Health Hazard Evaluation of Deepwater Horizon Response Workers

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Health Hazard Evaluation Interim Report 9
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CDC Workplace Safety and Health
National Institute for Occupational Safety and Health NIOSH
HHE Health Hazard Evaluation Program

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The cover photo shows oil in the water and along the beach during the Deepwater Horizon response in the Gulf of Mexico: June 2010.

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

National Institute for Occupational Safety and Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998

December 7, 2010
HETA 2010-0115

Fred Tremmel
Deepwater Horizon ICP
1597 Highway 311
Houma, LA 70395

Dear Mr. Tremmel:

On May 28, 2010, the National Institute for Occupational Safety and Health (NIOSH) received a request from BP for a health hazard evaluation (HHE). The request asked NIOSH to evaluate potential exposures and health effects among workers involved in Deepwater Horizon Response activities. NIOSH sent an initial team of HHE investigators on June 2, 2010, followed by additional teams.

This letter is the ninth and last in a series of interim reports. As this information is cleared for posting, we will make it available on the NIOSH website (www.cdc.gov/niosh/hhe). We will be producing a final report that pulls together all work done by the NIOSH health hazard evaluation program during the Deepwater Horizon Response.

This report (Interim Report #9) includes several discrete components of our investigation. For each, we provide background, describe our methods, report the findings, and provide conclusions and, where appropriate, interim recommendations. The components included in this report are as follows:

- 9A – Results of Bulk Sample Collections
- 9B – Health Symptom Survey Findings for Response Workers Assigned to Plaquemines Branch Incident Command System, Louisiana, June 2010
- 9C – Assessing Psychosocial and Work Organization Issues among Deepwater Horizon Response Workers in Venice, Louisiana, August 2010

Thank you for your cooperation with this evaluation. If you have any questions, please do not hesitate to contact me at 513.841.4382 or atepper@cdc.gov.

Sincerely yours,

Allison Tepper

Allison Tepper, PhD
Chief
Hazard Evaluations and Technical
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3 Enclosures

cc:
Mr. David Dutton, BP
Mr. Mark Saperstein, BP
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CDR Laura Weems, USCG
Mr. Clint Guidry, LA Shrimp Association
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Dr. Raoul Ratard, LA DHHS
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Interim Report #9A
Results of Bulk Sample Collections

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Introduction

On May 28, 2010, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from BP regarding concerns of potential occupational exposures during Deepwater Horizon oil spill response work in the Gulf of Mexico. On June 2, 2010, a team of NIOSH industrial hygienists and medical officers arrived in Louisiana to begin on-site evaluations of potential occupational exposures and health symptoms. Assessments were conducted during a variety of oil spill response work activities, including in-situ burning of surface oil, dispersant releases, oil skimming and booming, and decontaminating boom and vessels. During the course of the assessments, industrial hygiene sampling was conducted to determine specific compounds to which workers may be exposed as well as their levels of exposure. The majority of the sampling was comprised of personal breathing zone (PBZ) and area air samples during activities of concern. These sample results and the conclusions and recommendations based upon them were described in prior interim reports, which are posted on the NIOSH Deepwater Horizon Response website: http://www.cdc.gov/niosh/topics/oilspillresponse/gulfspillhhe.html.

In addition to air samples, a small number of bulk samples were also collected by the NIOSH industrial hygienists during the evaluations. Typically, the bulk samples were of materials such as surface oil or dispersant which were considered to be potential sources of exposure to airborne compounds, including volatile organic compounds (VOCs) and polynuclear aromatic hydrocarbons (PAHs). The bulk samples were analyzed to document the presence of these or other compounds. This report describes bulk sample collection methods and analytic methods and results.

Bulk Sample Collection during In-Situ Surface Oil Burns

As one method of oil surface removal, two task forces of vessels in the Gulf of Mexico conducted in-situ (i.e., on site) burns of surface oil. Each task force included a lead vessel, three large support/safety vessels, and four pairs of shrimping trawlers. Three rigid-hulled inflatable boats from which the burns were ignited were also available per task force. Each shrimping trawler and its partner trawler towed one end of an approximately 300-foot long boom behind them, creating a U-shaped area to collect a quantity of surface oil suitable for burning. When a sufficient quantity of fresh oil was collected within the boom, an ignition boat was sent to the area to ignite the fire by placing an ignition package into the pooled surface oil. During the burns, the trawlers slowly moved forward towing the boom to continually feed new surface oil into the fire. The duration of the burn depended on the quantity of oil enclosed by the boom and ranged from 45 minutes to 6 ½ hours.

Seven bulk oil samples were collected by a NIOSH industrial hygienist during exposure assessments made on June 8–9, 2010. Three bulk samples were fresh surface oil collected within the boom towed by shrimping trawlers, two bulk samples were burnt oil residue floating on the water's surface after a burn

was completed, and two bulk samples were emulsified or "weathered" surface oil that was deemed inappropriate to burn.

All samples were submitted for qualitative identification of VOCs and analyzed in two ways: as a headspace sample and a methylene chloride extract. An ambient headspace sample was collected directly above each vial containing the liquid sample using a thermal desorption tube, which was then analyzed by an automatic thermal desorption system interfaced to a gas chromatograph-mass spectrometer (ATD-GC-MS). A portion of each liquid sample was also added to methylene chloride solvent and transferred to a GC-MS for analysis.

Major compounds identified in the headspace samples were low molecular weight aliphatic hydrocarbons, mostly in the C_5–C_{12} range. Major compounds identified in the bulk extract solutions were higher molecular weight aliphatic hydrocarbons, mostly the C_9–C_{30} n-alkanes. Traces of PAHs, biphenyl and methyl biphenyls, and methyldibenzothiophene were also detected. The PAHs included naphthalene and alkyl naphthalenes (methyl-, dimethyl-, trimethyl isomers), $C_{13}H_{10}$ fluorene plus alkyl analogs (methyl-, dimethyl-, trimethyl- isomers), $C_{14}H_{10}$ isomer phenanthrene or anthracene plus alkyl analogs (methyl-, dimethyl-, trimethyl- isomers), $C_{18}H_{12}$ isomer chrysene or benzo(a)anthracene plus alkyl analogs (methyl-, dimethyl- isomers), and $C_{20}H_{12}$ isomer such as benzo(a)pyrene or benzo(e)pyrene.

As described in Interim Report #2 [NIOSH 2010a] released on July 12, 2010, results of PBZ and area air samples collected to assess worker exposures on board in-situ burn vessels showed the presence of C_6–C_{15} aliphatic hydrocarbons as well as some benzene, toluene, xylenes, isooctane, biphenyl, and naphthalene. Alkyl substituted naphthalenes and tetrahydro alkyl naphthalenes were also present. The presence of these compounds in the bulk oil samples may indicate the source of these airborne compounds. However, all air concentrations measured were well below the relevant occupational exposure limits (OELs). The results of the bulk samples do not change the findings and conclusions as described in Interim Report #2.

Bulk Sample Collection during Dispersant Release Activities

As part of the response to the Deepwater Horizon oil spill, the utility vessel International Peace (IP) was chartered to provide oil spill response services. Activities conducted by contract workers on board the IP included monitoring the effectiveness of dispersant applied to surface oil in the Gulf of Mexico. The effectiveness of the dispersant (Corexit® EC9500A) in dispersing the oil was evaluated by the contract workers following a protocol that included the collection of bulk water samples before and after dispersant application from the IP. The bulk water samples were collected at both 1 meter and 10 meters below the water surface.

While conducting an industrial hygiene evaluation of potential occupational exposures on board the IP, a NIOSH investigator obtained six bulk samples during dispersant evaluation activities on June 21, 2010. Two samples were oil from the water surface in an oil slick area prior to dispersant application, two samples were water collected from 1 meter depth in an area with no visible surface oil, and two samples were water/oil/dispersant mixtures collected from the water surface after dispersant application.

All samples were submitted for qualitative identification of VOCs and analyzed in two ways: as a headspace sample and a methylene chloride extract. An ambient headspace sample was collected directly above each vial containing the liquid sample using a thermal desorption tube, which was then

analyzed by ATD-GC-MS. A portion of each liquid sample was also added to methylene chloride solvent and transferred to a GC-MS for analysis.

Major compounds identified in the headspace analysis from the two surface oil samples were low molecular weight aliphatic hydrocarbons, mostly in the C_5–C_{12} range. Major compounds identified in the bulk extract solutions from these two samples were higher molecular weight aliphatic compounds, mostly C_9–C_{30} n-alkanes. Traces of PAHs and methyldibenzothiophene were also detected. The PAHs included $C_{13}H_{10}$ fluorene plus alkyl analogs (methyl-, dimethyl-, trimethyl- isomers), $C_{14}H_{10}$ isomer phenanthrene or anthracene plus alkyl analogs (methyl-, dimethyl-, trimethyl- isomers), and $C_{18}H_{12}$ isomer chrysene or benzo(a)anthracene plus alkyl analogs (methyl-, dimethyl- isomers). Few, if any, VOCs were detected in either the two water samples or the two water/oil/dispersant mixture samples.

As described in Interim Report #3 [NIOSH 2010b] released on July 22, 2010, results of PBZ and area air samples collected to assess worker exposures on board the IP showed the presence of various C_6–C_{18} hydrocarbons (straight and branch alkanes), similar to the major compounds in the bulk oil samples. All VOCs identified during PBZ and area air sampling showed airborne levels to be well below all applicable OELs. Nothing identified in these bulk sample results changes the findings and conclusions presented in the interim report.

Bulk Sample Collection of Corexit® EC9500A Dispersant

Several bulk samples of Corexit® EC9500A dispersant were analyzed by NIOSH. NIOSH requested and received a bulk sample from BP contractor Exponent in June 2010. Samples were qualitatively analyzed by GC-MS. At the request of the NIOSH industrial hygienist onboard the IP during the June 21-22, 2010 dispersant mission, a bulk sample of this product was collected from the tote used to spray the dispersant. Results of these analyses were reported in Interim Report #3 [NIOSH 2010b] released on July 22, 2010. All bulk samples contained small amounts of 2-butoxyethanol, a substance that was not reported on the product's material safety data sheet (MSDS). In Interim Report #3, NIOSH noted that the bulk collected on the IP came from a tote that had previously contained Corexit EC9527A®, a dispersant that had been used early in the response and contained 30%–60% 2-butoxyethanol. The potential for cross-contamination was a possible explanation for the presence of 2-butoxyethanol in that sample. It was not known whether the tote from which the BP contractor collected their two samples had previously contained other products containing 2-butoxyethanol, but that was a possibility given that the product was not collected from its original container but instead had been sub-sampled into other totes.

To further evaluate the presence of 2-butoxyethanol in the Corexit® EC9500A dispersant, NIOSH requested a sample of this product directly from the manufacturer. Additionally, Exponent submitted two bulk Corexit® EC9500A dispersant samples to NIOSH that were collected from a Clean Gulf Associates tote that had been stored at Airborne Support Inc. , in Houma, Louisiana. Portions of the shipment that included the tote from which the two samples were collected had been used during the response. All three samples were analyzed by GC-MS and none contained 2-butoxyethanol. The limit of detection was 0.1% by volume. This suggests that the small amounts found earlier in the other bulk samples were likely the result of cross contamination from totes that held products containing 2-butoxyethanol.

Bulk Sample Collection on a Vessel of Opportunity during "Dispersant Foam" Breakup

The Vessels of Opportunity (VoO) program was established by BP for the Deepwater Horizon response. As part of this program, local vessel owners contracted their boats to conduct a variety of activities including oil booming and skimming operations. On days when oil was not present on the water surface in the areas to which these vessels were assigned, the vessel captains often directed their vessels through patches of foam found on the sea surface to break up the foam. These patches of foam were often described by the crew as "dispersant foam."

On June 16, 2010, a NIOSH industrial hygienist was on board the St. Martin, a shrimping trawler, to evaluate potential occupational exposures. No surface oil was present in the area the St. Martin was patrolling on that day; therefore, no booming or skimming operations were conducted. The vessel captain spent much of the day directing the vessel through long patches of foam on the water surface. The NIOSH industrial hygienist obtained two bulk samples of the foamy water off the side of the St. Martin. The bulk samples appeared to be mostly water with little to no evidence of visible oil although some particulate matter, possibly plant material, was present.

Both samples were submitted for qualitative identification of VOCs and analyzed in three ways: as a headspace sample, as a methylene chloride extract, and as a direct injection for analysis. An ambient headspace sample was collected directly above each vial containing the liquid sample using a thermal desorption tube, which was then analyzed by an ATD-GC-MS. A portion of each liquid sample was also added to methylene chloride solvent and transferred to a GC-MS for analysis. Lastly, a 1 microliter aliquot of each sample was also injected directly into the GC-MS for analysis.

No VOCs were detected in the headspace samples, the methylene chloride extracts, or the direct injections.

As described in Interim Report #4 [NIOSH 2010c] released on August 11, 2010, results of PBZ and area air samples collected to assess worker exposures on board the St. Martin showed little to no detectable concentrations of airborne VOCs. The bulk sample results do not change the findings and conclusions presented in Interim Report #4.

Bulk Sample Collection on the Source Vessels, Development Driller II and the Discoverer Enterprise

NIOSH industrial hygienists obtained two bulk samples of drilling mud from the Development Driller II (DD II) and four bulk samples of oil being collected by the Discoverer Enterprise (Enterprise). Samples were obtained during the industrial hygiene exposure assessments at the oil source aboard these two vessels on June 21, 2010, and June 23, 2010, respectively. The drilling mud and the oil were considered to be the most abundant materials potentially encountered by workers on these vessels. The bulk oil samples were obtained prior to the addition of chemicals such as methanol and antifoaming agents. Results of bulk samples analyzed prior to analyzing PBZ and area air samples assisted in identifying sources for potential airborne contaminants encountered by workers.

The bulk samples of drilling mud and source crude oil were analyzed in two ways, as a headspace sample and a methylene chloride extraction. Individual compounds in the bulk samples were evaluated using GC-MS. The results were a listing of carbon-containing constituents.

Compounds found in the two bulk mud samples included 2-butoxyethanol (ethylene glycol monobutyl ether), 2-(2-butoxyethoxy)ethanol (diethylene glycol monobutyl ether), C_{14}–C_{20} alkenes (olefins), and some fatty acids or fatty acid esters. A review of drilling mud constituent MSDSs obtained for the DD II identified four of the twelve materials containing organic compounds – generally fatty acids or olefins. Two components contained ethylene glycol monobutyl ether and diethylene glycol monobutyl ether (Le Supermul and Temperus) [Halliburton 2007; Halliburton 2008]. Major components of other drilling mud constituents included minerals and mineral salts.

Major compounds identified in the four headspace samples of the bulk crude oil were low molecular weight aliphatic hydrocarbons, mainly in the C_5–C_{12} range plus benzene, toluene, ethyl benzene, and xylenes. Major compounds identified in the bulk crude oil methylene chloride extraction solutions were higher molecular weight aliphatic hydrocarbons, mostly C_9–C_{30} n-alkanes. Traces of PAHs, biphenyl and methyl biphenyls, and methyldibenzothiophene were detected. The PAHs included naphthalene and alkyl naphthalenes (methyl-, dimethyl-, trimethyl isomers), $C_{13}H_{10}$ fluorene plus alkyl analogs (methyl-, dimethyl-, trimethyl- isomers), $C_{14}H_{10}$ isomer phenanthrene or anthracene plus alkyl analogs (methyl-, dimethyl-, trimethyl- isomers), $C_{18}H_{12}$ isomer chrysene or benzo(a)anthracene plus alkyl analogs (methyl- and dimethyl- isomers), and $C_{20}H_{12}$ isomers such as benzo(a)pyrene or benzo(e)pyrene.

The bulk oil samples confirmed the presence of compounds which, if airborne in sufficient concentrations, could present a health hazard for the workers. The PBZ and area air sampling results, however, showed low or non-measurable airborne exposure levels during monitoring on June 21, 2010, and June 23, 2010. Low levels on June 23, 2010, occurred during an operational upset that included the Enterprise temporarily disconnecting from the lower marine riser package atop the damaged blow out protector. During that several hour period, all of the oil escaping from the MC252 Well No. 1 was released into the Gulf. These results have been presented previously in Interim Report #4 [NIOSH 2010c] released August 11, 2010. Nothing identified in these bulk sample results changes the findings and conclusions of the previously presented air sampling results.

Identification of Propylene Glycol t-butyl Ether during Decontamination Operations

On August 10, 2010, NIOSH industrial hygienists conducted an exposure assessment in Port Fourchon, Louisiana ,as described in Interim Report #8 [NIOSH 2010d]. During the evaluation, thermal desorption tubes were used to screen for airborne VOCs. An unidentified glycol ether was detected on a few of these screening samples during the initial analysis. Further analyses subsequently determined this unidentified glycol ether to be propylene glycol t-butyl ether, one of the components listed on the MSDS for the OMI 500 cleaning compound used at the site. Small peaks for an unidentified glycol ether were found on the PBZ charcoal tube air samples collected during the assessment. Quantification of these small peaks was done to determine if they were also from propylene glycol t-butyl ether and, if so, to estimate their concentration which was expected to be very low based on the preliminary analyses. While reanalysis of the original charcoal tube extracts was not possible, quantification of the samples was estimated based on a propylene glycol mono-t-butyl ether standard and calibration curve prepared and analyzed on the same instrument using the same analytical conditions from the original analysis. The calculated results for propylene glycol t-butyl ether were above the minimum quantifiable concentration on all seven of the PBZ air samples and ranged from 0.14–0.30 milligrams per cubic meter (mg/m^3). No OELS have been published for propylene glycol t-butyl ether by NIOSH, the Occupational Safety and Health Administration, the American Conference of Governmental Industrial Hygienists, or the American Industrial Hygiene Association.

Summary

Over the course of the Health Hazard Evaluation, NIOSH industrial hygienists collected bulk samples including dispersant, fresh, burnt, and emulsified oil, and drilling mud. Analysis for VOCs was conducted to determine the presence of compounds in the material that have the potential to volatilize and present an inhalation hazard for oil spill response workers. Low molecular weight aliphatic hydrocarbons were often found in headspace analyses of bulk oil samples; higher molecular weight aliphatic hydrocarbons and traces of PAHs were identified in the bulk oil extracts. Analyses of bulk samples of Corexit® EC9500A taken from totes that had previously contained other products including Corexit® EC9527A found traces of 2-butoxyethanol. Subsequent analyses of Corexit® EC9500A samples direct from the manufacturer and from other totes used during the response did not reveal the presence of this compound, suggesting cross-contamination was responsible for the presence of traces of 2-butoxyethanol in the initial bulk sample analyses. Analyses of foamy water described as "dispersant foam" did not reveal the presence of identifiable VOCs, although some particulate matter, possibly plant material, was present. Nothing identified in these bulk sample results changes the findings and recommendations as presented in the previously released interim reports, which are posted the NIOSH Deepwater Horizon Response website: http://www.cdc.gov/niosh/topics/oilspillresponse/gulfspillhhe.html.

Acknowledgments

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Interim Report #9B
Health Symptom Survey Findings for Response Workers Assigned to Plaquemines Branch Incident Command System, Louisiana, June 2010

Lead Authors: Christine West and John Gibbins
Contributing Authors: Bruce Bernard, Judith Eisenberg, and Charles Mueller

Introduction

Because of concerns about possible acute health effects from exposures on vessels performing oil cleanup, NIOSH investigators collected health symptom surveys from response workers. This report describes the results for workers surveyed from June 7–June 22, 2010 in the Plaquemines Branch Incident Command System (ICS); formally also known as Venice Louisiana Field Operations Branch.

Methods

Assigned safety personnel distributed surveys, available in English and Spanish, and sealable envelopes at work sites. NIOSH investigators collected the envelopes from the safety personnel. Additionally, NIOSH personnel distributed surveys during morning safety meetings at marinas operating under the Plaquemines Branch ICS.

The Plaquemines Branch ICS was divided into three Branches under which 17 Divisions operated, each corresponding to a given location in the waters of Plaquemines parish. Each Division was responsible for deploying boat crews that conducted off-shore cleanup operations. Surveys were collected from the following areas: Venice Field Operations Branch, Venice Marina, Venice Commanders' Camp, Cypress Grove Marina, Myrtle Grove Marina, Delta Marina, and Joshua's Marina. The response workers included boat captains, deck hands, contract cleanup workers, United States Coast Guard members who oversaw the cleanup, and safety personnel. Each boat crew in each division had similar job tasks, including deploying sorbent, snare, and containment boom; replacing boom as needed; or transporting workers to designated locations.

Workers were asked to report symptoms they experienced while working during response activities, whether they had exposures to oil and dispersants, and whether they had skin contact with the oil during the oil spill. For Tables 1 and 2, response workers who reported working on a boat for at least 1 day and reported exposure to oil, dispersant, cleaners, or other chemicals were classified as the exposed group; 377 response workers met this definition. Workers who reported zero days working on a boat and no exposure to oil, dispersant, cleaners, or other chemicals were classified as the unexposed group; 119 response workers met this definition. Workers who did not meet the inclusion criteria for either of these groups were classified as "other;" 330 response workers were included in this group, for a total of 826 questionnaires completed at these locations.

In addition to comparing the prevalences of symptoms in these three groups, NIOSH investigators assessed the relationships of upper respiratory symptoms[1], lower respiratory symptoms[2], and cough[3] to self-reported exposures to oil and dispersants (Table 3) and the relationship between symptoms of skin irritation[3] and skin contact with the oil. These analyses included all respondents who reported information about the specific exposures they thought they had experienced during response work. Bivariate analyses were done using Fisher's exact test using SAS 9.2 (SAS Institute, Cary, North Carolina). All tests were two-tailed, and statistical significance was set at $p<0.05$.

Results

The age and sex distributions of the three groups were similar; all groups were racially diverse (Table 1). Employer type was similar for all groups; the median number of days working on the oil spill was 21 for the exposed group, 14 for the unexposed group, and 15 for the "other" group.

Reported symptoms, grouped by type, are presented in Table 2. The most frequently reported symptoms for all groups were those consistent with heat stress, headache, and upper respiratory symptoms. Overall, response workers in the exposed group reported higher prevalences of all types of symptoms than both the unexposed and "other" group, which were similar to each other in symptom prevalences.

Table 3 presents the results of the bivariate analyses regarding respiratory symptoms and self-reported exposure to oil and dispersant. Of the 826 completed questionnaires, 416 (50%) reported oil exposure, 305 (37%) reported no oil exposure, and 105 (13%) did not answer this question. Among the 826 questionnaires, 156 (19%) reported dispersant exposure, 250 (30%) reported no dispersant exposure, and 420 (51%) did not answer this question. Of the 156 workers who reported exposure to dispersant, 148 (95%) also reported oil exposure. Among those response workers reporting exposure to oil, the prevalence of upper respiratory symptoms (25%) was significantly greater than the unexposed group (14.4%) (PR=1.76, $p<0.01$); the prevalence of cough (19.5%) was significantly greater than the unexposed group (7.9%) (PR=2.47, $p<0.01$); and the prevalence of lower respiratory symptoms (12%) was significantly greater than the unexposed group (4%) (PR=2.99, $p<0.01$). Likewise, among those response workers reporting exposure to dispersant, the prevalence of upper respiratory symptoms (33%) was significantly greater than the unexposed group (18.3%) (PR=1.78, $p<0.01$); the prevalence of cough (27%) was significantly greater than the unexposed group (10%) (PR=2.69, $p<0.01$); and the prevalence of lower respiratory symptoms (18%) was significantly greater than the unexposed group (4.7%) (PR=3.76, $p<0.01$). The prevalence of skin irritation among those reporting skin contact with oil (30%) was significantly greater than the prevalence for those without skin contact (9%) (PR=3.2, $p<0.01$).

Summary

For the exposed, unexposed, and "other" groups (as defined above), the symptoms most frequently reported by response workers in Plaquemines Branch ICS were those consistent with heat exposure, headache, and upper respiratory symptoms. Workers reporting exposure to oil and to dispersants had significantly higher prevalences of upper respiratory symptoms, lower respiratory symptoms, and cough

[1] Upper respiratory symptom was defined as a positive response to nose irritation, sinus problems or sore throat.
[2] Lower respiratory symptom was defined as a positive response to trouble breathing, short of breath, chest tightness, or wheezing.
[3] Skin irritation was defined as a positive response to itchy skin, red skin, or rash.

than those not exposed. The dispersants used in the response are known to cause upper airway irritation and could have contributed to these symptoms, however because nearly all respondents self-reporting dispersant exposure also reported oil exposure (95%), the effects of dispersants alone cannot be determined from this evaluation. Although volatile components of oil are irritants and can cause upper airway irritation and cough, the extent to which volatiles remained in the oil at the time of exposure reported by survey respondents is unknown. Lower respiratory symptoms have been documented in workers exposed to crude oil during oil spill cleaning operations, although the specific exposures for these symptoms were not identified. In addition to possible chemical exposures from oil cleaning operations are exposure to road and gravel dust at the marina and docks, tobacco smoke (personal smoking and second-hand exposure), upper respiratory infections resulting from crowded work and living conditions, previously existing medical conditions, and symptoms resulting from over-exertion in the heat. The NIOSH survey did not account for these factors. Additionally, these findings from a convenience sample of workers from one response location may not apply to other workers in different locations or performing different duties.

The National Institutes of Health (NIH) is currently planning a longitudinal study of approximately 20,000 response workers to evaluate health outcomes, including respiratory, neurobehavioral, carcinogenic, immunological, and mental health concerns. Information about this effort can be found at http://www.niehs.nih.gov/research/programs/gulfspill/. The Institute of Medicine held a workshop in September 2010 to obtain input from experts about the content of this study; an unedited transcript of this meeting can be found at http://www.niehs.nih.gov/about/od/programs/docs/oilspill-transcript9-22-10.pdf.

Recommendations:

- Workers who continue to experience symptoms should seek out health care from physicians familiar with occupational medicine principles to determine the work-relatedness of their condition.
- As recommended in previous NIOSH reports, workers should have access to information about occupational health issues and exposures related to the oil spill and the oil industry in general, and the specific hazards that were found in the Deepwater Horizon response. See: Health Effects from Crude Oil and Oil Dispersant Exposure in NIOSH-OSHA Interim Guidance for Protecting Deepwater Horizon Response Workers and Volunteers [http://www.cdc.gov/niosh/topics/oilspillresponse/protecting/#effects].
- NIOSH encourages response workers to participate in the NIH study when they are contacted. This study will describe the health status of response workers and may lead to a better understanding of exposures during oil spill disasters and their potential health effects.

Table 1. Health symptom survey—demographics

	Exposed*	Unexposed†	Other‡
Number of participants	377	119	330
Age range	18–74	18–70	18–70
Race			
White	58%	40%	42%
Hispanic	14%	27%	23%
Asian	5%	8%	2%
Black	19%	22%	25%
Other	3%	3%	4%
Not given	1%	0%	4%
Male	98%	95%	95%
Days worked oil spill (range)	1–90	0–50	0–61
Days worked oil spill (median)	21	14	15
Days worked boat	1–84	0	0–61
Employer			
BP	8%	5%	6%
Contractor	71%	83%	71%
USCG	3%	0	<1%
Other	11%	5%	12%
Blank	7%	7%	11%

*Participants were recruited from the Venice Field Operations Branch, Venice Marina, Venice Commanders' Camp, Cypress Grove Marina, Myrtle Grove Marina, Delta Marina, and Joshua's Marina. Those who reported working at least one day on a boat and reported exposure to oil, dispersant, cleaners, or other chemicals while working on a boat.

†Participants were recruited from the Venice Field Operations Branch, Venice Commanders' Camp, Cypress Grove Marina, and Myrtle Grove Marina. Those who reported that they had not worked on boats and had no exposures to oil, dispersant, cleaner, or other chemicals were included in this group. No participants from Venice Marina, Delta Marina, or Joshua Marina met this definition.

‡Participants who did not meet the inclusion criteria of either the exposed or unexposed groups.

Table 2. Health symptom survey—by group

	Exposed*	Unexposed†	Other‡
Number of participants	377	119	330
Injuries			
Scrapes or cuts	53 (14%)	14 (12%)	24 (7%)
Burns by fire	0	1 (1%)	1 (<1%)
Chemical burns	2 (0.5%)	0	2 (<1%)
Bad Sunburn	69 (18%)	9 (8%)	26 (8%)
Constitutional symptoms			
Headaches	89 (24%)	13 (11%)	39 (12%)
Feeling faint, dizziness, fatigue or exhaustion, or weakness	71 (19%)	14 (12%)	37 (11%)
Eye and upper respiratory symptoms			
Itchy eyes	39 (10%)	6 (5%)	18 (5%)
Nose irritation, sinus problems, or sore throat	94 (25%)	20 (17%)	47 (14%)
Metallic taste	12 (3%)	0	1 (<1%)
Lower respiratory symptoms			
Coughing	75 (20%)	8 (7%)	34 (10%)
Trouble breathing, short of breath, chest tightness, wheezing	47(12%)	4 (3%)	15 (5%)
Cardiovascular symptoms			
Fast heart beat	13 (3%)	1 (1%)	10 (3%)
Chest pressure	9 (2%)	0	4 (1%)
Gastrointestinal symptoms			
Nausea or vomiting	25 (7%)	3 (3%)	10 (3%)
Stomach cramps or diarrhea	40 (11%)	7 (6%)	17 (5%)
Skin symptoms			
Itchy skin, red skin, or rash	61 (16%)	9 (8%)	32 (10%)
Musculoskeletal symptoms			
Hand, shoulder, or back pain	52 (14%)	7(6%)	22 (7%)
Psychosocial symptoms			
Feeling worried or stressed	37 (10%)	5 (4%)	22 (7%)
Feeling pressured	17 (5%)	4 (3%)	13 (4%)
Feeling depressed or hopeless	12 (3%)	1 (1%)	4 (1%)
Feeling short tempered	37(10%)	5 (4%)	17 (5%)
Frequent changes in mood	22 (6%)	4 (3%)	15 (5%)
Heat stress symptoms§			
Any	126 (33%)	26 (22%)	73 (22%)
4 or more symptoms	25 (7%)	3 (3%)	10 (3%)

*Participants were recruited from the Venice Field Operations Branch, Venice Marina, Venice Commanders' Camp, Cypress Grove Marina, Myrtle Grove Marina, Delta Marina, and Joshua's Marina. Those who reported working at least one day on a boat and reported exposure to oil, dispersant, cleaners, or other chemicals while working on a boat.

†Participants were recruited from the Venice Field Operations Branch, Venice Commanders' Camp, Cypress Grove Marina, and Myrtle Grove Marina. Those who reported that they had not worked on boats and had no exposures to oil, dispersant, cleaner, or other chemicals were included in this group. No participants from Venice Marina, Delta Marina, or Joshua Marina met this definition.

‡Participants who did not meet the inclusion criteria of either the exposed or unexposed groups.

§Headache, dizziness, feeling faint, fatigue or exhaustion, weakness, fast heartbeat, nausea, red skin, or hot and dry skin.

Table 3. Prevalence and prevalence ratios for symptoms by exposures*

Symptoms	Exposure							
	Oil				Dispersant			
	Exposed n=416	Unexposed n=305	Prevalence Ratio (PR)	*P* value	Exposed n=156	Unexposed n=420	PR	*P* value
Upper respiratory†	106 (25%)	44 (14.4%)	1.76	<0.01	51 (33%)	77 (18.3)	1.78	<0.01
Cough	81 (19.5%)	24 (7.9%)	2.47	<0.01	42 (27%)	42 (10%)	2.69	<0.01
Lower respiratory‡	49 (12%)	12 (4%)	2.99	<0.01	28 (18%)	20 (4.7 %)	3.76	<0.01

*Participants were recruited from the Venice Field Operations Branch, Venice Marina, Venice Commanders' Camp, Cypress Grove Marina, Myrtle Grove Marina, Delta Marina, and Joshua's Marina. A total of 826 response workers completed the survey; not all participants answered every question. Among the 156 response workers who reported exposure to dispersant, 148 also reported exposure to oil.

†Upper respiratory symptom was defined as a positive response to nose irritation, sinus problems or sore throat.

‡Lower respiratory symptom was defined as a positive response to trouble breathing, short of breath, chest tightness, or wheezing.

Interim Report #9C
Assessing Psychosocial and Work Organization Issues among Deepwater Horizon Response Workers in Venice, Louisiana, August 2010

Lead Authors: Doug Wiegand and Stefanie Evans

Introduction

In August 2010, NIOSH investigators traveled to Venice, Louisiana, to conduct focus groups on work organization and job stress with Safety Professionals involved in the Deepwater Horizon response. This report presents the findings of the focus groups, which occurred nearly 4 months into the response effort.

Work Organization and Job Stress

Work organization refers to the nature of the work process (i.e., the way jobs are designed and performed) and to the organizational practices (e.g., management and production methods and accompanying human resource policies) that influence the design of jobs. Also included in this concept of work organization are external factors, such as the economic environment and political forces which may influence organizational policies [NIOSH 2002]. Work organization is of interest in occupational safety and health due to its link to *job stress*, or the harmful physical and emotional responses that occur when the requirements of a job are a poor match to the capabilities, resources, or needs of the worker [NIOSH 1999]. For example, extensive scientific evidence links job characteristics (e.g., low levels of control and job insecurity) to job stress and stress-mediated health outcomes such as cardiovascular disease and psychological disorders [Karasek and Theorell 1990; Sauter et al. 1998; Schnall et al. 2000; Reissman et al. 2010].

The Deepwater Horizon oil spill has had a serious impact on the stress and mental health of the Gulf Coast communities. State mental health and substance abuse agencies and domestic violence hotlines have reported sharp increases in reports of distress and requests for assistance (Yun et al. 2010). Disasters such as this not only take a toll on the mental health of the communities impacted, but also on the individuals who are employed to assist with recovery and cleanup efforts. By their nature, disaster response efforts occur in a chaotic environment, with uncertainty, time pressure, and a myriad of complex challenges [SAMHSA 2000].

NIOSH began surveying Deepwater Horizon response workers in June 2010 for various health effects, including the mental health symptoms of feeling worried/stressed, pressured, depressed/hopeless, short tempered; and/or experiencing frequent changes in mood. The percentage of individuals surveyed who reported one or more of these symptoms ranged from 1% to 24% across working groups, including on- and off-shore cleaning crews, wildlife decontamination, and U.S. Coast Guard safety and administrative personnel.

The purpose of the focus group assessment described in this report was to gain a greater understanding of the job stress and protective (e.g., coping) factors among emergency response workers during response operations. By understanding the psychosocial and work organization factors that contribute

to job stress, recommendations can be made to improve working conditions and set the stage for improved disaster preparedness in the future.

Methods

This assessment was qualitative in nature, using focus groups and informant interviews as the main methods for obtaining information. Qualitative methods were chosen because of the limited ability of traditional psychosocial and work organization tools to be of practical use in the dynamic emergency or disaster response work context.

NIOSH assembled a team of investigators with expertise in job stress, emergency preparedness and response, occupational health psychology, disaster psychiatry, and health communication. They developed a protocol to identify problems related to job stress for which NIOSH could make recommendations on what needed improvement. The protocol focused on the following key discussion topics:

- Work organization components associated with job stress for response workers and Safety Professionals
- Behavioral indicators of stress among response workers
- Participants' suggestions for improving work organization
- Use of stress coping strategies
- Impact of the response experience on Safety Professionals and their families
- Suggestions for how to make the experience easier on response workers and their families

Safety Professionals for the Deepwater Horizon response operating out of Venice, Louisiana, were chosen as the target population because of their knowledge of the organization of work, policies, and procedures for response workers on the water. While not necessarily representative of the general population of response workers, this target group of Safety Professionals was familiar with the day-to-day operations of the marine cleanup crews, and worked closely with them on health and safety-related issues.

NIOSH investigators attended morning safety meetings on August 9–10 to describe the purpose of the focus groups and recruit participants. Recruits were instructed to report to the safety office at the end of their shift on August 10. After greeting participants, investigators explained the voluntary nature and purpose of the focus groups and how the information would be disseminated, protecting individual identification. After conducting two focus groups on August 10, the field team was evacuated from Venice because of an incoming tropical depression. The team returned on August 25–26 to complete the focus groups.

Focus groups were conducted in a large air-conditioned tent, a conference room, and an outdoor staging area. The groups consisted of 5–10 Safety Professionals, a NIOSH psychologist, and a NIOSH health communication specialist. The majority of the sessions were facilitated by the psychologist while the health communication specialist served as a scribe. The NIOSH team identified common themes expressed by the study participants. The NIOSH team also held individual informant interviews to assure participation given the logistical challenges created by the staggered schedules of returning vessels. Sessions lasted between 60–90 minutes each.

Results[1]

The total pool of Safety Professionals from Venice BP headquarters at the time of this assessment included 48 individuals. Six focus groups and three informant interviews were completed, totaling 46 participants (96% participation). Thirty-four (74%) of the participants were Safety Observers, who were in charge of the health and safety of crews aboard Vessels of Opportunity (VoOs) and small fleets. Others included Safety Leads/Officers who had higher level management responsibilities (7, 15%), Safety Inspectors/Auditors who examined equipment and safety records (3, 7%), and Safety Administrators who worked closely with the other Safety Professionals in documenting safety issues and facilitating claims, reimbursements, etc. (2, 4%).

The participants' average age was 44 years (range 18–62), and 89% were male. Participants were working at the oil spill for an average of 57 days (range 6–120) at the time of the focus groups. A majority (63%) reported that their job prior to the oil spill response was safety-related. Others indicated a variety of jobs including small business owners, managers, truck drivers, and sales associates.

Job Stressors

The following themes, listed in order of importance, emerged from the discussions as major job stressors for the Safety Professionals and individuals they supervise or oversee: 1) heat; 2) basic living and food arrangements; 3) job insecurity; 4) management and communication issues; 5) frequent changes in rules, procedures, and protocol; and 6) safety knowledge, experience, and training.

Heat
The majority of participants identified environmental conditions as a major stressor. Workers often were exposed to extreme heat and humidity, which was intensified by personal protective equipment (PPE) requirements and sunlight reflecting off the water. Participants agreed that all necessary precautions were taken in terms of work organization to prevent heat stress, including appropriate work-rest schedules, access to air conditioning, and provision of water and electrolyte drinks.

Basic Living Issues
Per Diem and Access to Food: In the initial stages of the response, workers were given a per diem (monies beyond their contractual pay) and had breakfast, lunch, and dinner provided free of charge at a commissary provided by BP on-site. The commissary was disassembled during the first storm evacuation. When operations resumed, BP removed per diem from paychecks and purchased standard box lunches instead of re-assembling the commissary. Without the commissary, many workers had no access to a hot breakfast before reporting to work at 5:00 am because local eateries were not open at this hour.

The box lunches were described as inadequate for workers enduring long hours in the heat and on the water. Many participants reported that food in the box lunches often was spoiled. Additional food was provided for workers at the "Venice Responders' Village," (VRV) which was about 9 miles from the morning mustering station. The location of the VRV made it convenient only to those lodged there. The parking lot was located approximately a quarter mile from the food. Many workers were exhausted at

[1] Note that these results are summaries of the observations, opinions, and perspectives expressed by the participating Safety Professionals and do not necessarily reflect the opinion of NIOSH.

the end of the day and felt it took too much time to get in and out for a meal. Some participants questioned the sanitation and safety of the VRV (see under "Lodging," below).

The food available in Venice was perceived as being inadequate, with a very limited selection of nutritious meal choices, lack of variety (mostly fried foods), inconsistent hours of operation, and operating hours that did not match workers' schedules.

Lodging: Workers were subjected to crowded living quarters with limited personal space or privacy, which affected quality of sleep. Finding adequate lodging was extremely difficult, and many people shared rooms. Workers at the VRV were housed in truck trailers with a capacity of 36, stacked three bunks high. Some workers purchased trailers or campers due to lack of available lodging, but found it difficult to find trailer space.

The VRV was described as crowded and unsanitary. With so many workers living in cramped and close quarters, participants reported tension and frequent confrontations among workers. Some participants reported the presence of workers with criminal backgrounds who were hired without a background check and knives and "shanks" (homemade knives) at the work site. Several participants said there was at least one instance where one person pulled a gun on another person during an argument. This caused concern and raised questions among participants about their personal safety and the potential for violence at the VRV and main work site.

Fatigue: Participants often discussed the long work days (generally over 12 hours) and how physically and mentally fatigued they were. They reported little opportunity, if any, to take a day off to recuperate, even after working many consecutive days. They had concern that taking leave would result in being laid off, and many did not want to take the chance since it was clear that workers were easily replaceable given the number of people looking for work. Several participants noted that the Coast Guard workers were given days off and administrative leave, but Safety Professionals were not offered similar benefits.

Job Insecurity

Job insecurity was a major cause of stress. Workers were laid off with little warning, so people were uncertain if they would have a job the next day. Participants felt that little information was conveyed regarding how long they could expect to be employed. This uncertainty had many of the response workers on edge. Participants across focus groups feared being told "you're going to Mobile," which meant you were being laid off.

Management and Communication Issues

Participants discussed the stress arising from lack of clarity about the chain of command for decision-making and who had tasking authority and priority. For example, it was unclear as to who had the final authority on directives (e.g., should someone obey directives from a supervisor who works for a different contractor?). Participants recalled times when there were multiple, conflicting directives, leading to confusion and frustration (e.g., supervisors telling workers to stay off the water due to weather, followed by the Coast Guard encouraging them to stay on the water). Participants described frequent power struggles and differing priorities between BP, the Coast Guard, and Safety Professionals.

Participants also felt that no clear procedures or documentation were in place to handle workers reporting for duty or job referrals to specific job sites. Participants were not always clear as to why some workers were reporting to them for work and who referred them, which created confusion and

frustration. In addition, workers did not always have proper background checks or medical clearance and some were not physically fit to perform their jobs.

Frequent Changes in Personnel, Rules, Procedures, and Protocol
Participants described instability in supervision, rules, and task procedures as another source of job stress. Supervisors changed frequently, which resulted in people being unfamiliar with each other's interpretation and understanding of rules, procedures, and protocol. Rules were noted to change frequently, with little or no clear communication about these changes or their justification.

Safety Knowledge, Experience, and Training
Another theme regarding stressors included the degree of experience and training among response workers. Many of the workers did not come from safety or emergency response backgrounds and were unfamiliar with things such as PPE, safety terminology, marine operations, and emergency response. This lack of knowledge led to frustration over the need for on the job training, particularly for things with which they felt workers should have been trained on prior to arriving on the job site, such as proper PPE use.

In addition, some individuals felt the level of authority supervisors were given in this response operation was not commensurate with their knowledge, skills, and ability, but rather on the most recent training they had obtained. Many of the participants felt that seniority of experience should have outweighed training when delegating authority.

Behavioral Indicators of Job Stress

Most comments regarding behavioral indicators of job stress focused on people losing their tempers and acting out in frustration or anger as the day progressed. Many people said they could tell that morale suffered at times. They would notice a change in others' enthusiasm for the work, including becoming increasingly quiet and withdrawn.

In one focus group participants discussed the decline in personal health as the response effort continued. They pointed to stress, poor nutrition, crowded living quarters, and inadequate rest as potential causes of declining health. Several participants reported what they thought was an increase in the number of people reporting to the infirmary for psychological evaluations.

Coping with Job Stress

The most common description of methods for coping with job stress included decompressing at the end of the day by eating, showering, and resting. Participants reported watching TV or finding other ways to avoid thinking about work. Social camaraderie was another popular method of coping. Many participants noted that other workers drank alcohol, smoked cigarettes, or took prescription drugs to cope with stress.

Participants' Suggestions for Reducing Job Stress

When asked how the job stressors they identified could be reduced or eliminated, major themes included: 1) improve basic living arrangements and 2) increase and improve transparency of communication regarding management practices, decisions, and the supervisory hierarchy.

Improve Basic Living Arrangements
Most participants felt that BP should have continued to provide the workers with an on-site, easy-to-access commissary that served breakfast, lunch, and dinner. It was suggested that multiple food operators (e.g., temporary vendors and grocery stores) be contracted to increase access to a variety of food to meet dietary needs.

Participants also thought provisions should be made for all workers to have a defined amount of time off without a threat to job security. Many workers were working long hours for many consecutive days due to concern of being laid off if they took leave for rest and recuperation.

Participants suggested that entertainment be made available at the end of the work day or week to reduce stress. Comments were often made about how the military is treated to frequent entertainment when in war zones and that BP should consider doing the same for response workers. This would serve as a morale booster and expression of appreciation for the workers' efforts.

There are several bars in the Venice area, but participants felt those to be inappropriate social gathering places since alcohol consumption would impair performance and hydration on the job the following day. It was suggested that operations close early on Fridays for a social gathering with music and food provided as a community event.

Participants suggested designating a space for meditation and religious services to accommodate workers who rely on their faith to help them cope with stress.

Increase and Improve Transparency and Communication Regarding Management
Participants discussed the need for the management structure to be more coordinated, clarified, and openly communicated to eliminate confusion over the chain of command and task supervision, particularly when tasks involved different contractors. It was suggested that more detailed information be disseminated to workers each morning so that they could have clear expectations for the day and know who had task authority. Another suggestion was to provide training for all response workers on communication issues, teamwork, and tactfulness.

Participants encouraged an increase in transparency about management plans, decision-making and justification for directives or changes in directives. Additionally, decisions and their corresponding rationale needed to be communicated to the front line worker in a more timely and efficient manner.

Impact of Emergency Response Work on Workers' Family and Home Life

Participants frequently commented on the difficulty of being away from their homes for extended periods. Several participants noted that being away was causing problems because they were not available to take care of family needs.

Personal cell phones were unreliable because the reception was limited and service providers were overwhelmed, particularly in the early stages of the response. Some reported poor internet access, which impacted not only communication with family and friends, but also the ability to conduct personal business and pay bills.

Participants felt that their schedules did not permit adequate time to connect with family, and that most phone calls could not be made until the evening when workers were exhausted and irritable. This

strained some participants' relationships because they were not fully engaged in these conversations. Family and friends would comment on how distant and unhappy the participants seemed when speaking to them on the phone.

Despite the above, many of the experienced contractors noted that travel is a requirement of their job. Some voiced that their main family role is to provide a paycheck, and felt they were accomplishing that by being away. Nonetheless, participants felt that the uncertainty of the length of employment was creating stress with their families.

Finally, some participants felt they were being held on site for too long when a weather evacuation was imminent. The delay in their release might unnecessarily compromise their own and their family's ability to prepare for or evacuate from an oncoming storm.

Suggestions for Making the Response Work Easier on Family and Home Life
The main suggestion for improving family life involved making communication easier. One proposed solution was the establishment of a communication center where workers could use landlines and high speed internet access to contact their loved ones, conduct business, and address other needs. Most participants felt that BP should have worked with the cell phone and internet service providers to improve communication.

Another suggested strategy would be to place workers at a suitable job site closest to their homes. Participants believed worker assignments were made without considering where they resided. Some felt they could have reported to another response area closer to their homes.

Many participants said they would have their families come to visit them if there was adequate lodging, and suggested designating some lodging for family visits.

Some participants thought that having days off would improve their family lives. Others wanted to put in all the hours possible for the pay, which they felt would improve their situation in the long run.

A group of participants suggested that BP send thank you letters to the workers and/or their families when they first report to work and once the response is completed. They felt this would make the workers feel appreciated and affirm the importance of their work to their families.

Another suggestion was to involve an assigned "family liaison" to assist workers with personal challenges outside of work such that workers could avoid feelings of helplessness and worry over personal or family issues. Examples of situations included helping families plan weather evacuation strategies or helping arrange home and auto repairs.

Discussion

The workers were immersed in the context of the disaster response effort, so their descriptions of the chaos and complexity of the situation allowed us to understand their firsthand and real time perspectives and insights regarding job stressors and coping. The findings of this report are based on discussions with a specific subset of response workers and are not intended to generalize to the entire population of response workers.

The timing of this assessment and the nature of the disaster should be considered when interpreting the findings of this report. These focus groups were conducted nearly 4 months after the beginning of the Deepwater Horizon oil spill, and after a number of attempts to cap the well had failed. The NIOSH investigators believe that the assessment occurred during the "disillusionment" phase of the disaster, which typically is marked by frustration, anger, irritability, hopelessness, and divisiveness [CMHS 1994; SAMHSA 2000, 2004]. Such disillusionment was salient during this assessment as participants described their frustrations and dissatisfaction with the organization of work and how workers were treated.

Workers conveyed that BP did not seem interested in their well-being, and that they were viewed as easily replaceable commodities. The most frequently mentioned examples of this were removal of the commissary and per diem, and the perception that people could be quickly laid off and replaced if they did not comply with work demands such as long shifts and many consecutive days on the job. Workers felt that BP was supportive at first while the press was in the area, but that they turned their backs on the workers after the first evacuation when media attention diminished. This represents a violation of *psychological contract*, or the implicit agreement that the employer will value and care for the worker in exchange for good work [Morrison and Robinson 1997].

Participants felt that BP should have provided more resources to ensure workers' needs were being met on and off the job. Many of the workers were staying in temporary lodging because they could not commute from their homes, and were thus subjected to the isolation of the rural Venice area. Therefore, even when off the clock, people were still essentially in a work environment, preparing themselves for the next day on the job. Participants felt that hard work should be balanced by access to basic human needs, rest, and leisure activities.

Participants also felt that management could have reduced job stress by being more transparent regarding the length of time the workers would be employed. Many felt that job security should have been guaranteed at intervals (e.g., monthly) to eliminate daily anxiety that they would report to work only to be discharged. Job insecurity is a major stressor, which has been linked to a variety of negative mental and physical health outcomes [Dooley et al. 1987; Kuhnert et al. 1989; Dekker and Schaufeli 1995; Probst 2000].

Recommendations

Response operations in Venice have discontinued at the time of this report. Therefore, the recommendations below are posed for consideration during future disaster response efforts.

- In addition to providing and encouraging use of employee assistance programs for mental health and stress issues, organize work to help reduce stress at the group level. Consult with experts in emergency response on work organization issues. Resources for guidance on work organization during emergency response include:
  - The Center for Disease Control and Prevention's Emergency Preparedness and Response webpage: http://www.bt.cdc.gov/
  - The Substance Abuse and Mental Health Services Administration's (SAMHSA) Disaster Response webpage: http://www.samhsa.gov/Disaster/
- Closely examine whether workers have adequate food commensurate with the length and timing of their work shifts and the physical workload.

- Expand the communication network to ensure all workers have access to daily information such as schedules, weather conditions, and changes in roles or expectations. Consult with communication experts to develop a system that supplements the Incident Command System. Do not depend only upon verbal chain of command to disseminate information. For example, use bulletin boards in common areas (e.g., sign-in areas, bus stops, break areas, etc.) to display daily information for front line workers.
- Provide response workers with messages about what is being done to provide a healthy and safe temporary living environment, and have hot-lines or other means of communication for workers to report concerns. Continue working with public and environmental health professionals to address concerns regarding safety, sanitation, and crowding issues in the temporary living environments.
- Establish communication centers where workers have access to landlines and high-speed internet connections. Such centers should be open and available for use 24 hours a day to meet the varying needs to all response workers' schedules and needs to communicate to different time zones.
- Evaluate all workers' scheduling requirements and allow for sufficient rest between shifts. The National Sleep Foundation recommends that adults receive 7–9 hours of sleep in a 24-hour period (http://www.sleepfoundation.org).
- Conduct pre-employment screening of all response workers, including background checks, and medical evaluations to determine fitness for duty.
- Ensure response workers receive adequate job training before reporting for duty.
- During training, emphasize the importance of self-care, including nutrition, hydration, and sleep.
- Provide off-hours entertainment and socialization activities, as well as a site for meditation or religious services.
- Establish a safe mechanism for workers to inform management about needed changes in work organization.

Other Resources

- NIOSH Stress at Work webpage: http://www.cdc.gov/niosh/topics/stress/
- NIOSH Interim Report on Managing Traumatic Stress for Deepwater Horizon Response and Volunteer Workers: http://www.cdc.gov/niosh/topics/oilspillresponse/traumatic.html
- The Occupational Safety and Health Administration's resilience resources: http://www.osha.gov/SLTC/emergencypreparedness/resilience_resources/index.html
- George Washington University's Institute for Crisis, Disaster, and Risk Management: http://www.gwu.edu/~icdrm/index.html
- The U.S. National Response Team's Guidance for Managing Worker Fatigue During Disaster Operations: http://nrt.org/production/NRT/NRTWeb.nsf/allattachmentsbytitle/sa-1049tadfinal/$file/tadfinal.pdf?openelement

Note: *Each participant was given an HHE brochure (*http://www.cdc.gov/niosh/docs/2009-167/pdfs/2009-167.pdf*), which includes the web address where they can access the interim and final reports summarizing the various components of the HHE. Copies of a NIOSH brochure that includes tips for managing stress during the Deepwater Horizon Response were also distributed among the Safety Leads for dissemination to response workers (NIOSH 2010).*

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