

Examination of Long-Term Health Effects From the Macondo Well Blowout



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NIOSH Health Hazard Evaluation Report HETA 2010-0115 & 2010-0129-3138 (August 2011)

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Background & Purpose

- Clean-up following the **Macondo well blowout/explosion and collapse of BP Deepwater Horizon oil platform** involved tens of thousands of workers
- **Tasks** included oil and tar ball removal from beaches, oil skimming and booming, burning of surface oil, surface application of dispersant by vessels and aircraft, and containment and recovery work on vessels at the release site
- **Air monitoring data** (thousands of samples) collected by BP, NIOSH, OSHA, Coast Guard, and U.S. EPA
- Based on available data, **“Are clean-up workers expected to suffer long-term, adverse health consequences?”**

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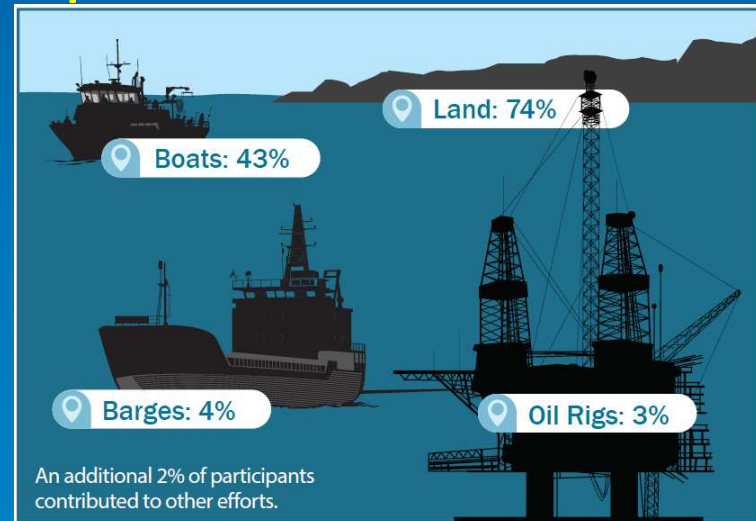
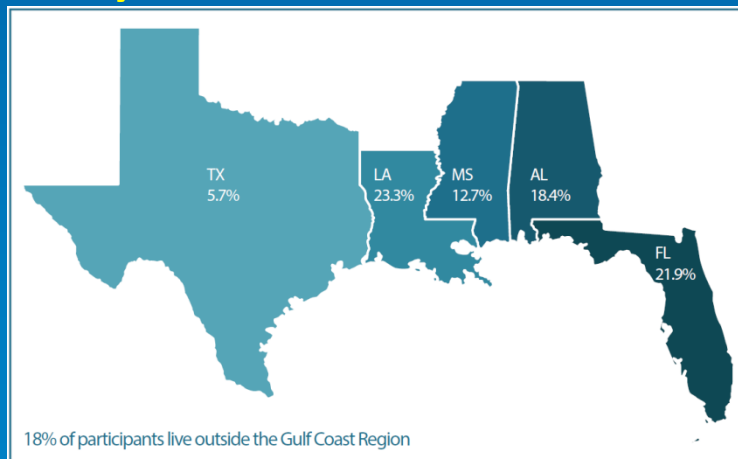
- “Personal breathing zone and area air sampling . . . revealed **nondetectable to low levels of individual chemicals. Nonetheless, mixed** low level **exposures** to crude oil, dispersant, and other chemicals; **heat stress, psychosocial strains, ergonomic and other injury hazards; and pre-existing personal health risk factors all may have contributed to health symptoms** reported by response workers. An additional potential contributing factor for the **acute respiratory symptoms** reported by some response workers is the formation of reactive **aldehydes** and **ozone** from the **environmental photochemical activity on volatile hydrocarbons.**”
- “**Nonspecific symptoms** such as **headache, eye and respiratory irritation, and fatigue** were **more commonly reported by responders** who self reported exposures to oil, dispersants, or other chemicals compared to workers who self reported no such exposures.”

Will Cleanup Workers Suffer long term harm?

- Will there be **chronic** health effects in workers?
- Symptom studies following the **2002 Prestige oil tanker spill** off the coast of Spain **suggest evidence of lasting respiratory harm to** workers involved in response and cleanup.
- Is this evidence **relevant** for Macondo well blowout response workers?

Seeking the Answer: GuLF Study

- The Gulf Long-term Follow-up (GuLF) Study -- multi-year study sponsored by the National Institute of Environmental Health Sciences (NIEHS)
(<https://gulfstudy.nih.gov/en/index.html>)
- Currently in its 4th year . . .
- From the GuLF study website: “**Preliminary observations . . . indicated that cleanup workers were about 30 percent more likely to have moderate to severe depression than residents who did no cleanup work. Results were similar for anxiety.**”



Other Studies of Cleanup Workers

- Goldstein *et al.* (*N Engl J Med* 364:14, 2011) reviewed many epidemiological studies of oil spill cleanup workers
- Most studies were based on self-reported **symptom surveys**
- As noted earlier, studies of the **2002 Prestige tanker oil spill suggest** lasting respiratory effects in cleanup workers.
 - **Bunker C oil** spill (estimated 50,000 tonnes)
 - **786 contaminated beaches, oil up to 1 meter thick**
- Did workers' exposures **differ** between the *Prestige* spill and the *Macondo well blowout* release?
 - If so, in what ways?
 - In what ways were they similar?

Exposures of *Macondo Well Blowout* v. *Prestige* Cleanup Workers

- Cleanup workers' exposures were **extensively** monitored at *Macondo*, but only **sparsely** monitored for *Prestige*
- Worker protection likely **more systematic/effective** at *Macondo*; **dermal exposure** likely more significant at *Prestige* than at *Macondo*
- **Oil properties** may have led to significant differences in exposures

Characteristic	Macondo (2010)	Prestige (2002)
Release point	Deep under water	Ocean surface
Oil type	Crude oil	Refined Bunker C (heavy #6) product
Use of dispersants	Extensive use, much under water	None (not effective on heavy oils)
Aromatic content (as released)	16%	32-50%
Benzene content (as released)	3,000 mg/kg	33-100 mg/kg

Macondo Cleanup Worker Exposure Chemicals Detected in Monitoring by BP

Contaminant	Units	Detection frequency	Range of detects	Average (with ND at 1/2 DL)	Average of detects
2-Butoxyethanol	ppm	205 / 1029	0.014 - 0.76	0.049	0.12
Acetone	ppm	4 / 9	0.35 - 1.2	0.37	0.72
Benzene	ppm	654 / 28827	0.0048 - 3.3	0.013	0.078
Cyclohexane	ppm	362 / 3722	0.03 - 1.5	0.039	0.20
Ethylbenzene	ppm	512 / 28827	0.016 - 12	0.050	0.22
Heptane	ppm	511 / 3722	0.015 - 3.8	0.058	0.29
Limonene	ppm	144 / 244	0.18 - 59	2.95	4.93
Methyl ethyl ketone	ppm	5 / 5	0.42 - 3.2	1.88	1.88
n-Hexane	ppm	691 / 3722	0.01 - 4.6	0.068	0.30
Petroleum Distillates	mg/m ³	24 / 38	1.8 - 140	27.1	42.4
Propylene Glycol	ppm	0 / 8	ND	ND	ND
Tetrahydrofuran	ppm	37 / 3726	0.041 - 0.71	0.022	0.12
Total hydrocarbons	ppm	4688 / 28827	0.12 - 480	1.04	4.25
Toluene	ppm	1134 / 28827	0.0081 - 64	0.061	0.40
Trimethylbenzenes	ppm	297 / 3722	0.056 - 39	0.084	0.44
Xylene	ppm	920 / 28828	0.017 - 38	0.16	0.62

Benzene Exposures at Macondo (8-hr TWAs)

Task	Benzene concentration (ppb) [action level = 500 ppb]	Task	Benzene concentration (ppb)
Air/water sampling	6	Nearshore operations	48
Animal rescue	11	Offshore operations	7
Beach cleanup	12	Oil recovery	35
Boom decon	10	Other	13
Boom deploy	17	Personnel decon	10
Boom repair	13	Refueling	42
Decon	11	Scouting	17
Dispersant operations	41	Skimming	15
Dredging	8	SMART	15
Drill ship	8	Tanker operations	8
Equipment decon	10	Unknown	25
Firefighter	7	Vehicle decon	10
Hazardous waste disposal	13	Vessel decon	12
In-situ burning	9	Vessel operations	18
Mud vessel	6	Vessel support	12

Worker Exposure at the *Prestige* Spill

Worker category	Exposure frequency	Benzene exposure concentration (ppb) Avg. \pm std. dev. (# workers)
Volunteer beach cleaners	4 hours/day, 5 days	41 \pm 7.7 (n=27)
Hired manual workers	6.5 hours/day, 4 months	15 \pm 4.5 (n=17)
High-pressure washers	6.5 hours/day, 3 months	0.93 \pm 0.36 (n=15)

Exposure Modeling of the *Prestige* Spill

- Contaminated beach scenario
- Application of mass transfer model yields benzene emission rates e_{ben} of the order of 0.001 g/m²-s

$$e_{ben} = s \frac{D_{ab}}{L} (0.037 Re^{4/5} - 871) Sc^{1/3} C_{film}$$

- Application of EPA SCREEN3 model for area source yields **concentration estimates an order of magnitude greater** than those actually measured at the *Prestige* spill -- possibly due to source depletion; instead maybe monitoring data not fully representative

Benzene Exposure Comparisons

- 5 of 28,827 measurements at *Macondo* exceeded the OSHA PEL of 1 ppm (1,000 ppb)
- 89% of *Macondo* measurements were lower than the 15 ppb level measured for hired manual workers at *Prestige*
- 99% of *Macondo* measurements were lower than the 41 ppb level measured for volunteer beach workers at *Prestige*
- **Conclusion:** Benzene (and other VOCs?) exposures were generally lower at *Macondo* (especially in consideration of worker protection)

Benzene Health Risks – Regulatory Guidelines

- OSHA Permissible Exposure Limit 1 ppm
- NIOSH Recommended Exposure Limit 0.1 ppm
- ACGIH Threshold Limit Value 0.5 ppm
- EPA Regional Screening Level (non-cancer) 0.04 ppm
- EPA Regional Screening Level (cancer) 0.0005 ppm

Perspectives on Epidemiological Studies

- Studies based on self-reported symptoms are difficult to interpret
- Psychologically-induced stress, and heat stress, potential confounders
- Other confounding variables (*e.g.*, smoking, alcohol) can differ between exposed workers and unexposed controls
- Baseline exposures may differ between exposed and control populations – *e.g.*, cleanup workers may draw from ship workers who are routinely exposed to marine diesel emissions

Conclusions

- Indications of long-term respiratory effects at the *Prestige* spill **may not translate** to similar observations at *Macondo*, since *Macondo* cleanup workers' exposures were likely lower
- However, the GuLF Study, with greater statistical power, may identify potential long-term effects
- Preliminary findings of the GuLF Study indicate depression and anxiety
- Chemical exposure may interact with other stressors (heat stress, psychological stress) to affect long-term health

Thank you . . .

- for your attention!

Questions or Comments?