Wildlife Service (FWS), and State forestry agencies through the National Association of State Foresters) The NWCG coordinates	Work shifts exceeding 16 hours and/or consecutive days that do not meet the work/rest ratio should be the exception. No work shift should exceed 24 hours. In situations where this does occur, incident management personnel will resume 2:1 work/rest ratio as quickly as possible. The IC or Agency Administrator	Plan for/ensure all personnel are provided a minimum 2:1 work to rest ratio (for every 2 hours of work or travel, provide 1 hour of sleep and/or rest). Standard assignment length is 14 days (exclusive of travel from and to home unit) with possible extensions identified below. Time spent in staging and preposition status counts toward the 14-day limit, regardless of pay	Interagency Incident Business Management Handbook

Appendix B: Federal Agency Operating Practices and Other Standards Addressing Work Hours and Work Rotations

Agency	Background & Applicability	Hour Limitations	Rest Periods & Rotation Length	Source
	programs of participating wildfire management agencies. Its goal is to provide more effective execution of each agency's fire management program. NWCG provides standards of training, equipment, qualifications, and other operational functions that individual agencies adopt and implement. Prior to assigning incident personnel to back-to-back assignments, their health, readiness, and capability must be considered.	must justify work shifts that exceed 16 hours and those that do not meet 2:1 work to rest ratio. Justification will be documented in the daily incident records. Documentation shall include mitigation measures used to reduce fatigue.	status, for all personnel, including incident management teams. After completion of 14-day assignment and return to the home unit, two mandatory days off will be provided (2 after 14). Extensions may be allowed in some circumstances.	
European Union	All workers Provides a useful example of how European Union views the work week, and the necessity for rest breaks and recovery periods. The directive also includes additional provisions for night time work, shift work, and annual leave.	Average working time not to exceed 48 hours for each 7-day period, including overtime.	Minimum daily rest period of 11 consecutive hours per 24-hour period. A minimum uninterrupted rest period of 24 hours for each 7-day period.	European Directive on Working Time (93/104/EC) in 1993.

Summary of Current Drowsy Driving Legislation (From the Journal "Sleep Review" – October 2007)	
State/Bill Number	**Summary of Legislation**
Illinois SB 104	A person who causes a fatal accident by operating a motor vehicle, all-terrain vehicle, snowmobile, or watercraft while he or she is aware of being fatigued is guilty of reckless homicide.
Kentucky HB 150	A person is guilty of reckless homicide when, driving while fatigued, he causes the death of another person.
Massachusetts S No. 2072	Addresses drowsy driving education and enforcement.
Michigan HB 4332	Includes driving while fatigued in definition of reckless driving.
New Jersey AB2265 (SB1851)	Requires the recording of driver distraction, including fatigue, on accident forms.
New Jersey AJR 86	Creates a commission to study highway rest areas for truck drivers.
New York A970	Requires holders of commercial driver's licenses to submit to medical examinations and testing for sleep apnea.
New York A1234 (S1290)	Creates a misdemeanor for driving while drowsy; creates felony crime of vehicular homicide caused by driving while ability-impaired by fatigue.
New York A2332	An act to amend traffic law in relation to driving while fatigued.
New York A4134 (S2488)	Adds fatigue to definition of recklessness in vehicular assault and vehicular manslaughter statues.
Oregon HB 3021	Creates offense of driving while fatigued; punishes by maximum of 5 years imprisonment, $125,000 fine, or both; requires that fatigue be included on driver's license test.
Tennessee SB 71 (HB 117)	Allows a judge or jury to infer fatigue as a cause in a traffic fatality when the defendant had not slept in the past 24 hours.

Appendix C: References

Table 1: Association between Working Extended Work Shifts/Work Weeks and Workplace Injury: Summary of Reviewed Literature

This table highlights studies that evaluated the association between hours worked and occupational injury. It presents data from several recent studies where the risk of injury has been quantified and/or modeled. None of the studies highlighted here or in Table 2 evaluate how the implementation of a well-designed and well-managed fatigue management program, such as the one recommended in Section 2.1, would impact the risk of injury. However, it is clear from the studies included in Table 2 that when aspects of such a program, e.g., including breaks throughout a work shift, are implemented, fatigue is reduced and performance is enhanced; the risk of injury may be similarly reduced. These data should be used collectively when designing a work schedule for an incident-specific fatigue management plan. It is "necessary to consider the various features of the schedule in combination with one another, rather than in isolation from one another" (Johnson & Lipscomb, 2006).

Reference	Risk of Injury **(as compared with working 8-hr work day, working during the day shift, and working a 40 hr work week)**					
	10-hr work shift	12-hour work shift	afternoon work shift	night work shift	successive shifts	> 40-hr work week
S. Vegso, et al, 2007						↑ by 88% for those who worked more than 64 hr during the previous week
Folkard & Lombardi, 2006 (model using results from numerous studies)	↑ by 13%	↑ by 27.5%	↑ by 15.2%	↑ by 27.9%	Night Shifts: ↑ by 6% for 2nd night worked ↑ by 17% for 3rd night worked ↑ by 36% for 4th night worked Day Shifts: ↑ by 2% for 2nd day worked ↑ by 7% for 3rd day worked ↑ by 17% for 4th day worked	Varies based on of length of shift and time of day. For any given work week duration, a long span of short shifts is likely to be safer than a short span of long shifts. 60 hour week – as 6 10-hr days: ↑ by

Appendix C: References

Reference	Risk of Injury **(as compared with working 8-hr work day, working during the day shift, and working a 40 hr work week)**					
	10-hr work shift	12-hour work shift	afternoon work shift	night work shift	successive shifts	> 40-hr work week
						16% (day) ↑ by 54% (night) as 5 12-hr days: ↑ by 28% (day) ↑ by 62% (night)
Dembe, et al, 2005		↑ by 37%				↑ by 23% (60 hrs/week)
Dong, 2005	↑ by 57% (> 8 hrs; construction workers)					↑ by 98% (> 50 hrs; all occupations)
Folkard & Lombard, 2004	↑ by 13%	↑ by 27.5%	↑ by 18.3%	↑ by 30.4%	Night Shifts: ↑ by 6% for 2nd night worked ↑ by 17% for 3rd night worked ↑ by 36% for 4th night worked Day Shifts: ↑ by 2% for 2nd day worked ↑ by 7% for 3rd day worked ↑ by 17% for 4th day worked	
Folkhard & Tucker 2003,			↑ by 18.3%	↑ by 30.4%	Night Shifts: ↑ by 6% for 2nd night worked ↑ by 17% for 3rd night worked ↑ by 36% for 4th night worked Day Shifts: ↑ by 2% for 2nd day worked ↑ by 7% for 3rd day worked	

Appendix C: References

Reference	Risk of Injury **(as compared with working 8-hr work day, working during the day shift, and working a 40 hr work week)**					
	10-hr work shift	12-hour work shift	afternoon work shift	night work shift	successive shifts	> 40-hr work week
					↑ by 17% for 4^{th} day worked	
Baker, 2003*	no significant ↑; accidents peaked – 10^{th} hour (day shift) and 12^{th} hour (night shift)					
Johnson & Sharit, 2001*		no significant ↑ (switched from 8- to 12-hr work shift)				

* "Research comparing 8- and 12-hour shift schedules has not consistently reported increases in health and safety risks with longer shift durations. Some of the 12-hr shift schedules offset longer shifts with fewer consecutive work days (a "compressed" work week) and more rest days so that total hours approximate a 40-hr week. Fewer commutes may be another offsetting advantage. Thus, future research needs to consider potential interactions of shift length with length of work week, opportunity for rest, and commuting requirements." (Caruso et al., 2006)

Considerations for evaluating data included in this table:

- This table highlights studies that evaluate the relationship between hours worked and risk of injury. It presents data from several recent studies where this relationship has been quantified or modeled. There are numerous studies that evaluate the relationship between hours worked and other health effects, which are of equal importance in understanding the full range of effects that workers may experience when working extended work shifts, work weeks, and work rotations. Many of these studies are highlighted in the literature review presented in this Appendix.
- None of the studies evaluated workers during disaster operation.
- Most of the studies included individuals working in a broad range of occupations, or focused on a single manufacturing or market sector. The study lead by Dong focused on constructions workers, an occupation that is frequently involved in disaster operations, but did not focus on construction operations during a disaster.

- All of the studies have design and data limitations; it is important to understand these limitations when evaluating the data presented in the study and in this table.
- The type and severity of injury is not well defined in the studies reviewed. Folkard and Lombardi (2006) note that "in the vast majority of cases the incidents on which these trends are based were not severe, but it is likely that they represent a relatively direct measure of the occurrence of mistakes and omissions." Injury severity likely varies among the individuals within each study and between the studies evaluated.

Table 2: Summary of Literature and Bibliography

Author(s)	Title	Publication	Findings/Recommendations
American Conference of Governmental Industrial Hygienists (ACGIH)	Threshold Limit Values (TLVs®) for Chemical Substances and Physical Agents and Biological Exposure Indices BEIs® (2008)	Published by the ACGIH, available at www.acgih.org	TLV® occupational exposure guidelines are recommended for more than 700 chemical substances and physical agents. There are more than 50 Biological Exposure Indices (BEIs®) that cover more than 80 chemical substances. Chemical Abstract Service (CAS) registry numbers are listed for each chemical. Introductions to each section and appendix provide philosophical bases and practical recommendations for using TLVs® and BEIs®.
International Agency for Research on Cancer (IARC) Monograph Working Group (A. Blair, et al)	Carcinogenicity of shift work, painting, and firefighting	Lancet Oncology; 8 (12), December 2007	A meeting of 24 international scientists at the IARC in October 2007 to review numerous epidemiological studies concluded that shift work that involves circadian disruption, occupational exposure as a painter, and occupational exposure as a firefighter are possibly carcinogenic to humans.

Author(s)	Title	Publication	Findings/Recommendations
E. Pukkala & M. Harma	Editorial: Does shift work cause cancer?	*Scandinavian Journal of Work & Environmental Health*, 2007; 33(5), 321-323.	Points out the need for reliable and unbiased human evidence to show a dose-response relationship between the studied exposure and the specific disease as well as identification of a specific mechanism explaining the possible epidemiologic association. Also discusses an epidemiologic study in this same issue (J. Schwartzbaum, A.Ahlbom, & M. Feychting: Cohort study of cancer risk among male and female shift workers, pp. 336-343) that suggests no effect of shift work on cancer risk. Points out limitations of that study, including small proportion of shift workers in the studied population.
D.L. Elliott & K.S. Kuehl	Effects of Sleep Deprivation on Firefighters and EMS Responders	Rpt. For International Fire Chiefs Association, 2007.	Supports other studies in finding an association between lack of sleep and decreased alertness, inability to think clearly, depression, and decrements in job performance as well as increased obesity and cardiovascular disease in workers working extended hours or night shifts. Examines measures for managing work hours' effects from both employment –related (e.g., worker environment & fatigue management) and personal control perspectives (e.g., sleep hygiene and life style).
J.A. Ricci, E. Chee, A.L. Lorandeau, J.	Fatigue in the U.S., workforce: Prevalence and implications for	JOEM, 2007, 49(1), 1-10	Study using a US national population-based random digit-dial telephone survey with a sample of 28,902 adults

Author(s)	Title	Publication	Findings/Recommendations
Berger	lost productive work time		age 18-65 found an estimated 2-week prevalence of fatigue of 37.9%, with 9.2% of workers reporting lost productive work time due to fatigue. Study also estimated an annual cost of $136.4 billion from fatigue-related, health-related lost productive work time to employers.
Occupational Safety and Health Administration	Ergonomics for the Prevention of Musculoskeletal Disorders Draft Guidelines for Shipyards (2007)	http://www.osha.gov/dsg/guidance/shipyard-guidelines.html	These guidelines provide recommendations for shipyards to help reduce the number and severity of work-related musculoskeletal disorders, increase employer and employee awareness of ergonomic risk factors, eliminate unsafe work practices, alleviate muscle fatigue, and increase productivity. The heart of these guidelines is the description of various solutions that have been implemented by shipyards. These guidelines expand on these recommendations, and include additional information that employers can use to identify problems and train employees. This document includes an introduction; a process for protecting employees; solutions that employers can use to help reduce MSDs in shipyards; and additional sources of information on ergonomics in shipyards.
C. Caruso	Possible broad impacts	Industrial Health, 2006, 44, 531-536	Summarizes research linking long work

Author(s)	Title	Publication	Findings/Recommendations
	of long work hours		hours to a variety of risks to workers, families, employers, and the community, including sleep deprivation, poor recovery from work, decrements in neuro-cognitive and physiological functioning, illnesses, adverse reproductive outcomes, and injuries. Suggests loss of workers with critical public safety skills may be a potential negative impact for society when these workers leave their jobs because of demanding work schedules. While this suggestion is based on a study of the nursing profession, this also has a potential application to emergency responders.
A. Pietroiusti, A. Forlini, A. Magrini, A. Galante, L. Coppeta, G. Gemma, E. Romeo, A. Bergamaschi	Shift work increases the frequency of duodenal ulcer in *H pylori* infected workers	Occ & Envir Med, 2006, 63, 773-775	In a study of 941 workers, 546 tested positive for *H pylori* infection (the main causative agent for peptic ulcer disease); 303 were daytime workers, and 132 were shift workers; the prevalence of gastric ulcers was higher in shift workers (28.7%) than in daytime workers (9.3%). Potential implications for physical health effects of shift work & extended hours.
A.E. Dembe, J.B. Erickson, R.G. Delbos, S.M. Banks	Nonstandard shift schedules & the risk of job-related injuries	Scand J Work Environ Health 2006: 32(3), 232-240	Examined reported incidence of work-related injuries/illnesses among a nationally representative sample of 10,793 working adults in the US over a 13-year period. Findings indicated workers in "nonstandard" shifts (i.e., other than 8-hr day shifts) have greater

Author(s)	Title	Publication	Findings/Recommendations
			risk of occupational injuries/illnesses.
S. Sonnentag, F.R.H. Zijlstra	Job characteristics and off-job activities as predictors of need for recovery, well-being, and fatigue	J of Applied Psych, 2006, 91(2), 330-350	Examined factors affecting workers' need for recovery. Concluded that the more demanding the situation and higher/longer lasting (more time/overtime) the required level of activity, the greater the consumption of personal resources and the greater the need for recovery. Also examined the effects of leisure activities on recovery rates, concluding that social and athletic leisure activities facilitate recovery. Practical implications include viewing high subjective need for recovery as an early warning indicator for prolonged fatigue and reduced well-being. Recommends organizational policies that prevent extended work days and promote active leisure activities after work.
G.M. Salzman, M.H. Belzer	Truck driver occupational safety and health: A conference report and selective literature review	NIOSH/Wayne State University, April 24-25, 2006	Detailed overview of medical, psychological, family/social hazards associated the extended hours commonly worked by truck drivers.
B. Fryer	Sleep deficit: The performance killer – A conversation with Harvard Medical School Professor Charles A. Czeisler	Harvard Bus Rev, Oct. 2006	Identifies four major sleep-related factors that affect cognitive performance: homeostatic drive for sleep at night; total amount of sleep over several days; circadian phase; and sleep inertia. Points out additional sleep-

Author(s)	Title	Publication	Findings/Recommendations
			related issues that accompany aging. Describes sleep deprivation as a public health hazard. Urges the development of corporate sleep policies similar to those relating to smoking, and sexual harassment. Recommends limiting scheduled work to no more than 12/hrs/day (16 under exceptional conditions); 11 consecutive hours of rest every 24 hrs; weekly work limited to maximum of 60 hrs; minimum of one day off/week, preferably two consecutive days. Also recommends mandatory educational programs about sleep, health, and safety focusing on effects of electronic devices on sleep and how alcohol and caffeine interfere with sleep, as well as annual screening for sleep disorders.
S. Folkard & D.A. Lombardi	Modeling the impact of the components of long work hours on injuries and "Accidents"	Amer J of Indust Med, 2006, 49:953-963	Identified and evaluated four trends in incidents associated with features of shift systems: increase in risks as shifts progress across the day (i.e., morning, afternoon, night); increase in risks across successive night shifts; increased risk across successive day shifts; and increased risk with time on shift. Recommends placing a limit on the acceptable level of fatigue or risk associated with a particular work schedule rather than setting specific work hour regulations. The model is

Author(s)	Title	Publication	Findings/Recommendations
			based on a "normal working week" of 5 successive 8-hr day shifts, setting the relative risk at 1.00, with the relative risks for all other working hour combinations expressed relative to this. Thus, 6 successive 8-hr day shifts would increase the risk 3%, but 4 successive 12-hr day shifts would increase the risk by 25%, and 6 successive 8-hr night shifts would increase the risk by 55%.
D. Johnson	The rest is up to you	Industrial Safety & Hygiene, Nov. 1, 2006	Focuses on the safety risks posed by wide spread sleep deprivation. Points out that "bosses" aren't the only ones responsible for the way people push themselves. Acknowledges but expresses skepticism regarding the adoption of many of the common sense recommendations from Harvard's Dr. Czeisler.
Anonymous	Are we seeing the end of lunch?	HR Dailey Advisor, Dec. 4, 2006	Highlights a steady decline in workers taking lunch breaks and estimates that 75% of workers eat but do it at their desks while working. Points out that blood sugar levels drop every 4-5 hrs, resulting in decreased efficiency if the body isn't refueled. Cites efforts by government agencies in Nova Scotia to push people to take lunch breaks
J. Johnson, J. Lipscomb	Long Working Hours, Occupational Health and the Changing Nature of Work	American Journal of Industrial Medicine, 49, 921-929 (2006)	An overview of historical, sociological, and health-related research presented at an international conference on long working hours. Is the introductory article

Author(s)	Title	Publication	Findings/Recommendations
	Organization		for a special section in this issue of the Journal. Provides a broad discussion of the changes in the workplace and societal trends that are associated with long working hours. Summarizes results of the other articles in the issue that address the safety and health effects of long working hours. Concludes that improved methodologies are needed to track exposure to long working hours and irregular shifts longitudinally. Research should focus on the adverse impact that sleep-deprived and stressed workers may have on the health of the public that they serve.
C Caruso, T. Bushnell, D. Eggerth, A. Heitmann, B. Kojola, K. Newman, R. Rosa, S. Sauter, B. Vila	Long Working Hours, Safety and Health: Toward a National Research Agenda	American Journal of Industrial Medicine 49:930-942 (2006)	The NORA Long Work Hours Team examined research papers and literature reviews, and gathered input from a conference on long work hours organized by the Team and faculty from the University of Maryland. A framework is proposed for long work hours, including determinants, outcomes, and moderating factors of long work hours, suggesting that studies need to include more clear and complete descriptions of work schedules, worker characteristics, and the work environment, and need to consider a wider range of possible health, safety, social and economic outcomes for workers, families, employers, and the

Author(s)	Title	Publication	Findings/Recommendations
			community. Additional studies are needed on vulnerable employee groups and those critical to public safety. More studies are also needed to develop interventions and test their effectiveness.
MB Spencer, KA Robertson, S Folkhard	The development of a fatigue/risk index for shiftworkers	Research Report 446, Health and Safety Executive (United Kingdom) (2006)	This report describes the work carried out to revise and update the Health and Safety Executive Fatigue Index. The fatigue index was originally developed as a method of assessing the risk arising from fatigue associated with work patterns for safety critical workers. The Fatigue Index is designed to provide an assessment of changes in work patterns and to determine whether any particular aspect of the work pattern was likely to increase levels of fatigue. The fatigue index is now widely used in the rail industry and is being increasing used in other sectors. The report includes an extensive discussion of literature related to shift work and fatigue, as well as risk of injuries and accidents related to shift work. Because there is now more information concerning trends in risk related to shift work, the authors were able to update the fatigue index and construct a new index entirely related to risk, rather than to fatigue and performance. These indices may be useful as risk assessment tools in evaluating the potential risk associated

Author(s)	Title	Publication	Findings/Recommendations
			with several alternative proposed work schedules at disaster work sites.
USCG	Crew Endurance Management System (December, 2005)	www.uscg.mil	Provides access to training materials, a guide, and a tool to assist the user in identifying risk factors and designing controls to address them. The information in the Guide was developed specifically for, and tested on, USCG assets. The guide and accompanying tool are designed to assist the user in understanding what crew endurance risk is, recognize the factors that compromise endurance, and develop strategies to manage and control crew endurance risk. Though specifically designed for USCG crews, the information and approach may be valuable in other workplaces.
V. Baxter, S. Kroll-Smith	Normalizing the workplace nap: blurring the boundaries between public & private space & time	Current Sociology 2005: 53(1), 33-55	Examined existing evidence of napping in the workplace using interviews with corporate CEOs, NASA and DOD reports, and web-based searches. Cited research supporting benefits of napping for workers during prolonged, irregular, and/or sustained work schedules.
A. Dahlgren, G. Kecklund, T. Akerstedt	Different levels of work-related stress & the effects on sleep, fatigue & cortisol	Scand J Work Environ Health 2005: 31(4), 277-285	Study compared effects of high stress and low stress work weeks for 55 Swedish office workers, indicating more sleepiness and sleep problems, including shorter sleep length during the high stress week, which was hypothesized to have the potential for health effects on a long-term basis. In addition, effects of

Author(s)	Title	Publication	Findings/Recommendations
			the high stress week carried over into the weekend, interfering with recuperation/restoration. Might be important to keep in mind when scheduling time off after numerous high stress extended work days during a disaster response (i.e., the longer the duration of the extended work hours period, the longer the amount of time should be allowed for recuperation/restoration).
X. Dong	Long work hours, work scheduling and work-related injuries among construction workers in the US	Scand J Work Environ Health 2005: 31(5), 329-335	Examined possibility of connections between number of hours worked and safety outcomes among construction workers, using a national sample of 2,100 construction workers. Study found that when workers worked more than 40 hrs/wk, injury risk increased slightly; over 50 hrs/wk, risk nearly doubled. Suggestions included providing more on-site breaks during the work day and public policy intervention to establish a ceiling on number of hours worked during a specific time frame.
Unknown	Shift work: too much overtime might compromise safety. (EHS News)	Occupational Hazards 2005: 67(1), 17	Quoted from study conducted by Circadian Technologies, Inc., which found a correlation between increased overtime hours and health care and worker’s compensation costs. Also indicated that high overtime levels can lead to increased stress, absenteeism, and turnover, which also can

Author(s)	Title	Publication	Findings/Recommendations
			compromise workplace health and safety.
R. Cordeiro, A. Dias	Stressful life events and occupational accidents	Scand J Work Environ Health 2005: 31(5), 336-342	Population-based case-control study of the influence of non-work-related factors on occupational accidents experienced by108 workers in Botucatu, Brazil; findings indicated contribution to accident levels by variables outside the work environment.
Editorial	Long work hours are a safety risk – causes and practical legislative implications	Scand J Work Environ Health 2005: 31(5), 325-327	Recent studies indicate that long work hours should be considered a serious accident-contributing factor; regular breaks may help to prevent accidents in industrial settings; need to increase public's awareness of risks associated with long work hours; recommendation that maximum work shifts not exceed 12 hours and work weeks not exceed 45 hours.
Editorial, M. Kompier	Assessing the psychosocial work environment – "subjective" versus "objective" measurement	Scand J Work Environ Health 2005: 31(6), 405-408	Noted that both "subjective" (e.g., questionnaires) and "objective" (e.g., physiological) measurements are useful data collection tools in job-related stress research. Recommends the Copenhagen Psychosocial Questionnaire (COPSOQ) as being scientifically grounded and because it pays attention to risk evaluation.
R. Kalimo	Editorial: Reversed causality – a need to revisit systems modeling of work-	Scand J Work Environ Health 2005: 31(1), 1-2	Acknowledged the merits of recognizing that the mental health-work characteristics relationship is not a one-way flow, but rather, a non-linear

Author(s)	Title	Publication	Findings/Recommendations
	stress-health relationships		cybernetic system with continuous feedback (i.e., mental health affects work as well as the other way around).
A.E. Dembe, J.B. Erickson, R.G. Delbos, S.M. Banks	The impact of overtime and long work hours on occupational injuries and illnesses: new evidence from the U.S.	Occup Environ Med 2005: 62, 588-597	Analysis of 110,236 job records from a nationally representative sample of American workers over a 13-year period indicated a 61% higher injury hazard rate for workers in jobs with overtime schedules; a 37% increased hazard rate for working at least 12 hours/day; and a 23% increased hazard rate for working at least 60 hours/week. Protective measures suggested included periodic rest breaks, using more people for fewer hours, health promotion education programs, periodic medical surveillance programs, and supportive services.
A. Sharifian, S. Farahani, P. Pasalar, M. Gharavi, O. Aminian	Shift work as an oxidative stressor	Journal of Circadian Rhythms, 2005: 3, 15	Study conducted with 44 workers on a rotational shift schedule to evaluate the effect of night shift working on total plasma antioxidant capacity relating to the role of oxidative stress in the induction of such disorders as cardiovascular disorders. Oxidative stress occurs when the production of free radicals exceeds the body's antioxidant capacity. Study indicated that shift work can act as an oxidative stressor and, as age and body mass index rise, reduce the body's antioxidant system's effectiveness. Suggested special dietary regime, including antioxident agents.

Author(s)	Title	Publication	Findings/Recommendations
A. Kerin, A. Aguirre	Improving health, safety and profits in extended hours operations (shift work)	Industrial Health 2005: 43, 201-208	Promotional article focusing on benefits of training in shift work lifestyle management CIRCADIAN offers for managers, employees, and families. Claims significant reductions in sleep, gastrointestinal, caffeine consumption, and family relationship issues following their training.
C. Fritz, S. Sonnentag	Recovery, health, and job performance: Effects of weekend experiences	J of Occ Health Psych, 2005, 10(3), 187-199	Study of 87 emergency medical service workers in Germany to examine the effects of weekend experiences on the extent of recovery from the work week. Findings included positive effects of social activities during the weekend in terms of decreased burnout and increased general well-being and negative effects of non-work-related hassles on both well-being and post weekend work performance. Has potential implications for disaster response situations once the emergency/rescue phase has passed, but extended and/or around-the-clock work hours are still on-going.
P. Tucker, C. Rutherford	Moderators of the relationship between long work hours and health	J of Occ Health Psych, 2005, 10(4), 465-476	Study of 372 British train drivers to determine the relationship between work hours and self-reported health as moderated by reasons for working overtime (e.g., voluntary/mandatory), schedule autonomy, and degree of social support. Found limited evidence of a relationship between long weekly work

Author(s)	Title	Publication	Findings/Recommendations
			hours and negative health effects among workers who lacked both schedule autonomy and social support.
OSHA	Quick Card: Protect Yourself Heat Stress (2005)	www.osha.gov	Short publication that may be used as a training tool for workers. Includes quick tips on factors leading to heat stress, symptoms of heat exhaustion, symptoms of heat stroke, preventing heat stress, and what to do for heat related illnesses.
B.A. Jackson, J.C. Baker, M.S. Ridgely, J.T. Bartis, H.I. Linn	Protecting Emergency Responders: Vol. #: Safety Management in Disaster and Terrorism Response	2004, DHHS(NIOSH) Publication NO. 2004-144; RAND Publication No. MG-170	Report based on post-9/11 research as well as experiences with the Northridge earthquake and Hurricane Andrew. Calls for improving responder health maintenance by preparing and implementing sustainability measures, including appropriate work/rest ratios when dealing with extended duration responses.
S. Folkard, D.A. Lombardi	Work schedules: shift work and long work hours – modeling the impact of the components of long work hours on injuries and "accidents"	Conference on Long Working Hours, Safety, and Health: Toward a national research agenda, April 29-30, 2004, CDC/NIOSH	Effort to develop a statistical model based on trends in the relative risks of accidents relating to working hours. Identified a deterioration in performance and alertness on 12-hr shifts in comparison with 8-hr shifts and a related risk of accidents; increased risk of accidents as the day progresses, with the highest risk on the night shift; and increased risk over successive night shifts. Identified factors to be considered when looking at effects of work schedules: number of hours worked per shift, number of hours

Author(s)	Title	Publication	Findings/Recommendations
			worked per week, and number of successive shifts worked.
C.C. Caruso, E.M. Hitchcock, R.B. Dick, J.M. Russo, J.M. Schmidt	Overtime and extended work shifts: recent findings on illnesses, injuries, and health behaviors	CDC/NIOSH, April 2004	Integrative review of 52 recently published research reports examining the connection between long working hours and illnesses, injuries, health behaviors, and performance. Found a pattern of deteriorating performance on psychophysiological tests and injuries while working long hours, especially with very long shifts and when 12-hour shifts were combined with more than 40/hrs/wk. Ninth-12th hrs associated with feelings of decreased alertness, increased fatigue, lower cognitive function, reduced vigilance, and increased injuries.
Alberta Human Resources and Employment	Fatigue, Extended Work Hours, and Safety in the Workplace (ERG015, 2004)	http://employment.alberta.ca/ cps/rde/xchg/hre/hs.xsl/563.html	Workplace Health and Safety Bulletin that discusses fatigue, extended work shifts, and safety in the workplace. Includes sections on: Sleep Loss and Sleep Disturbances, Extended Hours of Work, Time of Day and Incidents, Health and Safety Issues, and Coping at Work.
National Wildfire Coordination Group	Interagency Incident Business Management Handbook, Work/Rest and Length of Assignment Standards (2004)	http://www.nwcg.gov/teams/ ibpwt/documents/personnel/nwcg _wr-loa_2004.htm	Guidelines developed by an interagency workgroup that address designing work/rest schedules for wildland firefighters. Includes work/rest guidelines and length of assignment. Recommendations: Generally provide for a 2:1 work/rest schedule so that for

Author(s)	Title	Publication	Findings/Recommendations
			every 2 hours of work or travel, one hour of sleep and/or rest is provided. Assignment length generally set to 14 days of work with 2 days off. Also provides guidelines for back to back assignments and extending assignments.
S. Folkard & P. Tucker	Shift work, safety and productivity	*Occupational Medicine*, 2003; 53: 95-101.	Reviews findings of a number of studies of safety and productivity during different work shifts, concluding that both safety and productivity are reduced at night. Of particular concern are the number of successive night shifts, the length of the night shifts, and the provision of breaks within them.
Weston Solutions	Fatigue considerations and health and safety (Power Point presentation)	Sept. 29, 2003	Power Point presentation summarizing effects of extended work schedules and presenting effective countermeasures.
A. Baker, K. Heiler, S.A. Ferguson	The impact of roster changes on absenteeism an incident frequency in an Australian coal mine	Occup Environ Med 2003: 60, 43-49	Examined the impact on employee health and safety of changes to the roster system in an Australian mine – particularly focusing on changes from 8-hr to 12-hr shifts. The study did not find significant negative effects from a 12-hr pattern, although there were peaks in accident/incident rates in the 10th hr on day shifts and the 12th hr on night shifts.
N.W.H. Jansen, L.G.P.M. van Amelsvoort, T.S. Kristensen, P.A. van den	Work Schedules and fatigue: A prospective cohort study	Occup Environ Med 2003, 60; 47-53	Study of 12,095 workers as part of the Maastricht Cohort Study on Fatigue at Work found greater levels of fatigue among three- and five-shift workers, indicating fatigue as a possible reason

Author(s)	Title	Publication	Findings/Recommendations
Brandt, I.J. Kant			for quitting shift work. Also noted that perceived job characteristics might play a role in the findings.
K.B.Parkes	Shift work and environment as interactive predictors of work perceptions	J of Occ Health Psych, 2003, 8(4), 266-281	Study of on-shore- and off-shore oil industry personnel working shift work regarding environmental effects on job perception (e.g., satisfaction). Findings indicated that greater availability of around-the-clock supporting resources (e.g., meals, recreation facilities, supervisory support) for off-shore installations resulted in more favorable job perceptions by off-shore shift workers. Has potential implications for disaster response situations once the emergency/rescue phase has passed, but extended and/or around-the-clock work hours are still on-going.
P. Tucker, S. Folkard, I. MacDonald	Rest breaks and accident risk	The Lancet, 2003, 361(9358), 680	Examined the effectiveness of 15-minute rest breaks per 2 hrs of work at a British engineering company, finding them effective in preventing the accumulation of accident risks during sustained activities.
S.L.Sauter, et al (National Occupational Research Agenda Work Team)	The changing organization of work and the safety and health of working people	DHHS (NIOSH) Publication No. 2002-116, April 2002	Develops a scientific agenda to address occupational safety and health consequences of the changing organization of work, including the risk to safety and health from long hours of work.
C. Cruz, C. Detweiler, T.	A Laboratory Comparison of Clock-	2002, DOT/FAA/AM-02/8	Study examined effects of clockwise and counter-clockwise rotating shifts. Found

Author(s)	Title	Publication	Findings/Recommendations
Nesthus, A. Boquet	wise and Counter-Clockwise Rapidly Rotating Shift Schedules, Part I. Sleep		that direction of sleep rotation did not necessarily affect sleep or fatigue ratings.
Y. Liu, H. Tanaka	Overtime work, insufficient sleep, and risk of non-fatal acute myocardial infarction in Japanese men	Occup Environ Med 2002: 59, 447-451	Case control study conducted in Japan (260 cases/445 controls) to examine the relationship between work hours, hours of sleep, and the risk of acute myocardial infarction (AMI). Findings indicated progressively increased likelihood of AMI with an increase in hours worked (e.g., greater than 61 hrs/week) and with lack of sleep (e.g., less than 5 hrs/night for 2 or more days a week). There also was an indication of a relationship with few days off in the month preceding the AMI.
M.D. Johnson, J. Sharit	Impact of a change from an 8-h to a 12-h shift schedule on workers and occupational injury rates	Intl J of Indust Ergonomics 2001: 27, 303-319	Study of the impact of moving from an 8 hr to a 12 hr rotating schedule found no significant effects on the occupational injury rate. Also found greater work satisfaction with the 12 hour schedule as it allowed more time for family, social activities, etc.
S.L. Ettner, J.G. Grzywacz	Workers' perceptions of how jobs affect health: a social ecological perspective	J of Occup Health Psych 2001: 6(2), 101-113	In a national study, 2,048 workers were asked to rate the effects of their jobs on their physical and mental health. Individuals who worked nights or more than 45 hrs/wk were more likely to report negative effects.
A. Feyer	Editorial: Fatigue:	BMJ: 2001, 322, 808-809	Urges serious attention to fatigue-related

Author(s)	Title	Publication	Findings/Recommendations
	Time to recognize and deal with an old problem		issues, particularly relating to driving; pointed out that driving after 17-19 hours without sleep is the equivalent to driving with a blood alcohol level of .05%.
K. Reid, D. Dawson	Comparing performance on a simulated 12-hour shift rotation in young and old subjects	Occup Environ Med 2001: 58, 58-62	Study suggests that age (i.e., older than 40) is an important factor in performance during a 12-hour shift rotation; performance of older subjects was consistently lower than that of younger subjects.
J.M. Harrington	Health effects of shift work and extended hours of work	Occup Environ Med 2001: 58, 68-72	Concludes that work involving long hours or abnormal night-day schedules disrupts the circadian rhythm, which can negatively affect performance, sleep patterns, accident rates, mental health, and cardiovascular mortality.
Assistant Secretary J. Henshaw (OSHA)	Interpretive letter addressed to C. Terhorst, dated 10/17/01	www.osha.gov	Acknowledges that OSHA does not have a specific standard regarding heat stress in the workplace but that OSHA has previously used the General Duty Clause to cite employers that have allowed employees to be exposed to potential serious physical harm from excessively hot work environments. Identifies a range of feasible and acceptable methods to be used to reduce heat stress hazards in workplaces including allowing workers to drink water liberally, establishing a work/rest regimen so that exposure time in high temperatures is reduced, and developing

Author(s)	Title	Publication	Findings/Recommendations
			a heat stress program (including training, medical screening, acclimatization, and first aid).
NIOSH	Health Hazard Evaluations: *Occupational Exposure to Lead* 1994 to 1999 (2001)	www.cdc.gov/niosh	The Health Hazard Evaluations and Technical Assistance (HETA) program responds to requests from employers, employees, employee representatives, other Federal agencies, and State and local agencies. The typical HETA response to a request for assistance results in an evaluation of the workplace to determine if chemical, physical, biological, or other agents are hazardous to workers. The HETA program administers health hazard evaluations (HHEs) of occupational exposure to lead and other substances. One hundred thirty-nine lead-related HHEs were conducted from 1990 to 1999. This document presents titles and summaries of the 31 HHEs related to lead that were completed between 1995 and 1999.
H.B. Pressler	Nonstandard work schedules and marital instability	Journal of Marriage and the Family 2000: 62, 93-110	A study of 3,476 married couples indicated that night and rotating shifts significantly increased the odds of marital instability for couples with children.
ACTU (Australian Council of Trade Unions)	Health and safety guidelines for shift work and extended working hours	Sept. 2000 D NO. 66/2000	Identifies health and safety and family and social effects of shift work and extended work hours and recommends guidelines to deal with these risks, including limitations on the number of

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			hours worked per week and the provision of adequate breaks.
N. Kawakami, S. Araki, N. Takasuka, H. Shimizu, H. Ishibashi	Overtime, psychosocial working conditions, and occurrence of non-insulin dependent diabetes mellitus in Japanese men	J Epidemiol Community Health 1999: 53, 359-363	Study of workers at a Japanese electrical company indicated that longer overtime (i.e., more than 50 hrs/mo) and the use of new technology were risk factors for the development of non-insulin dependent diabetes mellitus in male workers.
J. Horne, L. Reyner	Vehicle accidents related to sleep: a review	Occup Environ Med 1999: 56, 289-294	Examines sleep-related vehicle accidents (SRVAs) and concludes that SRVAs can be reduced by greater education of employers and drivers about the dangers of driving while sleepy and about the most vulnerable times of the day for SRVAs (e.g., night shift work and driving home afterwards as well as mid-afternoon for older drivers).
R. Fairfax (OSHA)	Standard Interpretations Memorandum - OSHA policy regarding PEL adjustments for extended work shifts (11/10/99)	www.osha.gov	The memorandum resolves issues concerning adjustments of the PEL during extended work shifts. The methods discussed apply to exposures to the noise levels of Table G-16 of 29 CFR 1910.95 or substances found in Subpart Z. The only standards that require PEL adjustments are the lead standards in construction and general industry. The memorandum details two methods that OSHA Compliance Officers may use when employees work extended work shifts beyond 8 hours. One is to sample the worst continuous 8-

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			hour work period of the extended shift. The second is to collect multiple samples over the entire work shift and calculate the PEL based upon the worst 8 hours of exposure during the entire work shift.
V.M. Ognianova, D.L. Dalbokova, V. Stanchev	Stress states, alertness, and individual differences under 12-hour shiftwork	Intl J of Indust Ergonomics 1998: 21, 283-291	Study of the effects of 12-hr shifts on the alertness and stress states of 22 thermoelectric power plant operators found moderate levels of increased distractibility and reduced alertness and concluded that this did not affect the workers' efficiency and reliability on 12-hr night shifts.
R. Rosa, M. Bonnet, L. Cole	Work Schedule and task factors in upper-extremity fatigue	Human Factors 1998: 40, 150-159	Laboratory study with 16 participants to test the combined effects of work schedules and task factors on upper extremity fatigue during 8-hr and 12-hr shifts. Three repetition rates and 3 torque loads were used in the simulated manual assembly task; workers self-adjusted work cycle duration to maintain moderate fatigue levels. Increased load levels and repetition rates resulted in more rapid onset of fatigue with increased work duration and during night shifts, with highest fatigue levels observed during 12-hr night shifts and similar levels observed after a week of 8-hr night shifts and a week of 12-hr day shifts. Shorter work cycles or more frequent rest periods were suggested for

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			night or extended hour day shifts.
L. Smith, S. Folkard, P. Tucker, I. Macdonald	Work shift duration: a review comparing 8-hour and 12-hour shift systems	Occup Environ Med 1998: 55, 217-229	Analysis of shift work-related literature had equivocal findings indicating both positive (e.g., improvements in family relations, increased social activities, lower commuting costs) and negative (e.g., potential for build up of fatigue, sleep curtailment, limitations to educational and recreational opportunities) aspects of 12-hr shift work; identified need for further research into possible long-term aspects of 12-hr shifts.
S. Sokejima, S. Kagamimori	Working hours as a risk for acute myocardial infarction in Japan: a case-control study	BMJ 1998: 317, 775-780	Study of 185 Japanese men admitted to hospital with acute myocardial infarction (and 331 controls) found a U-shaped relationship between hours of work and the risk of acute myocardial infarction. The increased work hours were associated with a higher daily mean blood pressure, while the shorter working hours were associated with either a premorbid condition or the loss of employment.
J.C. Duchon, T.J. Smith, C.M. Keran, E.J. Koehler	Psychophysiological manifestations of performance during work on extended workshifts	Intl J of Indust Ergonomics 1997: 20, 39-49	Prospective study of workers in a western Canadian metals mine changing from 8-hr to 12-hr shifts found high levels of acceptance by workers as well as improved sleep; however, 12-hr shifts were associated with lower work effort attributed to workers pacing themselves to cope with the longer schedule.

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R.R. Rosa, M.J. Colligan	Plain language about shift work	NIOSH July 1997	Examines effects of shift work and offers suggestions on coping with shift work for organizations and for individuals.
G. Belenky	Sleep, sleep deprivation, and human performance in continuous operations	Walter Reed Army Inst of Research, 1997, www.usafa.af.mil/jscope/JSCOPE97/ Belenky97/Belenky97.htm	Examination of the effects of sleep deprivation on battlefield performance with the conclusion that 7-8 hrs sleep/night are necessary to sustain high levels of performance over days and weeks, Consequences of sleep deprivation can include reduced mental abilities, particularly higher order mental abilities that sustain situational awareness and tactical grasp.
K. Sparks, C. Cooper, Y. Fried, A. Shirom	The effects of hours of work on health: A meta-analytic review	J of Occup & Org Psych 1997, 70:391-408	Meta-analysis of 19 studies/qualitative analysis of 12 studies found some support for a relationship between increased hours of work and increased health symptoms, particularly heart disease. Findings may be moderated by the nature of the job, the working environment, age, and personal control over working hours.
M. Westman, D. Eden	Effects of a respite from work on burnout: Vacation relief and fade-out	J of Applied Psych, 1997, 82(4), 516-527	Examined the extent of relief from job stress and burnout provided by vacation respites, finding that vacations have an abrupt, positive effect that fades gradually, disappearing within 3 weeks. Calls for research into additional beneficial ways to facilitate recovery from job stress (e.g., short daily respites such as time off for physical exercise,

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			meditation, "power naps," etc.).
P. Tucker, J. Barton, S. Folard	Comparison of eight and twelve hour shifts: impacts on health, wellbeing, and alertness during the shift	Occup & Envir Med 1996: 767-772	Study of male chemical workers working 12-hr (n=92) and 8-hr (n=70) shifts found similar levels of psychological health and gastrointestinal complaints for both shift types and fewer cardiovascular disease symptoms among the 12-hr shift workers; 12-hr shift workers reported less disruption to social lives; both groups reported similar levels of alertness during the morning, although the 12-hr group experienced lower levels of alertness in the afternoon. Authors concluded that sequencing and timing of shifts might be more important than duration.
R.R. Rosa	Extended workshifts and excessive fatigue	J Sleep Res 1995: 4, Supple. 2, 51-60	Urges precautions in the use of extended work shifts, particularly when going 6-12 hrs past a 12-hr shift; also points out specific vulnerability to fatigue and sleepiness of workers in the final 4 hrs of a 12-hr night shift.
P. Totterdell, E. Spelten, L. Smith, J. Barton, S. Folkard	Recovery from work shifts: how long does it take?	J of Applied Psych, 1995, 80(1), 43-57	Study examined the amount of time needed to recover from day and night work shifts and found benefits from increased time for recovery (2 days rather than 1 day), particularly after night shifts. Findings also may be applicable to periods of extended work hours.
D.M. Jones, A.P. Smith	Handbook of Human Performance: Vol. 3:	Academic Press – Harcourt Brace Jovanovich, 1992, London	The type of sleep essential for brain restitution occurs during the first 5 hrs of

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(Eds.)	State and Trait		sleep; sleep during the inappropriate circadian phase is more difficult to maintain, more fragmented, and less restorative; sleep and performance are closely tied to the rising and falling of the body core temperature, with performance peaking with rising temperature and falling with the temperature trough (i.e., 2-6 am).
Office of Technology Assessment	Biological rhythms: implications for the worker: new developments in neuroscience	Congress of the U.S., 1991	Excellent, although a bit dated, overview of circadian rhythms, and how they can be affected by both shift work and extended work hours, particularly when extended into the evening and night hours. Points out reductions in efficiency and effectiveness when the circadian rhythm is disrupted, which have implications for decision making competence as well as for occupational safety.
L. White, B. Keith	The effect of shift work on the quality and stability of marital relations	J of Marriage & the Family 1990: 52(2), 453-462	Study of 1,668 married women and men indicated that shift work significantly increases the probability of divorce. Authors speculate that shift work encourages more independent life styles, reducing spouses' psychological dependence, and increases exposure to alternative attractions.
S.L. Sauter, L.B. Murphy, J.J. Hurrell, Jr.	Prevention of work-related psychological disorders: A national strategy proposed by	Amer. Psychologist, 1990, 45(10), 1146-1158	Recognizes the importance of psychological disorders as a leading occupational health problem. Identifies the extent of individual control and

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	NIOSH		involvement in work schedule determination as an important factor relating to negative health outcomes. Makes recommendations for controlling psychological risks factors at work, including providing for sufficient recovery from demanding tasks and/or allowing for increased individual job control.
USDA Forest Service	Fatigue Awareness Power Point Pres.	Missoula Technology and Development Center	Educational presentation on factors leading to fatigue, signs and symptoms of fatigue, strategies for dealing with fatigue. Recommends: 2:1 work/rest ratio, 14 hr shifts, 14-day deployments, and leadership monitoring and management of worker fatigue.
OSHA	Frequently Asked Questions: Extended Unusual Work Shifts	www.osha.gov	Short publication discussing what extended work shifts and unusual shifts are, what workers should know about the hazards, and what can be done to address the hazards.
DOT	Fatigue Resource Directory	http://human-factors.arc.nasa.gov/zteam/fredi/home-page.html#toc	The directory was originally compiled in conjunction with the NASA/NTSB Symposium Managing Fatigue in Transportation: Promoting Safety and Productivity which was held in Tysons Corner, Virginia on November 1-2, 1995. The directory is now maintained by the DOT. The purpose of the Fatigue Resources Directory is to provide transportation-industry members with current, accessible information on

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			resources available to address fatigue in transportation. It includes section on: Fatigue in Transportation, Countermeasures, Government Activities, Industry Activities, Public Interest Groups, and Scientific Information.
OSHA	Safety and Health Topics Page on Heat Stress	www.osha.gov	Index of weblinks to OSHA and other organizations resources on Heat Stress. Weblinks are grouped under: What OSHA standards apply, What are the hazards and possible solutions associated with heat stress, and What additional information is available.