## 1. Objective

The purpose of this procedure is to provide technical guidance note on Industrial best practice to QAPCO and contractors to enable them to conduct reliable qualitative & quantitative exposure assessment of physical, chemical and biological health hazards at the workplace.

## 2. Scope

This procedure is applicable to QAPCO operated facilities to conduct reliable quantitative exposure assessment of physical, chemical and biological health hazards.

## 3. Procedure Summary

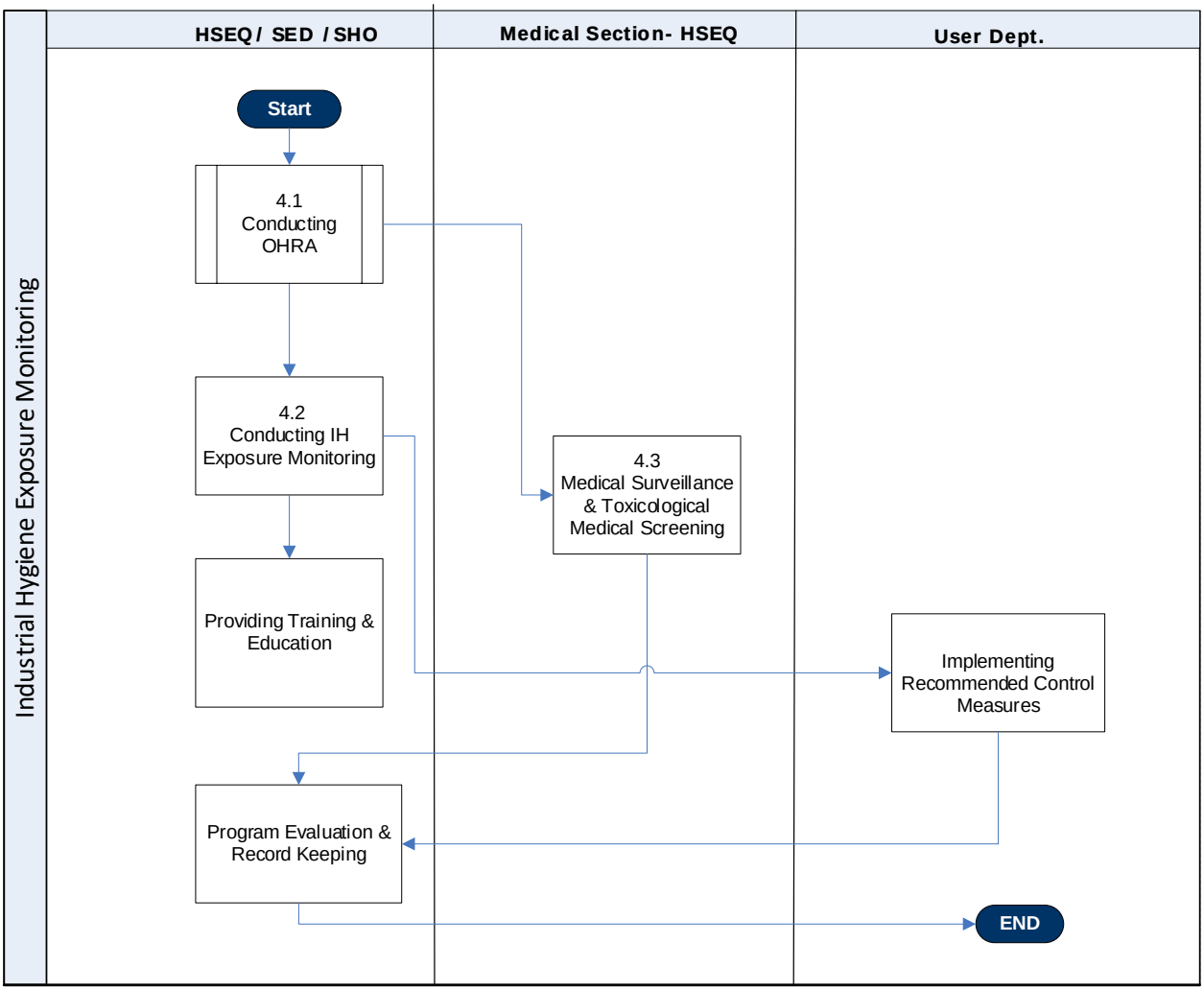
This procedure (to be referred as technical guidance note) provides information to SED department of QAPCO and contractors, to enable informed decisions to be made regarding quantitative assessment of the nature and extent of occupational exposure to hazardous agents. The Guidance outlines how occupational exposures can be assessed, the interpretation of technical field data, and the planning of health surveillance to support the quantitative exposure assessment surveys. Hazardous agents include physical, chemical, or biological species and are defined in detail.

By following this procedure, QAPCO will demonstrate that it has applied good industrial hygiene work practice. However, QAPCO and contractors are free to take an alternative/additional control strategies as an Industrial Best Practices; provided that they meet requirements stipulated in this Procedure as a minimum.

These agents are those identified through a Qualitative Occupational Health Risk Assessment [OHRA] survey and deemed to have the potential to pose medium to extreme risks to health of personnel in the workplace.

## Table of Contents

## 4. Industrial Hygiene Exposure Monitoring Process

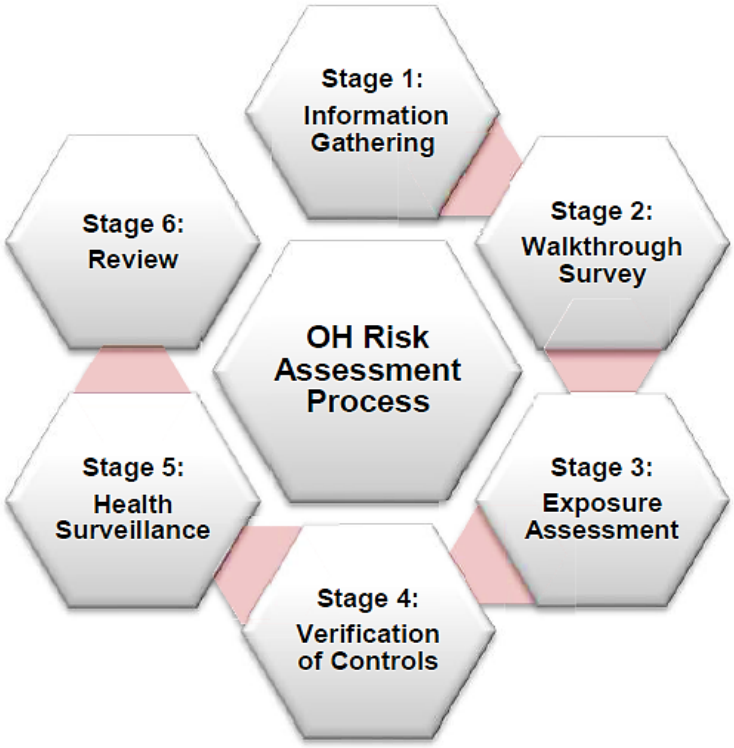



## Industrial Hygiene Exposure Monitoring Process Clarification

Industrial Hygiene Exposure Monitoring Program is one of the important element of Occupational Health/Industrial Hygiene Risk Management Program (IHRMP). Detailed methodology of OHRA and Industrial Hygiene Exposure Monitoring is as follows:

### 4.1 Occupational Health Risk Assessment (OHRA) Process:

The occupational health risk assessment process is based on the discipline of anticipating, recognizing, evaluating, and controlling agents in the working environment with the principal objective of protecting workers health and well-being. Consequently, it is a process of information gathering (Stage-1), face-to-face interviewing & data acquisition (Stage-2), establishing what measures are or need to be in place to control risk; then reviewing or verifying effectiveness of the control measures (Stage-3,4), Health Surveillance or Medical Surveillance strategies (Stage-5) and Reviewing of the Process (Stage-5). Graphically, the OH Risk Assessment process can be represented as shown below:




More details about OHRA, including Occupational Health & Industrial Hygiene Risk Registry, Risk Matrix etc. are included in QAPCO's Procedure of HSE Risk Assessments.

**4.1.1 Formation of Assessment Units (AUs) & Similar Exposure Groups (SEGs):**

For the purpose of conducting Industrial Hygiene surveys, OHRA and for the ease of the process, we have divided large QAPCO facility into discrete Assessment Units (AUs). Each AUs will be assessed separately. Also, QAPCO employees and contractors (worker population), who are subjected to the same hazards in the workplace and they experience a similar exposure pattern, are categorized in to SEGs (Similar Exposure Groups).

| AU # | Area/Location |
|---|---|
| Assessment Unit 1 | QAPCO Process Plant Areas<br>(All Plants, i.e. Ethylene, Utilities, LDPE-1,2,3, LLDPE, QVC) |
| Assessment Unit 2 | Non-process Areas including Offices, Control Room, Laboratory, Workshops, warehouse, Canteen etc.. |

**Similar Exposure Groups (SEGs)** for the QAPCO Operations can be classified as follows:

1. Operation staff (Operators, Shift Supervisors, Engineer, Lead Engineers)
2. Administration staff (Section Heads, Plant Managers and other office staff)
3. Maintenance crew
4. Trade workers (Welders/fitters/Grinders/ workshop staff etc…)
5. Other category

### 4.2 Industrial Hygiene Exposure Monitoring (Personal & Workplace):

Industrial Hygiene Exposure Monitoring can be classified as 1) Personal Monitoring and 2) Workplace Assessments. Personal Monitoring are conducted by placing IH Sampling Media on Individual for full-shift or partial shift. This monitoring can also be referred as "Dosimetry". Workplace Assessments are kind of Area Monitoring or workplace sampling for quantitative measurements of health hazards.

At QAPCO operated facilities, on above classified Assessment units, both types of IH monitoring should be performed as a part of overall Qualitative & Quantitative OHRA.

- **Physical Health Hazards:** Personal and/or workplace monitoring for following Physical health Hazard should be performed for each applicable AU as per defined frequency. (More details in Appendix)
    - Occupational Noise
    - Ionizing Radiation
    - Heat Stress/Thermal Stress
    - Particulates/Dust

- **Chemical Health Hazards:** Personal and/or workplace monitoring for all Hazardous Chemicals should be performed for each applicable AU as per defined frequency (More details in Appendix). followings are the commonly identified Hazardous Chemical category:
    - Petroleum Hydrocarbons
    - Total Volatile Organic Compounds (TVOCs)
    - Acids, Alkalis, Caustic & Corrosives, Chlorine
    - Carcinogen Compounds- i.e. EDC, VCM, Benzene, 1-3 Butadiene etc.
    - Hydrogen Sulfide (H2S), Sulfur Dioxide (SO2), Carbon Monoxide (CO)

  For workplace monitoring, measuring conditions are chosen to ensure that the results will be representative of exposure under normal working conditions. An adequate number of measurements should be made over a representative period to detect possible variations due to day/night, as well as seasonal or process cycles.

  In-line with Requirements stipulated in QAPCO's Permit to Work Procedure, Gas Monitoring/Recording is part of Lead Job Executor's Responsibility. These Gas testing includes the measurements of Toxic Gases, Flammable Gases (LEL) and Oxygen contents which are in additional to Routine IH Monitoring of chemical hazards.

- **Psychosocial, Ergonomics and Biological Health Hazards:** These categories of health hazards may not be quantitatively monitored similarly to the Physical and chemical hazards. To identify and evaluate these health hazards, various other tools can be used such as: Employee surveys, Checklists, Visual assessment of workstation, Medical leave Records etc. Exposure Monitoring for these hazards can be clubbed with OHRA Report or separate survey can be performed based on Qualitative Risk Ratings.

The I.H surveys & exposure assessments must also be backed by specialist resources and services, such as: Analytical laboratories or statistical data analysis, to obtain meaningful and robust data. Consequently, a quantitative exposure assessment survey must be well planned in advance and must be initiated with a clear set of priorities that target the extreme, high & moderate risks. There are many reasons why an exposure assessment survey needs to be developed and carried out within an organization. These are to:

- Evaluate the outcomes of a qualitative risk assessment.
- Demonstrate compliance with workplace exposure limits.
- Help the design and implementation of a control strategy.
- Check the effectiveness of existing control measures.
- Inform management and employees of the nature and extent of risks to health in the workplace.
- Indicate the need for health surveillance.
- Report OH trends to various stakeholders.

Industrial Hygiene monitoring equipment shall be regularly calibrated and properly maintained, as per the manufacturer manual recommendation/instruction. Industrial Hygiene Instrumentation Records, including calibration details, are maintained with SED in computerized format.

### 4.2.1 Personal Monitoring of Benzene, 1-3 butadiene, EDC & VCM (Carcinogen Compounds):

Personal exposure to carcinogen compounds shall be monitored in order to ensure that the permissible exposure limits are not exceeded than the stipulated guideline values or Action Levels Set by QAPCO. Monitoring requirements are applicable on “Regulated Area” where, they are manufactured, processed, stored, handled or used.

Personal Exposure Monitoring & lab Analysis shall be performed by accredited IH Sampling Protocols and Methodologies established by International organizations, such as ACGIH, NIOSH, OSHA etc.

### 4.2.2 Sampling Protocol, Strategy & Monitoring Frequency:

Quantitative surveys deal with field measurements of the level(s) of hazardous agents present in the workplace. As a result, the sampling protocols and strategy will be influenced by the following individual parameters as well as by their respective interactions:

- Duration and frequency of exposure.
- Number of people who are potentially & similarly exposed
- Degree of accuracy and precision required from the data.
- Number of samples or events required to obtain a survey which is representative of the workplace.
- Availability & accessibility of sampling methodologies, and with adequate detection limits.
- Cost of equipment, time & available resources.
- Regulatory requirements or voluntary in-house requirements for gathering exposure data.
- Required correlation with health surveillance data.

Assessment of workplace agents or verification of control measures must be carried out by approved, validated and traceable sampling methods. The most common sources of these methods are given in the references below.

| Group | Issuing Authority | Title |
|---|---|---|
| Measurement of airborne chemical agents | UK-HSE MDHS Series | Methods of the Determination of Hazardous Substances, published by the United Kingdom Health & Safety Executive, and downloadable from: http://www.hse.gov.uk/pubns/mdhs/ |
| | US-NIOSH | Manual of Analytical Methods, published by the United States National Institute of Occupational Safety & Health and downloadable from http://www.cdc.gov/niosh/docs/2003-154/ |
| | US-OSHA | Sampling and Analytical Methods, published by the Occupational Safety & Health Administration of the United States Department of Labour, and downloadable from http://www.osha.gov/dts/sltc/methods/index.html |
| Measurement of Noise | British Standards Institute & ISO | BS ISO 10302-1:2011 - Acoustics. Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices. Airborne noise measurement |
| Measurement of Hand Arm and Whole Body Vibration | British Standards Institute & ISO | BS EN ISO 5349 Mechanical vibration – Measurement and evaluation of human exposure to hand-transmitted vibration. |
| | | BS EN ISO 8662-4 Hand-held portable power tools – Measurement of vibrations at the handle. Part 4. Grinding machines. |
| Examination, testing and inspection of localised exhaust (extraction) systems | UK-Health & Safety Executive | Controlling airborne contaminants at work. A guide to local exhaust ventilation (LEV), HSG258 (2nd Edition) published 2011, and downloadable from http://www.hse.gov.uk/pubns/priced/hsg258.pdf |
| | ACGIH | Industrial Ventilation: A Manual of Recommended Practice for Design, 27th Edition, 2010. |

Frequency of conducting Industrial Hygiene Monitoring, Surveys and OHRAs at QAPCO AU are described in below table:

| S# | Type of Survey, Monitoring | Area / Location | Monitoring Frequency |
|---|---|---|---|
| 1. | Ionizing Radiation Monitoring Surveys- (All 39 Sources of QAPCO) | AU-1: LDPE-1,2,3 & LLDPE | Bi-Annual |
| 2. | Personal Radiation Dose Monitoring- TLD Badges for classified Radiological Workers | AU-1: LDPE-1,2,3 & LLDPE (classified Radiological Workers working in these areas) | Quarterly |

| S# | Type of Survey, Monitoring | Area / Location | Monitoring Frequency |
|---|---|---|---|
| 3. | Indoor Air Quality (IAQ) Surveys | AU-2: Chemical warehouses | Quarterly |
| 4. | Food Hygiene Inspections | AU-2: QAPCO Canteen / Pantries | Quarterly |
| 5. | Work-place Exposure & Fugitive Emission Survey | AU-2: QAPCO petrol station | Annually |
| 6. | Personal Exposure Monitoring for carcinogenic compounds: Benzene, 1-3 Butadiene, EDC & VCM | AU-1: Ethylene, Vinyl- EDC/VCM | Quarterly |
| 7. | I.H. Concern Based Monitoring | AU-1, AU-2 | Within 5 working days |
| 8. | Odor Monitoring Surveys | AU-1: Fence line | Quarterly |
| 9. | Specialized survey- Cumulative data collection, i.e. Ergonomics, Manual Material handling (MMH), etc.. | AU-1, AU-2: Activity Based | Once: to get the base-line data<br>Repeat: if any changes identified |
| 10. | Occupational Health Risk Assessment Surveys (OHRA)- Qualitative & Quantitative | AU-1, AU-2 | Once: to get the base-line data<br>Repeat: if any changes identified |
| 11. | Laboratory Chemical Fume Hoods Inspections & Face Capture Velocity (FCV) Measurements to certify the F.H | AU-2: Laboratories (QAPCO & QVC) | Annually<br>(Repeat: if any modification) |
| 12. | PSSR- Occupational Health Inspection | AU-1, AU-2 | As & when requested |

### 4.3 Medical Surveillance & Toxicological Medical Screening:

Roles and responsibilities of identifying needs & implementation of Health surveillance or Toxicological Medical screening, lies with Medical Section of HSEQ Division. Generally, I.H Exposure Monitoring Data and Risk Categorization of each SEG, are the basis of defining medical surveillance program.

Reference to Industrial Hygiene Exposure monitoring of QAPCO Employees Hazardous chemical's exposure (i.e. carcinogen compounds), Medical surveillance and toxicological screening tests should be conducted in addition to normal Pre-employment, periodical and end of service Medical examinations.

## 5. Records

The owner / executor shall maintain the following records / documents for reference:

| # | Document / Record name | Retention period | Retention policy | Retention method | Classification |
|---|---|---|---|---|---|
| 1 | Technical reports, Survey findings, Walk-through surveys etc. | 5 Years | Will be maintained by SED | Soft copy | Internal |

## 6. Document References / Attachments

| # | Document ID | Document name | Summary of dependency or use |
|---|---|---|---|
| **6.1 Document References** | | | |
| 1 | ISBN 9780717661886, HSG-173 | Monitoring Strategies for Toxic Substances, HSG173, 2nd edition, Health & Safety Executive, 2006. | Reference |
| 2 | M-QA-01 | Integrated Management System Manual | Reference |
| 3 | ISBN 978 1 607260 59 2 | Threshold Limit Values for Chemical Substances & Physical Agents & Biological Exposure Indices, American Conference of Governmental Industrial Hygienists (ACGIH)- Latest Edition, 2017 | Technical Reference to prepare Appendix |
| 4 | Publication No 77-173, NIOSH, 5th Edition- 2017 | Occupational Exposure Sampling Strategy Manual, NIOSH. | Information used in Section-4 |
| 5 | J R Mulhausen, J Damiano (eds.), | A Strategy for Assessing and Managing Occupational Exposures, 4th edition, American Industrial Hygiene Association, 2015 | Reference |
| 6 | ISBN 978 0 7176 1232 1 | Lighting at Work- HSG-38, HSE Executive, UK | Appendix, illlumination |
| 7 | | | |
| **6.2 Attachments** | | | |
| 1 | PR-SE-03-AP01 | Occupational Exposure Limits for chemical and physical agents | Procedure Implementation |

## 7. IT System Requirements

| # | IT system module name | Summary of IT system module use |
|---|---|---|
| 1 | NA | NA |

## 8. Abbreviations / Definitions

| # | Abbreviation / Key word | Definition summary |
|---|---|---|
| 1. | ACGIH | American Conference of Governmental Industrial Hygienists who publish annual recommendations regarding safe limits for exposure to chemical and physical agents. |
| 2. | TLV | Threshold Limit Value (TLV): a term used by ACGIH to express the airborne concentration of a material to which nearly all persons can be exposed day after day, without adverse effects. |
| 3. | ALARP | As Low As Reasonably Practicable |
| 4. | Action Level (for EDC & VCM) | Action level means, a concentration of EDC and VCM of 0.5 ppm averaged over 8-hours workday, it is an indication of monitoring requirements. |
| 5. | PEL | Permissible Exposure Limits averaged over 8-hours exposure. (i.e. 1 ppm for EDC VCM & Benzene) |
| 6. | Ceiling | Ceiling Values [or a maximum exposure limit] that must not be exceeded at any time |
| 7. | Carcinogen | Cancer causing substances |
| 8. | Controlled Area | Where airborne concentrations of hazardous chemicals are higher than Permissible Exposure limits |
| 9. | OHRA | Occupational Health Risk Assessment |
| 10. | AU | Assessment Unit |
| 11. | SEG | Similar Exposure Group |
| 12. | OSHA | Occupational Safety & Health Administration- USA |
| 13. | IH | Industrial Hygiene |
| 14. | NIOSH | National Institute for Occupational Safety & Health- USA |
| 15. | EDC | Ethylene Di Chloride |
| 16. | VCM | Vinyl Chloride Monomer |
| 17. | MW | Molecular Weight |
| 18. | IDLH | Immediate Danger to Life & Health |
| 19. | LEL | Lower Explosive Limit |
| 20. | PSSR | Pre-startup Safety Review |
| 21. | SEM | Sustainability & Environment Department Manager- QAPCO |
| 22. | CHSEQO | Chief Health, Safety, Environment & Quality Officer |

## 9. Revision History

| Rev. # | Rev. Date | Section No. | Reason for revision / modification |
|---|---|---|---|
| 0 | 30.09.2016 | All | Aligned and revised as per new organization and BT-4 documents. This procedure supersedes PR-320-MED-13 |
| 01 | 26/04/2018 | Cover Page Sec.-4 | Updated Designations of Signatory Authorities and other management. Abbreviations/Definition- Designation Correction |
| | | Section-8 | Integration of QVC Procedure on Personal Monitoring for EDC/VCM (P-VGEN-607) |
| 02 | As per ISO Achiever Publishing Date | All<br><br>4.2.2 | Developed the procedure as per new template requirements. Changed procedure number from PR-253-ENV-03 to PR-SE-03.<br><br>Revised Frequency of conducting Industrial Hygiene Monitoring, Surveys and OHRAs |