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Air Surveillance Program Procedure

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1.0 PURPOSE

Some Operations and/or Maintenance work performed in and around facilities, entities, and associated contractors throughout the Kingdom of Saudi Arabia involves activities which produces dust, vapors, and particulates (e.g., manufacturing, cleaning, intrusive work). Due to the health hazards (i.e., inhalation, absorption, ingestion) associated with exposure to constituents generated by these activities it is necessary for Entities, and/or their contractors, to implement a procedure to give the requirements and guidance for providing air sampling, monitoring, and surveillance.

2.0 SCOPE

The scope of this procedure is to provide means to the user to create a custom procedure outlining and detailing the requirements and responsibilities when performing air sampling, monitoring, and surveillance tasks. This procedure applies throughout the Kingdom of Saudi Arabia to Operations and Maintenance functions and activities on, in, and around government owned facilities and projects.

3.0 DEFINITIONS

<table>
<tr><th>Definitions</th><th>Description</th></tr>
<tr><td>Air Monitoring</td><td>Air surveillance with the use of direct-reading instruments capable of providing real-time indication of air contaminant levels.</td></tr>
<tr><td>Air Sampling</td><td>The collection of air or airborne contaminants in a suitable container or an appropriate medium for contaminant identification and quantification.</td></tr>
<tr><td>Air Surveillance</td><td>The use of direct-reading and air sampling instruments to grossly identify (i.e., gross alpha/beta) and quantify airborne contaminants for personnel protection.</td></tr>
<tr><td>Annual Limit on Intake (ALI)</td><td>The derived limit for radioactive material taken into the body of an adult worker by inhalation or ingestion in a year.</td></tr>
<tr><td>Breathing Zone</td><td>The zone of the ambient environment in which a person performs the normal respiratory function (typically, a 12-inch (30.5 cm) hemisphere encompassing the front half of a person’s head, neck, and shoulders).</td></tr>
<tr><td>Derived Air Concentration (DAC)</td><td>The quantity obtained by dividing the ALI for any given radionuclide by the volume of air respired by an average worker during a working year (in the USA, Appendix A of 10 CFR 835 contains a table of DAC values).</td></tr>
<tr><td>Gas Chromatography/Mass Spectroscopy (GC/MS)</td><td>An analytical technique that combines a gas chromatograph for compound separation with a mass spectroscope for compound identification.</td></tr>
<tr><td>General Area Sampling</td><td>The method by which the air of the work area or perimeter of a defined zone is sampled to determine the concentration of contaminants. General area samples are defined for the purposes of this procedure by required sample flow rate.
The categories are:
<table>
<tr><th>Sample Type</th><th>Sample Flow Rate (lpm)</th></tr>
<tr><td>1. Low-volume area</td><td>< 10</td></tr>
<tr><td>2. Medium-volume area</td><td>10 – 100</td></tr>
</table>
</td></tr>
<tr><td>Lapel Air Sample (Personal Air Sample)</td><td>The air sampling method for identifying and quantifying personal exposure to respired contaminants. Samples are obtained in the immediate breathing zone of the employee. The sample collection medium is often attached to the lapel. Lapel samples are defined for the purposes of this procedure as low-volume personal samplers and high-</td></tr>
</table>

Definitions	Description
	volume personal samplers. Typical flow rates are between 0.01 and 0.2 liter per minute (lpm) for low-volume personal samplers and between 2 and 4 lpm for high-volume personal samplers.
NIOSH	National Institute for Occupational Safety and Health.
Permissible Exposure Limit (PEL)	In the USA, regulatory exposure limits published by the Occupational Safety and Health Administration (OSHA). These limits represent legal standards enforceable by federal administrative courts. In other countries, applicable laws will apply. In the absence of such regulations, the OSHA PELs will be the standard.
Threshold Limit Value (TLV)	In the USA, TLVs are voluntary recommended exposure limits published for chemical and physical agents by the American Conference of Governmental Industrial Hygienists. Since these are recommended levels only, they are guidelines for all operations, in all regions and countries.
TLV-Ceiling C	The concentration that should never be exceeded, even instantaneously.
TLV-Short Term Exposure Limit (STEL)	The concentration to which workers can be exposed for short periods of time (four 15-minute excursions above the PEL are allowed, with 1 hour between excursions) without suffering from irritation, chronic, or irreversible tissue damage, or deleterious narcosis. This measure supplements the TLV time-weighted average (TWA).
TLV-TWA	The time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

4.0 REFERENCES

- OSHA 1910.119 Hazardous Materials
- Health and Safety Executive, EH40/2005 Workplace exposure limits
- EOM-KSH-PR-000003 Occupational Health Records Maintenance System
- EOM-KSS-PR-000007 Confined Space Entry Procedure

5.0 RESPONSIBILITIES

5.1 Facility / Contract Manager

Responsible for ensuring the resources and arrangements are available for the implementation and management of this procedure.

5.2 HSE Representative

- Select, maintain, calibrate, and use instrumentation necessary for monitoring/sampling of airborne contaminants;
- Maintain monitoring records on site;
- Evaluate air surveillance data to determine exposure, exposure potential, and controls.

6.0 REQUIREMENTS

6.1 Air surveillance

Consists of air monitoring and air sampling. The objectives of air sampling are to determine:

- The type of radioactive (ionizing & non-ionizing) or chemical compounds present.

- The hazards associated with these compounds.
- The quantity of airborne contaminants.
- Oxygen deficient/excessive atmospheres.
- Explosive atmospheres, etc.

Air surveillance will be carried out with the use of air monitoring instruments to screen for the presence of airborne contaminants. If unknown contaminants are detected, the action levels outlined in **Attachment 1 - Action Levels for Direct-Reading Measurements in Uncharacterized Atmospheres** are to be used. As unknown contaminants are identified through air sampling and laboratory analysis, comparisons of applicable exposure standards and air sampling results will be made to determine suitable exposure control measures.

To assess the impact of work operations on personnel and the environment, measurements will be taken in various locations, including personal breathing zone area, work areas, downwind perimeter areas, and upwind background areas. Data obtained from these locations will be used to establish worker protection levels and to assess the effectiveness of engineering controls and the impact of work operations upon the environment.

Biased air surveillance techniques will be employed based on worst-case exposure situations. Where appropriate, full-shift, time-weighted average measurements will be compared with applicable exposure standards such as PEL, TLV, or DAC.

6.2 Air Monitoring (Direct Methods)

Some of these instruments may be used in the total organic vapor or gas chromatographic mode. Radiological Continuous Air Monitors (CAMs) will be used to give early warning of airborne radioactivity. CAM alarm levels will be set at levels that are less than the most restrictive DAC that may be encountered at the project/facility.

The primary sources of information concerning specific instruments are the manufacturers' reference documents. These should be consulted for operation, maintenance, and calibration specifications.

6.2.1 Availability and Use

Facilities will have direct-reading instrumentation available during drilling or other major intrusive activities. Trained personnel will use this instrumentation to conduct air monitoring for work efforts.

For work efforts in areas suspected of containing radioactive or chemical contaminants, the air will be monitored as specified by the HSE Representative.

Minimum air surveillance measurements for intrusive work activities (i.e., drilling, excavation into known and/or suspected contaminated areas) include monitoring for oxygen, combustible gas, total volatile organic compounds, and airborne radioactive material.

Air sampling for specific potentially toxic compounds may also be conducted to aid in further assessing the adequacy of project-work-element-specified personal protective equipment (PPE) levels. EOM-KSS-PR-000007 Confined Space Entry Procedure monitoring will comply.

Direct-reading instruments will be used to screen for commonly encountered organic or inorganic gases such as methane and hydrogen sulfide. Direct-reading aerosol monitors may also be used to quantify total particulate levels resulting from intrusive activities.

A trained, qualified HSE Representative, with consultation and concurrence provided by the environmental, safety, and health supervisor, will implement air surveillance and sampling procedures.

6.2.2 Action Levels

The guidelines presented in **Attachment 1 - Action Levels for Direct-Reading Measurements in Uncharacterized Atmospheres** illustrate action levels for vapor, combustible gas, oxygen, particulate measurements, and airborne radioactivity of unidentified types. These levels should be used in conjunction with other available information such as historical radiological or chemical use and disposal information. Data from vapor, gas, particulate, or radiological measurements, as determined by direct-reading instruments, will be used as a supplement to other information and not as the single selection criterion.

Many potentially toxic inorganic, semi-volatile, or particulate compounds do not elicit a response from commonly used direct-reading instruments.

6.3 Air Monitoring (Indirect Methods)

Contaminant identification and accurate quantification usually require sample collection followed by laboratory analysis. Air sampling pumps with filter, solid sorbent, or other collection devices are commonly used. Indirect air samples will be collected and analyzed using nationally recognized protocols such as National Institute for Occupational Safety and Health (NIOSH) reference procedures and methods.

Air sampling for radioactive materials is like conventional particulate contaminant sampling methods. However, important differences do exist, including the concept of radioactive decay, which is an important consideration when sampling for short-lived isotopes such as radon progeny.

6.4 General Considerations for Sampling

Practical considerations for radiological and chemical contaminant sampling include sampling strategy, sample type and location, filter loading, and volume corrections.

6.4.1 Sampling Strategy

The HSE Representative will develop specific sampling strategies for hazardous work permits, as needed. Air samples will be obtained and analyzed as indicated by direct-reading results.

Direct-monitoring results above the action limit, requiring upgrade to a higher level of protection, will mandate air sampling for organic, inorganic, and/or radioactive contaminants. In addition, random screening samples will be obtained during major work operations where contaminants are disturbed with mechanized equipment (e.g., drilling, split-spoon sampling) to determine the reliability of the direct-reading results.

In general, more samples are obtained during early phases of major task work to assist in the proper selection or verification of proper selection of PPE, and the concept of biased sampling is used. For example, when personal samples are collected, employees with the most potential for exposure are selected to wear the sampling apparatus.

The biased sampling philosophy represents a conservative approach. PPE will be selected based on data indicating the highest probable exposure, thus ensuring adequate protection for all workers.

6.4.2 Sample Type and Location

General Area Samples: General area samples will be obtained in the work area and at controlled access area perimeters to estimate potential worker exposure and environmental exposures, respectively. Work area samples will be obtained near generation sources to estimate the most severe potential exposure. Perimeter samples will be obtained in upwind and downwind locations to determine background and work activity impact upon uncontrolled areas.
Personal Samples: Personal breathing zone (lapel) air samples will be obtained if airborne concentrations exceed, or are expected to exceed, 10 percent of the applicable airborne limit (DAC, TLV, etc.). The need for personal samples is generally based on the results of work area samples.

6.4.3 Filter Loading

Filter loading is an important sampling consideration from a chemical and radiological standpoint. Overloading of the filter may cause underestimation of exposure due to the loss of material during filter weighing or sample cassette unloading. Self-absorption of alpha particles is a source of analytical bias with overloaded filters. Filter loading must be kept as low as possible to minimize alpha self-absorption. Projected sample times will be calculated and actual sampling duration adjusted to prevent filter loading.

6.4.4 Volume Corrections

Volume corrections may be necessary if sample pumps use variable flow meters (rotameters) for flow rate indication. The correction is not made for non-rotameter sampling pumps. The following formula is employed to calculate the average sample flow rate occurring during the total sample period:

$$\overline{Q} = Average\ flowrate\,(l / \min) = \frac{Q(install) + Q(final)}{2}$$

The average sample flow rate (Q) is then multiplied by the total sample duration to calculate the total sample volume.

6.5 Air Sampling for Chemical Contaminants

Sampling for chemical contaminants may involve a variety of methods, including the use of impingers, impactors, cyclones, filters, and solid sorbents (carbon, silica gel, etc.).

The selection of collection devices will depend on the physical and chemical properties of the contaminants. Sampling protocols developed by NIOSH (or international equivalent) will be used for chemical sampling efforts. The analytical support subcontractor must be contacted for specialized sampling and analytical methods for which standard protocols do not exist.

6.5.1 Sampling Duration & Selection of Exposure Standard

Chemical exposure standards, such as the TLVs, define sampling periods in relation to specific physiological responses. The HSE Representative will select appropriate sampling times based on the nature of the expected contaminant. For example, with an acutely toxic or irritating material such as cadmium oxide, the ceiling TLV is the most important parameter. For cumulatively toxic compounds such as inorganic lead or mercury, an estimate of daily average exposure is usually best. The corresponding standard would be the TLV-TWA. Sample times are also based on the nature of the work operation and exposure (continuous, intermittent, etc.).

6.5.2 Gas and Vapor Collection Methodology

Adsorption tubes (e.g., carbon, silica gel) are commonly used for gas and vapor collection. Other methods, such as sampling flasks or bags, may also be employed per the HSE Representative.

Adsorption tubes typically use a minimum of two sections. Backup sections of the adsorption tubes are analyzed separately. Sampling results are suspected of underestimating exposure if the second adsorption stage contains more than 25 percent of the mass collected in the front section. The HSE Representative should note on the sampling sheet that contaminant breakthrough with consequent underestimation of exposure occurred. Future samples should adjust sample volume to prevent breakthrough.

6.5.3 Particulate Sampling

Particulate sampling is commonly done for total mass or for the fraction of mass considered to be respirable for chemical contaminants. Other sampling devices, such as impingers, impactors, electrostatic precipitators, etc., may be employed if, in the judgment of the HSE Representative, they are called for.

Filters used for gravimetric analysis must be desiccated in an evacuated desiccation chamber and weighed before and after use.

6.5.4 Unknown Contaminants

Atmospheres that contain unknown organic or inorganic contaminants, as detected by direct-reading instruments, will be sampled with solid sorbents that collect a wide variety of substances. Carbon, or other sample sorbents as recommended by the analytical subcontractor will be used to sample unknown atmospheres.

Analysis to determine the nature of unknowns will be carried out with GC/MS systems to separate and identify unknown compounds. Chemicals identified in this manner will then be analyzed with internationally recognized methods (such as those outlined in the NIOSH Manual of Analytical Methods).

6.6 Air Sampling for Radioactive Contaminants

Radiation protection programs, plans, and procedures will be prepared in accordance with the guidance provided by the regulators having primacy.

6.6.1 Sampling Strategy

Air sampling for radioactive contaminants will be task-specific and based on the potential presence of radioactive materials. Priority will be given to situations in which aerosols can be generated (e.g., drilling, excavation, sampling of dry soils, decontamination activities).

When work operations necessitate the use of respiratory protection, breathing zone (lapel) air sampling will be conducted. Filters for sampling should prevent subsurface deposition of particulates. Filters suitable for this purpose include those with a polycarbonate membrane.

Air sample filters will be analyzed for alpha and/or beta-gamma, with emphasis on the comparison to applicable DACs of radionuclides known to be in the workplace. If contaminants have not been identified in a work area, conservative DACs will be used to determine action levels.

6.6.2 Exposure Standards

Exposure standards are used to control internal exposures to radioactive materials. Under extreme conditions, external exposure to radionuclides may be the limiting condition. Under such circumstances, limitations on occupancy may be governed by considering both external and internal exposure limits.

An airborne radioactivity area warning sign will be posted if airborne radioactivity exceeds or has the potential to exceed 10 percent of the DAC. Personal air samples are required for everyone who enters known or potential airborne radioactivity areas.

6.6.3 Exposure Control

Exposure to airborne radioactive materials is controlled by assessing derived air concentration - hours (DAC-HRs) exposures.

Records of individual exposure (in DAC-HRs) will be maintained (see **Attachment 2 - EOM-KSH-TP-000008 - Personal DAC-Hour Record Template**). Records are required if personnel exposure is expected to exceed 4 DAC-HRs in a single week. DAC-HRs are calculated in the following manner:

For single nuclides:

$$DAC - HRS = \frac{(fraction DAC) x (hours of exposure)}{(protection factor)}$$

For multiple nuclides:

$$Fraction\ DAC = \frac{Concentration\ A}{DAC\ A} + \frac{Concentration\ B}{DAC\ B}$$

Respiratory protection is required for entry into areas with airborne radioactivity greater than the DAC.

6.6.4 DAC Action Levels

Personnel entry into airborne radiation areas with exposure potentials that exceed 10 DAC-HRs in any consecutive 7-day period is prohibited without prior approval of the HSE Representative.

Personnel entry into airborne radiation areas with exposure potentials that exceed 20 DAC-HRs in any consecutive 7-day period is prohibited without prior approval of the HSE Representative.

Personnel who exceed 5 DAC-HRs in a calendar quarter must participate in the bioassay program.

6.6.5 Personal Breathing Zone Air Monitoring

Personal breathing zone (lapel) samples are required for workers who enter areas that exceed 10 percent of the DAC as measured by area sampling techniques. The biased sampling protocol outlined in Section 6.1 will be used to select workers for personal samples. For a form that contains a sample that is used to record relevant sampling information. (see **Attachment 3 - EOM-KSH-TP-000009 - Personal Air Sampling/Monitoring Data Sheet Template**).

6.6.6 Perimeter Workplace Monitoring

Area samples will be collected at the boundary of radiologically controlled access areas to document the effectiveness of site controls that should keep exposure to offsite individual(s) as low as reasonably practical.

Perimeter monitors or samplers will be placed in predominately downwind areas around the work facility and in at least one upwind area to measure contamination migration away from the facility in relation to background. These measurements will allow the HSE Representative to evaluate the integrity of the clean areas.

6.7 Recordkeeping

Maintenance of appropriate records is essential for a complete air surveillance program. The following are the minimum requirements:

6.7.1 Air Surveillance Records

Air surveillance for chemical and particulate contaminants will be recorded. Records will be forwarded to the HSE Supervisor, who will forward the pertinent records to the Occupational Health Records Maintenance System.

Completed monitoring data sheets; copies of available bioassay reports; and correspondence relating to exposure evaluation, summaries, and reporting will be retained in the project site HSE files. At a minimum, the following air monitoring data will be completed:

- Copy of the air monitoring data sheets, which include instrument calibration. (see **Attachment 3 - EOM-KSH-TP-000009 - Personal Air Sampling/Monitoring Data Sheet Template** and **Attachment 4 - EOM-KSH-TP-000010 - Air Sampling/Monitoring Data Sheet Template**)

- Chain-of-custody record.
- Copy of chemical laboratory work order forms.
- Copy of analytical results.

6.7.2 HSE Documentation

The HSE Representative will document the following information:

- Date of sampling.
- Operation monitored.
- Location of sampling.
- Meteorology data.
- Time of monitoring.
- Monitoring/sampling equipment operated.
- Source(s) of contamination.
- Suspected contaminants.
- Exact time the monitoring/sampling equipment was operated.
- Who performed the equipment calibration?
- When and how the equipment was calibrated.
- Date of equipment calibration.
- Complicating or mitigating factors.

The HSE Representative will calculate analytical results immediately upon receipt of data. To eliminate delays, laboratory results will be sent to the HSE Representative so calculations can be completed for implementation of proper controls in a timely manner.

6.8 Sample Submission

Where applicable, air sampling collection media requiring laboratory analyses will be analyzed by a laboratory accredited by an appropriate agency (such as the American Industrial Hygiene Association) or one successfully participating in the NIOSH Proficiency in Analytical Testing Program. Samples are to be properly packaged and shipped.

7.0 ATTACHMENTS

1. Action Levels for Direct-Reading Measurements in Uncharacterized Atmospheres
2. EOM-KSH-TP-000008 - Personal DAC-Hour Record
3. EOM-KSH-TP-000009 - Personal Air Sampling/Monitoring Data Sheet
4. EOM-KSH-TP-000010 - Air Sampling/Monitoring Data Sheet

Attachment 1 - Action Levels for Direct-Reading Measurements in Uncharacterized Atmospheres

Contaminant Category	Action Level[a]	Action[b]
Organic gases/vapors	Background to 5 ppm above background	Monitor contaminant level in or near the breathing zone of workers. Use modified C or Level C protection.
	> 5 ppm to 500 ppm	Upgrade protection to Level B and obtain further information. Analyze sorbent samples by GC/MS.
	> 500 ppm to 1000 ppm	Upgrade protection to Level A and obtain further information. Analyze sorbent samples by GC/MS.
	> 1000 ppm	Stop work activities.
Combustible gas[c]	> 10 % LEL	Requires continuous (as practical) monitoring.
	< 20 % LEL	Limit activities in the area to those that do not generate sparks. Use nonsparking tools and gear. Investigate the source of the combustible gas.
	20 % LEL	Limit all activities in area. Stop work activities.
Oxygen	< 19.5 %	Monitor while wearing SCBA.
	19.5 % to 25 %	Continue measurements with respiratory protection equipment based on other factors such as the presence of toxic air contaminants.
	> 25 %	Fire hazard potential exists. Stop work activities.
Particulate (respirable dust)	2 mg/m^3	Use modified C or Level C protection. Air purifying respirator should be equipped with high-efficiency/organic vapor/acid gas combination cartridges. Basic dust control techniques will be used for all intrusive activities.
	> 2 mg/m^3 to 10 mg/m^3	Upgrade to Level B protection. Collect air sample information.
	> 10 mg/m^3 to 20 mg/m^3	Upgrade to Level A protection. Collect air sample information.
	> 20 mg/m^3	Stop work activities.
Particulate (radioactive materials using a respirable dust monitor)	0.1 DAC	Monitor contaminant level in occupied work area.
	> 0.1 DAC to 1 DAC	Post area as an airborne radioactive area, Use HWP to specify respiratory protection requirements. Collect samples of contaminant in occupied work area and in breathing zone of workers.
	> 1 DAC	Post area as an airborne radioactive area. Use HWP to specify respiratory protection requirements. Collect samples to monitor contaminant in occupied work area with continuous air monitors and in breathing zone of workers. Track cumulative exposure and maintain exposures as low as reasonable practical.

[a]Readings in the immediate vicinity of the borehole or other intrusive activity.

[b]Refer to CP-306, Personal Protective Equipment, for guidance on personal protective equipment.

[c]Low oxygen concentrations may affect the validity of combustible gas measurements.

Attachment 2 - EOM-KSH-TP-000008 - Personal DAC-Hour Record Template

Name:			Company:		Emp. No.:	
Day of Month	Month		Month		Month	
	Daily Total	7-Day Total	Daily Total	7-Day Total	Daily Total	7-Day Total
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
Total						

Attachment 3 - EOM-KSH-TP-000009 - Personal Air Sampling/Monitoring Data Sheet Template

HSE Representative		Survey No.	Date
Weather Conditions		HWP No.	
		Level of PPE	
Worker Activities			
Monitored Worker - Name	National ID #	Company	Employee #
Other Workers in Group			
Worker Name	National ID #	Company	Employee #

Sample Type: __ Personal __ Area	Sample Media: __ Mixed Cellulose Ester __ Charcoal Tube __ Glass Fiber __ Other (describe)

Pump Manufacturer	Model	Serial

Calibration Data	Date & Time	Calibrator	Measurement 1 (liters/min)	Measurement 2 (liters/min)	Measurement 3 (liters/min)
Pre-Cal					
Post-Cal					
	Average Pre/Post Flow Rate: Liters/min				

Pump Use Time Started	Time Stopped	Comments

Total Sampling Time:	Sample Volume:
HSE Representative's Signature	Date

HSE Representative	Survey No.	Date

Radiological Results

Nuclide	Net Activity (mCi)	Concentration (mCi/ml)	Lower Limit of Detection (mCi/ml)	DAC (mCi/ml)	Estimated Exposure (DAC-Hr)

Chemical Results

Substance	Mass Detected (mg)	Detection Limit (mg)	Concentration	8-hour TWA	Exposure Standard	EQ

EQ = exposure quotient = exposure ¸ standard

Comments

Attachment 4 - EOM-KSH-TP-000010 - Air Sampling/Monitoring Data Sheet Template

Work Description		Work Location
Monitor: name, employer		Project No. HWP No.
Employee(s) at site/Employer/Program Identification Number		Date
1.		Sheet of
2.	Weather Conditions	Photo Reference
3.		
4.	Potential Interferences	
5.		
6.		Calibration Reference (Date/Instrument No.)
7.		PID
Notes:		FID
		LEL
		Other 1
Activity/Process		Other 2
Direct Monitoring Data		

TIME	LOCATION	PID	FID	LEL	Other 1	Other 2	Location*

Review		**Action** File	
_____ HSE Representative	_____ Date	OHRMS	
_____ Facility / Contract Manager	_____ Date		

*Location: P = Individual breathing zone, A = area of boring, G = general worker area, S = site boundary