Air Monitoring Guidelines for Human Health Impacts of ISB

In situ burning may affect two groups of people: the workers conducting the burn (the responders), a fairly homogeneous group of young, healthy adults, and the general public, which is much more heterogeneous and includes individuals who are more susceptible to toxic agents. The basic premises and possible monitoring options for each group are discussed below.

Monitoring for Responders

The responders, i.e., the workers assigned to conduct the in situ burn, are likely to be healthy and physically fit adults. Responders' locations will vary with the nature of the burn and the stage at which it is conducted. Most of the time they are expected to be upwind of the slick and the smoke plume. However, at times they may be downwind of the evaporating slick and therefore be exposed to volatile organic compound (VOCs). Responding crews may also be downwind and near the burning oil where they can be exposed to combustion products.

Responders may be exposed to VOCs from the evaporating slick, similar to what is expected during skimming operations, and to combustion by-products from the burning oil: carbon dioxide, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulates, and other combustion products. Air concentration of those substances depends on many variables, and we can expect substantial variability. Responders may be exposed to levels of gases and particulates above the permissible occupational exposure limits, and should therefore be provided with personal protective equipment and be trained in its proper use. In reality, responders' exposure is likely to be intermittent, and will vary greatly depending on location, weather conditions, and assigned tasks. Overall exposure duration is expected to vary from minutes to several hours.

Sampling Purpose

Sampling the responders' exposure level should serve several purposes, among them:

- Characterize exposures and hazards associated with the operation to provide better protection;
- Compliance with OSHA requirements, per 29 CFR 1910.134 b.(8)[1] and 29 CFR 1910.120.q.3.(ii)[2];
- Data collection for scientific purposes.

Air sampling should not substitute for workers' protection and safe work practices. Responders should be protected from overexposure regardless of monitoring and air sampling.

Exposure Limit

Exposure limits for responding personnel should be based on occupational exposure guidelines (see Table 1) such as OSHA's Permissible Exposure Limits (PEL) or applicable State standards. Exposure to the general public should not exceed the National Ambient Air Quality Standards (NAAQS).

[1] Regulations concerning respiratory protection

[2] Regulations concerning Hazardous Waste Operations and Emergency Response (HAZWOPER)

Table 1. Occupational Exposure Limits and the National Ambient Air Quality Standard for the Most Significant Products of ISB

COMPOUND	OSHA PEL[1]	ACGIH TLV[2]	NAAQS[3]
benzene (in VOC)	1 ppm (5 ppm)*	10 ppm (32 ppm)	N/A
nitrogen dioxide	(1 ppm)	3 ppm (5 ppm)	0.053 ppm annual average
sulfur dioxide	2 ppm (5 ppm)	2 ppm (5 ppm)	0.03 ppm annual average (0.14 ppm 24 hour average)
carbon monoxide	35 ppm (200 ppm)	25 ppm	9 ppm
PAHs	0.2 mg/m^3	0.2 mg/m^3	N/A
particulates PM-10	5 mg/m^3	5 mg/m^3	0.05 mg/m^3 annual average (0.15 mg/m^3 24 hour average)

1. U.S. GPO, 1993. 29 CFR 1910.1000, Table 2.
2. American Conference of Government Industrial Hygienists, 1993. Threshold Limit Values for Chemical Substances and Physical Agents, 1993-1994. Cincinnati, OH.
3. U.S. GPO, 1993. 40 CFR 50.4 to 50.11.

* Numbers in parentheses indicate short-term exposure limits (STEL)

When To Sample

Sampling should be done as long as there is a potential for exposure .

Sampling Method

Industrial hygiene equipment and methods may be used. This may include personal sampling pumps, passive dosimeters, and real-time instruments. In general, the sampling should:

- follow sound industrial hygiene practices and procedures, including taking blank samples, proper sample packaging, etc.;
- be a combination of area samples (e.g., instruments placed on the boom towing boats), and personal sampling on the workers themselves;
- include both short-term peak exposure and time-weighted average, taken over the total length of exposure;
- be done for all substances of concern, making VOCs and particulates the top priority;
- determine background levels before and after the burn; and
- avoid erroneous readings caused by sources of smoke or fuel on the vessels, e.g., exhaust fumes, fuel vapors.

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Protection

Responders should use safe operating procedures such as staying upwind of the burn and the slick as much as possible and keeping safe distances from the fire. Responders should use respiratory protection and protective clothing as needed. It should be emphasized that safety risks such as heat and cold stress, falling overboard, or vessel collisions are just as real as chemical exposure, and more acutely dangerous. Responders should receive safety training that should include description of the hazards involved, precautions to be taken, and proper use of the safety equipment.

Monitoring for General Public

The general public usually includes people of all ages. It also includes individuals with allergies and with respiratory, cardiovascular, and other diseases. The vulnerability of these individuals to combustion by-products may be much greater than that of the responders. The distance between the general public and the burning site may vary greatly, depending on the specifics of the burn. The operational guidelines suggest six miles when the wind blows toward shore. However, burns may be conducted closer than six miles if conditions permit. Similarly, a burn may be inappropriate at six miles or a greater distance, if conditions are unfavorable.

Several miles downwind of the burn, levels of vapors evaporating from the slick and gaseous by-products form the fire are expected to be near background levels. Particulate level is the main concern. Based on data from experimental burns and from computer models, the level of particulates in the center of the plume three miles downwind of the burn is expected to be around 150 $\mu g/m^3$ (McGrattan et al. 1993). If the burning is conducted according to the operational guidelines suggested above, PM-10 levels six miles away from the burn should be significantly lower than 150 $\mu g/m^3$ in the center of the plume, and much lower than that at ground level. Concentrations at any one location will depend on specific atmospheric conditions at the time of the burn.

Visual Observations

Visual observations should be conducted to track plume direction and height, and to verify that the smoke behaves as predicted by the weather reports. Observations from ships and aircraft should continue as long as the burning takes place.

Monitoring Considerations

In situ burn is a relatively new response technique. There are legitimate concerns about exposure to the smoke plume by the general public and environment. In order to make decisions concerning the continuation of an in situ burn, it is advisable to collect information concerning concentrations of smoke particulates of 10 µm (PM-10) or less. Monitoring should be established when there is reason to believe that the weather conditions and/or location of the burn could produce a situation in which the general public or sensitive environments could be affected by fallout from the smoke plume. Depending on circumstances, the burn may be monitored by qualitative assessment (i.e., visual observation) and/or by quantitative methods that employ air sampling.

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Exposure Limits

Exposure limits for the general public should be based on the National Ambient Air Quality Standards, which is used by EPA for air quality control. The standard for respirable particulates 10 μm in diameter and smaller (PM-10) is shown in Table 1. To err on the side of safety, this Upper Mississippi River policy adopts an action level of a 150 $\mu g/m^3$ average over one hour. Concentrations above this level should result in operational measures to control the rate of burn/smoke formation.

Sampling Limitations

In general, air sampling should not be regarded as a requirement for conducting in situ burning but as an option if the situation warrants. Sampling should not be used as the means to determine whether the public is adequately protected: the public should be protected regardless of air sampling. We believe that such protection may be achieved by adhering to operational guidelines. Sampling, however, may be valuable by providing feedback information to the OSC, by increasing the comfort level of both those conducting the burn and those potentially exposed to it, and by collecting data that may be of value for future in situ burning. Trends are more important than a single number. The readings of a real time particulate monitor may fluctuate widely, depending on nearby activity such as passing cars or smoke from fireplaces in nearby houses. A single reading may be misleading. Averaging the concentration readings over a period of time (e.g., 15 minutes) should provide an indication of the trend, that is, whether particulates concentration goes up or remains steady. Visual observations coupled with sampling that could provide the general trend of particulate concentration should be useful in ascertaining the effect of the burn on exposure of the general population to particulates.

It is also important to state clearly the limitations and shortcomings of sampling data. These data should be interpreted correctly, and the numbers should be presented with the associated uncertainty and possible interferences and inaccuracies. Otherwise, the numbers may not mean much or, worse yet, be misleading.

Sampling

Sampling may be conducted for several reasons:

1. To assess exposure levels at different points, in order to provide immediate feed back to the OSC, and to verify visual observations of plume behavior.
2. Validation of air dispersion models
3. To satisfy other scientific or historical data collection needs

Based on previous experience, the concentration of gases in the plume would drop to below the exposure limit within several hundred yards of the burn. Particulate concentration in the center of the plume may remain above the level of concern for several miles downwind. Sampling of particulates should therefore be the main effort.

When To Sample

Sampling is an option that may be exercised anytime during the burn. It may be desirable when there is a potential for exposure (even if it is expected to be below the limit). Therefore, sampling may be done

when the plume drifts over a populated area, over natural resources, or for scientific data collection, at various locations downwind of the burning site. Since the purpose of this sampling is to monitor in situ burning effects on sensitive populations, there is no need to require it when there is no reason to believe that a sensitive population will be affected. If the smoke plume is expected to be carried away from population centers or sensitive areas, sampling should not be required.

Sampling Equipment

Sampling equipment should be:

- Portable, easily deployable, and available when needed;
- Sensitive, accurate, and precise enough to provide meaningful data;
- If possible, provide real-time readings for immediate feedback and, in addition, have the capability to log readings over several hours, to get the average concentration over an extended period of time.

Real-time particulate samplers are commercially available from several manufacturers.

In addition, sampling pumps using filter media may be deployed at various locations. Their data, which is not real time, may be used for exposure assessment, model validation, and to provide information for future in situ burning.

Recommended Air Monitoring Equipment for ISB

The primary health concern for in situ burning is the evolution of particulates from the burning of crude oil, fuel products or other hydrocarbons. Secondly, within the first several hours of the burn, the generation of volatile organic compounds (VOCs) and polynuclear aromatic hydrocarbon's (PAHs) vapors could be additional health and safety concerns in the immediate area. Air monitoring is an important tool in communicating risks involved to the public at an emergency response. If it is determined that a burn will be conducted and there is risk of exposure to a human population center, then air monitoring should be completed (see pages 16 to 19). The Responsible Party (RP) may conduct air monitoring in conjunction with a burn, either independently or with government oversight. The air monitoring results should be immediately reviewed and assessed to determine the effectiveness of the burn and to address any public health concerns.

The U.S. EPA Region 5 and Region 7 Emergency Response Branches and their contractors, along with the U.S. EPA Environmental Response Team (ERT) and United States Coast Guard Strike Teams, are often called in emergencies to conduct perimeter and on site air monitoring. The U.S. EPA regional offices maintain a 24 hour readiness along with contractor support to provide air monitoring equipment at an emergency response. Equipment arrival time would depend on the mobilization time to the scene from the Regional Office. For a spill on the upper Mississippi this would translate to 3 to 10 hours. The Federal On-Scene Coordinator (FOSC) can mobilize additional air monitoring resources from the ERT or from the USCG Strike Teams. The State Emergency Response Coordinator, or local HAZMAT team, can also mobilize air monitoring resources during an emergency.

The ERT in Edison, New Jersey, is on call 24 hours and is equipped and specialized in supporting OSC's in conducting air monitoring. The ERT can mobilize to the site within 12 to 24 hours after being notified

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by a FOSC to support air monitoring activities. The United States Coast Guard maintains the Strike Teams to provide assistance to the OSC during an emergency. The Strike Teams are equipped and trained to provide air monitoring, safety monitoring, and other assistance to the OSC as needed. The Strike Teams can mobilize to the site in 12- 24 hours to provide air monitoring assistance.

During an incident when in situ burning is being evaluated, and humans could be exposed to the smoke plume, it is recommended that the Incident Commanders plan to have air monitoring set up prior to and during the burn event. The U.S. EPA and its contractors would immediately mobilize staff and equipment to monitor for particulates using Real Time Aerosol Monitors (RAMs). In addition, carbon monoxide, carbon dioxide, and VOCs can be monitored directly at the burn location. The U.S. EPA Region 5 and 7 offices and their contractors maintain air monitoring equipment to support these operations.

It is recommended that direct reading instrumentation be used to monitor the effectiveness and potential health concerns during a burn. The data should be evaluated, assessed and communicated to the workers and to the public as soon as the results become available. The Real-Time Aerosol Monitors (RAMS), Mini Real-Time Aerosol Monitors (Mini-RAMS), or equivalents, serve as valuable tools to access the particulates in a plume which could impact humans during an in situ burn. The current guidelines for safe levels of particulates are a PM-10 (particulate matter less than 10 microns) concentration of less than 150 micrograms per cubic meter. The proposed Clean Air Act Amendments may change the PM-10 standard. The RAM and Mini-RAM instruments will directly read a measure of the total particulate in milligrams per cubic meter and give real time data for monitoring the particulates in air. The instruments can be used to screen residential areas during an in situ burn so that particulate concentrations can be monitored and the risk to the public and on-site workers may be assessed. The RAMS and Mini-RAMS have been used successfully at tire fires, train derailments involving flaring of hydrocarbons, and other chemical fires where an observable plume is seen.

In addition to the above instruments, the U.S. EPA would mobilize a photo ionization detector, explosimeter, and a portable gas chromatograph to monitor volatile emissions directly at the source of the burn. The U.S. EPA maintains portable gas chromatographs, colorimetric tubes, and fixed sampling pumps, to monitor volatile emissions, PAHs, particulates, carbon monoxide and carbon dioxide during an in situ burn.

The air monitoring equipment described in the following table can be mobilized to an emergency by calling the U.S. EPA Regional Office or the National Response Center.

U.S. EPA Region 5 (24 hour Spill line) (Minnesota, Wisconsin, Illinois)	312-353-2318
U.S. EPA Region 7 (24 hour Spill Line) (Iowa and Missouri)	913-281-0991
National Response Center (Manned by USCG can tie into USEPA regional Office or USCG Office)	800-424-8802

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The State Emergency Response Section or Local HAZMAT team can also mobilize air monitoring equipment to the scene. Both can be contacted through the State Emergency Response telephone numbers found in the Notification Section of the UMR Spill Plan (see pages 6-7).

Another resource for air monitoring equipment can be vendors, such as industrial hygiene subcontractors, who rent air monitoring equipment. These vendors can make equipment available within 24 hours of an incident.

The NOAA Scientific Support Team can also provide air monitoring resources from its field office at Louisiana State University. This resource can be activated through the NOAA Scientific Support Coordinator for the Great Lakes and Inland Rivers in Cleveland, Ohio.

The purchase price of the mini-RAM is $1,400 and the RAM is $6,700.

Table 2 shows the current inventory of air monitoring capabilities for in situ burning in U.S. EPA Regions 5 and 7.

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Table 2. USEPA Regions 5 and 7 Air-Monitoring Capabilities For ISB

EPA Regions 5 (resources located in Chicago, IL, unless otherwise noted)

INSTRUMENT OR TECHNIQUE	TARGET COMPOUND(S)	SAMPLING PERIOD OR TURNAROUND TIME	COMMENTS\ LIMITATIONS
Real-Time Aerosol Monitors	Will yield measure of total particulates, with continuous digital display, concentration ranges from mg/m3 to mg/m3, with option for respirable size selection	Portable particulate monitor. Can provide immediate results once calibrated and in operation; battery operated.	3 units located in Chicago, Illinois; mobilization time determined by distance to site.
Mini Real-time Aerosol Monitors (Mini-RAMs)	Will yield measure of total particulates in milligrams per cubic meter.	Once calibrated, they will give reading 36 seconds after turned on and then a reading every 10 seconds for 500 minutes; can provide time-weighted ave.	2 Units located in Chicago, Illinois, mobilization time determined by distance to site.

EPA Region 7 (resources located in Kansas City, KS, unless otherwise noted)

Combustible Gas and Oxygen Alarm Model 261	Measures levels of oxygen and flammables	Real-time monitoring	Indicates whether it is safe to enter an area; won't measure mists of some oils.
Minirams (Total particulate Miniature Real-time Aerosol) Model PDM-3	Will yield measure of total particulates in milligrams per cubic meter.	Once calibrated, they will give reading 36 seconds after turned on and then a reading every 10 seconds for 500 minutes.	Three available at START KC office. Could be zeroed out before ignition of spill. No analysis of components of particles measured.

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(Continued)

Table 2 continued

INSTRUMENT OR TECHNIQUE	TARGET COMPOUND(S)	SAMPLING PERIOD OR TURNAROUND TIME	COMMENTS\ LIMITATIONS
Gilian Personal Sampling Pumps HFS Air Sampling Systems	Capable of sampling for wide range of compounds, including PAHs.	Sample duration of at least 4 hours necessary, longer for some compounds.	START has access to 15 and there are 15 at EPA Region 7. A realistic startup is 48 hours after notice, because of need for charging and calibrat- ion, and purchase of unique sampling trains, which include absor- bent tubes, cassettes, filters and microimpinger traps.
Draeger Tubes	Region has tubes for H2S, CO, CO2, TPHs, SO2, benzene, toluene and xylenes. No PAH tube on market.	Real-time results that are quasi-quantitative.	Almost instantaneous results. EPA also has Sensidyne kits, which will give similar results.
OVAs	Provides concentrations of unidentified total volatiles.	Gives real-time results of total volatiles.	3 OVAs in KC START office, 2 in St. Louis; it does not provide chemical-specific results
HNu	Provides analysis of total volatiles present; some limitations in reading, compounds depending on span in photo-ionization detection (PID) lamp.	Gives real-time results of total volatiles.	3 Hnu's in KC START office, 2 in St. Louis; use limited in wet conditions; soot during burn would likely coat lamp, making it unusable. No chemical-specific results.

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(Continued)

Table 2 continued

INSTRUMENT OR TECHNIQUE	TARGET COMPOUND(S)	SAMPLING PERIOD OR TURNAROUND TIME	COMMENTS\ LIMITATIONS
TVA-1000	Analysis of total volatiles, with both flame ionization detector and photo-ionization detector.	Gives real-time results of total volatiles. Can be set for 8-hour exposure mode.	2 Available in KC START office; lamp of PID less exposed to moisture and soot, so of a little more use than Hnu.
Monitox	Designed for confined space, rather than ambient sampling. Only H2S and HCN available.	Designed to show whether threshold levels of gases exist.	2 of each in KC START office.
Polyurethane foam (PUF) samplers	Could be used to collect volatile and semivolatile samples; use on PAHs in region been very limited.	Sampling durations of several hours -- up to 3 days -- are standard.	Eight are regularly available in Kansas City, but more are available from other regions. Require power source.
PM-10 Air Samplers	Will measure particles of <10 microns.	Sampling durations of several hours are required.	Require power source; is a radioactive element involved.
Single Point Monitor from MDA Scientific	Inorganics, including ammonia, hydrogen cyanide and sulphuric acid	The SPM is designed to work with specific key, and cassette, which must be kept frozen. They are not kept on hand by START. Acquisition time would be 48 hours.	The setup time and limitation of sampling to such analytes as cyanides, acids and amines makes its use during any in situ burn response unlikely.

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(Continued)

Table 2 continued

INSTRUMENT OR TECHNIQUE	TARGET COMPOUND(S)	SAMPLING PERIOD OR TURNAROUND TIME	COMMENTS\ LIMITATIONS
Summa Canisters	Summas can be used to collect a wide range of volatile compounds, but they do not lend themselves to collection of semi-volatiles, particularly PAHS, which stick to the inside of the canister.	Sampling periods vary from minutes to several hours. 24-hour analytical turnarounds are possible.	Real-time applications must be tied to presence of Mobile Laboratory or use of portable GC, such as Photovac. Not applicable to nonvolatiles.
Portable Gas Chromatograph, Photovac	Volatile Compounds	Estimated 2-3 hours after arrival at spill.	The Photovac has been used primarily to analyze head space samples from soil in the region. It has the potential to analyze air samples collected in Summa canisters, but it is necessary to extract samples collected from Summas. It does not lend itself to analysis of semi-VOCs.
EPA Mobile Lab	Can measure volatiles from samples collected from air, water or soil.	Will ultimately be capable of prompt turn-around of field samples collected in Summas or soil-gas bottles. The Lab is currently being retrofitted and updated.	Mobile Lab must be driven to spill site; it will require four ad-ditional hours to calibrate equipment. Some extractions will require 24-48 hours. Could be used for samples containing VOCs, semi-VOCs, PCBs and PAHs.

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Sampling Location

Sampling location should be based on priority concerns, with the first priority given to population centers downwind of the burn. For scientific data collection, (e.g., model validation) we recommend that samplers be placed at different distances from the burn to collect particulate concentration data at ground level. Data collected would be extremely valuable for future burns.

If it is determined that sampling is needed, real-time particulate samplers (PM-10) should be positioned on: 1) the shoreline, at the expected centerline of the plume; 2) at the population center of concern; and 3) in several locations in the vicinity of the population downwind of the burn. PM-10 samplers which can operate for more than eight hours, can collect PM-10 reading before the burn commences, (to gather background data during the burn), during the actual burn, to assess the burn effect; and, if possible, after the burn is over, to collect post-burn readings. Sampling results should be relayed to the FOSC. If it is established that the readings exceed the level of concern, the FOSC will be so advised.

Other Sampling Considerations

1. Area background readings should be taken before and after the burn to determine baseline levels.
2. EPA and regional air monitoring stations may be able to assist by providing historical data, and by conducting air sampling during the burn itself.