

# Gulf Science Data

## Data Publication Summary Report

# Personal Breathing Zone Samples for Industrial Hygiene Program

Reference No. OTH-03v01-02

April 2014

Prepared by BP Exploration & Production Inc. and  
BP Gulf Coast Restoration Organization

# Version History

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Files associated with this data posting are available on BP's Gulf Science Data website ([gulfsciencedata.bp.com](http://gulfsciencedata.bp.com)).

## Data Publication Summary Report

Data Posting Version Number	Data Posting Date	Updates since Previous Posting
OTH-03v01	April 2014	Initial posting of the Personal Breathing Zone Samples for Industrial Hygiene Program dataset.

## Associated File Names

Document Type	Folder / Subfolder	File Name
Data Files	Other / Industrial Hygiene	IndustrialHygiene_OTH-03v01-01a.zip IndustrialHygiene_OTH-03v01-01b.csv
Citation	Other / Industrial Hygiene	IndustrialHygiene_OTH-03v01-01_Citation.pdf
Data Publication Summary Report	Other / Industrial Hygiene	IndustrialHygiene_OTH-03v01-02.pdf

## Supporting Files

Document Type	Folder / Subfolder	File Name
Work Plans and/or Related Documents	Work Plans	Multiple files. (See Appendix A for study reference numbers.)

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**Attachment**

Attachment 1   Study Description

**Acronyms**

AIHA	American Industrial Hygiene Association
BP	BP Exploration & Production Inc. and BP Gulf Coast Restoration Organization
BTEX	benzene, toluene, ethylbenzene, and xylenes
CSV	comma-separated value
DWH	Deepwater Horizon
EPA	U.S. Environmental Protection Agency
HHE	health hazard evaluation
LOD	limit of detection
LOQ	limit of quantitation
MC252	Mississippi Canyon lease block 252
µg	micrograms
mg/m <sup>3</sup>	milligrams per cubic meter
MSRC	Marine Spill Response Corporation
NIEHS	National Institute of Environmental Health Sciences
NIOSH	National Institute for Occupational Safety and Health
NRDA	Natural Resources Damage Assessment
OSHA	Occupational Safety and Health Administration
OVA	OSHA versatile sampler
QA/QC	quality assurance and quality control
OVN	organic vapor monitor
PELs	permissible exposure limits
PPE	personal protective equipment
ppm	parts per million
PTFE	polytetrafluoroethylene
SRN	study reference number
THCs	total hydrocarbons
UAC	Unified Area Command
USCG	United States Coast Guard
VOCs	volatile organic compounds

# Personal Breathing Zone Samples

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## Introduction

Following the April 20, 2010, Deepwater Horizon (DWH) accident, BP Exploration & Production Inc. and BP Gulf Coast Restoration Organization (BP) and federal and state governmental agencies have engaged in one of the largest environmental data gathering efforts in history. Data have been collected to guide efforts to respond to the accident and remove oil from the environment (Response), assess potential damage to natural resources (natural resource damage assessment [NRDA]), and develop restoration plans that seek to address any natural resource damage resulting from the accident (Restoration). Data have been collected cooperatively by BP and the agencies, including agencies that serve as DWH natural resource damage trustees (Trustees). Data have also been collected independently by BP and by government agencies. These efforts are ongoing and include work to analyze and organize data.

To improve public access to these data, and to promote scientific research related to the Gulf of Mexico and these data, BP is posting data in an accessible form on BP's Gulf Science Data website ([gulfsciencedata.bp.com](http://gulfsciencedata.bp.com)).

In support of DWH Response activities, industrial hygiene data were collected to monitor worker health. The industrial hygiene data included in this publication includes the results of personal breathing zone samples collected by BP and its contractors to assess an individual's potential exposure to airborne chemicals during the response. This report provides additional context for the posted dataset, including information about the collection, analysis, and organization of the data.

Much of the data in this posting was provided to the National Institute of Environmental Health Sciences (NIEHS), a division of the National Institute of Health, for the purpose of conducting an independent long-term health study of response workers. The data in this posting differs from the data that was provided to NIEHS on April 20, 2011, in several respects:

- The results of samples collected after data was provided to NIEHS (i.e., from April 14, 2011, to January 30, 2012) have been added to the data set.
- Samples have been excluded from this posting where the data quality review process indicated that the results were invalid or not representative of worker exposure. The vast majority of these samples were excluded because the sampling durations were less than 3 hours and the sampling results were below detection limits, making it difficult to accurately compare these short duration sample results to the 8-hour time weighted average permissible exposure limits (PELs).<sup>1</sup>

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<sup>1</sup> For badge samples, the limit of detection (LOD) is inversely related to sampling duration, so that badge samples taken over short durations have higher detection limits than badge samples taken over an 8 hour day.

- The results of field-collected quality control samples (i.e., field blanks) are included in this data posting. For the industrial hygiene program, field blanks are passive dosimeters or badges that were not exposed to the environment, but are analyzed using the same methods as the personnel samples to determine if any of the analytes pre-existed in the sample media or were inadvertently introduced during shipping, storage, or analysis.
- Names of workers, organizations, and other personal information have been excluded.

Users of the data provided in this posting are encouraged to review the data files with all supporting documentation in order to understand its scope, extent, and limitations. Please direct any questions about this dataset to [gulfsciencedata@bp.com](mailto:gulfsciencedata@bp.com).

## Summary of Industrial Hygiene Program

BP worked closely with the Unified Area Command (UAC) to identify, evaluate, and prevent or reduce worker exposure to oil and response chemicals using administrative and/or engineering controls<sup>2</sup>, as well as other methods. For certain response activities, appropriate types of personal protective equipment (PPE), such as Tyvek® suits and/or respirators, were worn to prevent exposure. In addition to implementing exposure controls, BP also implemented an extensive air monitoring program to evaluate worker exposure to oil and chemicals.

The associated data files for this posting include samples collected from workers while conducting different types of response activities, including:

- Offshore Vessels – Samples were collected on response workers and vessel crew that were involved with source removal activities such as containment and recovery, dispersant application, or in-situ burning of oil.
- Nearshore Vessels – Samples were collected on response workers and vessel crew that were involved with activities such as boom handling, oil skimming, or scientific research.
- Beach – Samples were collected on workers performing shoreline cleanup operations.
- Decontamination – Samples were collected on workers involved with decontamination of equipment and vessels.

The industrial hygiene monitoring program included the collection of both “personal breathing zone” samples over the course of a work shift and work zone “real-time” measurements. This data set only reports the personal breathing zone samples.

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<sup>2</sup> Implementation of administrative controls (such as providing instructions for response teams to maintain specified distances from dispersant flight paths) and engineering controls (such as providing increased ventilation) were among the preferred methods for reducing worker exposure.

The "personal breathing zone" is generally defined as the zone within a 10 inch radius of a worker's nose and mouth. Most personal breathing zone samples were collected by clipping a passive dosimeter, or badge, onto an individual worker and were used to assess potential chemical exposures. The goal was to collect personal samples from approximately 10% of the workforce in the area of potential exposure. After a personal breathing zone sample was collected, it was submitted to one of two American Industrial Hygiene Association (AIHA)-certified laboratories for analysis.

Work zone ("real-time") measurements were also collected in the area of worker activity using instruments that provide instantaneous measurements of chemical concentrations. These real-time air monitoring measurements are not included in this data posting.

Sampling of offshore response workers continued through September 2010, until the MC252 well was permanently plugged and sealed (i.e., September 19, 2010).

Sampling of response workers in decontamination areas, nearshore and beach environments continued through February 2012.

## Data Posting Description

### Study List

The personal breathing zone samples were collected for the purpose of evaluating worker exposure for the industrial hygiene program. This personal breathing zone sample data has been assigned a single Study Reference Number (i.e., SRN-2001).

The SRN provides a link between the work plans, data contained in the datasets, and the study description. The study description is provided as Attachment 1 to this report and the associated work plans are posted on the Gulf Science Data website.

### Parameter List

The personal breathing zone samples were analyzed for the following parameters:

- Benzene, toluene, ethylbenzene and xylenes (BTEX). BTEX are the most commonly measured volatile constituents of crude oil. Approximately 33,000 personal breathing zone samples and field blanks were analyzed for BTEX and the results were compared to occupational exposure limits.
- Total volatile organic compounds (VOCs) or total hydrocarbons (THCs). Total VOCs or THCs are reported as an estimated value based on the response of *n*-hexane. Total VOC or THC results provide an indication of whether one or more particular hydrocarbon constituents may be elevated. Approximately 32,700 personal breathing zone samples and field blanks were analyzed for total VOCs or THCs.
- Cyclohexane, *n*-heptane, *n*-hexane, tetrahydrofuran, and trimethylbenzenes. These VOCs were added to the list of analytical parameters after they were detected in ambient air samples collected near the source. The data file contains cyclohexane, *n*-heptane, *n*-



hexane, tetrahydrofuran, and trimethylbenzenes results for approximately 4,200 personal breathing zone samples and field blanks.

- 2-Butoxyethanol. This is a constituent of the dispersant Corexit 9527 manufactured by Nalco Corporation that was used during the response. The data file contains 2-butoxyethanol results for 1,168 personal breathing zone samples and field blanks.
- Gravimetric oil mist. Sampling for oil mist was generally conducted on workers involved with power washing of boom or vessels at onshore decontamination sites. Two types of oil mist samples were collected during decontamination activities; some samples were collected for analysis of oil mist as total particulates and some samples were collected for analysis of oil mist as thoracic particulates<sup>3</sup>. A separate data file contains gravimetric oil mist results for 546 samples.
- Limonene. Limonene is a component of the oil extracted from citrus rinds and is a constituent of some cleaning agents used for vessel and boom decontamination. The data file contains limonene results for 279 samples and field blanks.
- Acetone and 2-butanone (also known as methyl ethyl ketone). These are VOC constituents of vinyl cements used for boom repair. The data file contains acetone results for 9 samples and 2-butanone results for 5 samples.
- Propylene glycol. Propylene glycol is a constituent of two dispersants (Corexit 9500 and Corexit 9527) used during the response. The data file contains propylene glycol results for 14 samples and field blanks.

Personal breathing zone samples were submitted to AIHA-accredited laboratories for analysis using standard Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) analytical methods. Table 1 summarizes the parameter list and associated analytical methods.

### Sample Types

The vast majority of personal breathing zone samples were collected by clipping a passive dosimeter sampling device, also known as a badge or an organic vapor monitor (OVM), to the clothing of a worker and recording the start and end times so that the measured result can be reported as a time-weighted average. A description of the passive samplers and other types of sampling devices used during the response are summarized below:

Passive Dosimeters – Over 32,000 personal breathing zone samples and field blanks were collected using passive dosimeters or OVMs. Samples were collected by exposing a passive dosimeter or badge to workplace air and were then submitted to a laboratory for analysis of BTEX, total VOCs or THCs, and other VOCs. The data file indicates that the following types of

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<sup>3</sup> Thoracic particulates represent a fraction of total particulates small enough that, when inhaled, are potentially capable of reaching the lung airways.

passive dosimeters were used to collect personal breathing zone samples; TraceAir AT 521 (1-sided or 2-sided), 3M 3500, 3M 3520, and SKC Badge Types 575-001 (charcoal) and 575-002 (anasorb).

Pre-weighed polytetrafluoroethylene (PTFE) filters – Approximately 546 samples were collected for gravimetric oil mist analysis by drawing air through a 2-micron Teflon® filter cartridge with a personal sampling pump. Samples intended for analysis of oil mist as total particulates were collected by drawing air directly through the filter. Samples intended for analysis of oil mist as thoracic particulates were collected by first drawing air through a cyclone to remove larger size particles.

Charcoal Tubes – Approximately 50 samples were collected by drawing air through charcoal sorbent tubes with personal sampling pumps and then analyzed for BTEX, total hydrocarbons, and 2-butoxyethanol.

OSHA Versatile Sampler (OVS) Tubes – Approximately 14 samples were collected for propylene glycol analysis using an OVS-7 tube. OVS tubes contain a glass fiber filter to trap aerosols and a two-section sorbent bed to adsorb vapors in one specially-constructed glass tube. A personal sampling pump is typically used with a flow rate of 1 liter per minute to obtain the appropriate sample volume.

### Non-Detected Values

Chemical results reported by laboratories for analytes which are tested for, but not detected because their concentration is below the LOD, are referred to as non-detects. In the data file, non-detect results are flagged with a “U” in the “Qualifiers” field.

For approximately 5,800 badge samples, the data file contains two separate results; one reported at the limit of quantitation (LOQ) and a second result reported at a lower LOD. The analytical results for personal breathing zone samples were originally reported by the laboratories at the LOQ, but BP later requested that the results be re-calculated and re-reported at lower LODs consistent with those reported for samples collected by NIOSH. One of the contracted laboratories re-reported the results to lower LODs using methodology reviewed by NIOSH and NIEHS; however the other laboratory was not able to re-report data with lower LODs because the original calibration standards were not low enough.

The original results are presented in the field called “Concentration” for the personal breathing zone oil mist data and “Concentration – NDs set to LOQ” for the personal breathing zone badge data. The re-reported values are presented in the field called “Calculated Concentration - NDs set to LOD.”

**The user must look at the complete set of data and carefully consider how to treat non-detects, depending on the intended use.**

## Data Exclusions

The following data types have been excluded from this data posting, but may be included in future postings:

- Air monitoring was conducted in work zones using portable measuring devices (e.g., photoionization detectors, particulate monitors, and sorbent detector tubes). These real-time measurements are not included in this data posting.
- Air samples and measurements were collected along the shoreline and along the perimeter of decontamination branches. These data are part of the Community Air Sampling and Branch Perimeter Sampling programs and will be published in a future data posting.
- Over 500 samples have been excluded because the data quality review process indicated that the results were invalid or were not representative of worker exposure. The vast majority of these samples were excluded because the sampling durations were less than 3 hours and did not have detectable levels of any analytes. Approximately 9 samples of less than 3 hours duration remain in the data files because they had at least one analyte that exceeded detection limits. It is important to note that the detection limit for short duration samples are higher than the detection limits for longer duration samples.
- Laboratory quality control samples (e.g., laboratory blanks) are not included in this data posting.
- The latitude and longitude for oil mist samples are not included because they were not included in the dataset that was provided to NIEHS, but a short description of worker location is provided as “Location or Station ID”.
- Personally identifiable information of workers and samplers, such as names, telephone numbers, e-mail addresses, and social security numbers are not included in this data posting.

Data included in this posting may be periodically updated on the website.

## Data Use Considerations

To aid users in evaluating the data contained in this data posting, several issues that may impact its use are summarized below.

- The concentrations provided in the data file are considered time-weighted averages and, unless otherwise noted, are suitable for comparison to applicable occupational exposure limits. The personal badge sample results are reported in parts per million (ppm); field blank results are reported in micrograms ( $\mu\text{g}$ ); propylene glycol, petroleum distillates, and gravimetric oil mist results are reported in milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ).
- The data file includes the latitude and longitude for most samples; however, these coordinates typically represent the location at which a person was issued a passive

dosimeter/OVM badge and may not be representative of the location(s) at which the worker may have worked. Based on this consideration, a sample location map is not provided with this data posting.

- The data file includes approximately 711 badge samples that were collected appropriately but were not analyzed within the specified holding time. The results of those samples are noted as “Sample exceeded holding time” in the Sample Comment column.
- In accordance with NIOSH Method 5524 that was used for analysis of oil mist<sup>4</sup>, the laboratory reported two separate results for each sample; metal working fluids as total particulates or thoracic particulates (also known as gravimetric oil mist) and extracted metal working fluids aerosol. The posted data file includes only results for gravimetric oil mist because those are the results that were compared to an associated occupational exposure limit.
- The concentrations of gravimetric oil mist represent either total particulates if the pump configuration field is denoted as “tp” or thoracic particulates if the pump configuration field is denoted as “cyclone”.
- The oil mist data file includes numerous additional fields intended to document the level of PPE worn by the worker; however, this information was entered inconsistently by field staff and the resulting discrepancies were not corrected prior to the date of this posting.
- Samples analyzed for THC's were blank-corrected based on results of field blank.
- An independent data validation firm has completed Level 4 data validation of approximately 20% of the laboratory sample delivery groups, but the results of this effort have not been recorded in the associated data files.

## Data Validation and Verification

To verify the quality of these data, data validation and data verification were conducted as discussed below.

### Data Validation

Validation of analytical chemistry data is performed to assess the data's completeness, correctness, and compliance with applicable analytical method requirements. Data validation is performed by independent third-party data validators who assess the compliance of a dataset against the analytical method criteria. Typically, field and laboratory quality control analyses and instrument calibrations are the primary focus of validation activities. Deviations from method-specified criteria are reported, and the impact of these deviations on the associated data are evaluated and documented to inform the data users. Data validators assign qualifiers to

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<sup>4</sup> NIOSH Method 5524 is a gravimetric method that was developed for analysis of metal working fluids but the same methodology was used for analysis of oil mist.

individual results associated with method deviations to indicate if the results are considered to be estimated, negated, or rejected. Result qualifiers assigned during data validation are included as a separate field in the data file(s) to provide this detailed information to data users. For this posting, the majority of the data were reported without data validation qualifiers, and the data are usable as reported.

Data validation was performed by firms retained by BP in accordance with the U.S. Environmental Protection Agency (EPA) National Functional Guidelines for Organic Data Review (U.S. EPA 2002, 2008), including professional judgment in applying the guidelines. Multiple firms conducted data validation in support of the Mississippi Canyon lease block 252 (MC252) Response studies, and each firm developed and utilized a standard operating procedure to document its application of EPA guidelines.<sup>5,6</sup> Users of the data provided in this posting are encouraged to review the data file(s) in total along with the data validation qualifiers to assess the applicability of these data for the intended use.

All of the data included in this publication have been validated by professional, independent, third-party validation firms and some data have received an additional level IV validation; the results of level IV validation efforts will be incorporated into the data files and updated on the website at a later date.

### Data Verification

Data verification personnel retained by BP have conducted an extensive effort to verify the quality of field sample attributes. To maximize the scientific benefit of data verification efforts, these personnel used methodologies to identify potential errors.

Initial data verification activities focused on review of the completeness and reasonableness based on the data reported for each sample. Each field in the data file was reviewed for consistency within and between samples. Potential issues were reported to the BP data management team, investigated, and corrected, if necessary.

### Data File Description

To facilitate the use of Personal Breathing Zone data collected for the Industrial Hygiene program during the response, BP is providing the data in the form of two comma-separated value (csv) files.

IndustrialHygiene-OTH-03v01-01a.csv - The personal breathing zone badge sample file is large and contains more than 184,000 rows of information.

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<sup>5</sup> Analytical chemistry data received what is known Level II Data Verification (by eDataPro), while up to 20% of the data received more comprehensive full “Stage 4” validation by Environmental Standards, Inc.; however, the associated data files do not include the Stage 4 validation codes.

<sup>6</sup> While the National Functional Guidelines (U.S. EPA 2002, 2008) served as the basis for the data validation reviews, details for each firms’ approach varied based on their professional interpretation and application of these guidelines.

IndustrialHygiene-OTH -03v01-01b.csv - The personal breathing zone oil mist data file contains 546 rows of information.

A full description of the file format and the data dictionaries are provided in Appendix B.

## Supporting Information

This section describes additional information available on the Gulf Science Data website that provides background and context for the posted datasets.

### Study Descriptions

Study descriptions provide a brief summary of the plans, objectives, and approach, along with a table summarizing the sample list and available analytical data provided in this data posting. This data posting has been assigned a unique Study Reference Number (i.e., SRN-2001) which provides a means of linking the information in this DPSR to the data contained in the data files and the associated work plans.

### Response Work Plans

During the Response, work plans were prepared, reviewed, and approved prior to field work. Copies of approved work plans for the industrial hygiene program (i.e., SRN-2001.1-WorkPlan.pdf and SRN-2001.2-WorkPlan.pdf) are included with this data posting.

## Other Data Sources

OSHA, NIOSH, and the United States Coast Guard (USCG) conducted worker and area monitoring during the response and have published the results of their surveys. A summary of their efforts and links to their data is provided below:

### OSHA

OSHA conducted personal and area monitoring and has published a database that includes the results of over 900 personal samples and 179 direct reading measurements. The personal samples were analyzed at the OSHA Lab in Salt Lake City, Utah, and the dataset includes approximately 4,500 results for BTEX and other organic contaminants, dispersant compounds, decontamination agents, petroleum distillates, and miscellaneous compounds.

The OSHA dataset, supporting information, and links to additional information are available at: [https://www.osha.gov/oilspills/index\\_sampling.html](https://www.osha.gov/oilspills/index_sampling.html)

Results from real time monitoring instruments (direct reading) results can be found at: [https://www.osha.gov/oilspills/oil\\_directreading\\_bysite.html](https://www.osha.gov/oilspills/oil_directreading_bysite.html)

Laboratory results can be found at: [https://www.osha.gov/oilspills/oil\\_slc\\_bysite.html](https://www.osha.gov/oilspills/oil_slc_bysite.html)

## NIOSH

On May 28, 2010, BP requested that NIOSH conduct a health hazard evaluation (HHE) of Deepwater Horizon response workers. NIOSH investigators completed exposure monitoring, observational assessments, health surveys, and focus groups for a variety of work sites and work activities. The findings were released in a series of nine interim HHE reports for which a link is provided below.

NIOSH conducted personal and area monitoring and has published a database that includes the results of approximately 500 personal samples and approximately 1,700 direct reading measurements. The personal samples were analyzed at Bureau Veritas' laboratory in Novi, Michigan, and the dataset includes results for BTEX and other organic contaminants, dispersant compounds, decontamination agents, diesel exhaust, total hydrocarbons, and many miscellaneous compounds.

The NIOSH dataset, HHE reports, supporting information, and links to additional information are available at: <http://www.cdc.gov/niosh/topics/oilspillresponse/gulfspillhhe.html>

## USCG

USCG conducted personal monitoring and has published a database that includes over 200 personal samples. The personal samples were analyzed at OSHA's laboratory in Salt Lake City, Utah, and the dataset includes approximately 1,100 results for BTEX and other organic contaminants, dispersant compounds, petroleum distillates, oil mist (mineral), and miscellaneous compounds.

The USCG laboratory analysis results (organized by site) are available at: [http://www.osha.gov/oilspills/uscg\\_lab\\_bysite.html](http://www.osha.gov/oilspills/uscg_lab_bysite.html)

**Other Sources of Health Monitoring Data.** Examples of other sources of health monitoring data include the Marine Spill Response Corporation (MSRC) who operated its own vessels and performed its own direct reading air monitoring and the National Response Center (NRC) who operated skimming vessels and performed its own direct reading air monitoring.

## Notes

BP is providing the dataset and supplemental information to make data available in a form that can be used in other studies and research. The DWH NRDA Trustees have not participated in the development of the dataset in this form or in production of this document. Data that are the subject of this report may be updated after any further QA/QC reviews.

Additional information and research, including existing and future research related to the DWH accident, may affect the use and interpretation of this information and the underlying data. BP reserves the right to supplement this document, to provide interpretation and analysis of this document and any data contained herein, and to raise objections to the admission, use, and

interpretation of this document in part or in full, and any material described herein, in any legal proceeding.

## **References**

- U.S. EPA. 2002. Guidance on Environmental Data Verification and Data Validation. EPA QA/G-8. EPA/240-R-02/004. U.S. Environmental Protection Agency, Office of Environmental Information. Washington, DC.
- U.S. EPA. 2008. USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. EPA/540-R-08/01. U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, DC.



# Tables

**Table 1. Parameter List and Associated Analytical Methods**

Chemical Name	CAS No.	Laboratory Method used by BVNA	Laboratory Method used by Galson
Benzene	71-43-2	OSHA 7	NIOSH 1501
Toluene	108-88-3	OSHA 7	NIOSH 1501/OSHA III
Ethylbenzene	100-41-4	OSHA 7	NIOSH 1501
Xylenes	1330-20-7	OSHA 7	NIOSH 1501
Total VOCs/HCs as n-alkane	NA	OSHA 7/NIOSH 1550	NIOSH 1500, 1501
Acetone	67-64-1	NA	NIOSH 1300
2-Butoxyethanol	111-76-2	OSHA 7	NA
Cyclohexane	110-82-7	OSHA 7	NA
Heptane	142-82-5	OSHA 7	NA
Limonene	138-86-3	NA	OSHA PV 2036
Methyl ethyl ketone	78-93-3	NA	NIOSH 1300
Oil mist	NA	NA	NIOSH 5524
Propylene glycol	57-55-6	NIOSH 5523	NA
n-Hexane	110-54-3	OSHA 7	NA
Tetrahydrofuran	109-99-9	OSHA 7	NIOSH 1609
Total trimethylbenzenes	25551-13-7	OSHA 7	NA

BVNA = Bureau Veritas North America, Inc.

OSHA = Occupational Safety and Health Administration

NIOSH = National Institute for Occupational Safety and Health

NA = not applicable

# Appendices

## Appendix A

# Personal Breathing Zone Samples for Industrial Hygiene Program Study List

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Study Type	SRN	Study Name in the Database	Study Description Title
BP Independent	2001	Industrial Hygiene	Personal Breathing Zone Samples for Industrial Hygiene Program

SRN: study reference number

## Appendix B

# Data File Dictionaries

The personal breathing zone sample data are published in two separate comma-separated value (CSV) files for portability among data systems. The CSV files consist of a well-defined set of data columns. The following section describes the columns in the data files. The column name is shown as it appears in the first row of the CSV file, the description is intended to define the values in that column, and the data type identifies whether the column contains text, a date, or a numeric value.

## Analytical Chemistry for Personal Breathing Zone Samples

The following table describes the columns in the CSV file containing analytical chemistry data for personal breathing zone samples.

Column Name	Description	Data Type
Data Source Retrieval Date	Date associated with when the data was retrieved from the database.	Date
Data Release Version Date	Date associated with the current data posting date.	Date
Data Release Description and Version Number	A general description of data provided in the data posting (i.e., Submerged Sediment Chemistry) and a version control number.	Text
Study Reference Number	Study reference number (SRN) assigned by BP to provide a link between the data provided in the data file and the associated work plans and study descriptions provided on the Gulf Science Data website (gulfsciencedata.bp.com).	Text
Study Name	The study name used by the original investigator or by NOAA. Related studies are also grouped together under a single harmonized group study name. This study name may be referenced by some documentation and other data systems.	Text
Location or Station ID	A name given to the location where samples were collected. Many samples were collected opportunistically in the field, targeting observed or suspected oil presence, and the locations were not assigned a name. Therefore, not all samples have a location ID.	Text
Location Detail	Sample Location corrected by correction code	Text
Location Class	Sample Location Class (Beach, Nearshore, Offshore) reported by field data	Text
Location Class Final	Sample Location Class corrected by correction code	Text
Latitude	The north latitude, in decimal degrees, where the sample was collected. This coordinate (with the corresponding longitude) may be either the specific location of the sample or the location assigned to the station where sampling was conducted.	Numeric
Longitude	The west longitude, in decimal degrees, where the sample was collected. See the description of the latitude column.	Numeric
Task	Sampling Activity reported by field data	Text
Job Task or Place	Sampling Activity corrected by correction code	Text
Personnel Title	Job Title of person sampled	Text

Column Name	Description	Data Type
Additional Exposure Info	Additional Exposure Information	Text
Interpretive Sample ID	The identifier given to represent a unique combination of location, date (and time) and depth. This identifier is part of the primary key of this table.	Text
Analytical Sample ID	The client sample identifier given to a portion of the interpretive sample, or to the whole interpretive sample, when submitted to a laboratory for analysis. There may be one or several analytical sample IDs for each interpretive sample ID.	Text
Laboratory Sample ID	The internal laboratory sample identifier for the sample.	Text
Sample Date	The date on which the sample was collected.	Date
Duration - Minutes	Total Sample Time based on field data (minutes)	Number
Gear Type Code	Database code that describes the type of Media used for sample collection	Text
Gear Type Name	Type of Media used for sample collection	Text
Sample Type	Indicates whether the sample is a natural environmental sample, a field QC sample (i.e., a blank), or a lab QC sample.	Text
Field Matrix	General description of the substance collected and submitted for analysis.	Text
Field Sample Material	Specific description of the substance collected and submitted for analysis.	Text
Chemical Name	The name of the chemical analyzed. An effort has been made to harmonize the chemical naming conventions, where possible. During the ongoing QA process, this harmonization will be further refined and provided in subsequent versions of this database.	Text
Chemical Code	A standardized system-specific code to uniquely identify each chemical. Chemical codes are one-to-one homologous with chemical names.	Text
Chemical Type	Indicates whether the chemical is a target analyte or an added standard (e.g., surrogate).	Text
Concentration - NDs set LOQ	The reported concentration of the chemical in the sample, or the level of quantitation for non-detect results.	Numeric
Unit	The units of the associated concentration value.	Text
Validation Qualifiers	Qualifiers applied by the data validation firm.	Text
Limit of Quantitation	The lowest concentration of an analyte in a sample that can be determined with acceptable precision and accuracy	Numeric
Validation Level	The type and amount of data validation performed.	Text
Nondetect Flag	Indicates whether or not the analyte was detected in a sample. 'Yes' is equivalent to a qualifier that includes "U".	Text
Calculated Concentration - NDs set LOD	Re-calculated concentration of the chemical in the sample, or the level of detection for non-detect results.	Numeric
Calculated Unit	The units of the associated concentration value.	Text
Calculated Qualifiers	Re-calculated qualifiers determined during concentration re-calculation.	Text
Calculated Limit of Detection	Recalculated Limit of Detection established from the lowest calibration standard utilized on the gas chromatograph	Number
Calculated Nondetect Flag	Indicates whether or not the re-calculated concentration was detected in a sample. 'Yes' is equivalent to a qualifier that includes "U".	Text
Preparation Method	Method used to prepare the sample for analysis as reported by the laboratory.	Text
Analytical Method	Method used to produce the measured concentration as reported by the laboratory.	Text

Column Name	Description	Data Type
Lab Replicate	Code to distinguish multiple measurements when all other identifying attributes are identical.	Text
Dilution Factor	The factor by which the sample was diluted for analysis.	Numeric
Date Analyzed	The date that the sample was analyzed to produce the reported concentration.	Date
lab	The laboratory generating analytical chemistry data for the sample.	Text
Sample Comment	Information pertaining to the handling or shipment of the sample	Text

## Analytical Chemistry for Oil Mist Samples

The following table describes the columns in the CSV file containing analytical chemistry and other data for oil mist samples.

Column Name	Description	Data Type
Data Source Retrieval Date	Date when the data was retrieved from the database.	Date
Data Release Version Date	Current data posting date.	Date
Data Release Description and Version Number	A general description of data provided in the data posting (i.e., Industrial Hygiene) and a version control number.	Text
Study Reference Number	Study reference number (SRN) assigned by BP to provide a link between the data provided in the data file and the associated work plans and study descriptions provided on the Gulf Science Data website (gulfsciencedata.bp.com).	Text
Study Name	The study name used by the original investigator or by NOAA. Related studies are also grouped together under a single harmonized group study name. This study name may be referenced by some documentation and other data systems.	Text
Location or Station ID	A name given to the location where samples were collected. Many samples were collected opportunistically in the field, targeting observed or suspected oil presence, and the locations were not assigned a name. Therefore, not all samples have a location ID.	Text
Job Task or Place	Sampling Activity corrected by correction code	Text
Additional Exposure Info	Additional Exposure Information	Text
Interpretive Sample ID	The identifier given to represent a unique combination of location, date (and time) and depth. This identifier is part of the primary key of this table.	Text
Analytical Sample ID	The client sample identifier given to a portion of the interpretive sample, or to the whole interpretive sample, when submitted to a laboratory for analysis. There may be one or several analytical sample IDs for each interpretive sample ID.	Text
Laboratory Sample ID	The identifier assigned by the laboratory.	
Sample Date	The date on which the sample was collected.	Date
Pump Configuration	Indicates whether the pump was set up for sampling of total particulates (tp) or thoracic particulates using cyclone (cyclone).	Text
Pre-Calibration Flow Rate	Flow rate measured before sampling.	Numeric
Post-Calibration Flow Rate	Flow rate measured after sampling.	Numeric
Flow Rate Unit	Units for flow rate.	Text
Pump Period	Sampling duration measured by pump timer.	Numeric

Column Name	Description	Data Type
Sample Period	Sampling duration recorded by sampler.	Numeric
Period Unit	Units for pump duration.	Text
Pump ID	Identification of pump used for sampling.	Text
Dry Calibrator Serial No.	Identification of dry calibrator used for calibration of flow rate.	Text
Sample Type	Indicates whether the sample is a natural environmental sample, a field QC sample (i.e., a blank), or a lab QC sample.	Text
Field Matrix	General description of the substance collected and submitted for analysis.	Text
Field Sample Material	Specific description of the substance collected and submitted for analysis.	Text
Chemical Name	The name of the chemical analyzed. An effort has been made to harmonize the chemical naming conventions, where possible. During the ongoing QA process, this harmonization will be further refined and provided in subsequent versions of this database.	Text
Chemical Code	A standardized system-specific code to uniquely identify each chemical. Chemical codes are one-to-one homologous with chemical names.	Text
Chemical Type	Indicates whether the chemical is a target analyte or an added standard (e.g., surrogate).	Text
Concentration	The reported concentration of the chemical in the sample.	Numeric
Unit	The units of the associated concentration value.	Text
Qualifiers	The data qualifiers originally applied by the analytical laboratory.	Text
Validation Level	The type and amount of data validation performed.	Text
Nondetect Flag	Indicates whether or not the analyte was detected in a sample. 'Yes' is equivalent to a qualifier that includes "U".	Text
Analytical Method	Method used to produce the measured concentration as reported by the laboratory.	Text
Date Analyzed	The date that the sample was analyzed to produce the reported concentration.	Date
Lab	The laboratory generating analytical chemistry data for the sample.	Text
Sample Comment	Information pertaining to the handling or shipment of the sample	Text
Method of Decontamination	Description of how the worker was decontaminating equipment	Text
Cleaning Product	Type of Cleaning Product	Text
Cleaning Product Other Description	Other type of Cleaning Product not listed	Text
Surface Area Covered	Percent of Area Covered in Oil	Text
Respirator Half	Worker Wearing Half Face Respirator (yes or no)	Yes/No
Respirator Full	Worker Wearing Full Face Respirator (yes or no)	Yes/No
Respirator SCBA	Worker Wearing Full Face Respirator (yes or no)	Yes/No
Respirator Airline	Worker Wearing Airline Respirator (yes or no)	Yes/No
Respirator Mask	Worker Wearing Dust Mask Respirator (yes or no)	Yes/No
Respirator None	Worker Not Wearing Respirator (yes or no)	Yes/No
Respirator Other Description	Other Type of Respirator Description	Text
Cartridge p100	Worker Wearing P100 Cartridge (yes or no)	Yes/No
Cartridge ov	Worker Wearing OV Cartridge (yes or no)	Yes/No
Cartridge Other	Worker using other type of respirator Cartridge (yes or no)	Yes/No
Cartridge Other Description	Type of Cartridge Worker is using if Other selected	Text
Hands Cotton	Worker Wearing Cotton Gloves (yes or no)	Yes/No

Column Name	Description	Data Type
Hands Leather	Worker Wearing Leather Gloves (yes or no)	Yes/No
Hands Abrasion	Worker Wearing Abrasion Resistant Gloves (yes or no)	Yes/No
Hands Nitrile	Worker Wearing Nitrile Type Gloves (yes or no)	Yes/No
Hands Nitrile Type	Type of Nitrile Gloves worn	Text
Hands PVC	Worker Wearing PVC-Type Gloves (yes or no)	Yes/No
Hands PVC Type	Type of PVC-Type Gloves worn	Text
Hands Other	Worker Wearing Other Type of Gloves (yes or no)	Yes/No
Hands Other Description	Type of Other Gloves	Text
Hands None	Worker Not Wearing Gloves (yes or no)	Yes/No
Feet Steel	Worker Wearing Steel Toed Boots (yes or no)	Yes/No
Feet Leather	Worker Wearing Leather Boots (yes or no)	Yes/No
Feet Rubber	Worker Wearing Rubber Boots (yes or no)	Yes/No
Feet Covers	Worker Wearing Boot Covers (yes or no)	Yes/No
Feet None	Worker Wearing No Feet PPE (yes or no)	Yes/No
Feet Other	Worker Wearing Other Type of Feet PPE (yes or no)	Yes/No
Feet Other Description	Other Type of Feet PPE Description	Text
Hearing Plugs	Worker Wearing Hearing Plugs (yes or no)	Yes/No
Hearing Plugs Type	Type of Hearing Plugs	Text
Hearing Muffs	Worker Wearing Hearing Muffs (yes or no)	Yes/No
Hearing Muffs_type	Type of Hearing Muff	Text
Validation Level	The type and amount of data validation performed.	Text
Hearing Other	Worker Wearing Other Type of Hearing PPE (yes or no)	Yes/No
Hearing Other Description	Type of Other Hearing PPE	Text
Eyes Glasses	Worker Wearing Eye Glasses (yes or no)	Yes/No
Eyes Goggles	Worker Wearing Eye Goggles (yes or no)	Yes/No
Eyes Shield	Worker Wearing Face Shield (yes or no)	Yes/No
Eyes None	Worker Wearing No Eye PPE (yes or no)	Yes/No
Eyes Other	Worker Wearing Other Type of Eye PPE (yes or no)	Yes/No
Eyes Other Description	Other Type of Eye PPE Description	Text
Head Hat	Worker Wearing Hard Hat (yes or no)	Yes/No
Body Frc	Worker Wearing Flame Retardant Clothing (yes or no)	Yes/No
Body Apron	Worker Wearing Apron (yes or no)	Yes/No
Body Sleeves	Worker Wearing Barrier Sleeves (yes or no)	Yes/No
Body Pants	Worker Wearing Barrier Pants (yes or no)	Yes/No
Body None	Worker Wearing Head/Body PPE (yes or no)	Yes/No
Body Visible	Worker Wearing a Hi-Visible Garment (yes or no)	Yes/No
Barrier Suit	Worker Wearing Breathable Barrier Suit (yes or no)	Yes/No
Body Impervious Suit	Worker Wearing Impervious Suit (yes or no)	Yes/No
Body Waders	Worker Wearing Chest Waders/Hip Boots (yes or no)	Yes/No
Body Other	Worker Wearing any other Head/Body PPE not listed (yes or no)	Yes/No
Body Other Type	Other type of Head/Body PPE not listed	Text



# Attachment 1

# Study Description

# Gulf Science Data

## Study Description

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# Personal Breathing Zone Samples for Industrial Hygiene Program

April 2014

Study Reference No. 2001

Prepared by BP Exploration & Production Inc. and BP Gulf Coast Restoration  
Organization

# Study Description

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## Introduction

The *Offshore Air Monitoring Plan for Source Control* and the *On-Shore/Near Shore IH Monitoring Strategy* (Work Plans) were implemented as part of the response to the Deepwater Horizon (DWH) accident by BP Exploration & Production Inc. and BP Gulf Coast Restoration Organization (BP). Prepared by BP's Gulf of Mexico Strategic Performance Unit for the Incident Command, these plans specify methods for evaluating worker exposure to oil and other chemicals in support of the overall Industrial Hygiene (IH) program.

The offshore plan addresses air monitoring and air sampling for workers on vessels performing source control and oil skimming operations. The onshore and near shore plan addresses air monitoring and air sampling for workers performing various response-related activities such as oil skimming, boom placement and repair, vessel decontamination, and shoreline cleanup.

Samples associated with the IH program were collected from April 27, 2010, through January 30, 2012. Table 1 summarizes the details of the industrial hygiene air monitoring program.

## Plan Objectives

Both plans address IH air monitoring and sampling during response activities.

The objectives of the *Offshore Air Monitoring Plan for Source Control* were to monitor (1) the air around the source control activities to protect downwind receptors, (2) the air in the vicinity of source control activities to protect worker health, and (3) specific activities to support safe operations.

The objective of the *On-Shore/Near Shore IH Monitoring Strategy* was to perform representative personal sampling and real-time monitoring during various types of response activities such as beach cleanup, vessel decontamination, boom placement or repair, and wildlife decontamination.

## Sampling Approach

IH technicians conducted air monitoring and sampling during source control activities (24 hours per day, 7 days per week), and also at other sites where workers were potentially exposed to airborne contaminants generated by the presence of oil and/or use of other chemicals.

In accordance with the plans, IH technicians collected:

- “Real-time” measurements using calibrated direct reading instruments to provide immediate determinations of contaminant concentrations in the “area” near the work activity. Real-time measurements were compared to action levels, which are levels at which mitigation actions may be needed to protect workers.
- Personal samples to evaluate contaminant concentrations within the breathing zone of individuals who could potentially be exposed to airborne contaminants. The results of

personal breathing zone samples are time-weighted averages that were compared to occupational exposure limits.

Real-time air monitoring refers to direct reading instruments that allow for a nearly instantaneous determination of chemical concentration. Continuous air monitoring was conducted on source control vessels using AreaRAE, MultiRAE, and/or UltraRAE photoionization detectors (PIDs) that measured volatile organic compounds (VOCs) and were equipped with electrochemical sensors for monitoring benzene, carbon monoxide (CO), hydrogen sulfide (H<sub>2</sub>S) and lower explosive limit (LEL). For source control vessels that were involved with in-situ burning operations, additional monitoring was conducted for sulfur dioxide using a single gas monitor such as an MSA Altair 5, and particulate matter using data logging monitoring devices. For nearshore and onshore cleanup activities, air monitoring was conducted using a MultiRAE Plus PID equipped with electrochemical sensors for CO and LEL.

Personal air sampling refers to the collection of an air sample from the personal breathing zone of a response worker. The "personal breathing zone" is generally defined as the zone within a 10 inch radius of a worker's nose and mouth. Personal breathing zone samples were collected using badges that were clipped onto individual workers to assess time-weighted exposures to targeted chemicals. For source control activities, the representative population selected for sampling was determined by the IH leader. For nearshore and onshore response activities, the goal was to collect personal samples from approximately 10% of the workforce in the area of potential exposure.

A majority of the personal breathing zone samples were collected using passive dosimeters (also known as Organic Vapor Monitor [OVM] badges). Some of the samples were collected using charcoal tubes (or other absorbent tubes) with a personal sample pump used to draw air through the adsorbent media. Passive dosimeters were typically analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX), total VOCs or total hydrocarbons (THCs), and other VOCs (such as acetone, 2-butanone, 2-butoxyethanol, cyclohexane, heptane, *n*-hexane, limonene, tetrahydrofuran, and trimethylbenzenes) as appropriate.

Other types of personal breathing zone samples were collected to evaluate worker exposure during specific tasks. For example, gravimetric oil mist samples were collected in the breathing zone of workers involved with pressure washing during decontamination. These gravimetric oil mist samples were collected by drawing air through Teflon® filters with a personal sampling pump. A small number of samples were collected for propylene glycol analysis by drawing air through an Occupational Safety and Health Administration (OSHA) Versatile Sampler (OVS) tube with a personal sampling pump.

After a personal breathing zone sample was collected, it was promptly sent to one of two American Industrial Hygiene Association (AIHA)-certified laboratories for analysis. More than 32,000 personal breathing zone samples and associated field blanks were collected during the response to the DWH accident.

## Sample Information and Analytical Data

The data files associated with these plans are intended to summarize the results of worker monitoring and personal breathing zone sampling associated with the IH program during the

response to the DWH accident. As additional data types are made available, this study description will be revised and updated.

## Notes

BP is providing the datasets and supplemental information to make data available in a form that can be used in other studies and research. The DWH natural resource damage assessment (NRDA) Trustees have not participated in the development of the dataset in this form or in production of this document. Data that are the subject of this report may be updated after any further quality assurance and quality control reviews.

Additional information and research, including existing and future research related to the DWH accident, may affect the use and interpretation of this information and the underlying data. BP reserves the right to supplement this document, to provide interpretation and analysis of this document and any data contained herein, and to raise objections to the admission, use, and interpretation of this document in part or in full, and any material described herein, in any legal proceeding.

## References

- BP. 2010a. Deepwater Horizon MC252 Response, Offshore Air Monitoring Plan for Source Control, prepared by BP Gulf of Mexico Strategic Performance Unit (SPU), Revision 6, June 24, 2010.
- BP. 2010b. Mississippi Canyon 252 On-Shore/Near Shore IH Monitoring Strategy MC-252 Well Incident, prepared by BP Gulf of Mexico SPU, May 23, 2010.

Table 1. Summary of Work Plan and Associated Efforts for Study Reference No. 2001	
Incident Command Program:	Industrial Hygiene
Work Plan(s):	<i>Deepwater Horizon MC252 Response, Offshore Air Monitoring Plan for Source Control, Revision 6, June 24, 2010.</i>  <i>Mississippi Canyon 252 On-Shore/Near Shore IH Monitoring Strategy MC-252 Well Incident, May 23, 2010.</i>
Study Dates:	April 27, 2010 to January 30, 2012
Field Sampling Approach:	Industrial hygiene technicians collected real-time measurements using direct reading instruments in the area where response workers conducted source control, cleanup, or decontamination activities, and collected personal samples from the breathing zone of representative response workers.
Sampling Methods:	Most personal samples were collected using passive dosimeters (e.g., TraceAir AT 521 [1-sided or 2-sided], 3M 3500, 3M 3520, and SKC Badge Types 575-001 and 575-002) that were typically analyzed for BTEX, total VOCs or THC's, and other VOCs when appropriate.  Other sampling methods included drawing air through charcoal tubes (for VOCs), pre-weighted Teflon® Filters (for gravimetric oil mist), and OSHA Versatile Samplers (OVS-7) tubes (for propylene glycol).
Scope of Data Collection:	Personal monitoring and sampling was conducted at locations where response workers were potentially exposed to oil and other chemicals.
Analytical Guidance:	Personal samples were analyzed using standard and/or modified OSHA and National Institute for Occupational Safety and Health (NIOSH) methods approved by the American Industrial Hygiene Association (AIHA).