Dragon, Karen E. (CDC/NIOSH/EID)

From: Eileen Senn [eileensenn@gmail.com]
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To: NIOSH Docket Office (CDC)
Subject: Comments on NIOSH Docket Number: NIOSH 223
Attachments: Qualitative Exposure Assessment Gulf Cleanup Workers.doc

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Submitted electronically by email to nioshdocket@cdc.gov

NIOSH Docket Office
Docket No. NIOSH-223

Top of Form

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Greetings,

Thank you for the opportunity to comment on the draft guidance document, *Emergency Responder Health Monitoring and Surveillance* (ERHMS), NIOSH Docket Number: NIOSH 223.

My comments are limited to *Section 7. Integration of Exposure Assessment, Responder Activity Documentation, and Controls into ERHMS***,** pages 30 to 36 of the draft document and *Appendix B: Exposure Assessment and Strategy in Incident Response Operations*, pages 166 to 177.

Sincerely,

Eileen Senn

1) **The ERHMS system should encourage response workers to keep records with information relevant to their exposures and develop a standardized form for workers to use in this regard.** Accessibility (brevity, literacy level, and perhaps native language) would be the crucial factor in encouraging worker use of such a form.

Response workers know much about their exposures and that information should be captured. Workers can be given a phone number to text, a paper journal, or a website to access to make dated entries. Pertinent information would include the names of their employer and supervisor(s); general and specific location(s) worked; degree of mobility; hours worked including time started and stopped; off-duty hours in the area; job title and description including tasks performed, tools, equipment, and machinery used; chemical products used; estimated distances and whether upwind or downwind from exposure sources; descriptions of exposure sources; odors noticed, how strong they were, and what they smelled like; short-term health effects experienced; skin contact with contaminants; area of skin contact in square inches on what part(s) of the body; skin problems experienced; contaminant contact with eyes and any vision problems experienced; personal protective equipment (PPE) used; how often PPE was replaced or decontaminated; whether or not a respirator was worn and for how long, including whether it was worn continuously or off and on; the specific type of respirator worn, for example, disposable dust mask or flexible facepiece with removable cartridges; color coding on respirator cartridges; how often respirator cartridges were replaced; whether fit-tested on each respirator used; suspected chemical contamination inside gloves, shoes, clothing, or respirators whether from improper storage, improper decontamination, or other reason; suspected contamination of food, beverages, gum, tobacco products, and cosmetics whether from contamination of eating surfaces, improper storage, or other reason; suspected contamination of personal vehicle or home whether from dirty work clothing and shoes or other sources; access to sinks and showers for hand washing during work and showering at the end of the shift; access to emergency eyewash and shower; weather variables including temperature and humidity, rainfall, sunlight and cloud cover, wind speeds and direction, currents, tides, wave heights, etc.

Response workers should also be asked to retain copies of their paystubs. More details are given in my August 2, 2010 post on The Pump Handle, *Advice for Gulf responders about chemical exposures.*

2) **The ERHMS system should direct more attention to the creation of qualitative exposure assessments including narrative descriptions of exposures.** A team of experts should create narrative descriptions of typical and worst exposures for typical response tasks being performed. Exposure assessments should be *narratives informed by numbers*, not just quantitative numbers. The following thirteen factors should be considered in qualitatively assessing and writing about potential exposures to contaminants: [1]

1. Sources of contaminants
2. Identities of contaminants
3. Properties of contaminants
4. Toxicity of contaminants
5. Amounts of contaminants
6. The pathways contaminants travel to reach employees
7. Employee job functions involving contaminants
8. Processes and operations involving contaminants
9. Duration of exposures to contaminants
10. Frequency of exposures to contaminants
11. Routes of entry of contaminants into the human body
12. Sensory perceptions of employees to contaminants
13. Effectiveness of any control measures used to reduce exposures to contaminants, for example, substitution, isolation, work scheduling, ventilation, personal protective equipment, notification, hazard communication, and medical removal.

I have attached *A Qualitative Exposure Assessment for Gulf Cleanup Workers* as an example.

3) **The ERHMS system should mandate bulk samples be collected, analyzed, and preserved**. Much about the nature of exposures can be learned by analysis of bulk samples of dusts, liquids, and gases present in emergencies. Multiple bulk samples should be collected, qualitatively and quantitatively analyzed, preserved, and retained for further analysis in the future, in case that is required. Samples should be split and sent to two or more labs for analysis since experience has shown this can result in different results. Often more information about potential exposures can be obtained from bulk samples than from air samples because issues like particle size, vapor pressure are not at play. Bulk samples are ubiquitous and easy to collect at the time of an emergency but may be impossible to obtain after the fact.

4) The ERHMS system should explain how to use direct reading equipment for quantitative sampling with instantaneous results. Full-shift air sampling that requires laboratory analysis is a poor fit for many emergency situations. The types, strengths and weaknesses, and possible applications of commercially available direct reading, preferably data-logged**,** equipment to emergency situations should be explained, preferably in an appendix to the report. A starting place would be the OSHA and NIOSH Topic Pages on direct reading instruments for gases, vapors, and particulates such as MultiRae and ultrafine particle monitors. Readings taken with these instruments can be compared to readings from unaffected areas and trends can be monitored over time.

5) **The ERHMS system should acknowledge that in many cases, response workers' exposures will be uncertain.** Because most chemicals have no Occupational Exposure Limit (OEL), the reality is that criteria to evaluate most exposures do not exist. In addition, it is misleading to attempt to categorize exposures as acceptable based on sampling just a few of many contaminants present. False reassurances to response workers must not be given based incomplete, unrepresentative, poorly documented, untimely, and misinterpreted air sampling data.

6) **The ERHMS system should explain how to reduce OELs for 12-hour work shifts.** Many time-weighted average exposure limits apply to an 8-hour day and 40-hour work week. For response workers who have a 12-hour day, samples should be compared with two-thirds of the 8-hour exposure limits. For workers living in the exposure area, 24-hour exposures must be calculated and exposure limits reduced to one-quarter of the 8-hour limits. Avoiding long work days would be preferable, however, to having to do this.

7) **The ERHMS system should explain how to calculate additive exposures.** The science on calculating additive exposure is very weak. In general, chemicals that affect the same organ systems are considered to have additive effects. A place to start for how to do the calculations is the OSHA Technical Manual, Section 2, Chapter 1, Personal Sampling for Air Contaminants, X, Organic Vapors and Gases, K, SAE for chemical mixture. www.osha.gov/dts/osta/otm/otm_ii/otm_ii_1.html#organic_vapors_gases

8) **The ERHMS system should explain that the most protective OELs must be utilized to evaluate air sampling data.** The strengths, weaknesses, and possible application of all available Occupational Exposure Limits (OELs) should be discussed, including:

- OSHA Permissible Exposure Limits (PEL) www.osha.gov/SLTC/pel/index.html
- NIOSH Recommended Exposure Limits (REL) www.cdc.gov/NIOSH/92-100.html
- ACGIH Threshold Limit Values (TLV) www.acgih.org/TLV/
- AIHA Workplace Environmental Exposure Levels (WEEL) www.aiha.org/content/insideaiha/volunteer+groups/weelcomm.htm
- EPA Acute Exposure Guideline Levels (AEGL) www.epa.gov/oppt/aegl/
- AIHA Emergency Response Planning Guideline (ERPG) www.aiha.org/content/insideaiha/volunteer+groups/erpcomm.htm
- Temporary Emergency Exposure Limits (TEEL) developed by the Subcommittee on Consequence Assessment and Protective Actions (SCAPA) for the U.S. Department of Energy (DOE) / National Nuclear Security Administration (NNSA) www.atlintl.com/DOE/teels/teel.html
- Health Protective Levels developed by California www.cdph.ca.gov/programs/hesis/Documents/riskreport.pdf

Where there is no OEL, consideration should be given to using risk-assessment based protective limits such as:

- ATSDR Minimum Risk Levels (MRLs) http://www.atsdr.cdc.gov/mrls/index.asp
- USEPA IRIS levels www.epa.gov/IRIS/

9) **The ERHMS system should unlink the use of respirators from OEL exceedences.** Respirator selection and use during emergencies cannot be held to the same rigid standards as in fixed workplaces where exposures have been well characterized. Response workers should not be denied the benefits of wearing a respirator because no OEL exceedences have been documented. Instead, respirators can be offered and their use enforced in situations where they are likely to reduce exposures to at least some contaminants that are present. When this is done, workers must be informed that the respirator is offering an unknown level of protection and that they should avoid or minimize exposures in other ways whenever possible.

10) **The ERHMS system should spell out criteria for deciding how and when response workers will be asked to risk uncertain or unacceptable exposures.** Workers must not learn after the fact that they have been exposed to uncertain or unacceptable exposures. They must not be misled about risks. Instead, they must be told in advance of the risks they are being asked to take and given the opportunity to decline or volunteer for the exposures. This must be done in a way that eliminates pressure from peers or supervisors.

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[1] Fundamentals of Industrial Hygiene, Fifth Edition, edited by Barbara A. Plog and Patricia J. Quinlan, Chapter 15, Evaluation, National Safety Council, 2002.

Qualitative Assessment Needed of
Chemical Exposures to Gulf Cleanup Workers

Eileen Senn, MS

July 13, 2010

BP, OSHA, and NIOSH are all conducting **quantitative** air sampling in the ongoing Deepwater Horizon Response. As far as I have been able to determine, none have performed the prerequisite primary step of compiling a comprehensive and rigorous **qualitative** exposure assessment. This is alarming because air sampling cannot be rationally planned without such a qualitative exposure assessment, especially in the Gulf where the exposure situation is unprecedented and complex and not easily grasped without such an assessment. An estimated 45,000 cleanup workers are involved and potentially exposed http://www.deepwaterhorizonresponse.com/go/doc/2931/774039/.

OSHA and NIOSH have now officially recommended the use of respirators by the offshore Gulf cleanup workers closest to the crude oil, including those drilling relief wells, applying dispersant, and providing support and supplies. While respirators are not generally recommended for onshore and nearshore workers, there are exceptions for workers if they are near to or downwind of burning oil, far from shore, performing high pressure washing, cleaning fresh crude oil from wildlife, or experiencing symptoms or health problems. Whether or not a worker receives a respirator is often dependent on air sampling results http://www.cdc.gov/niosh/topics/oilspillresponse/protecting/.

To accurately and completely describe the worst chemical exposures to cleanup workers during the ongoing Deepwater Horizon Response, we need to know the identity, quantity, and toxicity of each chemical contaminant; characteristics of chemicals such as form, volatility, and solubility; where contaminants are located in the Gulf compared to worker locations; worker job descriptions; and exposure variables. Careful interviews and observations of workers in action are needed to ascertain activities that that may cause chemicals to become airborne or contact workers' eyes, skin, hair, gloves, shoes, or clothing. Photographs and videotape of workers in action allow such observations in more detail. A careful review and summary of previous industrial hygiene and epidemiology studies on similarly exposed workers is also part of a qualitative exposure assessment.

Potential worker exposures to chemicals by all routes of exposure must be evaluated in a qualitative exposure assessment - skin contact, inhalation of contaminated air or airborne soil/sand, accidental ingestion, contact with the eyes, and skin puncture. These can occur simultaneously.

I will describe some of the information that should be included in a qualitative assessment.

Overview of Contaminants

There is a complex mixture of at least fifty toxic chemicals in the Gulf air, water, sentiment, sand and soil - possibly numbering into the hundreds. The chemicals are in the physical states http://en.wikipedia.org/wiki/State_of_matter of liquids, gases, vapors, mists, respirable particulate, fumes, and solids and semi-solids like tar mousses, mats, balls and chips http://en.wikipedia.org/wiki/Tarball_(oil). These forms contain volatile organic compounds (VOCs) http://en.wikipedia.org/wiki/Volatile_organic_compound, aldehydes http://en.wikipedia.org/wiki/Aldehydes, acid gases http://en.wikipedia.org/wiki/Acid_gas, metals http://en.wikipedia.org/wiki/Toxic_metals, organic sulfur compounds http://en.wikipedia.org/wiki/Organosulfur_compounds, and Polycyclic Aromatic Hydrocarbons (PAHs) http://en.wikipedia.org/wiki/Polycyclic_aromatic_hydrocarbon.

Chemical Variables

These chemicals are undergoing physical changes http://en.wikipedia.org/wiki/Phase_change such as evaporation http://en.wikipedia.org/wiki/Evaporation, condensation http://en.wikipedia.org/wiki/Condensation, aerosolization http://en.wikipedia.org/wiki/Aerosolization, melting http://en.wikipedia.org/wiki/Melting, and chemical reactions such as http://en.wikipedia.org/wiki/Chemical_reactions decomposition http://en.wikipedia.org/wiki/Chemical_decomposition, combustion http://en.wikipedia.org/wiki/Combustion, hydrolysis http://en.wikipedia.org/wiki/Hydrolysis, oxidation, reduction, http://en.wikipedia.org/wiki/Oxidation, and biodegradation http://en.wikipedia.org/wiki/Biodegradation.

Exposure Variables

Worker exposures to these chemicals are influenced by spill events, chemicals being used, cleanup tasks being performed, equipment being used, worker locations relative to sources of chemicals, and number of hours worked or off-duty in the exposure environment, such as sleeping onboard a vessel. Temperature and humidity, rainfall, sunlight and cloud cover, wind speeds and direction, currents, tides, wave height, sea spray, boat spray, and other variables also influence exposures. These are more variables than in indoor settings like factories or even partially open chemical plants, refineries, and construction sites. It would be no exaggeration to say that no two days in the Gulf are identical in terms of exposure variables.

Specific Contaminants

Crude oil http://en.wikipedia.org/wiki/Petroleum#Composition: gases including butane, ethane, methane, propane and hydrogen sulfide; liquids including pentane, isopentane, n-hexane, n-heptane, n-octane, n-nonane, n-decane, n-undecane, hexadecane, cyclopropane, cyclobutane, cyclopentane, cyclohexane, cycloheptane, cyclooctane, cyclononane, benzene, ethyl benzene, toluene, xylene; metals including arsenic, iron, nickel, copper, vanadium; hydrogen sulfide gas; and Polycyclic Aromatic Hydrocarbons

(PAHs), including anthracene, benzo-a-pyrene, chrysene, naphthalene, phenanthrene, and pyrene.

Normally one relies on the Material Safety Data Sheet (MSDS) http://en.wikipedia.org/wiki/Material_safety_data_sheet to determine the identities and percentages of ingredients in a product. Unfortunately, the BP MSDS for Mississippi Canyon Petroleum Crude Oil http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/incident_response/STAGING/local_assets/downloads_pdfs/OnshoreNearShoreIHMonitoringStrategy6-24-2010Redacted.pdf (pages 23 to 33) lists only three ingredients – benzene, hydrogen sulfide, and PAHs – and no percentages. For comparison, a better MSDS has been produced by El Paso Corporation http://www.elpaso.com/msds/A0017-Crude%20Oil.pdf.

A more extensive list of hydrocarbons in crude oil and their percentages is in Table D-1 of the U.S. Centers for Disease Control 1999 *Toxicological Profile for Petroleum Hydrocarbons* http://www.atsdr.cdc.gov/ToxProfiles/tp123.pdf.

Weathered crude: As crude oil "weathers" from exposure to water and sun, the more water-soluble and volatile components are reduced and the less water-soluble and volatile components such as metals and PAHs are concentrated. The BP MSDS for Mississippi Canyon Weathered Crude http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/incident_response/STAGING/local_assets/downloads_pdfs/Mississippi_Canyon_252_Weathered_Crude_Oil_MSDS_English.pdf states:

> A complex mixture of hydrocarbons consisting predominantly of paraffins, cyclic paraffins, and aromatic hydrocarbons having carbon numbers of C10 or greater.

Only one specific ingredient is listed: naphthalene at less than 0.1%

Dispersant Corexit EC9500A
www.deepwaterhorizonresponse.com/posted/2931/Corexit_EC9500A_MSDS.539287.pdf**:** Contains10 to 30% petroleum distillates, 1 to 5% propylene glycol and 10 to 30% proprietary organic sulfonic acid salt. EPA's website lists more ingredients http://www.epa.gov/bpspill/dispersants.html#chemicals. Also contains metals – arsenic, chromium, and copper www.epa.gov/emergencies/content/ncp/products/corex950.htm.

Dispersant Corexit EC9527A
www.deepwaterhorizonresponse.com/posted/2931/Corexit_EC9527A_MSDS.539295.pdf**:** Contains 30 to 60% 2-Butoxy ethanol, 1-5% propylene glycol, and 10 to 30% proprietary organic sulfonic acid salt. EPA's website lists more ingredients http://www.epa.gov/bpspill/dispersants.html#chemicals. Also contains six metals - chromium has the highest percent http://www.epa.gov/oem/content/ncp/products/corex952.htm.

Dispersant-coated crude oil micelles http://en.wikipedia.org/wiki/Micelle**:** same as crude oil and dispersants http://en.wikipedia.org/wiki/Dispersant combined. Micelles make the oil more soluble and bioavailable.

Combustion products of crude oil: sulfuric acid, acrolein, carbon dioxide, carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, acetaldehyde, formaldehyde, particulate, 1,4-dioxane, Polycyclic Aromatic Hydrocarbons (PAHs).

Fuels including gasoline http://en.wikipedia.org/wiki/Gasoline**, diesel** http://en.wikipedia.org/wiki/Diesel_fuel**, and marine** http://en.wikipedia.org/wiki/Diesel_Fuel_Marine: benzene, butane, cyclohexane, ethylbenzene, heptane, hexane, pentane, toluene, trimethybenzene, xylene, and other petroleum hydrocarbons and additives.

Internal combustion engine exhaust http://en.wikipedia.org/wiki/Internal_combustion_engine#Air_pollution**:** respirable particulate matter, carbon monoxide, carbon dioxide, sulfur dioxide, sulfuric acid mist, nitrogen oxide, nitrogen dioxide, formaldehyde, acetaldehyde, benzene, 1,3 butadiene

Large ship engines http://en.wikipedia.org/wiki/Ship_pollution**:** oxides of nitrogen and sulfur

Airplane piston engine exhaust http://en.wikipedia.org/wiki/Avgas**:** same as internal combustion engines plus tetraethyl lead

Diesel exhaust http://www.osha.gov/SLTC/dieselexhaust/chemical.html**:** same as internal combustion engines plus styrene, toluene, xylene, acrolein, Polycyclic Aromatic Hydrocarbons (PAHs), metals, including arsenic, beryllium, cadmium, chromium, lead, mercury, nickel, selenium.

Detergents http://en.wikipedia.org/wiki/Detergent **and cleaning products** http://en.wikipedia.org/wiki/Cleaning_product**:** variable, may include d-Limonene http://en.wikipedia.org/wiki/D-Limonene, and petroleum hydrocarbons. Consult product label and Material Safety Data Sheet (MSDS).

Pesticides http://en.wikipedia.org/wiki/Pesticide**:** variable, active ingredients may include fipronil, permethrin, chlorpyrifos, and D-Phenothrin http://www.hnsa.org/doc/pdf/sbpc.pdf (page 83). Non-active ingredients include petroleum hydrocarbons. Consult product label and information.

Biocides http://massbay.mit.edu/resources/pdf/ballast-treat.pdf**:** variable, for treatment of ship and oil rig bilge and ballast water. May include ozone, gluteraldehyde, or hydrogen peroxide.

Insect repellents http://en.wikipedia.org/wiki/Insect_repellent**:** variable, may include N, N-Diethyl-meta-toluamide (DEET), hydroxyethyl isobutyl piperidine carboxylate (Picaridin). Consult product label and information.

Decomposing birds, animals, fish, plants and other forms of life http://en.wikipedia.org/wiki/Bacterial_decay**:** Volatile organic compounds (VOCs)

Spill Events that Give Rise to Exposure

Amount of oil released and burned on the water (in-situ): 130 million gallons of oil have been released and 10 million gallons burned in 275 controlled burns. Current projections estimate Deepwater Horizon's discharge at 35,000 to 60,000 barrels per day http://www.deepwaterhorizonresponse.com/go/doc/2931/661583/ . At 43 gallons per barrel this is 1.5 to 2.5 million gallons per day.

Amount of oil and gas burned by flare: www.nola.com/news/gulf-oil-spill/index.ssf/2010/07/burning_and_flaring_of_oil_lea.html **:** Since it went into operation on June 16, the Q4000 has burned an average of 8,556 barrels (360,000 gallons) of oil per day, totaling 119,780 barrels (5 million gallons) as of June 29 -- about half the oil burned thus far. Together the Q4000 and the Discoverer Enterprise have flared more than 1 billion cubic feet of gas.

Amount of dispersants http://www.deepwaterhorizonresponse.com/go/doc/2931/762207/**:** 1.79 million gallons of dispersant have been applied, 1.07 million gallons on the surface and 721,000 gallons under the water. Average daily use 22,000 gallons. http://www.propublica.org/blog/item/after-epa-directive-on-average-bp-reduced-dispersant-use-by-9-percent.

Spill Equipment that Gives Rise to Exposure

Mobile vehicles on water: 121 aircraft and 6,720 vessels, including 2,710 Vessels of Opportunity, 500 barges, 580 skimmers, and 2,930 other vessels http://www.deepwaterhorizonresponse.com/go/doc/2931/774039/.

Mobile vehicles on land: Automobiles, trucks, earth-moving equipment, all-terrain vehicles.

Spill Tasks that Give Rise to Exposure

Offshore: Drilling relief wells, operating burn vessels, aerial dispersant spraying at altitudes of 30-50 feet, dispersant application from vessels with spray booms, and providing support and supplies. Near or downwind of oil leak, burning oil, dispersant applications, or other sources.
Nearshore: Near or downwind of burning oil, dispersant applications, or other sources; handling anchors, boom, taglines
Onshore: Performing high pressure washing, cleaning fresh crude oil from wildlife, cleaning vessel decks and hulls to remove oil and dispersant.

Chemical Health Effects

The scientific community lacks complete information on either the short-term or long-term health effects of the mixture of chemicals during the ongoing Deepwater Horizon Response.

.However, some of the effects of individual chemicals are known http://www.sciencecorps.org/crudeoilhazards.htm, including:

Potential short-term health effects include Irritation to eyes, skin, and respiratory system; dizziness; rapid heart rate; headaches; tremors; confusion; unconsciousness.

Potential long-term health effects include cancer, birth defects, and permanent nerve damage as well as damage to the liver, kidneys, respiratory, reproductive, blood, and immune systems.

New Jersey Hazardous Substance Fact Sheets

To obtain complete and reliable health and safety information on specific chemicals, review New Jersey Department of Health and Senior Services (DHSS) Hazardous Substance Fact Sheets (HSFSs) http://web.doh.state.nj.us/rtkhsfs/indexfs.aspx. They have a user-friendly format and are available in English for more than 1,700 chemicals and in Spanish for more than 600 chemicals. Direct links to fact sheets for some chemicals in the Gulf are also online http://tools.niehs.nih.gov/wetp/index.cfm?id=2495#OtherOilSpillResources.

Conclusions

Once the elements of qualitative exposure assessment which I have begun to describe are comprehensively and rigorously developed and thoroughly understood, control measures http://www.state.nj.us/health/surv/documents/ihfs.pdf can be selected, including respirators. Without such an exposure assessment, important exposures may be overlooked and not controlled.

In addition, without such an assessment, health effects and air sampling results may be attributed to the wrong source because the same contaminant may come from several sources. For example, in the Gulf, we can see that many of the same hydrocarbons can come from multiple sources - crude oil, dispersant, vehicle fuels and exhaust, burning crude, cleaning materials, decomposing life forms, and pesticide non-active ingredients.

BP and OSHA should work with NIOSH to develop such an exposure assessment.