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Project Occupational Health and Industrial Hygiene Procedure

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1.0 PURPOSE

The purpose of this Procedure establishes the basic Industrial Hygiene (IH) requirements for the Project. It is designed to provide guidance to Project personnel and Responsible Contractors, concerning occupational health risk assessment and risk mitigation to protect the health of Project personnel. Key elements of this plan may include but not limited to the following:

- Heat-stress prevention.
- Particulates (other than nuisance), fumes, vapors and synthetic fibers.
- Noise.
- Hazardous Substances such as Hexavalent Chromium, water/soil-borne hazards (such as legionella) and ionizing radiation.
- Vibration.
- Requirements for RE to undertake a Health Based Risk Assessment including hazard ranking and identifying controls.
- Implementation of monitoring programs, as applicable, and Training.

The Contractors IH plan shall be completed by a competent person knowledgeable of the hazards and risks.

2.0 SCOPE

The scope of this procedure applies to all works performed under all Government Construction Contracts executed throughout the Kingdom of Saudi Arabia.

3.0 DEFINITIONS

HAZID	Hazard Identification
HSSE	HSSE Health, Safety, Security and Environment
IH	Industrial Hygiene
JHA	Job Hazard Analysis
NOHSC	The National Code of Practice for the Labelling of Workplace Substances
OSHA	Occupational Health and Safety Administration
PPE	Personal Protective Equipment
RE	Responsible Entity
SDS	Safety Data Sheet.
UV	Ultra Violet

4.0 REFERENCES

- NOHSC: 1008(2004)
- OSHA 29 CFR 1926.52 Occupational Noise Exposure
- EPM-KS0-PL-000002 Project Sub-contractor HSSE Evaluation, Selection and Monitoring Procedure
- EPM-KSS-PR-000001 Project General Safe Work Requirements Procedure
- EPM-KSS-PR-000003 Project Personal Protective Equipment Procedure
- EPM-KSS-PR-000024 Project Hazard Communication Procedure
- EPM-KSH-PR-000003 Project Occupational Health Records Maintenance System Procedure
- EPM-KSH-PR-000004 Project Respiratory Protective Equipment Procedure
- EPM-KSH-PR-000007 Project Control of Hazardous Materials Procedure
- EPM-KSH-PR-000010 Project Hearing Conservation Program Procedure

5.0 RESPONSIBILITIES

5.1 Project Manager

The Project Manager is responsible for ensuring the resources and arrangements are available for the implementation and management of this procedure.

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5.3 Contractor Construction Site Manager

The Site Construction Manager shall undertake the following responsibilities:

- Being fluent in the requirements of the Plan.
- Providing onsite or off-site resources to effectively implement the Plan.
- Be familiar with the status of the Plan through briefings from the Contractor Site HSSE Manager.

5.4 Contractor Site HSSE Manager

Contractor Site Health, Safety, Security and Environment (HSSE) Manager has the overall responsibility in confirming that Responsible Entity (REs) complies with the requirements of this document. Regarding this Industrial Hygiene Plan, specific duties include management of:

- Ensuring Industrial Hygiene Assessments (e.g., noise-level measurements, air sampling, etc.) are completed.
- Assigning Field Industrial Hygiene resources.
- Monitoring the implementation of the Plan on the site.

5.5 Contractor IH Team

The Contractor IH team is responsible for overseeing the implementation of practices, procedures, and work methods to reduce worker exposure to unacceptable work related risks through the following:

- Reviewing work methods and Job Hazard Analysis (JHAs) to confirm proper protection is identified, as applicable
- Requiring or implementing monitoring to verify adequacy of control practices or work methods
- Reviewing RE's Health and Hygiene Risk Assessments
- Consult with medical staff regarding health surveillance requirements for Project personnel working with hazardous materials
- Recordkeeping and reporting of IH activities
- Maintaining the Contractor's electronic Safety Data Sheet.(SDS database and processing hazardous substance approvals
- Carrying out compliance and validation inspections and audits of Subcontractor's compliance to required Industrial Hygiene practices and procedures across the project
- Coordinating or assisting, as applicable, compliance and validation assessments concerning material handling, and pest and vermin control.

5.6 Responsible Entities (RE)

When referring to Responsible Entities, it is referring to Sub-contractor under control of the contractor. RE Management and Supervision shall be responsible for the following:

- Implementing the requirements of the Plan.
- Verify appropriate involvement of their employees in the application of the Plan.

- Provide access to industrial hygiene services for personnel and work areas under their immediate control.
- Reporting potential or actual IH exceedances to the Medical Clinic and Contractor HSSE Department.
- Assigning a qualified and trained Industrial Hygienist as applicable to scope of work and as identified in Hazard Identification (HAZID(s)) and Health Based Risk Assessment.
- Develop and implement heat stress prevention plan in accordance to guidelines of this Plan.

5.7 Project Personnel

All Project personnel, including Responsible Entities personnel, are responsible for the following:

- Attending HSSE Orientation and specific occupational exposure related disease prevention programs when offered.
- Using protective measures identified to prevent occupational illness or injury.
- Reporting any signs or symptoms of any occupational diseases or injuries, immediately, to their Supervisor and Medical Services Subcontractor.
- Participating in IH surveillance programs as requested.
- Participating in Industrial Hygiene Monitoring (Contractor or Responsible Entities initiated) as required.
- Not interfering in the Monitoring Instrumentation, they or their Coworkers maybe required to wear/use.

6.0 RISK ASSESSMENT

An integral aspect of the work planning process when dealing with occupational health and hygiene, is the performance of a proper risk assessment. Risk Assessments must be conducted at the Planning Stage to identify the hazard risks and determine control measures.

The Risk Assessments that shall be conducted at the Planning Stage are as follows:

- Project Risk Assessment.
- Work Method Statements (WMS)
- Job Hazard Analysis (JHA).
- Safety Task Analysis and Risk Reduction Talk (STARRT)

The Hierarchy of control shall be used to reduce the likelihood of an incident occurring.

- ***Elimination*** (Remove the Hazard)
- ***Substitution/Isolation*** (Replacing material, process or hazard with a lower risk one/ separate people from the hazard (such as suitable guarding, distance, etc.)
- ***Engineering Controls*** (Redesign or replacement of plant and equipment)
- ***Administration Controls*** (Procedures, training, signage)
- **PPE**

The following sections below outline specific controls that are required to assist with the above.

7.0 REQUIREMENTS

7.1 Responsible Entities IH Plans / Health Based Risk Assessment

REs shall develop an IH Plan based on their health based risk assessments that detail potential hazards for RE scope specific work activities. The RE's IH plan will address all applicable risks and detail the RE's requirements for IH monitoring, testing and communication of test result requirements.

7.2 Target Organs / Health Performance Indicators

Target organs are those body parts that sustain some adverse effect when exposed to, or contaminated by, harmful substances or agents. These hazards will be identified using Health Based Risk Assessments and use control methods (substitution, training, suitable or specialty Personal Protective Equipment (PPE), etc.) to reduce risks to a level As Low as Reasonably Practicable. The table below provides guidance to develop Industrial Hygiene (IH) monitoring programs to be described as applicable in RE's IH Plan. Guidance on IH monitoring processes is in Air Surveillance Guidelines (Attachment 2).

Table 6.2-1: Target Organs / Health Performance

Organ (Body Part)	Condition / HPI	Potential Cause(s)
BLADDER	Cancer	2-Naphthylamine
BONE	Osteo-necrosis	Vinyl chloride monomer, work in pressurized area e.g. diving works
BRAIN	Narcosis Encephalopathy	Organic solvents Mercury, lead, manganese, carbon disulfide, carbon monoxide
CARDIO-VASCULAR	Anemia White cell Count changes	Lead, arsenic Benzene, carbon tetrachloride Ionizing radiation
EARS	Deafness Temporary / Permanent Threshold Shift	Noise in excess of country-specific standards Exposure to otogenic agents
EYES	Cataracts Corneal Ulcers	Ionizing radiation, Ultra Violet (UV) light, heat, acids/alkalis, arc flash
HANDS / ARMS	Vibration White Finger Carpal Tunnel Syndrome Tenosynovitis Dermatitis	Use of vibrating tools Repetitive pulling and/or twisting actions Repetitive pulling and/or twisting actions with forceful movements Exposure to skin irritants
KIDNEY	Toxicity Infection	Organic solvents, lead, mercury, cadmium Micro organisms
LIVER	Hepatitis Cancer	Organic solvents, arsenic, manganese, beryllium, vinyl chloride monomer
LUNGS	Pneumoconiosis (Extrinsic allergic alveoli) Asthma Irritation / Inflammation Infection Cancer	Mineral dust: coal, silica, asbestos, iron, tin, barium, organic dusts, mineral fibers, metal fume Proteins and low molecular weight chemicals in toxic dosages Nitrous fumes, phosgene, chlorine, hydrogen sulfide, sulfur dioxide, ammonia Legionella Asbestos, nickel, hexavalent chrome
NOSE	Ulceration	Chrome
PERIPHERAL NERVES	Neuropathy	Lead, mercury, carbon disulfide, tetrachloroethane, trichloroethylene, organophosphorus compounds, vibration
SKIN	Dermatitis Cancer	Exposure to skin irritants such as, solvents, acids / alkalis, mercury, chrome, nickel, arsenic, mineral oils, wood, plants, resin, heat Aromatic polycyclic hydrocarbons, arsenic, UV light, ionizing radiation

Organ (Body Part)	Condition / HPI	Potential Cause(s)
TEETH	Loosening Erosion Mottling Discoloration	Mercury Sulfuric acid Fluorides Vanadium, iodine, bromine

7.3 Hazardous Substances

A substance is defined by Legislation as being hazardous if any of the ingredients are present in a concentration greater than the cut-off levels in the Hazardous Substances Information System (HSIS); or any of the ingredients meet the requirements in the Approved Criteria for Classifying Hazardous Substances, The National Code of Practice for the Labelling of Workplace Substances (NOHSC): 1008(2004).

Further information about the management of Hazardous Substances on the Project can be found in EPM-KSS-PR-000024 Project Hazard Communication Procedure, and EPM-KSH-PR-000007 Project Control of Hazardous Materials Procedure and outlines the process for bringing a hazardous substance onto site, performing risk assessments, use of the Hazardous Substance Register, use of Safety Data Sheets (SDS's), and storage, labeling, signage, training and general exposure control requirements.

EPM-KSH-PR-000004 Project Respiratory Protective Equipment Procedure outlines respiratory equipment use, care and maintenance requirements, medical clearance for use, fit testing and specialty PPE guidance.

7.4 Chemicals

Chemicals for the Project are managed as per the EPM-KSS-PR-000024 Project Hazard Communication Procedure, and EPM-KSH-PR-000007 Project Control of Hazardous Materials Procedure. This procedure details approvals, storage, decanting and training requirements. All Chemicals will be used and comply with SDS requirements and follow proper storage of chemicals requirements.

7.5 Synthetic Mineral Fibers

The Project has prohibited the use of asbestos products in the construction of the plant due to its hazardous properties; however, alternate synthetic fiber products may also present health hazards to individuals that work with or handle the materials.

REs shall assess their scope of work for potential exposure to synthetic mineral fibers. Where risk of exposure exists, REs shall develop, submit to Contractor for approval, and implement a plan to safely store, handle, install, and dispose of synthetic fiber products. The plan shall also include assessment of hazards and risks associated with the materials, mitigation of hazards, monitoring for potential exposure, and protection of all project personnel.

Synthetic mineral fibers are fibrous inorganic substances made primarily from rock, clay, slag, or glass. These fibers are classified into three general groups:

- Fiberglass (glasswool and glass filament)
- Mineral wool (rockwool and slagwool)
- Refractory ceramic fibers (RCF)

The National Standard for Synthetic Mineral Fibers NOHSC:1004 (1990) is applicable to the Project and applies to all applications involving mineral wool (rockwool and slagwool), glasswool (including superfine glassfibre) and ceramic fibers, and activities involving their installation or removal or any related handling or work.

Standard work practices, including prescribed engineering controls, general housekeeping, personal hygiene, air sampling, First Aid, personal protective equipment, and health surveillance principles as specified in NOHSC:1004 (1990), will be applied to the Project to the extent necessary to prevent worker exposure above the national standard for synthetic mineral fibers.

7.6 Hexavalent Chromium

Chromium is an element whose atomic structure can exist in several different oxidation states. The most commonly occurring of these are Divalent Chromium – Cr (II), Trivalent Chromium – Cr (III) and Hexavalent Chromium – Cr (VI).

Cr (VI) is a toxic chemical form of chromium and is produced entirely from industrial processes. Exposures will typically occur during welding, painting, abrasive blasting and use of refractory materials, concrete or treated wood products. In construction, stainless steel welding and cutting involves the greatest risk of exposure since Cr (VI) is found as a significant by-product in the metal fume. The primary route of entry for Cr (VI) is inhalation. Ingestion and skin absorption are also routes of entry into the body.

Responsible Entities shall assess their scope of work for potential exposure to Cr (VI). Where potential exposure exists, Responsible Entities shall develop and implement a procedure to identify, control, and monitor any activities that would potentially create exposure. Contractor will provide guidance to subcontractors, if needed. The procedure must include the following:

- ***Chromium Material Assessment*** – A material assessment to determine the presence of chromium for Project specified materials. The material assessment is the basis for determining the need for a Hexavalent Chromium monitoring program.
- ***Conduct Exposure Assessment Profiles*** –These assessments ascertain the potential for airborne exposure based on specific work operations, materials and conditions. Appropriate controls must be addressed for materials that pose a skin hazard, such as Cr (VI) containing paint, abrasive blasting grit, and freshly treated wood, regardless of any potential for airborne contamination.
- ***Cr (VI) Program Implementation*** – Elements of an effective Cr (VI) protection program may include exposure assessments, engineering controls, exclusion zones, personal protective equipment, IH monitoring, medical surveillance, training and compliance plan.

The program must incorporate specific work practices and controls for the following activities if Hexavalent Chromium is an exposure, as applicable:

- Shielded Metal Arc Welding (SMAW) and Flux Cored Arc Welding (FCAW).
- Gas Metal Arc Welding [GMAW (MIG)], Surface Tension Transfer welding (STT), and/or Grinding.
- Gas Tungsten Arc Welding [GTAW (TIG)] and Submerged Arc Welding (SAW).
- Plasma Arc, Thermal Cutting, and Arc Gouging.
- Painting.
- Abrasive Blasting.
- Wood Cutting and Disposal.
- Concrete.

7.7 Noise

The Project follows OSHA Standard requirements for construction and operations areas within the Project site, 85 $dB_{(A)}$ in the maximum exposure limit.

7.7.1 Health Effects of Excessive Noise

- Excessive noise can cause ringing in the ears (Tinnitus). This is temporary at first but can become permanent. This ringing can be very distracting and cause severe difficulties in concentration or sleep.

- Noise can affect sense of balance and cause dizziness.
- Noise is a source of stress which can lead to tiredness, irritability and headaches.
- Noise can raise blood pressure, putting strain on the heart.
- Noise affects the eyes, causing loss of clarity, color perception and night vision. Fine close work becomes difficult as noise causes the pupils of the eyes to dilate, forcing the eyes to constantly refocus.
- Noise increases the risk of accidents by masking sounds of approaching danger or warnings. Noise also increases the risk of accidents through its effect on balance and concentration.
- Noise interacts with other workplace hazards. Workers exposed to noise together with some other workplace hazards may have an increased risk of hearing loss. These hazards include: carbon monoxide, trichloroethylene, ototoxins, vibration, and heat.

7.7.2 Reducing Noise Risks

There are four possible ways of reducing noise risks:

- Reduce the noise at its source:
    - Evaluate machinery/equipment in the procurement stages; procure equipment with sound reduction features if possible.
    - Block the noise transmission path.
    - Move noisy machinery or noisy processes to remote areas of the worksite away from workers.
    - Fit sound absorbent materials to the ceiling and walls if feasible.
- Prevent workers' exposure to noise:
    - The time spent by workers in a noisy environment can be reduced by job rotation or rest periods.
- Provide hearing protection:
    - Protection such as ear plugs and ear muffs are the last resort, where other methods of controlling noise have not been applied or are not practical
    - Hearing protection must be properly fitted to provide effective protection from exposure to noise

Table 6.7.2-1: Noise Levels and Allowable Exposure Time

Noise Level in $dB_{(A)}$	Exposure Time
82	12 hours
84	10 hours
85	8 hours
88	4 hours
91	2 hours
94	1 hour
97	30 minutes
100	15 minutes
103	7.5 minutes

The 85 $dB_{(A)}$ average exposure standard the maximum acceptable exposure level for noise at the workplace. Workplace noise exposure levels therefore must not exceed 140$dB_{(C)}$ even for an instant, but the average exposure level over a 10-hr. shift should not extend 84$dB_{(A)}$), and should be kept below that level where practicable.

Awareness campaigns regarding hearing protection requirements are included in safety meetings, induction training, annual audiometric testing as applicable, etc.

7.7.3 Noise Identification and Assessment

Responsible entities at the site will have a noise monitoring program that identifies employees for inclusion in the EPM-KSH-PR-000010 Project Hearing Conservation Program Procedure. IH monitoring of noise exposed workers will be carried by placing workers in similar exposure groups and carrying out monitoring with noise dosimeters. “Exposure groups” that have a risk of noise exposures exceeding the action level of 82 $dB_{(A)}$ will be included in the Hearing Conservation Program Procedure.

All Occupational exposure monitoring of noise carried out by Responsible Entities will be forwarded to the Contractor Industrial Hygiene team when completed.

7.7.4 Noise Monitoring

Monitoring consists of and will be carried out by Contractor (on an assurance basis only) and REs including but not limited to:

- Checking if equipment brought onto site complies with specifications. This could be done by obtaining information available from suppliers or by noise assessments.
- Reducing noise from identified noise sources by exchanging equipment and/or processes for a quieter alternative or by engineering control methods to quieten the existing one.
- Reviewing to make sure equipment contains noise abatement devices per manufacturer’s recommendations.
- Verifying that all plant is properly maintained; e.g., all noise control measures like silencers and enclosures are intact.
- Monitoring whether noisy areas are identified and well-marked so Project personnel can avoid entering them unnecessarily.
- Monitoring whether training and hearing tests have been carried out and if personal hearing protectors are adequate and are being worn and maintained correctly.
- Utilizing safety toolbox meetings to provide feedback on effectiveness of noise control measures and personal hearing protectors to Project personnel.
- Providing affected employees with results of noise assessments conducted.
- Carrying out personal exposure monitoring and assessment.

7.7.5 Hearing Protection Areas

Areas where people may be exposed to excessive noise should be sign-posted as ‘hearing protection areas,’ and their boundaries should be clearly defined.

Where sign-posting is not practicable, alternative arrangements should be made in consultation to make sure that Project personnel and others can recognize circumstances in which personal hearing protectors are required. Methods of achieving this include the following:

- Attaching prominent warning notices to tools and equipment indicating that personal hearing protectors must be worn when operating them.
- Providing written and verbal instructions on how to recognize circumstances in which personal hearing protectors are needed.
- Effectively supervising identified “hearing protection areas”.

7.7.6 Selection, Use, Maintenance, and Training for Personal Hearing Protectors

Information regarding selection, use, and maintenance of personal hearing protectors is detailed in EPM-KSS-PR-000003 Project Personal Protective Equipment Procedure.

7.7.7 Audiometric Testing Program

The hearing of personnel exposed to noise >85dB$_{(A)Leq8}$ will be initially tested pre-hire or immediately post-hire. Further monitoring will be through regular audiometric examinations arranged by the Responsible Entities.

Responsible Entities will have an audiometric testing program that shall be available to any Project personnel likely to be regularly exposed to excessive noise; e.g., exceeding the $L_{Aeq,8}$ of 85 dB$_{(A)}$, or exposed to ototoxins. These individuals will have an initial baseline audiogram as part of the pre-placement physical and will have annual audiograms.

7.7.8 Industrial Ototoxic Agents

Workplaces may also contain ototoxic agents. Ototoxic agents are chemical substances that have a detrimental effect on an individual's hearing. Threshold shifts produced by these agents may compound those produced by excessive noise exposure.

Some examples of industrial ototoxic agents are solvents including toluene, styrene, trichloroethylene, carbon disulphide, hexane and butanol, and toxic metals including lead, mercury and trimethyltin. Also, mixtures of solvents that include xylene, heptane and ethyl benzene have been implicated in some ototoxic studies.

7.7.9 Dust

Dust monitoring from other than soil handling activities may be required to be undertaken based on health based risk assessments concerning the work activities. The formal reports that result from IH monitoring shall be forwarded to the Contractor IH Team for review.

Dust from soils handling activities during construction of the Project will be controlled. Some natural dust will be controlled because of on-site Project dust control activities within the disturbance zone but natural or anthropogenic activities that are off-site resulting in dust generation will not be mitigated by Contractor.

7.7.10 Vibration Management

The Project will strive to eliminate or reduce the potential for personnel to be exposed to excessive levels of vibration, so far as is reasonably practicable.

7.7.11 Vibration Exposure Limits

The Project has established guidelines as follows:

- For Hand/Arm Vibration (HAV):
    - Daily exposure action value of 2.5 m/s²
    - Daily exposure limit value of 5 m/s²
- For Whole Body Vibration (WBV):
    - Daily exposure action value of 0.5 m/s²
    - Daily exposure limit value of 1.15 m/s²

Vibration shall be considered, as applicable, when planning work tasks, preparing JHAs and STARRT, and shall include control measures to manage the risks.

7.7.12 Vibration Risk Management

Vibration hazards and associated risks shall be managed by applicable Responsible Entity in accordance with the following steps:

- Identify sources of WBV and HAV. Assess potential health risk using guidelines above.
- Assess potential health risk using Vibration Exposure limits above.
- Select and implement exposure control measures, including maintenance requirements to verify ongoing effectiveness.
- Monitor and review the effectiveness of the control measures to determine whether the chosen controls have been implemented as planned, are effective, and have not introduced new hazards or worsened existing hazards.
- Document the controls and the effectiveness of controls as noted by monitoring and assessment activities.
- Vibration hazards and mitigations are to be identified in JHAs and communicated to the workers during the STARRT process.

7.7.13 Whole Body Vibration Management

REs shall consider vibration when assessing the hazards and risks of specific scopes of work and selecting the methods to perform and complete the work. Documentation of these assessments shall be made available for audit by Contractor.

To the extent practical, REs will do the following:

- Choose equipment that has been designed or adapted to minimize vibration.
- Maintain vehicles and equipment adequately, particularly suspension components.
- Maintain driver's seats in good repair and ensure they give good support.
- Check with the manufacturer to determine whether the suspension seat is suitable for the vibration characteristics of the machine, and that it is correctly adjusted to the operator's weight.
- Check to see that the vehicles have the right tires and that they are inflated to the right pressure for the ground surface.
- Provide training to employees regarding sitting and posture and how to adjust the seat for good seating position and posture. Particularly important where a suspension seat is fitted for the driver's weight and different people drive the vehicle.
- Improve the ground surfaces over which vehicles must be driven regularly, for example repairing potholes, clearing debris, or leveling.

7.7.14 Hand-Arm Vibration Management

Hand-arm vibration is vibration transmitted from work processes into workers' hands and arms. It can be caused by operating handheld power tools, such as road breakers, and hand guided equipment, such as powered lawnmowers, or by holding materials being processed by machines, such as pedestal grinders.

Identifying and reporting signs and symptoms at an early stage is important, as it will allow for the Project to act to prevent health effects from becoming serious. The symptoms include any combination of the following:

- Tingling and numbness in the fingers.
- Not being able to feel things properly.
- Loss of strength in the hands.
- Fingers going white (blanching) and becoming red and painful on recovery (particularly in the cold and wet, probably only in the tips at first).

To the extent practical, Responsible Entities will do the following:

- Choose alternative work methods which eliminate or reduce exposure to vibration.
- Verify equipment selected or allocated for tasks is suitable and can do the work efficiently. Equipment that is unsuitable, too small, or not powerful enough is likely to take much longer to complete the task and expose employees to vibration for longer than is necessary.
- Select the lowest vibration tool that is suitable and can do the work efficiently.
- Check with suppliers that their equipment is suitable and will be effective for the work by:
    - Comparing vibration emission information for different brands/models of equipment.
    - Asking for vibration information for the way the equipment is to be used.
    - Asking for information on any training requirements for safe operation.
- Find out about the equipment's vibration reduction features and how to use and maintain the equipment to make these features effective.
- Use devices such as jigs and suspension systems to reduce the need to grip heavy tools tightly.
- Plan work to avoid individuals being exposed to vibration for long, continuous periods – several shorter periods is preferable.
- Provide employees with protective clothing when necessary to keep them warm and dry and encouraging good blood circulation which should help protect them from developing vibration white finger.
- Provide anti-vibration gloves suitable for the tool being used.

7.8 Heat Stress

Human beings have a core temperature that normally lies within a narrow range around 37°C (98.6°F). Heat from the environment and working muscles (i.e., Heat Stress) can cause an increase in the core temperature (hyperthermia) and the body's response (termed Heat Strain) is to dissipate the heat. The result may be a range of adverse health effects, which in extreme cases may be fatal. The health effects can be exacerbated by a range of personal factors.

Heat Stress contributors are radiant heat, air temperature, air humidity, air velocity, metabolic workload, and clothing insulation. Factors that affect heat strain will include physiological characteristics of workers; e.g., fitness, acclimatization, state of hydration, medication, etc.

Responsible Entities shall assess the scope of work and identify the heat-related hazards and develop a heat-stress prevention procedure to be approved by Contractor. The requirements of the heat stress prevention procedure shall include the requirements of this Plan. REs shall train their personnel on applicable elements of their heat-stress prevention procedure and specifically on self- monitoring such as:

- Understanding signs and symptoms of heat stress.
- Using their urine color to check for early signs of dehydration.
- Understanding the need to avoid alcohol, caffeinated drinks and large, heavy meals.
- Applying sunscreen regularly for outdoor activities.
- Taking breaks in cool down areas, pacing their work, knowing their limits.
- Immediately reporting any suspected heat related disorder to their supervisor.

7.8.1 Heat Stress Standard

The Heat Stress Standards adopted by the Project are based on the Thermal Work Limit (TWL), which is a measure of the acceptable heat tolerance for the work and environmental conditions.

7.8.2 Thermal Work Limit

The environmental parameters and work organization shall be managed so that the Thermal Work Limit (TWL) measurement relating to a given work situation is maintained at a level of > 220 Watt/m^2; or that the work is designated as "Unrestricted Work." TWL uses five environmental parameters (dry bulb, wet bulb, and globe temperatures, wind speed and atmospheric pressure) and accommodates for clothing factors to

arrive at a prediction of a safe level at which the body can cool, and the maximum continuously sustainable metabolic rate (W/m^2) for the conditions; i.e. the TWL. At high values of TWL, the thermal conditions impose no limits on work. Determinations of the TWL are carried out using the Calor heat stress monitor.

Environmental parameters are to be assessed by a qualified and trained Industrial Hygienist. Contractor IH personnel will provide guidance to REs, if needed.

7.8.3 Radiant Heat Standard

Radiant heat from the environment, including from hot objects, can be taken up by the body if the skin temperature is lower. Radiant heat exchange requires no physical contact. The level of radiant heat to which an individual can be exposed can be measured and expressed in terms of kilowatts per square meter (kW/m^2).

The Radiant Heat Standard:

- Exposure of unprotected skin at normal work positions or access positions including emergency exits or evacuation routes shall be < 1.5 kW/m^2
- Exposure of unprotected skin in the event of an emergency evacuation situation for the general workforce (excluding the Emergency Response Team) shall be < 2.2 kW/m^2

7.8.4 Physiological Monitoring

Where practical controls have been implemented, but there is still a health risk, various forms of risk assessment are available. In some cases, (i.e., such as when full impermeable suits are worn), direct physiological monitoring of each worker may be required to monitor heat strain and verify the state of hydration. Responsible Entities, HSSE Advisors in coordination with the Contractor IH team, and the on-site Medical Services Physician will determine if physiological monitoring is required, on a case by case basis.

Physiological monitoring, when required, will be conducted in a controlled confidential manner by the Subcontractor's Industrial Hygienist. Physiological monitoring will be based on industrial hygiene observations and data and may include evaluation of the following:

- Core body temperature.
- Blood pressure.
- Heart rate.
- Specific Gravity of Urine.

7.8.5 Self-Monitoring

Personnel may also self-monitor the status of their own hydration by comparing the color of their urine to the chart below. Lighter color indicates good hydration – darker color indicates poor hydration. Self-testing for specific gravity of urine may be part of the self-performed diagnostic checks. This can be done using test "sticks" to check the specific gravity of urine. The sticks are not mandatory, but should be available.

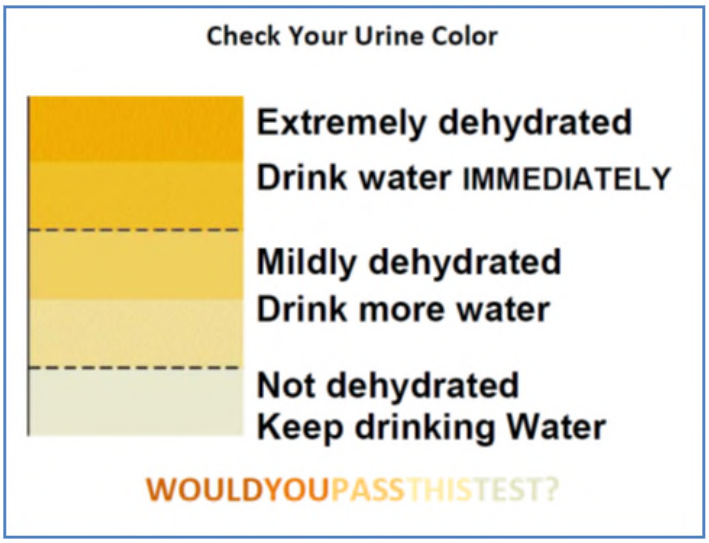

Figure 6.8.5-1: Hydration Color Test

7.8.6 Work Area / Site Heat Stress Requirements

As a minimum, the Responsible Entities will have systems in place to provide or manage the following:

- Monitor weather/temperature/heat stress index forecasts through the HSSE Daily Notice, or alternative, that equals or betters that provided by the Contractor and plans work and controls for the following day on these predictions.
- Respond to predictions of heat stress provided by the Contractor in the Daily HSSE Notice that classifies the risk as high, extreme or critical. Where critical is predicted, the sub-contractor will carry out a heat based risk assessment before commencing work and put appropriate controls in place to protect its workforce.
- A plentiful supply of cool water that is easily accessible to the work area(s). This water supply must be of sufficient quantity to maintain hydration at a minimum availability of 1 litre/person/hour).
- An adequate supply of electrolyte supplements, easily accessible to the work area(s) will be supplied by the RE, if determined as required based on REs and health based risk assessment.
- Provide safe apparel that mitigates sun exposure including brims for hats. Consideration shall be taken in regards to heat related PPE/apparel options such as, but not limited to, phase change vests, vortex cooling devices, industrial fans, suitably rated portable air conditioners, hard hat coolers and cooling scarves.
- Provide personnel, shaded “cool down” areas, near the work area(s) that will maintain a maximum temperature of 26^{o}C.
- Acclimatise employees in accordance with the regime detailed in Acclimatization Regime (Figure 4.8.6-1) at a minimum:

Workers with previous exposure to hot environments - acclimatized	Workers without previous exposure to hot environments – non-acclimatized
Day 1 – 50% exposure	Day 1 – 20% exposure
Day 2 – 60% exposure	Day 2 – 40% exposure
Day 3 – 80% exposure	Day 3 – 60% exposure
Day 4 – 100% exposure	Day 4 – 80% exposure
	Day 5 – 100% exposure

Figure 6.8.6-1: Acclimatization Regime

- Maintain, monitor and ensure that PPE/Apparel stocks, shade areas, cool down areas, and other heat stress prevention measures are in place for applicable tie period of potential heat stress exposure
- Monitors their workforce for early signs and symptoms of heat stress and respond appropriately to ensure the individual does not progress to a heat stress case. Monitoring includes observation via qualified personnel (e.g. Industrial Hygienists) to quantify exposures and apply appropriate controls and implement changes to work practices to ensure heat exposures are adequately controlled.

7.9 Ionizing Radiation

Ionizing radiation can be found on the Project in the forms of, but not limited to:

- X-rays.
- Industrial radiography equipment.
- Soil density equipment.
- Sealed gauges.

The management of Ionizing Radiation on the Project is the responsibility of the Responsible Entities. They must ensure that they are meeting the requirements of the EPM-KSS-PR-000001 Project General Safe Work Requirement Procedure. This covers such things as Radiation Safety Officer (RSO) duties, transportation, storage, use, permitting and emergency procedures.

7.10 Legionella Testing

Legionella testing may be required to be undertaken based on the Responsible Entity's health based risk assessment. Results shall be provided to the Contractor IH team. Examples of potential Legionella exposure include, but are not limited to the soils surrounding truck washing areas, truck washing basins, retention ponds, misting coolers and cooling towers.

7.11 Pest and Vermin Control

Camp Management Subcontractor and designated General Services Subcontractor have responsibilities for pest and vermin control, the submittal of appropriate plans/procedure that meet regulatory requirements, and notifications to personnel in regards to placement of pesticides. Assurance activities related to pest and vermin control are managed by the Contractor HSSE Department.

7.12 Manual Handling

All manual handling hazards must be identified, their risks assessed, and how the risks may be reduced considered. As a definitive, absolute safe lifting weight is not possible, a common sense, risk based approach is required for assessing manual handling tasks and determining the best approach. Accordingly, REs manual handling programs will require an assessment of their scope of work for manual handling activities, and will include the following four step assessment process:

- ***Step 1: Hazard Identification*** – Identifying hazards associated with manual handling.
- ***Step 2: Risk Assessment*** – Assess the risks arising from the hazard.
- ***Step 3: Risk Control*** – Decide on and use appropriate control measures.
- ***Step 4: Monitor and Review Risk Controls*** – Assess effectiveness of controls.

For the purposes of this Plan “manual handling” means any activity requiring the use of force exerted by a person to lift, lower, push, pull, carry or otherwise move, hold or restrain a person, animal or thing. It also includes any activity involving repetitive and/or forceful movements (e.g., keying data into a computer; using a screwdriver) and any activity where the person must maintain constrained or awkward postures (e.g., driving a truck) of manual handling.

7.12.1 Hazard Identification

The Project will seek to actively identify manual handling tasks and activities that may give rise to injuries or harm or those where personnel have identified concerns by completing the following actions:

- ***Review injury/hazard reports*** – Review injury, incident and hazard reports for injuries or hazards related to manual handling.
- ***Consult with personnel, supervisors and safety and health representatives*** – Ask personnel about which manual handling tasks they consider may lead to physical strain, ask supervision about difficulties that their staff have experienced in executing manual handling tasks, and consult with Project HSSE representatives on manual handling issues and/or trends.
- ***Review tasks*** – Carry out workplace inspections and identify any relevant contributing factors and observe the manual handling tasks.
- ***Look for trends*** – Review information collected from checking injury/hazard reports, personnel interviews, and manual task observations to identify trends or common manual handling problems.

7.12.2 Risk Control

Risk factors can be reduced by several engineering and administrative approaches, including the following:

- Coordinating with vendors to load or package materials in a manner to reduce the risk of manual handling of the materials at the Project.
- Modifying workplace layout and equipment (rearrange the layout or design of plant, equipment and furniture to reduce twisting, reaching, stooping and poor application of force. Introduce lifting devices and mechanical equipment where practicable).
- Modifying the load (the load being handled can be modified or re-packaged into bigger or smaller weights, or into different size or shape).
- Controlling the work environment (this involves changing or modifying work environment factors that affect manual handling).
- Redesigning work patterns (changing how long an activity is done, how often it is done, and how it is done).
- Warming up and stretching prior to manual handling.
- Providing mechanical handling equipment when indicated.

8.0 TRAINING

To provide consistency and completeness in IH management, training will be provided as appropriate for personnel required to participate in the IH procedures:

- All Project Personnel are made aware of IH requirements through the PIC Induction and RE induction/training programs.
- Supervisory and HSSE personnel receive an overview of this Plan through the Contractor HSSE Supervisor Induction.
- Project Personnel to attend specific occupational exposure related disease prevention programs when offered.

9.0 MONITORING AND EVALUATION

Assessments shall be conducted by the Project HSSE Manager on a periodic basis to confirm the implementation and evaluate the effectiveness of the Plan per the requirements detailed in the EPM-KS0-PL-000002 Project Sub-contractor HSSE Evaluation, Selection and Monitoring Procedure. The Industrial Hygiene Assessment Checklist (Attachment 1) will be used in these assessments. Improvement actions are assigned for completion, entered onto the HSSE Action Tracking Register, and tracked to closure.

10.0 RECORDS

Industrial hygiene records for Responsible Entities shall be sent to the Contractor and will be maintained by the Contractor IH Team. Records related to medical surveillance will be maintained by the Medical Services Subcontractor. Personal medical records will be maintained “Confidential” and made available to the individual person for review, and/or will be made available to other individuals identified by the person in writing.

Personal and area monitoring results will be input and stored in the Contractor database for audit purposes.

Some IH records may be classified as medical records – e.g. Audiometric test records – Also see the EPM-KSH-PR-000003 Project Occupational Health Records Maintenance System Procedure for details as, these are considered medical records and shall be kept as defined.

11.0 ATTACHMENTS

1. EPM-KSH-TP-000021 - Industrial Hygiene Assessment Checklist
2. Air Surveillance Guidelines

Attachment 1 - EPM-KSH-TP-000021 - Industrial Hygiene Assessment Checklist

ATTENTION: Check either "YES," "NO," or "N/A." If corrective action is required, answer "NO." For every "NO" answer, provide a brief description of the issue in the "COMMENTS" column. Add the finding / issue to the HSSE Tracking Register.

No.	Industrial Hygiene Assessment Checklist	ANSWER			Comments
		YES	NO	N/A	
	OCCUPATIONAL HEALTH AND HYGIENE				
	Subcategory 1: General				
1	Has the project conducted the required review of risk assessments to determine the extent of the Health and Hygiene program for the project?				
2	Is a complete set of Material Safety Data Sheets held and maintained by the project organizational element responsible for the occupational health and industrial hygiene program?				
3	Does the HSSE Department retain copies of Material Safety Data Sheets?				
4	Where applicable, have arrangements been made with an accredited laboratory for the analysis of potable water for inorganic and organic substances and pathogens?				
5	As necessary, have arrangements been made for chlorine dosing of piped and stored water for human consumption and washing facilities?				
6	Are suitable and sufficient sanitary facilities provided at readily accessible places to maintain the hygiene standards required on the project?				
7	Has a risk assessment been completed identifying indigenous pest and vermin species in the area (where applicable)?				
8	Where applicable, have appropriate measures been implemented to control the pests and vermin and to mitigate the effects on personnel?				
9	Has the project implemented a Health Education Program?				
	OCCUPATIONAL EXPOSURE TO CARCINOGENS AND TERATOGENS				
	Subcategory 1: Responsibilities				
1	Where applicable, has the Contractor Corporate Industrial Hygienist reviewed the qualifications and approved the HSSE Representative (or designee) to perform carcinogen/teratogen exposure assessments and develop the required compliance plan?				
2	Where applicable, has the Contractor Corporate Industrial Hygienist provided support to the project, as needed, in the identification and assessment of exposure to carcinogens?				
3	Where applicable, has the Contractor Corporate Industrial Hygienist reviewed Contractor packages and associated assessments and plans (related to carcinogens and teratogens) as required by a project?				
4	Does the project procurement manager maintain a list of all chemicals present at the project site?				
5	Does the project procurement manager maintain Safety Data Sheets (SDSs) for all chemicals present at the site?				

Attachment 2 - Air Surveillance Guidelines

The following information provides guidance for air surveillance of chemical and radioactive contaminants for determining background, general work area, perimeter, and breathing zone contaminant levels.

Specific definitions:

- **Air Monitoring:** Air surveillance with the use of direct-reading instruments capable of providing real-time indication of air contaminant levels.
- **Air Sampling:** The collection of air or airborne contaminants in a suitable container or an appropriate medium for contaminant identification and quantification.
- **Air Surveillance:** The use of direct-reading and air sampling instruments to grossly identify (i.e., gross alpha/beta) and quantify airborne contaminants for personnel protection.
- **Breathing Zone:** The zone of the ambient environment in which a person performs the normal respiratory function (typically, a 30.5 cm (12 in.) hemisphere encompassing the front half of a person's head, neck, and shoulders).
- **Gas Chromatography/Mass Spectroscopy (GC/MS):** An analytical technique that combines a gas chromatograph for compound separation with a mass spectroscope for compound identification.
- **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):** Where an atmospheric exceedance is defined as a toxic atmosphere. The various TLVs & OEL's that exist are:
    - **Ceiling C or Peak Limitation:** The concentration that should never be exceeded, even instantaneously.
    - **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).
    - **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.
- **Lapel Air Sample (Personal Air Sample):** The air sampling method for identifying and quantifying personal exposure to respired contaminants. Samples are obtained in the immediate breathing zone of the person. 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-volume personal samplers. Typical flow rates are between 0.01 and 0.2 liter per minute (lpm) for low-volume personal samplers and between 2.0 and 4.0 lpm for high-volume personal samplers.
- **General Area Sampling:** 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:

Sample Categories	Sample Flow Rate (lpm)
1. Low-volume area	< 10
2. Medium-volume area	10 – 100
3. High-volume area	100 – 1500

1. General Requirements

Air surveillance consists of air monitoring and air sampling. The objectives of air sampling are to determine:

- The type of 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 the following table are to be used.

Contaminant Category	Action Level[(a)]	Action[(b)]
Organic gases/vapors	Background to 5 parts per million (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 % Lower Explosive Level (LEL)	Requires continuous (as practical) monitoring.
	< 20 % LEL	Limit activities in the area to those that do not generate sparks. Use non-sparking 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 self-contained breathing apparatus (SCBA).
	19.5 % to 25 %	Continue measurements with respiratory protection equipment based on other factors such as the presence of toxic air contaminants.
	> 5 %	Fire hazard potential exists. Stop work activities.
Particulate (Inhalable & 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.

NOTES:

(a) *Readings in the immediate vicinity of the borehole or other intrusive activity.*

(b) *Refer to the Personal Protective Equipment Procedure, for guidance on personal protective equipment.*

(c) *Low oxygen concentrations may affect the validity of combustible gas measurements.*

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, or TLV.

Air Monitoring (Direct Methods)

Some of these instruments may be used in the total organic vapor or gas chromatographic mode.

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

2. Availability and Use

Project work facilities will have direct-reading instrumentation available. Trained personnel will use this instrumentation to conduct air monitoring for work efforts.

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, and total volatile organic compounds.

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.

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 Industrial Hygienist, will implement air surveillance and sampling procedures.

3. Action Levels

The guidelines presented in the table illustrate action levels for vapor, combustible gas, oxygen, particulate measurements, and airborne radioactivity of unidentified types. These levels should be used in conjunction with all other available information such as historical chemical use and disposal information.

Data from vapor, gas, or particulate 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.

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 NIOSH reference procedures and methods.

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.

5. Sampling Strategy

The responsible Industrial Hygienist 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, and/or inorganic 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, persons 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. 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% of the applicable airborne limit (TLV, etc.). The need for personal samples is generally based on the results of work area samples.

7. Filter Loading

Filter loading is an important sampling consideration from a chemical standpoint. Overloading of the filter may cause underestimation of exposure due to the loss of material during filter weighing or sample cassette unloading. Projected sample times will be calculated and actual sampling duration adjusted to prevent filter loading.

8. 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.

9. 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, Tenax®, 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 Responsible Entities must be contacted for specialized sampling and analytical methods for which standard protocols do not exist.

10. Sampling Duration & Selection of Exposure Standard

Chemical exposure standards, such as the OELs, define sampling periods in relation to specific physiological responses. The industrial hygienist will select appropriate sampling times based on the nature of the expected contaminant. Sample times are also based on the nature of the work operation and exposure (continuous, intermittent, etc.).

11. Gas and Vapor Collection Methodology

Adsorption tubes (carbon, silica gel, Tenax) are commonly used for gas and vapor collection. Other methods, such as sampling flasks or bags, may also be employed if, in the judgment of the Industrial Hygienist, they are called for.

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% of the mass collected in the front section. The Industrial Hygienist should note on the sampling sheet that contaminant breakthrough with consequent underestimation of exposure occurred. Future samples should adjust sample volume to prevent breakthrough.

12. 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 Industrial Hygienist, they are called for. Filters used for gravimetric analysis must be desiccated in an evacuated desiccation chamber and weighed before and after use.

13. 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. Tenax, carbon, or other sample sorbents as recommended by the analytical Responsible Entities 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).

Documentation

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

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 or holding NATA accreditation. Samples are to be properly packaged and shipped.

Air surveillance for chemical and particulate contaminants will be recorded. Records will be forwarded to the Project Document Control Center and then forwarded to the Project HSSE Manager.

Completed monitoring data sheets and correspondence relating to exposure evaluation, summaries, and reporting will be retained in the Project HSSE files.

Records

At a minimum, the following air monitoring documents will be completed and kept:

- Copy of air monitoring data sheets, which includes instrument calibration.
- Chain-of-custody record.
- Copy of chemical laboratory work order forms.
- Copy of analytical results.