Interim Guidance for Protecting Deepwater Horizon Response Workers and Volunteers

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and
Occupational Safety and Health Administration
U.S. Department of Labor

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Recommendations contained in the Interim Guidance will be updated as more information about exposures is collected and assessed in relationship to the incidence and prevalence of symptoms, illnesses and injuries.

The recommendations provided in this Interim Guidance focus on issues specific to the Deepwater Horizon Response and do not address issues common to all disaster response work activities. For more information on general disaster response, consult the NIOSH Emergency Response Topic Page at http://www.cdc.gov/niosh/topics/emergency.html.

I. General Recommendations

The National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) recognize that many important and well-considered efforts to protect the health and safety of Deepwater Horizon Response workers and volunteers are currently being implemented. To ensure a comprehensive approach to safety and health, NIOSH and OSHA recommend that:

1. Exposures to toxic chemical and physical agents, heat, fatigue and psychological stress should be reduced by using engineering and administrative controls (including work-rest cycles, distance, location and barrier protection) and, where necessary, the use of personal protective equipment (PPE);

2. Exposures to toxic chemical and physical agents should be comprehensively and routinely assessed during work activities under varying conditions. Validated methods for area and personal breathing zone sampling should follow an approved, standardized and comprehensive Deepwater Horizon Response air sampling plan coordinated among all relevant government agencies and non-governmental organizations (and their contractors) that are conducting sampling activities;

3. Dermal exposures to crude oil and toxic chemical agents should be minimized and appropriate PPE should be worn for response activities in which the chance for dermal exposure is high;

4. Selection and use of PPE, including the full protective ensemble, should consider and address the potential to increase heat stress problems in workers and volunteers;

5. All workers and volunteers should be educated about hazards associated with response activities,[1] encouraged to participate in worker and volunteer rostering,[2] and have a pre-placement medical evaluation;

6. All health symptoms, illnesses, injuries or near-misses related to work activities should be reported by workers and volunteers; should be recorded by employers, contractors and volunteer organizations; and should be evaluated by safety and health or licensed health care professionals with action taken to protect workers;

7. Periodic, systematic reviews and evaluation of health symptoms, illnesses, injuries or near-misses related to work activities should be done and preventive action taken; and

8. Workers and volunteers should be provided training and assistance to prevent psychological stress associated with response activities and to support resiliency.[3, 4]

II. Health Effects from Crude Oil and Oil Dispersant Exposure

Crude oil is a complex mixture of chemical constituents including various alkanes (butane, pentane, and hexane); aromatic hydrocarbons (benzene, ethyl benzene, toluene, and xylenes); cycloalkanes; other nitrogen, oxygen, and sulfur compounds (hydrogen sulfide); and trace metals such as iron, nickel, copper and vanadium. Some constituents of crude oil can have significant toxicity. For example, several aromatic hydrocarbons are considered to be human carcinogens.[5] The International Agency for Research on Cancer (IARC) indicates that for crude oil, there is inadequate evidence for the carcinogenicity in humans, although there is limited evidence for carcinogenicity in experimental animals.[6]

Hydrocarbon exposure from crude oil constituents will vary based on its exposure to the atmosphere, time in the marine aquatic and coastal environment, treatments with dispersants and interaction of the chemicals, wave action and heat. Generally, the more “aged” or “weathered” crude oil is (by mixing with seawater and traveling long distances from the source), the lower are the concentrations of volatile organic compounds (VOCs). Although it generates less VOCs, weathered crude oil still contains harmful chemicals which can cause skin irritation and other irritant reactions. Thus, use of gloves and protective clothing is recommended to minimize skin contact with weathered oil, including oil deposited on the shore (“tarballs” or “tarpatties”). Appropriate hand hygiene facilities should be readily available to clean incidental skin exposures.

Weathered crude oil is unlikely to pose an inhalation risk although a potential risk does exist for it to be aerosolized into respirable airborne droplets or volatilized by activities such as pressure washing. Even though detection of hydrocarbon “odors” is common in areas contaminated by crude oil, odor is not a reliable indication of a health hazard. Some individuals, though, are bothered by odors and can develop symptoms (e.g., may report dizziness, nose and throat irritation, headache and/or nausea). These individuals may need medical evaluation when symptoms occur, especially if severe or persistent. Individuals with severe or persistent symptoms should be relocated to perform tasks where symptoms can be alleviated.

Studies of tanker oil spill responses have reported adverse health effects in response workers.[7,8,9,10,11,12,13,14,15] A summary of studies about the human health effects associated with selected oil tanker disasters can be found in Appendix A. These studies may underestimate the health effects associated with the Deepwater Horizon Response activities since the magnitude and duration of the Response is unprecedented. In addition, there is an incomplete understanding about the human health toxicity associated with the use of large amounts of dispersant, about the toxicity of the mixed exposure to large amounts of crude oil, dispersants and combustion products together and the cumulative effect of such exposures occurring over a long duration.

Since knowledge about potential inhalational exposures to the mixed exposure of crude oil, dispersant and combustion products associated with the Deepwater Horizon Response work is incomplete and still evolving, NIOSH and OSHA believe it is prudent to reduce the potential for adverse health effects by the responsible use of engineering controls, administrative controls and PPE, including respirators when appropriate. In the absence of comprehensive and coordinated health surveillance among workers and volunteers, and the absence of interpretable, quantitative exposure data, NIOSH and OSHA recommend that employers take precautions sufficient to ensure workers are protected from the chemical, physical and psychological hazards posed by the Deepwater Horizon Response.

Note 1: OSHA is currently monitoring worker exposures and looking for levels of airborne exposure shown likely to cause health effects from chemical exposure to fresh crude oil, weathered oil, dispersants, cleaning agents and other materials. Current OSHA monitoring results can be found at http://www.osha.gov/oilspills/oil_directreading_bysite.html. To date, no air sampling by OSHA has detected any hazardous chemical levels of concern.

Note 2: At the request of BP, NIOSH is conducting health hazard evaluations (HHEs) to evaluate worker exposures and health effects from the fresh crude oil, weathered oil, dispersants, cleaning agents, and other chemicals (e.g., diesel emissions) across all response activities. NIOSH is posting updates about HHE activities on the NIOSH website at http://www.cdc.gov/niosh/hhe/ .

III. Conducting Exposure Assessment

At this time, there is a need for a coordinated, comprehensive and routine air sampling plan for all response worksites among those government agencies and non-governmental organizations (and their contractors) that are conducting sampling activities. A comprehensive exposure assessment of the Deepwater Horizon Response work activities involves evaluation of multiple different work settings, each with its own set of exposure variables. These work settings involve changing weather conditions, various types and amounts of VOCs being released, work tasks resulting in potential skin and inhalational exposures, and exposure to wildlife and physical hazards, such as heat, snakes and insects. In addition, response workers and volunteers are engaging in activities that may be unfamiliar, thus increasing the potential for injury or exposure.

Exposure assessment to hydrocarbons using traditional 8-hour, 40-hour per week, shifts should be adjusted to reflect the greater duration of work shift and work week exposure experienced by Deepwater Horizon Response workers. Most existing occupational exposure limits for determining harmful levels of chemical agents are based on an 8-10 hour workday and a 40-hour work week.[16] For extended hours, downward adjustment should be made to the exposure limit based on hours worked. Rote application of exposure criteria without adjustment will not provide sufficient protection to workers engaged in long-duration response work. Published methods are available to adjust exposure criteria for extended work shifts.[17]

Respiratory protection precautions are necessary for uncharacterized chemical exposures until the need for such precautions has been ruled out by comprehensive assessment of exposures to toxic chemical agents during work activities under a variety of relevant conditions. Quantitative methods for area and personal breathing zone sampling should follow an approved, standardized and representative Deepwater Horizon Response air sampling plan coordinated among all government agencies and non-governmental organizations (and their contractors) which are conducting sampling activities. Routine, ongoing exposure assessment should continue as part of a comprehensive worker safety and health program.

IV. Pre-Placement Medical Evaluation

NIOSH developed recommendations for pre-placement medical evaluations for workers involved in the Deepwater Horizon Response (http://www.cdc.gov/niosh/topics/oilspillresponse/preplacement.html). These recommendations are designed to: (1) provide health care professionals with guidance on the important elements of a pre-placement evaluation; (2) assist health care professionals in identifying (a) workers with health concerns that need to be addressed, (b) workers that may have specific susceptibilities for whom activities may need to be restricted or modified, and (c) workers with medication, immunization or training needs; and (3) provide valuable information to the worker on his/her health status and the potential demands of the work they are undertaking. However, NIOSH recommendations are not intended to replace existing medical evaluation programs.

V. Medical Care and Symptoms, Near-Miss, Injury and Illness Reporting and Recording

Workers are urged to report any symptoms they associate with their response work to their employer, their physician, poison control center, state or local health department or a local health facility. Symptoms reported from excessive exposure to crude oil/dispersants commonly include eye, nose and throat irritation, headache, dizziness, upset stomach, cough or shortness of breath.

Workers are urged to seek medical attention for any symptoms they associate with their response work. Workers should also have immediate access to medical care provided by licensed healthcare professionals with appropriate expertise. All medical conditions should be assessed for work-relatedness of the illness or injury.

As a part of a comprehensive worker safety and health program, there should be a system for reporting symptoms, near-misses, injuries and illnesses, and workers should be encouraged to report these occurrences. Symptoms, near-misses, illness and injury data should be analyzed to assess real-time trends so that preventive actions can be taken to prevent similar incidents. This information is also useful in identifying the potential for long-term health effects. Symptoms, near-miss, illness and injury data should be readily available to all partners, including state and local health officials, as well as the general public.

VI. Heat Stress Prevention

Deepwater Horizon Response workers and volunteers are at very serious risk for developing heat stress. Many heat stress programs already have been implemented in the Deepwater Horizon Response. The following discussion is meant to review the basic elements of a heat stress program. Excessive exposure to hot environments can cause a variety of heat-related problems, including heat stroke, heat exhaustion, heat cramps, and fainting. Heat can also increase the risk of injuries in workers from sweaty palms, fogged-up safety eyewear, and dizziness. Protective clothing and other PPE will increase the risk of heat-related problems. PPE should be selected to minimize heat stress on the wearer.

Workers at greater risk of heat stress include those who are 65 years of age or older, are overweight, have heart disease or high blood pressure, or take medications that may be affected by extreme heat. Heat stroke is the most serious heat-related disorder and occurs when the body becomes unable to control its temperature; the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. Heat stroke can cause death or permanent disability if emergency treatment is not given. Note that requiring or allowing workers to use certain types of PPE, particularly dermal PPE, that is not required for their specific work task, will increase the potential for the development of heat stress.

Prevention of heat stress in workers is important. A heat stress program should be developed that includes the following elements:

- A training program informing workers about the effects of heat stress, and how to recognize heat-related illness symptoms and prevent heat-induced illness;
- A heat acclimatization program for new workers or workers returning to work from absences of three or more days;[18]
- Specific procedures to be followed for heat-related emergency situations;
- Provisions to administer first aid immediately to workers displaying symptoms of heat-related illness.

Additional elements of a heat stress program may include the following:

- Addressing and reducing physical demands on workers;
- Using relief workers or assigning extra workers for physically demanding jobs;
- Providing cool water to workers—avoiding drinks with caffeine, alcohol, or large amounts of sugar;
- Establishing specific work-rest regimens based on the physical demands and environmental heat-related conditions;
- Scheduling work cycles to coincide with cooler temperatures in the day or night;
- Providing cool and shady areas for use during rest breaks; and
- Monitoring workers through a buddy system for signs of heat stress.

Several resources about preventing heat stress are available at the following websites:

NIOSH (http://www.cdc.gov/niosh/topics/heatstress/)
OSHA (http://www.osha.gov/SLTC/heatstress/index.html)
Cal/OSHA (http://www.dir.ca.gov/dosh/healthillnessinfo.html)

VII. Fatigue Prevention

Disaster response workers often work longer shifts and more consecutive shifts than the typical 40-hour work week. Working longer hours may increase the risk of work injuries and accidents and can contribute to poor health. The scientific literature indicates that working at least 12 hours per day was associated with a 37% increased risk of injury[19] and construction workers working more than 8 hours per day had a 15% higher injury rate.[20] Fatigue and stress from strenuous work schedules can be compounded by heavy physical workloads, unfavorable environmental conditions (e.g., damaged infrastructure, hazardous materials and debris, sparse living conditions), long commutes, and personal demands on workers.

Therefore, disaster response organizations should have management plans in place to minimize fatigue risks, recognize hazards, and provide regular opportunities for worker rest and recovery. The National Response Team, an organization of 15 Federal departments and agencies responsible for coordinating emergency preparedness and disaster response, has prepared guidance and checklists for managing fatigue during disaster recovery operations.

Consider the following general guidelines: [21,22,23,24]

- *Regular Rest:* Establish at least 10 consecutive hours per day of protected time off-duty in order to obtain 7-8 hours of sleep. Rest and a full complement of daily recovery sleep are the best protections against excessive fatigue in sustained operations. Allowing only shorter off-duty periods (e.g. 4-5 hours) can compound the fatigue of long work hours.

- *Rest Breaks*: Frequent brief rest breaks (e.g., every 1-2 hours) during demanding work are more effective against fatigue than few longer breaks. Allow longer breaks for meals.

- *Shift Lengths*: Five 8-hour shifts or four 10-hour shifts per week are usually tolerable. Depending on the workload, twelve-hour days may be tolerable with more frequent interspersed rest days. Shorter shifts (e.g. 8 hours), during the evening and night, are better tolerated than longer shifts. Fatigue is intensified by night work because of nighttime drowsiness and inadequate daytime sleep.

- *Workload*: Examine work demands with respect to shift length. Twelve-hour shifts are more tolerable for "lighter" tasks (e.g., desk work). Shorter work shifts help counteract fatigue from highly cognitive or emotionally intense work, physical exertion, extreme environments, or exposure to other health or safety hazards.

- *Rest Days*: Plan one or two full days of rest to follow five consecutive 8-hour shifts or four 10-hour shifts. Consider two rest days after three consecutive 12-hour shifts.

For additional information on working hours, see www.cdc.gov/niosh/topics/workschedules.

VIII. Traumatic Incident Stress Prevention

Workers and volunteers may experience stress and fatigue when they respond to environmental disasters, both natural and human-caused. Deepwater Horizon Response workers and volunteers are at risk of feeling uncomfortable levels of stress from what mental health professionals refer to as a *traumatic incident*. The term *traumatic* is used because of an unexpected and troubling change in the natural order of things, such as the untimely death or injury of oil-covered wildlife and the impact on fishing communities and the environment. It is important that responders monitor their health and well-being during their response activity period, and even months after their response work has ended.

Specific recommendations to help manage responder stress and fatigue during and after a response (in addition to tips for parents, teachers, and response workers) can be found on the Substance Abuse & Mental Health Services Administration (SAMSHA) website at http://samhsa.gov/Disaster/ and the NIOSH website at http://www.cdc.gov/niosh/topics/oilspillresponse/traumatic.html.

IX. Use of Personal Protective Equipment

A variety of PPE will be needed by Deepwater Horizon Response workers and volunteers. Administrative controls and engineering controls should be utilized first to minimize the need for PPE in any particular job. Where such controls will not effectively minimize the exposures, then PPE will be necessary. Appropriate selection of PPE begins with answering two questions: (1) what are the hazards faced by a worker or volunteer in a particular job? (2) what is the anticipated level of hazard exposure for a worker or volunteer in doing that job?

Crude oil and its constituents, as well as oil dispersants, can cause skin irritation and inflammation. NIOSH and OSHA recommend avoiding all unprotected skin and eye contact to crude oil, dispersants and other chemicals used during response activities. PPE to prevent skin contact must be selected carefully for use in a hot, wet environment. Skin damage due to chaffing from increased sweating, coupled with the mechanical stress of ill-fitting PPE, can compromise the skin's natural barrier against bacteria. In addition, the use of sunscreen, shaded safety glasses and wide-brimmed hats are recommended.

For many response tasks, gloves, protective clothing and protective footwear will be necessary. Several types of materials are capable of protecting against crude oil, including those made from neoprene, nitrile and butyl rubber, as well as other commercially available products. PPE should be evaluated before purchase and use by contacting the manufacturer to be sure it has barrier performance against the expected exposures. For eye/face protection, safety glasses, safety goggles, or face shields may be required depending on the specific work activity.

A good source for information about eye and face protection, protective clothing, gloves and protective footwear can be found at http://www.osha.gov/oilspills/oil_ppematrix.html.[25]

A. Guidance on Selection of Protective Clothing

Choosing the proper chemical and flame resistant protective garments is an exercise in the selection of fabric, seam and design. The selection must be based on expected exposure and verified by field audits and changed if the selected PPE does not perform adequately. The potential for contribution to heat stress must also be considered in the selection of protective clothing, in addition to the potential exposure to fire, water, oil and tar, and other chemicals.

In general, overprotection from chemical and fire exposure generally creates a greater potential for heat stress. Partial body garments such as aprons and sleeves may be used to help reduce the risk of increased heat stress where the potential for heavy exposures to certain parts of the body is limited and hygiene facilities to handle incidental exposures exist. Evaluate the job to determine where it is feasible to use lower levels of PPE to reduce potential heat stress.

1. Selection of Fabric

When exposures may require repulsion of droplets of oil, repellant-treated fabrics should be used. Some treated fabrics will become oil soaked when subjected to higher quantities of liquid oil under pressure. Coated fabrics generally offer a higher level of barrier to liquid oil and are divided into two categories – impermeable and selectively permeable barrier materials or fabrics. Both types will provide a physical barrier to liquid and solidified oil. These fabrics come in a range of weights and durability. Full body garments made from impervious film fabrics have higher potential for heat stress. Microporous film fabrics often use thin films to achieve high moisture transport. These products may be easily abraded and damaged, thus compromising the barrier protection of the fabric. Uncoated or permeable fabrics, spun-bonded polypropylene and polypropylene SMS (spunbond/meltblown/spunbond), will, in general, absorb or allow penetration of oil but typically result in lower heat stress for the wearer. Garments made with permeable fabrics should be considered in situations where little or no liquid oil contact is expected, such as removing tar balls from the beach. Partial body garments, such as sleeves and aprons worn over these garments, can provide added barrier protection in areas of the body where greater exposure is expected or observed. Partial body garments can be made from the same impermeable fabrics or from impervious film fabrics. Flame resistant clothing should be selected in accordance with 29 Code of Federal Regulations (CFR) Section 1910.132, the General Industry Standard for PPE.

2. Selection of Seams

Taped and welded seams are appropriate when the seams will come into contact with liquid chemicals under pressure or when there is sufficient liquid to form pools, puddles or run-off on the garment. Garments made from impervious film fabrics should have welded or taped seams to prevent liquids from entering through the seams when significant contact with liquids is expected. Sewn, serged or bound seams without sealing tape should only be considered in situations which involve minimum liquid volumes and minimum contact pressure. Sewn, serged or bound seams are normally found on most garments made from uncoated fabrics, microporous film fabrics, and some garment made with lightweight impervious film fabrics.

3. Selection of Design

The most common form of chemical and flame resistant clothing is the coverall. However, full body protection can also be obtained with the combination of jacket and bib overalls, or a shirt and pants combination. The protection provided by the garment closure and interface areas between garments should be considered when selecting PPE. Closures and interface areas (i.e., glove to jacket) provide a potential point of entry for hazards. If significant liquid contact is expected, the closure and interface areas should be minimized and provide the same level of protection as the rest of the garment. If less than full body protection is acceptable, partial body garments present a significantly lower heat stress impact than full body coveralls. There are many job activities associated with this response where the worker will have localized exposure to contaminated materials or fire. Partial body garments, such as sleeves, aprons, pants and shirts, can help protect those parts of the body that will be potentially exposed, such as forearms, front of the body or legs.

Note: Workers should remove gloves, and any other PPE that could contaminate food or drink, and thoroughly wash their hands with soap and water before eating. Workers should also remove all PPE before leaving the contaminated area at the end of the shift to reduce take-home exposure.

B. Reuse of Personal Protective Equipment

Consult the manufacturer's instructions on whether personal protective equipment should be disposed of or cleaned after use. If it can be cleaned, consider whether any special procedures are required for disposing the decontaminated waste. Tears, rips, pinholes, and other damage can result in penetration of the crude oil or other contaminants through the PPE. When damage is present, the PPE generally will need to be replaced since repair is often impractical.

1. Protective Clothing and Gloves

All chemicals including crude oil can be expected to permeate through protective barriers sooner or later. Permeation can take place without visible evidence in the protective materials. Many manufacturers of PPE, in particular manufacturers of gloves, will provide information on breakthrough times from various chemicals (time it takes for the chemical to pass through the protective material). The PPE will need to be removed and discarded prior to the stated breakthrough time. Users should consult with the specific manufacturer to confirm the performance of their product.

2. Respirators

Given the warm and humid conditions existing during the Deepwater Horizon Response, disposable filtering facepiece respirators will likely need to be discarded after several hours of use, in part because they will become moist with perspiration. These respirators should be discarded and replaced if they are soaked, contaminated, damaged, or hard to breathe through. For intermittent use of disposable filtering facepiece respirators, they may be stored in a clean, breathable container, such as a paper bag between uses. Disposable filtering facepiece respirators must be used only by a single wearer. Elastomeric respirators can be cleaned, disinfected and reused. Specific information on cleaning re-usable respirators can be found in the OSHA Respiratory Protection Standard. [26]

C. Use of Respiratory Protection

A decision to use respiratory protection should be based on the best available qualitative information using the expert opinion method and on the best available comprehensive quantitative information about the type and level of exposure to toxic chemical and physical agents by the inhalational route. The use of effective engineering and administrative controls, and other personal protective equipment should be implemented before the use of respirators for worker protection is considered.

1. Source Control Activities

The source control vessels conduct activities closest to the area where crude oil appears on the surface, including drilling relief wells, conducting underwater operations at the source including dispersant application, and providing support and supplies. If surface application of dispersant is deemed necessary, it should be applied at a safe distance from vessels operating in the area. Variable concentrations of hydrocarbons are likely present in the air in and around these vessels. Engineering and administrative controls should be used to control hydrocarbon vapor levels during source control activities, but exposures to crude oil-derived VOCs and other constituents may not be eliminated entirely. Significant spikes in concentrations may occur unexpectedly, and would necessitate donning a respirator especially when engineering and administrative controls cannot provide protection.

For workers involved in source control activities, respirators should be used in those situations where potentially excessive exposure is reasonably anticipated or where indicated by exposure assessment or where symptoms/health effects are being reported. Where eye protection is not needed against irritating gases/vapors, NIOSH and OSHA recommend using a half facepiece respirator. If eye protection is needed, NIOSH and OSHA recommend a full facepiece elastomeric respirator with an organic vapor/P100 cartridge. A full facepiece respirator provides eye protection against irritating gases/vapors and a relatively high level of respiratory protection when exposures are variable and potentially higher. Cartridges including P100 particulate filters (oil resistant) are recommended over N95 filters (not resistant to oil aerosols). The combination organic vapor/P100 cartridge provides comprehensive protection against both particulates and gases and vapors, and the P100 filter provides some protection against water mist for the organic vapor filter component.

2. Off-Shore Activities

a. Vessels Involved in Burning Crude Oil

Vessels involved in crude oil burning are exposed to crude oil/dispersant that is less aged and may emit more VOCs than crude/dispersant closer to shore that may have undergone more weathering. The primary hazards from in-situ burns are likely to be heat, exposure to products of combustion and, rarely, flash fire. Some vessels engaged in burning may be working in close proximity to source control activities.

Products of combustion will include a complex mixture of particulate matter, smoke and soot; VOCs such as partially oxidized alcohols, aldehydes, and ketones; metals like vanadium, chromium, and nickel; and gases such as carbon dioxide and carbon monoxide.[27,28] The chemical composition of these emissions will vary based on the oil composition, weather conditions during each burn, and the completeness of the combustion process. When in-situ (i.e., on-site) burns are conducted, they should be conducted remotely with all vessels positioned upwind at an adequate distance away from the resultant smoke plume. Every effort should be made to keep workers from the area of the smoke plume, and to evacuate them as quickly as possible when changing conditions may put them in the area of the contaminants of the burn.

Under ideal conditions, vessels will be located a sufficient distance upwind from burns, and respiratory protection may not be necessary. The employer should assess the specific job tasks before the burning activity to evaluate potential worker exposures and then select respiratory protection and other PPE according to the results of their evaluation. Respiratory protection will be needed, however, when shifts in wind cause exposure to the combustion products in the plume. Under such circumstances, or where symptoms/health effects are being reported, inhalational exposure may occur and NIOSH and OSHA recommend respiratory and eye protection.

In conjunction with an immediate evacuation protocol, NIOSH-approved escape respirators may be used in response to unanticipated exposure events. The rated duration of the escape respirator provided to each occupant should be no less than the employer's determination of the reasonable time for egress to refuge quarters or to maneuver the vessel to clean air. The NIOSH-approved protections for the escape respirators must include organic vapors (OV) and particles (P100 or HE). Escape respirators should be cached to provide workers with immediate access to the units. Once the escape respirator is donned, all production tasks in progress should be discontinued and workers should be evacuated to designated refuge locations and the vessels maneuvered to avoid further exposure. Work should not resume until the cause of the event has been investigated and the caches of escape respirators restocked.

If protection is required during continuing operations, a full facepiece elastomeric respirator or a powered air purifying respirator (PAPR) with a loose-fitting hood can be used. The units should be equipped with cartridges for organic vapors (OV) and particles (P100 or HE). A full facepiece respirator or a PAPR with a loose fitting hood are preferred because they provide both eye protection against irritating smoke and an appropriate level of respiratory protection. Cartridges including P100 particulate filters (oil resistant) are recommended over N95 filters (not resistant to oil aerosols). The combination organic vapor/P100 cartridge provides comprehensive protection against soot, gases and vapors. Another means of protection is non-vented safety goggles to prevent eye irritation and a half-mask respirator with an organic vapor/P100 cartridge.

Note: Flame resistant clothing will help protect workers, for instance, such as those workers in the igniter boat during in-situ burning. The clothing should be cleaned, maintained, and regularly inspected in accordance with the manufacturer's instructions. Some flame resistant clothing may lose its protective qualities after repeated or improper cleanings. Wearing any flammable clothing over flame resistant clothing will negate the flame resistant protection. Flame resistant clothing should be selected in accordance with 29 CFR Subpart I (Personal Protective Equipment), Section 1910.132, General Requirements .

b. Vessels Not Involved in Source Control or Burning

Some vessels operating off-shore engage in deployment of containment and sorbent booms, skimming operations to remove oil from the water and dispersant application. These vessels are not involved in burning nor are they located in close proximity to in-situ burning. Generally, these vessels have contact with oil that has weathered, and, as such, does not emit significant amounts of VOCs. Respiratory protection generally will not be necessary as symptoms/health effects are not expected to occur in this setting. Dermal protection is needed.

Other vessels not involved in burning may operate at a farther distance from shore and possibly encounter more volatile crude. In this case, administrative controls (e.g., worker rotation and decrease in work hours) and respiratory protection (e.g., half-mask elastomeric respirator with an organic vapor cartridge) should be implemented where symptoms/health effects are being reported.

Note: Representative and routine air and personal breathing zone monitoring should be conducted to verify that unsafe exposures are not occurring, especially when these vessels operate in areas where partially weathered crude oil exist.

3. Shoreline Clean-up Activities

The types of activities associated with shoreline cleaning include manual removal of "tarballs" or "tarpatties," shovel removal of oiled-contaminated sand, low pressure flushing, manual sorbent application, and manual cutting of vegetation. Since inhalational exposure to oil and dispersants during shoreline clean-up operations is low because of weathering, respiratory protection is not recommended. However, if symptoms/health effects occur, the affected worker(s) should be removed and evaluated medically, and then the worksite should be assessed for potential exposure to heat and VOCs for the remaining workers.

Note: If high pressure washing is conducted, aerosolization of oil mist into respirable droplets could occur and respiratory protection is recommended with use of at least the level of a disposable P100 filtering facepiece respirator. The use of highly concentrated detergents, degreasers, and solvents, and the use of heated water during pressure washing, may volatilize hydrocarbons and result in the need for respiratory protection. Respiratory protection, if deemed necessary by professional judgment and/or air monitoring results, should include the use of a combination organic vapor/P100 cartridge half mask respirator. Eye and skin protection during such activities also will be necessary.

4. Decontamination Activities

a. PPE and Other Equipment

Vessels, PPE and other equipment may become contaminated with weathered oil. Respiratory protection is generally not necessary for this activity, although other PPE, including dermal, eye, face protection and protective footwear is necessary. If a high pressure washing mechanical sprayer is used to decontaminate PPE and other equipment, respirable particle aerosolization of oil mist could occur. When there is potential exposure to oil mist, particulate respiratory protection of at least the level of a P100 disposable filtering facepiece respirator is recommended in addition to skin, eye, face protection and protection footwear, particularly if highly concentrated detergents, solvents or degreasers are used.

b. Cleaning Wildlife

Task observations of cleaning and caring for birds, turtles and other wildlife indicate that aerosols of water, crude oil, soap, ammonia and other chemicals are likely to be generated. Eye and face protection, in addition to skin protection is recommended. When irritating concentrations of ammonia are experienced, dilutional ventilation, for example, by means of fans and other means to increase air exchange, are recommended.

Recommended PPE includes eye protection, i.e., safety glasses, goggles or face shields. Birds will peck under stress and may aim for the eyes. Eye protection is also necessary to protect against large droplet sprays from struggling birds. Oil-resistant outer protective clothing is recommended. An oil-resistant gown may provide sufficient upper body protection, avoiding the need for coveralls. Gloves (neoprene or nitrile rubber) that are oil resistant and provide protection against pecking and sharp talons are recommended. Non-skid footwear or boots that are oil-resistant and waterproof are also recommended.[29] Respiratory protection is not generally recommended, unless wildlife is heavily coated with fresh crude oil. In such cases, a half mask respirator with an organic vapor cartridge is recommended.

5. Waste Stream Management Activities

Response and remediation workers are engaged in the disposal and recycling of hazardous solid and liquid wastes during collection, storage, transport and final disposal. Deepwater Horizon Response waste management workers are at risk of a number of hazards including falls, other musculoskeletal injury, and dermal exposure to the components of the waste stream. Waste stream management workers should be trained, provided appropriate PPE, and have their work activities monitored for exposure in compliance with applicable state and Federal laws and regulations. [30]

D. Resources for Use of Respiratory Protection

For authoritative information from a trusted source to verify which respirators are approved by NIOSH, how to get them and how to use them, see the *NIOSH Respirator Trusted-Source Information Page* at http://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/RespSource.html#sect1. For more information on NIOSH-approved respirators, see http://www.cdc.gov/niosh/topics/respirators/. For information on chemical hazards, see the NIOSH Pocket Guide to Chemical Resources which can be found at http://www.cdc.gov/niosh/npg/.

When respiratory protection is required, a complete respiratory protection program is required in accordance with OSHA's Respiratory Protection Standard (29 CFR Section 1910.134) which is can be found at http://www.osha.gov/SLTC/respiratoryprotection/index.html . Elements of a respiratory protection program include training, fit testing, medical clearance, change-out schedule, and respirator cleaning, maintenance, and inspection procedures.

E. Voluntary Use of Respirators

Even when comprehensive and routine air monitoring indicates that no inhalational hazard exists, an employer may permit respiratory protection to be worn voluntarily by employees provided it will not in itself create a hazard. See the OSHA Respiratory Protection Standard (29 CFR Section 1910.134).[31] The Interim Guidance makes clear those exposure situations where the use of respiratory protection is recommended (see Section IX.C.1. through 5.).

The only situation where voluntary use may be helpful is when an individual is bothered by non-hazardous levels of hydrocarbon odor and cannot be relocated to another work area. In that case, a carbon-impregnated odor-reduction filtering facepiece respirator may provide some odor reduction potential—and can be worn voluntarily without the employer having to implement a respiratory protection program. These types of respirators do <u>not</u> provide health protective effects; they only provide odor reduction. In addition, all respirators have adverse effects on breathing, vision and communication, result in some discomfort, and are associated with additional physiological stress.[32]

Employers or volunteer organizations who supply respirators for voluntary use must provide response workers with the information in Appendix D (Information for Employees Using Respirators When Not Required by the Standard) of the OSHA Respiratory Protection Standard, 29 CFR Section 1910.134.[33]

Appendix A
Human Health Effects Studies from Selected Oil Tanker Spill Disasters

Previous reports have associated symptoms and other adverse health effects in clean-up workers and communities with spills of crude and fuel oil from tankers. These studies involve crude oil or refined petroleum products that may not be directly comparable to crude oil in the Deepwater Horizon event. Studies of eight tanker disasters are shown below. More detailed information is available in several recent reviews by Aguilera et al 2010[8] and Rodriguez-Trigo et al 2007[15].

Spill	Type of Oil	Health Effects	Author
Exxon Valdez (Alaska, 1989)	Crude	Worker comp claims (1811): sprains/strains (506), respiratory (264), cut/laceration (150) & contusion/crushing (144).	Gorman et al, 1991[11]
		Alaskan Native and Euro-American residents found to have depressive symptoms. One year later, PTSD was associated with social disruption.	Palinkas et al, 1992[34] and 2004[35]
MV Braer (Scotland, 1993)	Crude	Residents affected by the oil spill compared to a control community 95 km away. Subject had significantly more headache, throat irritation, and itchy eyes. Day 1 after the spill was the most frequent day for onset of symptoms; 97% resolved by day 7. Six months later, exposed residents more likely to report their health was poor or had deteriorated.	Campbell et al, 1993;[36] Campbell et al, 1994[37]
Sea Empress (Wales, 1996)	Crude	Residents in exposed areas reported higher rates of physical and psychological symptoms than control areas.	Lyons et al, 1999[38]
Nakhodka (Japan, 1997)	Fuel C oil	Residents had low back pain and leg pain, headache, and symptoms of the eyes and throat despite low measured levels of exposure.	Morita et al, 1999[9]
Erika (France, 1999)	Heavy #6 Fuel Oil	Workers (1465) surveyed: backache (439), headache (317), skin irritation (230), eye irritation (126), difficulty breathing (98), nausea & vomiting (91).	Schvoerer et al, 2000[39]
Prestige (Spain, 2002)	Residual fuel oil ("bunker C oil")	Workers had headaches, itchy eyes, nausea, vomiting, dizziness, throat & respiratory problems. Risk factors for symptoms included working periods longer than 20 days in highly polluted areas, performing three or more activities, and having skin contact with fuel on head/neck or upper limbs. Receiving health and hygiene information prior to starting a clean-up activity was a protective factor.	Suarez et al, 2005[40]
		Cleanup exposure caused increase in genotoxic damage.	Perez-Cadahia et al, 2006[10]
		Workers (7000) had significantly higher rates of upper and lower respiratory tract symptoms, with a dose related increase based on number of days, number of hours worked per day and number of activities.	Zock et al, 2007[7]
Tasman Spirit (Pakistan, 2003)	Crude	Workers had acute decline in lung function measured by spirometry in 31 clean-up workers. More weeks of work was associated with greater losses of lung function. One year later, repeat spirometry among 20 workers showed function comparable with controls.	Meo et al, 2008;[41]Meo et al, 2009[42]
Heibei Spirit (South Korea, 2007)	Crude	Workers had increased levels of VOC metabolites in urine. Resident of heavily/moderately oil-soaked areas had higher anxiety and depression. Both groups had increased headache, nausea, dizziness, sore throat, cough, skin rash, and sore eyes.	Lee et al, 2010[43] Lee et al, 2010b[44]

References

[1]National Institute for Environmental Health Sciences. Oil Spill Emergency Response and Cleanup. Training tools can be found at http://tools.niehs.nih.gov/wetp/index.cfm?id=2495

[2] National Institute for Occupational Safety and Health. NIOSH Voluntary Roster of Cleanup Response Workers. See at http://www.cdc.gov/niosh/topics/oilspillresponse/workerroster.html

[3] Emergency Mental Health and Traumatic Stress, http://mentalhealth.samhsa.gov/cmhs/EmergencyServices/

[4] National Institute for Occupational Safety and Health. NIOSH Topic Page: Traumatic Incident Stress http://www.cdc.gov/niosh/topics/traumaticincident/

[5] National Institute for Occupational Safety and Health. NIOSH Pocket Guide to Chemical Hazards, DHHS (NIOSH) Publication No. 2005-149 http://www.cdc.gov/niosh/npg/

[6] Interagency Agency for Research on Cancer, Crude Oil, IARC Summary and Evaluation, Volume 45, 1989 http://www.inchem.org/documents/iarc/vol45/45-02.html

[7] Zock JP, Rodriguez-Trigo G, Pozo-Rodriguez F, Barbera JA, Bouso L, Torralba Y, Anto JM, G FP, Fuster C, and Verea H. Prolonged Respiratory Symptoms in Clean-Up Workers of the Prestige Oil Spill *Am J Respir Crit Care Med*, 176:610-616, 2007.

[8] Aguilera F, Mendez J, Pasaro E, and Laffon B. Review on the Effects of Exposure to Spilled Oils on Human Health. *J. Appl. Toxicol.* 30:291-301, 2010.

[9] Morita A, Kusaka Y, Deguchi Y, Moriuchi A, Nakanaga Y, Masayuki I, Miyazaki S, and Kawahara K. Acute Health Problems among the People Engaged in the Cleanup of the Nakhodka Oil Spill. *Environmental Research, Section A*, 81:185-194, 1999.

[10] Perez-Cadahia B, Laffon B, Pasaro E, and Mendez J. Genetic Damage Induced by Accidental Environmental Pollutants. The Scientific World Journal 6:1221-1237, 2006.

[11] Gorman RW, Berardinelli SP, Bender TR. Exxon/Valdez Alaska oil spill. HETA 89-200 and 89-273-2111. Cincinnati: Hazard Evaluation and Technical Assistance Branch, NIOSH, US Department of Health and Human Services; 1991. See http://www.cdc.gov/niosh/hhe/reports/pdfs/1989-0200-2111.pdf

[12] Perez-Cadahia B, Mendez J, Pasaro E, Lafuente A., Cabaleiro T, Laffon B. Biomonitoring of human exposure to *Prestige* Oil: Effects on DNA and endocrine parameters. *Environmental Health Insights* 2:83-92, 2008.

[13] Perez-Cadahia B, Laffon B, Porta M, Lafuente A., Cabaleiro T, Lpoez T, Caride A, Pumarega J, Romero A, Pasaro E and Mendez. Relationship between blood concentrations of heavy metals and cytogenic and endocrine parameters among subjects involved in cleaning coastal areas affected by the *Prestige* tanker oil spill. *Chemosphere* 71:447-455, 2008.

[14] Perez-Cadahia B, Laffon B, Valdiglesias V, Pasaro E and Mendez J. Cytogenetic effects induced by *Prestige* oil on human populations: The role of polymorphisms in genes involved in metabolism and DNA repair. *Mutation Research* 653:117-123, 2008.

[15] Rodríguez-Trigo G, Zock JP, Isidro Montes I. Health effects of exposure to oil spills. *Arch Bronconeumol*. Nov;43(11):628-35, 2007

[16] NIOSH recommends that no 8-hour period in an extended work shift exceed the established exposure limit. Otherwise downward adjustment must be made to the exposure limit proportionately based on hours worked compared to the traditional 8-hour work shift basis for exposure limits.

[17] American Conference of Governmental Industrial Hygienists, 2010 TLVs and BEIs Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents, Cincinnati, OH. http://www.acgih.org/TLV/

[18]Acclimatization means temporary adaptation to work in the heat that occurs gradually is exposed to it and occurs in most people in four to fourteen days of regular work for at least two hours per day in the heat. See State of California, Heat Illness Prevention Standard. See http://www.dir.ca.gov/Title8/3395.html

[19] Dembe A et.al. The Impact of Overtime and Long Work Hours on Occupational Injuries and Illnesses: New Evidence from the United States, *Occup Environ Med* 62: 588-597, 2005.

[20] Dong, Xiuwen. Long Working Hours, Work Scheduling, and Work-Related Injuries in Construction. *Scandinavian Journal of Work, Environment, and Health*, 31(5):329-335, 2005.

[21] Belenky G, McKnight AJ, Mitler MM, Smiley A, Tijerina L, Waller PF, Wierwille WW, and Willis DK, *Potential Hours-of-Service Regulations for Commercial Drivers: Report of the Expert Panel,* 1988.

[22] U.S. Department of Transportation. Hours of Service Regulations, 49 CFR Parts 385, 390, and 395: *Hours of Service of Drivers, Driver Rest and Sleep for Safe Operations,* Final Rule, 2003

[23] Rosa R. Examining Work Schedules for Fatigue: It's Not Just Hours of Work. In: Hancock PA and Desmond PA (eds.), *Stress, Workload, and Fatigue.* Mahwah, New Jersey: Lawrence Earlbaum Associates, pp. 513-528, 2001.

[24] Rosa R. Extended Workshifts and Excessive Fatigue. *Journal of Sleep Research,* 4, Suppl 2, 51-56, 1995.

[25] OSHA. Keeping Workers Safe During Oil Spill Response and Cleanup Activities: General Personal Protective Equipment Sampling Matrix. See http://www.osha.gov/oilspills/oil_ppematrix.html

[26] OSHA. Respiratory Protection Standard. Appendix B-2 to § 1910.134: Respirator Cleaning Procedures (Mandatory). See http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9782&p_table=STANDARDS

[27] Fingas MF, Li K, Ackerman F, Campagna PR, Turpin RD, Getty SJ, Solecki MF, Trespalacios MJ, Pare J, Bissonnette MC and Tennyson EJ. Emissions from Mesoscale In-situ Oil Fires: The Mobile 1991 and 1992 Tests. Proceedings of the Sixteenth Arctic and Marine Oil Spill Program Technical Seminar, Environment Canada, Ottawa, Ont., 1993, pp. 749-821.

[28] Fingas MF, Ackerman F, Li K, Lambert P, Wang P, Bissonnette MC, Campagna PR, Boileau P, Laroche N, Jokuty P, Nelson R, Turpin RD, Trespalacios MJ, Halley G, Beanger J, Pare JRJ, Vanderkooy N, Tennyson EJ, Aurand D and Hiltabrand R. The Newfoundland Offshore Burn Experiment—NOBE—Prelimary Results of Emissions Measurement. Proceedings of the Seventeenth Arctic and Marine Oil Spill Program Technical Seminar, Environment Canada, Ottawa, Ont., 1994, pp. 1099-1164.

[29] U.S. Fish and Wildlife Service, Best Practices for Migratory Bird Care During Oil Spill Response (November, 2003). See http://www.fws.gov/contaminants/OtherDocuments/best_practices.pdf

[30] OSHA Hazardous Waste Operations and Emergency Response Standard. 29 CFR Section 1910.120. See at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9765

[31] OSHA Respiratory Protection Standard. 29 CFR 1910.134(c)(2)(i) states "An employer may provide respirators at the request of employees or permit employees to use their own respirators, if the employer determines that such respirator use will not in itself create a hazard. If the employer determines that any voluntary respirator use is permissible, the employer shall provide the respirator users with the information contained in Appendix D to this section (''Information for Employees Using Respirators When Not Required Under the Standard'')." Seehttp://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=12716&p_table=standards

[32] White MK, Hodous T and Hudnall JB. Physiological and subjective responses to working in disposable protective coveralls and respirators commonly used by the asbestos abatement industry. American Industrial Hygiene Association Journal. 50(6):313-310 (1989).

[33] OSHA Respiratory Protection Standard, Appendix D to 29 CFR Section 1910.134 (Mandatory), Information for Employees Using Respirators When Not Required by the Standard. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9784

[34] Palinkas LA, Russell J, Downs MA, Petterson JS . Ethnic differences in stress, coping, and depressive symptoms after the Exxon Valdez oil spill. J Nerv Ment Dis. 1992;180(5):287-295.

[35] Palinkas LA, Petterson JS, Russell JC, Downs MA. Ethnic differences in symptoms of post-traumatic stress after the Exxon Valdez oil spill. Prehosp Disaster Med. 2004;19(1):102-112.

[36] Campbell D, Cox D, Crum J, Foster K, Christie P, Brewster D. Initial effects of the grounding of the tanker Braer on health in Shetland. The Shetland Health Study Group. *British Medical Journal.* 1993 Nov 13;307(6914):1251-5.

[37] Campbell D, Cox D, Crum J, Foster K, Riley A. Later effects of grounding of tanker Braer on health in Shetland. *British Medical Journal* 1994 Sep 24;309(6957):773-4.

[38] Lyons RA, Temple JM, Evans D, Fone DL, Palmer SR. Acute health effects of the Sea Empress oil spill. *J Epidemiol Community Health.* 1999 May;53(5):306-10.

[39]Schvoerer C, Gourier-Frery C, Ledrans M, Germonneau P, Derrien J, Prat M, et al. Etude épidémologique des troubles de santé survenus à court terme chez les personnes ayant participè au nettoyage des sites pollués par le fioul de l'Erika. 2000. Available from: http://www.invs.sante.fr/publications/erika3/rapmaree_dist.pdf (accessed 6/14/10) (French).

[40] Suárez B, Lope V, Pérez-Gómez B, Aragonés N, Rodríguez-Artalejo F, Marqués F, Guzmán A, Viloria LJ, Carrasco JM, Martín-Moreno JM, López-Abente G, Pollán M. Acute health problems among subjects involved in the cleanup operation following the Prestige oil spill in Asturias and Cantabria (Spain). *Environ Res.* 2005 Nov;99(3):413-24.

[41] Meo SA, Al-Drees AM, Meo IM, Al-Saadi MM, Azeem MA. Lung function in subjects exposed to crude oil spill into sea water. *Mar Pollut Bull* 2008; 56(1): 88-94.

[42] Meo SA, Al-Drees AM, Rasheed S, Meo IM, Khan MM, Al-Saadi MM, Alkandari JR. Effect of duration of exposure to polluted air environment on lung function in subjects exposed to crude oil spill into sea water. *Int J Occup Med Environ Health*. 2009;22(1):35-41.

[43] Lee J, Kim M, Ha M, Chung BC. Urinary metabolic profiling of volatile organic compounds in acute exposed volunteers after an oil spill in Republic of Korea. *Biomed Chromatogr* 2010; 24: 562–568.

[44] Lee CH, Kang YA, Chang KJ, Kim CH, Hur JI, Kim JY, Lee JK. [Acute health effects of the Hebei oil spill on the residents of Taean, Korea.] *Prev Med Public Health.* 2010b Mar;43(2):166-73.