HEALTH SAFETY ENVIRONMENT MANAGEMENT SYSTEM

CHEMICAL HAZARDS STANDARD

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TABLE OF CONTENTS

1. INTRODUCTION

Chemical agents [also known as chemical substances] are a fundamental and integral part of virtually all aspects of life & survival, human and animal body compositions, foodstuffs & drinks, pesticides, drugs & medicines, cosmetics, fuel, transportation, construction, industry and many more.

Due to their abundance and diversity in use, chemical agents can undergo numerous transformations, reactions and changes during their life cycle, depending on their intended use.

Chemical agents are present in many forms, ranging from solids, to dusts and fumes, fibres, gases, or liquids. These can either be pure [i.e. single elements] materials or mixtures comprising several components of different chemical species. The diversity and different properties of chemical agents mean that some can be non-hazardous [e.g. food & drinks], whilst others are classified as hazardous and toxic.

A broad range of routine and daily activities carried out within the ADNOC Group involves the production, processing, use, handling or disposal of chemical agents in many physical forms. Where personnel interface with the different elements of the agent's specific life cycle, there will always be a potential for exposure that can lead to risks to health.

2. PURPOSE

This Standard establish requirements for ADNOC Group and Contractors to enable informed decisions to be made regarding assessment of the nature and extent of potentially hazardous chemical agents.

The Standard outlines how chemical health hazards can be assessed; what information shall be collected; the interpretation of field data, and the planning of control measures to ensure that people are not exposed to unnecessary risks to health.

The Standard establishes requirements for ADNOC Group and their Contractors to enable them to conduct reliable qualitative and quantitative assessments of chemical agents that may be present in the workplace.

Activities that are carried out by the ADNOC Group and several of their contractors involve complex interfaces and reactions between processes, plant & machinery, and people. In many cases, such interactions can directly or indirectly present scenarios or conditions that pose risks to the health and wellbeing of personnel at work.

This Standard provides a framework and detailed guidance on:

(i) The nature of the hazards and their effects on the human body with respect to chemical exposure;

(ii) The routes of interaction between the occupational health hazards (mentioned above) and the human body due to chemical exposure;

(iii) Evaluating the risks associated with occupational health hazards (mentioned above) present in the working environment with respect to chemical exposure;

(iv) Controlling the risks to As Low as Reasonably Practicable (ALARP);

(v) Meeting Legislative and Regulatory requirements.

3. SCOPE

This Standard only discusses Chemical Hazards that has identified potential health hazard(s). Chemical hazards having safety and environmental effects are discussed in ADNOC Hazardous Substances and Hazard Communication Standards [Ref. 55 & 64].

This Standard stipulates the mandatory requirements applicable to ADNOC Group (Directorates & Functions in ADNOC Head Quarter, Group Companies and Affiliates) and its Contractors.

ADNOC Group and Contractors shall ensure that all expectations listed herein are fully understood, implemented and thoroughly monitored.

4. LAWS AND REGULATIONS

The relevant UAE Legislations applicable to this Standard includes but not limited to:

(i) Ministerial Resolution No. 4/1 of 1981 on defining works that are hazardous or in which it is permissible to reduce the legally decided working hours, dated 6 January 1981.

(ii) UAE Labour Law Federal Law No. (8) of 1980 Labour Law and its Amendments.

(iii) UAE Ministerial Order No. (32), 1982. Specifying Preventive Methods and Measures for Protecting Workers against Work Hazards.

(iv) Federal Cabinet Resolution No. (39) of 2006, banning the import and production of asbestos.

(v) Abu Dhabi Emirate: Law 21 of 2005 for Waste Management.

(vi) Federal Ministerial Decision No. (32) of 1982 on Protecting Employees from Hazards at Work;

(vii) Federal Law No. 24 of 1999 for the Protection and Development of the Environment – Regulation for Handling Hazardous Materials, Hazardous Waste and Medical Waste.

(viii) Cabinet Decree (12) of 2006 Regarding Regulation Concerning Protection of Air from Pollution

(ix) Interim Guideline for the Disposal of Asbestos/ACM Waste at Landfill (Tadweer. 16/1)

(x) CWM Technical Guideline: Management of Asbestos/Asbestos Containing Material (ACM) in the Emirate of Abu Dhabi (CWM.TG/8).

ADNOC Group shall ensure that their activities and the activities of their contractors comply with all relevant Federal and Abu Dhabi laws and regulations at all times, including any that may be introduced after the publication of this Chemical Hazards Standard.

5. DEFINITIONS & ABBREVIATIONS

TERMS	DESCRIPTIONS
µm	Micrometre
ACGIH	American Conference of Governmental Industrial Hygienists
ACM	Asbestos Containing Materials
Acute	A condition where a high dose or concentration is delivered in a single short term event, causing rapid and often significant consequences
ANSI	American National Standards Institute

TERMS	DESCRIPTIONS
Asbestos	Asbestos is the name given to six (6) minerals that occur naturally in the environment as bundles of fibers that can be separated into thin, durable threads for use in commercial and industrial applications. These fibers are resistant to heat, fire, and chemicals and do not conduct electricity
ATEX	ATmosphere EXplosibles; rating of equipment suitable for use in explosive atmospheres
Baseline Survey	Baseline Survey also called Basic Scoping Survey, is an exposure assessment strategy employed when the Qualitative OHRA reaches one or more of the conclusions: there is an exposure risk but its extent is uncertain; a new process is being commissioned; an unusual activity is planned; significant changes were made to an existing process; control measures were introduced since the last assessment was made
Benzene	A sweet-smelling, chronically toxic, colourless liquid hydrocarbon (C_6H_6). Benzene is a naturally occurring component of crude oil and gasoline in low concentrations (usually < 5%)
BS	British Standard
CAS	Chemical Abstract Service
CE	Conformite Europeenne. CE marking is a certification mark that indicates conformity with health, safety, and environmental protection standards for products sold within the European Economic Area. The CE marking is also found on products sold outside the EEA that are manufactured in, or designed to be sold in, the EEA
Chemical Agent	Any material that has a known chemical composition, regardless of its source or origin. This may be a pure single element or a mixture of several elements/chemical species
Chronic Health Effects	A condition where the dose or concentration is delivered at some frequency (e.g. daily or weekly) and over a period of time leading to slow and progressive consequences that manifest themselves in years
CWM-AD	Centre for Waste Management Abu Dhabi
DOL	US Department of Labour
EC	The European Community number (EC Number) is a unique seven-digit identifier that was assigned to substances for regulatory purposes within the European Union by the European Commission
EN	European Standards
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
GR	Goods Receipt
Hazardous Chemical Agent	A substance that can cause short or long term harm to human health and wellbeing. It shall be ignitable, toxic, corrosive or reactive
HEPA	High Efficiency Particulate Air
HVAC	Heating, Ventilation & Air Conditioning
IARC	International Agency for Research on Cancer
ISO	International Organisation for Standardization

TERMS	DESCRIPTIONS
LC_{50}	Lethal Concentration 50%; LC values usually refer to the concentration of a chemical in air but in environmental studies it can also mean the concentration of a chemical in water
LD_{50}	Lethal Dose 50%; LD_{50} is the amount of a material, given all at once, which causes the death of 50% (one half) of a group of test animals. The LD_{50} is one way to measure the short-term poisoning potential (acute toxicity) of a material
LEV	Localised Exhaust Ventilation
MEL	Maximum Exposure Limit
MIG	Metal Inert Gas Welding
MMF	Manmade Fibres
MMSF	Manmade Synthetic Fibre
MMVF	Manmade Vitreous Fibre
NIOSH	National Institute for Occupational Safety and Health – United States
NIOSH REL	NIOSH's Recommended Exposure Limit for an 8 hour Time Weighted Average exposure and/or ceiling
OEL	Occupational Exposure Limit as listed by UK-HSE WEL, ACGIH TLV (Threshold Limit Value) or OSHA PEL (Permissible Exposure Limit); an upper limit/maximum acceptable concentration of a hazardous substance in workplace air
OSHA	Occupational Safety & Health Administration (United States)
PEL	Permissible Exposure Limit
Physical Form	Form of chemical agent at various phases, i.e. solid, liquid, gas or plasma form and may interchange between these phases depending on temperature or pressure
PPE	Personal Protective Equipment; any device or appliance designed to be worn or held by an individual for protection against one or more health and safety hazards
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) is a European Union regulation. REACH addresses the production and use of chemical substances, and their potential impacts on both human health and the environment
RPE	Respiratory Protective Equipment
SDS	Safety Data Sheet
SMVF	Synthetic Manmade Vitreous Fibre
TLV	Threshold Limit Value
Toxicokinetics	Study of how a substance gets into the body and what happens to it in the body
UN number	Also known as UN IDs, which are of four-digit numbers that identify dangerous goods, hazardous substances and articles (such as

TERMS	DESCRIPTIONS
	explosives, flammable liquids, toxic substances, etc.) in the framework of international transport
WEL	Workplace Exposure Limit

6. ROLES AND RESPONSIBILITIES

Roles	Responsibility
ADNOC Senior Management (i.e., Duty Holder for ACM management)	▪ Ensures adequate resources are made available such as training covering all topics in this Standard; ▪ Ensures implementation of this Standard and allocation of resources; ▪ Defines the roles and responsibilities of line managers, specialist advisors [where applicable], supervisors and the workforce in the implementation this Standard. ▪ Responsible for ensuring that the requirements for the safe handling, removal, temporary storage, transportation and proper disposal of ACM have been effectively implemented and managed; ▪ Ensures that all buildings under their control have been surveyed by a licensed Asbestos Supervising Consultant to identify any potential asbestos containing materials; ▪ Ensures that each building where ACM have been identified or is assumed to be present, has a competent person in place to manage the requirements of this Standard; ▪ Delegates the responsibility of managing the requirements of this Standard to their building managers or relevant person(s); ▪ Ensures that where ACM is present or is assumed to be present, an Asbestos Management Plan is developed to ensure that the risk from exposure is managed and controlled; ▪ Ensures that for any works that may involve ACM, an independent competent licensed Asbestos Supervising Consultant is engaged directly by Senior Management to manage and oversee such works; and ▪ Ensures that any works that may involve ACM are undertaken by a Licensed Asbestos Contractor.
Facility Manager/Line Managers/Supervisors	▪ Makes all personnel aware of the hazards associated with substances before use by ensuring availability of up-to-date SDS in appropriate locations; ▪ Ensures personnel handling chemical agents are competent and have received adequate information, instruction and training; ▪ Ensures that adequate personal protective equipment is provided and used where required; and ▪ Reports accidental spills and defective equipment containing chemicals.

Roles	Responsibility
OH/IH SME	▪ Ensures all chemical hazards at the facilities are addressed during the preparation of Occupational Health Risk Assessment as per Occupational Health Risk Management Standard (HSE-OH-ST03); ▪ Provides technical expertise to evaluate chemicals produced, used or stored at their facility; ▪ Conducts regular reviews of SDS, ensuring the replacement of outdated versions and ensure that these are communicated to all relevant personnel in the life cycle of the substance; ▪ Carries out inspections and audits to ensure the effectiveness of procedures and control measures; ▪ Arranges health surveillance and exposure monitoring surveys after consultation with the Occupational Health and Medical practitioners, where necessary; and ▪ Advises on appropriate selection and training of chemical protective equipment, as well as real-time exposure monitoring to mitigate exposure of chemical emergency responders during spillages and chemical waste treatment employees during waste disposal activities. ▪ Ensures the maintenance of the ADNOC Asbestos and Chemical Registers; and ▪ Ensures that any findings of any asbestos survey has been communicated to all relevant parties.
Employees	▪ Shall be aware of the hazards posed by handling and use of chemicals, as well as hazards posed by asbestos containing material during its maintenance and removal; ▪ Shall follow proper procedures and instructions and be aware of appropriate control measures to observe during accidental contact/exposure to chemicals, as well as incidental contact/exposure to asbestos containing material; and ▪ Shall report any suspected/confirmed ACM that has potential to become airborne to his/her respective line manager or OH/IH SME.
Licensed Asbestos Contractor	▪ Prior to undertaking any works, shall request from the duty holder a copy of the asbestos management plan for the building/facility; ▪ Prior to any works being undertaken, shall inform the duty holder of the need to engage a Licensed Asbestos Supervising Consultant. No work shall be undertaken unless both of these parties are in place; ▪ Prior to any works being undertaken, shall develop a plan of works in strict accordance with the requirements of the Standard; ▪ Prior to any works being undertaken, in conjunction with the Asbestos Supervising Consultant, shall ensure that all notifications and approvals from relevant authorities are in place; and

Roles	Responsibility
	▪ Shall undertake all works in strict accordance with the requirements agreed in the asbestos management plan and/or the plan of works.
Independent Licensed Asbestos Supervising Consultant	▪ Ensures that prior to any works being undertaken, the duty holder is fully aware of his/her statutory duties; ▪ Ensures that prior to any works commencing, the relevant authorities are informed and approvals (where required) are in place; ▪ Ensures that any sampling/identification being undertaken is in strict accordance with the requirements of this Standard; ▪ Ensures that where ACM is identified, a management plan is developed that clearly identifies requirements for the building; ▪ Ensures that the results of the management plan are clearly communicated to the duty holder and other relevant stakeholders; ▪ Monitors any works involving ACM and ensure the requirements of the plan of works and/or the management plan are adhered to; and ▪ Shall report findings to Senior Management on a regular basis.

7. REQUIREMENTS

7.1. PHYSICAL FORMS OF CHEMICAL AGENTS

The physical form in which a chemical agent is in the workplace environment is extremely important in occupational health, since it explains how a worker can be exposed. There are four main categories of physical state for chemical agents. These are: the solid (e.g. dusts, fibres), liquid, gas and aerosols (e.g. smoke, fumes, mists).

Chemicals are used extensively in Oil & Gas industry and it is important to exercise caution in the usage of such chemicals. Some chemicals are inherently hazardous that need to be handled in a safe manner. Hazardous chemicals in the workplace are categorised into three different categories:

(i) Physical hazards (e.g. flammable, explosive, and reactive);

(ii) Health hazards (e.g. toxic, corrosive, narcotic, irritating and carcinogenic); and

(iii) Environmental hazards (e.g. aquatic toxicity and ozone-depleting).

The various types of chemical agents under each of these categories are presented in Table 7.1.1 [Ref. 11].

7.1.1 PARTICULATE MATTER

In the field of industrial hygiene, particulate matter (PM) is traditionally defined as small (less than 100 micrometres in diameter) pieces of solid materials, liquid droplets, or microbiological organisms. Particulate matter typically encountered in the occupational environment can be divided into a number of “types,” based primarily on how the PM was created, its shape, and its composition. Table 7.1.1 provides a list of the broader classifications and some sub classifications of PM.

Table 7.1.1: General Types of Particulate Matter (PM) [Ref. 72]

PM Type	Sub-Type	Defining Characteristic	Examples/Sources
Dust	General	Produced by mechanical action on longer pieces of the material (e.g., grinding, cutting, tearing)	Lead dust while scraping paint Quartz dust when jack hammering
	Fibres	Dust classified because of its shape as long thin tendrils	Asbestos Ceramic fibres Fiberglass
	Biological (not micro-organisms)	Typically organic dusts created by disturbance of plant or animal materials	Wood dust Cotton dust Animal dander
	Radioactive	Radiotoxicity is often more significant than chemical toxicity	Radon progeny Radioactive waste Uranium
Mist	General	Droplets of liquid. Always defined in the context of an aerosol. Created by mechanical action breaking liquid into small particles	Droplets from bubbling dip tanks Paint overspray.
	Fog	Droplets of liquid caused by re-condensation of vapour	Boiling acids in chemical digestion
Fume	All	Formed by the evaporation and rapid condensation of metal vapour into very small particles	Welding Arc or torch cutting Foundry work
Biological agents	All	These include living and non-living agents that may be allergenic, toxigenic or infectious	Bacteria (and related organisms) Viruses Fungal spores Prions
Smokes	All	Smokes are the products of incomplete combustion of organic materials. Created by vaporization of organic material with subsequent condensation. Sometimes used interchangeably with “fumes”	Diesel exhaust Coke or coal powered furnaces Human tissue during laser surgery Second-hand cigarette smoke

Table 7.1.2 lists the particle sizes of various forms of chemical agents. Knowing a chemical agent’s particle size is essential as it will determine the region in the respiratory system where it will deposit. The particle size is also a determinant of a substance’s toxicity (i.e., the lower the substance’s particle size, the higher the tendency for it to deposit in the deeper regions of the lung, which makes it more difficult for it to be exhaled or excreted from the body since it can be absorbed in the blood).

Table 7.1.2: Particle Sizes of Various Chemical Agent Forms [Ref. 11]

State [Type]	Sources in Workplace Air	Approximate Particle Size [µm]
Category 1: Airborne Solids or Liquids		
Dust [Solid] - Inhalable Particles	Grinding, abrasion, and other mechanical actions.	≤50
Dust [Solid] - Thoracic Particles	Grinding, abrasion, and other mechanical actions.	≤30
Dust [Solid] - Respirable Particles	Grinding, abrasion, and other mechanical actions.	≤10
Smoke [Solid]	Incomplete combustion of organic matter, or generation of oxides during heating of metals	0.01–1
Fume [Solid]	Condensation of vapours	0.001–1
Fibres [Solid]	Cutting, abrasion, handling of fibrous materials. Fibre aspect ratios may vary [i.e. width to length]. For Asbestos fibre aspect ratio is in excess of 20:1. Length is greater than 5 picometers. Refractory Ceramic Fibres aspect ratio is in excess of 3:1. Length is greater than 5 µm.	Particle size not applicable, dependent on length
Mist [Liquid]	Agitation, Spraying, Condensation, or other mechanical action.	0.01-200
Fog [Liquid]	Same as Mist but more visible.	0.01-200
Category 2: Airborne Molecules		
Gases	Naturally occurring, releases, vents.	2-5 x 10^{-4}
Vapours	Evaporation, sublimation from liquids or solids.	>5x10^{-4}

7.2. GHS CLASSIFICATION AND LABELING OF CHEMICALS

The scope, elements, hazard groups, hazard classes and labels of the Globally Harmonized System of Classification and Labelling of Chemicals is covered under the ADNOC Hazard Communication Standard (HSE-OS-ST27). This section will only focus on GHS Health Hazard Classification and provide an extensive discussion on the criteria for each health hazard class.

7.2.1. GHS HEALTH HAZARD CATEGORIES

(a) Acute Toxicity

Five (5) GHS categories have been included in the GHS Acute Toxicity scheme from which the appropriate elements relevant to transport, consumer, worker and environment protection can be selected. Substances are assigned to one of the five toxicity categories on the basis of LD_{50} (oral, dermal) or LC_{50} (inhalation). The LC_{50} values are based on 4-hour tests in animals. The GHS provides guidance on converting 1-hour inhalation test results to a 4-hour equivalent. The five categories are shown in the Table 7.2.1.

Category 1, the most severe toxicity category, has cut-off values currently used primarily by the transport sector for classification for packing groups.

Category 5 is for chemicals which are of relatively low acute toxicity but which, under certain circumstances, may pose a hazard to vulnerable populations. Criteria other than LD_{50}/LC_{50} data are provided to identify substances in Category 5 unless a more hazardous class is warranted.

Table 7.2.1: Range of GHS Acute Toxicity Categories [Ref. 4]

Acute toxicity	Cat 1	Cat 2	Cat. 3	Cat 4	Cat. 5
Oral (mg/kg)	≤ 5	> 5 - ≤ 50	> 50 - ≤ 300	> 300 - ≤ 2000	Criteria: Anticipated oral LD_{50} between 2000 and 5000 mg/kg; Indication of significant effect in humans;* Any mortality at class 4;* Significant clinical signs at class 4;* Indications from other studies.* *If assignment to a more hazardous class is not warranted.
Dermal (mg/kg)	≤ 50	> 50 - ≤ 200	> 200 - ≤ 1000	> 1000 - ≤ 2000	
Gases (ppm)	≤ 100	> 100 - ≤ 500	> 500 - ≤ 2500	> 2500 - ≤ 5000	
Vapors (mg/l)	≤ 0.5	> 0.5 - ≤ 2.0	> 2.0 - ≤ 10	> 10 - ≤ 20	
Dust & mists (mg/l)	≤ 0.05	> 0.05 - ≤ 0.5	> 0.5 - ≤ 1.0	> 1.0 - ≤ 5	

(b) GHS Skin Corrosion

Skin corrosion means the production of irreversible damage to the skin following the application of a test substance for up to 4 hours. Substances and mixtures in this hazard class are assigned to a single harmonized corrosion category. See the Skin Corrosion/Irritation Table 7.2.2.

Several factors should be considered in determining the corrosion potential before testing is initiated:

(i) Human experience showing irreversible damage to the skin;

(ii) Structure/activity or structure property relationship to a substance or mixture already classified as corrosive;

(iii) pH extremes of ≤ 2 and ≥ 11.5 including acid/alkali reserve capacity

Table 7.2.2: GHS Skin Corrosion Categories [Ref. 4]

Skin Corrosion Category 1			Skin Irritation Category 2	Mild Skin Irritation Category 3
Destruction of dermal tissue: visible necrosis in at least one animal			Reversible adverse effects in dermal tissue	Reversible adverse effects in dermal tissue
Subcategory 1A Exposure < 3 min. Observation < 1 hr.	Subcategory 1B Exposure < 1 hr. Observation < 14 days	Subcategory 1C Exposure < 4 hrs. Observation < 14 days		

(c) Skin Irritation

Skin irritation means the production of reversible damage to the skin following the application of a test substance for up to 4 hours. Substances and mixtures in this hazard class are assigned to a single irritant category. See the Skin Corrosion/Irritation Table 7.2.2.

Several factors shall be considered in determining the irritation potential before testing is initiated:

(i) Human experience or data showing reversible damage to the skin following exposure of up to 4 hours;

(ii) Structure/activity or structure property relationship to a substance or mixture already classified as an irritant.

(d) Eye Effects (Table 7.2.3)

Several factors should be considered in determining the serious eye damage or eye irritation potential before testing is initiated:

(i) Accumulated human and animal experience;

(ii) Structure/activity or structure property relationship to a substance or mixture already classified;

(iii) pH extremes like ≤ 2 and ≥ 11.5 that may produce serious eye damage.

Table 7.2.3: GHS Eye Effects Categories [Ref. 4]

Category 1 Serious eye damage	Category 2 Eye Irritation	
Irreversible damage 21 days after exposure	Reversible adverse effects on cornea, iris, conjunctiva	
	Irritant Subcategory 2A Reversible in 21 days	**Mild Irritant** Subcategory 2B Reversible in 7 days

Eye irritation means changes in the eye following the application of a test substance to the front surface of the eye, which are fully reversible within 21 days of application. Substances and mixtures in this hazard class are assigned to a single harmonized hazard category.

(e) Sensitization

Respiratory sensitizer means a substance that induces hypersensitivity of the airways following inhalation of the substance. Substances and mixtures in this hazard class are assigned to one hazard category.

Skin sensitizer means a substance that will induce an allergic response following skin contact. The definition for “skin sensitizer” is equivalent to “contact sensitizer”. Substances and mixtures in this hazard class are assigned to one hazard category. Consideration should be given to classifying substances which cause immunological contact urticaria (an allergic disorder) as contact sensitizers.

(f) Germ Cell Mutagenicity

Mutagen means an agent giving rise to an increased occurrence of mutations in populations of cells and/or organisms. Substances and mixtures in this hazard class are assigned to one of two hazard categories. Category 1 has two subcategories. See the Germ Cell Mutagenicity information in Table 7.2.4.

Table 7.2.4: GHS Germ Cell Mutagenicity Categories [Ref. 4]

Category 1 Known / Presumed		Category 2 Suspected / Possible
Known to produce heritable mutations in human germ cells		
Subcategory 1A Positive evidence from epidemiological studies	Subcategory 1B Positive results in: ▪ In vivo heritable germ cell tests in mammals ▪ Human germ cell tests ▪ In vivo somatic mutagenicity tests, combined with some evidence of germ cell mutagenicity	▪ May induce heritable mutations in human germ cells ▪ Positive evidence from tests in mammals and somatic cell tests ▪ In vivo somatic genotoxicity supported by in vitro mutagenicity

(g) Carcinogenicity

Carcinogen means a chemical substance or a mixture of chemical substances which induce cancer or increase its incidence. Substances and mixtures in this hazard class are assigned to one of two hazard categories. Category 1 has two subcategories.

A substance which induces cancer or increases its incidence. Under the GHS [Ref 4] these are classified in Table 7.2.5 with the following carcinogenic effects:

Table 7.2.5: Carcinogenicity Categories [Ref. 4]

Conditions	Description of Adverse Effects
Carcinogenicity	A substance which induces cancer or increases its incidence. Under the GHS [Ref 4] these are classified as follows and with the following effects: **Category 1A & 1B:** substances known to have carcinogenic potential for humans based on evidence [Cat. 1A]; or presumed to have carcinogenic potential for humans based on animal evidence [Cat. 1B] (cut-off/concentration value of ≥ 0.1%). **Category 2:** substances that are suspected to be human carcinogens (cut-off/concentration value of ≥ 1.0%) **GHS categorization of carcinogens [Ref. 4]** **Category 1A:** Known to have carcinogenic potential for humans; the placing of a substance is largely based on human evidence **Category 1B:** Presumed to have carcinogenic potential for humans; the placing of a substance is largely based on animal evidence **Category 2:** Suspected human carcinogen

Table 7.2.6 provides cut-off concentration values for ingredients of carcinogenic mixtures.

Table 7.2.6: Cut-off concentration values for ingredients of carcinogenic mixtures [Ref. 4]

Ingredients classified as:	Cut-off concentration limits triggering classification of a mixture as:		
	Category 1 carcinogen Category 1A	Category 1B	Category 2 carcinogen
Category 1A carcinogen	>0.1%	-	-
Category 1B carcinogen	-	>0.1%	>0.1 % (note 1)
Category 2 carcinogen	-	-	>1.0 % (note 2)

This compromise classification scheme involves consideration of differences in hazard communication practices in existing systems. It is expected that the number of affected mixtures will be small: the differences will be limited to label warnings; and the situation will evolve over time to a more harmonized approach.

Note 1: If a Category 2 carcinogen ingredient is present in the mixture at a concentration between 0.1% and 1%, every regulatory authority would require information on the SDS for a product. However, a label warning would be optional.

Note 2: If a Category 2 carcinogen ingredient is present in the mixture at a concentration of > 1% both as SDS and a label would generally be expected [Ref. 4]

(h) Reproductive Toxicity

Reproductive toxicity includes adverse effects on sexual function and fertility in adult males and females, as well as developmental toxicity in offspring. Substances and mixtures with reproductive and/or developmental effects are assigned to one of two hazard categories, 'known or presumed' and 'suspected'. Category 1 has two subcategories for reproductive and developmental effects. Materials which cause concern for the health of breastfed children have a separate category, Effects on or Via Lactation (Table 7.2.7).

Table 7.2.7: GHS Reproductive Toxicity Categories [Ref. 4]

<table>
<tr><th colspan="2">Category 1</th><th>Category 2 Suspected</th><th>Additional Category</th></tr>
<tr><td colspan="2">Known or presumed to cause effects on human reproduction or on development</td><td rowspan="2">Human or animal evidence possibly with other information</td><td rowspan="2">Effects on or via lactation</td></tr>
<tr><td>Category 1A Known
Based on human evidence</td><td>Category 1B Presumed
Based on experimental animals</td></tr>
</table>

(i) Target Organ Systemic Toxicity (TOST): Single Exposure & Repeated Exposure

The GHS distinguishes between single and repeat exposure for Target Organ Effects. Some existing systems distinguish between single and repeat exposure for these effects and some do not. All significant health effects, not otherwise specifically included in the GHS that can impair function, both reversible and irreversible, immediate and/or delayed are included in the nonlethal target organ/systemic toxicity class (TOST). Narcotic effects and respiratory tract irritation are considered to be target organ systemic effects following a single exposure.

Substances and mixtures of the single exposure target organ toxicity hazard class are assigned to one of three hazard categories in Table 7.2.8.

Table 7.2.8: Target Organ Systematic Toxicity Single Exposure Categories [Ref. 4]

Category 1	Category 2	Category 3
Significant toxicity in humans ▪ Reliable, good quality human case studies or epidemiological studies Presumed significant toxicity in humans ▪ Animal studies with significant and/or severe toxic effects relevant to humans at generally low exposure	Presumed to be harmful to human health ▪ Animal studies with significant toxic effects relevant to humans at generally moderate exposure ▪ Human evidence in exceptional cases	Transient target organ effects ▪ Narcotic effects ▪ Respiratory tract irritation

(j) Aspiration Hazard

Aspiration toxicity includes severe acute effects such as chemical pneumonia, varying degrees of pulmonary injury or death following aspiration. Aspiration is the entry of a liquid or solid directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system. Some hydrocarbons (petroleum distillates) and certain chlorinated hydrocarbons have been shown to pose an aspiration hazard in humans. Primary alcohols, and ketones have been shown to pose an aspiration hazard only in animal studies.

Substances and mixtures of this hazard class are assigned to one of two hazard categories on the basis of viscosity, as mentioned in Table 7.2.9.

Table 7.2.9: GHS Aspiration Toxicity Categories [Ref. 4]

Category 1: Known (regarded) human	Category 2: Presumed human
▪ Based on human evidence ▪ hydrocarbons with kinematic viscosity ≤ 20.5 mm2/s at 40° C.	▪ Based on animal studies ▪ surface tension, water solubility, boiling point ▪ kinematic viscosity ≤ 14 mm2/s at 40℃ & not Category 1

7.2.2. TOXICOKINETICS

Toxicokinetics is essentially the study of how a substance gets into the body and what happens to it in the body. Adverse health effects of a chemical agent are mainly dependent on its concentration in the body. In turn, concentration is a function of the relative rates [also known as the kinetics] of four processes mentioned in Figure 7.2.1.

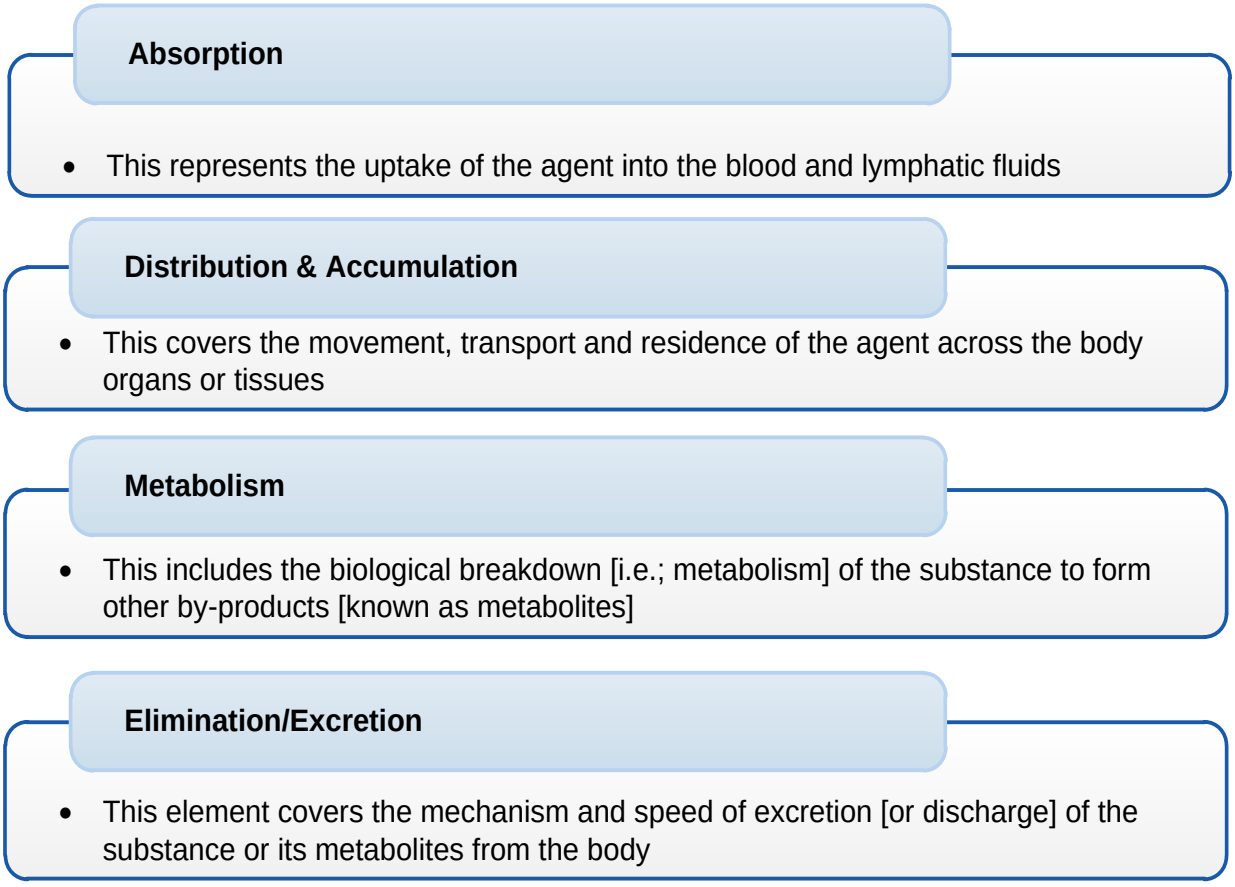


Figure 7.2.1: Elements of Toxicokinetics in the Body

7.2.3. ROUTES OF EXPOSURE

There are different routes of exposure to chemical hazard as described in Table 7.2.6. The pathways and mechanisms involved in absorption are also described.

Table 7.2.6: Types of Chemical Agents and their Routes of Exposure

Type of Chemical Agent	Routes of Exposure
Gases, vapours, mists, aerosols, or dusts particles	**Inhalation** through respiratory system into bronchi and lungs. Some vapors are designated with a **Skin** Notation, which means potential significant contribution to overall exposure by cutaneous route, including mucous membranes and eyes
Liquids, chemically tainted or contaminated food & drinks, eating with dirty hands	**Ingestion**, including swallowing of residual contaminants.

Type of Chemical Agent	Routes of Exposure
Liquids and finely divided solids	Some liquids and solids are designated with a **Skin** Notation, which means potential significant contribution to overall exposure by cutaneous route, including mucous membranes and eyes
	Direct injection through sharp objects and needles.
Pesticides	**Ocular exposure** (conjunctiva, cornea, lens, retina, optic nerve)

7.2.4. WORKPLACE EXPOSURE LIMITS

The principal organisations that have commissioned research and then introduced workplace exposure limits have been ACGIH, US-OSHA, US-NIOSH, the United Kingdom Health and Safety Executive, Deutsche Forschung Gemeinschaft in Germany, and more recently, the European SCOEL (Scientific Committee on Occupational Exposure Limits).

The selection of the principal workplace exposure limits used globally and their issuing bodies are provided in ADNOC Occupational Health Risk Management Standard (HSE-OH-ST03). [Ref. 25]. Any quantified airborne exposure of an employee to a chemical substance shall be assessed, in order of priority:

TLVs as per Cabinet Decree (12) of 2006 Regulation concerning Protection of Air from Pollution > WELs as per UK-HSE EH-40 > US OSHA PELs > NIOSH RELs > ACGIH TLVs.

It is the responsibility of the ADNOC Group OH/IH SME to ensure that the latest versions of the workplace exposure limits which are relevant to the substances being assessed are used or referred to when assessing exposure to chemical agents.

7.3. CHEMICAL HEALTH RISK ASSESSMENT

7.3.1. QUANTITATIVE ASSESSMENT

ADNOC Group and Contractors shall conduct a risk assessment where there is a likelihood of an employee being exposed to chemical agents or ACM. The main purpose of the assessment is to assist the ADNOC Group and Contractor with control actions and measures ensure that the risks to health are eliminated or minimised. The targets of the risk assessment are to:

(i) Identify the tasks or activities where there may be a risk from exposure to chemical agents;

(ii) Define the groups of personnel who may be at risk;

(iii) Provide a reliable quantification of the nature and extent exposure and compare this against the relevant workplace exposure limits;

(iv) Identify the groups of personnel who are at high, high-medium, and medium risk;

(v) Identify what actions need to be taken to control exposure [e.g. engineering solutions, personal protection, administrative controls, etc.]; and

(vi) Establish whether the high and high-medium risk groups require specific health surveillance or biological monitoring.

The principles and methodology for carrying out risk assessments are specified in ADNOC Occupational Health Risk Management Standard [Ref. 25]. It is essential that assessments of risks from chemical

agents are conducted by a "competent person" and that the information collected during the assessment complies with the requirements set out in this Chemical Hazards Standard.

The assessment shall be formally recorded and contain a plan showing prioritised actions for dealing with the high and high-medium risks; a schedule of deliverables complete with responsibilities for tracking and closing out the agreed actions.

The assessment and action plan shall be treated as a live document that can be regularly reviewed and updated as part of the Management Review of the OH Management System.

7.3.2. QUANTITATIVE [EXPOSURE] SURVEYS

Quantitative [exposure] surveys of chemical agents in the workplace shall be carried out where the initial qualitative assessments have returned inconclusive findings, or when additional information is required to further assess the nature and profile of exposure.

Measurement of airborne contaminants is a complex and specialized task which shall be carried out by experienced and competent personnel, and following approved methodologies and analytical procedures. As mentioned in the ADNOC Occupational Health Risk Management Standard (HSE-OH-ST03, Ref. 25), current HSE-MDHS (UK), NIOSH-NMAM (US), OSHA (US) or ISO sampling methodology shall be used for airborne sampling and analysis of workplace health hazards.

7.4. CONTROL OF RISKS

The information gathered during the qualitative and quantitative risk assessments shall be used to complete the following tasks:

(i) Task 1: Immediately addressing the high and high-medium risks by providing effective controls or else stopping the process under control has been restored. Under these circumstances, if PPE is recommended then it must be seen as a temporary measure until control is restored;

(ii) Task 2: Identifying what measures will practically control exposure; what level of exposure reduction can realistically be achieved from these controls; and whether these measures will be considered as ALARP;

(iii) Task 3: Establishing priorities and a timetable for implementing the actions. This task can also be used to establish what long-term changes are necessary, what benefits will be gained; how many people will be impacted by the changes;

(iv) Task 4: Assigning roles and responsibilities for implementing the Remedial Action Plan (if any);

(v) Task 5: Monitoring and reviewing the Remedial Action Plan (if any) and Risk Conclusions.

All hazards/risks shall be controlled providing sufficient resources, time, expenditure and planning to the task. Invariably, there are always several control solutions that are available through the Hierarchy of Controls (refer to the ADNOC HSE Risk Management Standard, HSE-RM-ST-01, Ref. 86). It is often the case that a combination of control measures will be needed to adequately control the risks to ALARP.

A control measure is considered adequate only when the eight (8) basic principles of good practice have been met; the workplace exposure has not been exceeded; and risks have been reduced to ALARP. The eight principles of good practice are:

(i) Processes shall be designed or altered such that they minimizes release & spread of hazardous substance(s) into the workplace;

(ii) Control measures shall take account of all routes of exposure;

(iii) Controls shall be proportionate to the level of risk;

(iv) Controls shall be chosen on their effectiveness and reliability;

(v) PPE shall be provided in combination with other controls, but only when other measures have not resulted in effective control;

(vi) Controls shall be regularly reviewed and upgraded;

(vii) Users of the controls shall be given information, awareness and training on the hazards, & on correct use and maintenance of controls; and

(viii) Controls shall not increase the overall risk to health & safety and must be compatible with other measures.

7.4.1. ELIMINATION & SUBSTITUTION

Elimination and/or Substitution are the highest priority because they address the cause of the risk [i.e. exposure is controlled at source]. Thus, the principal objective shall be to replace an existing hazardous substance with another which presents lower or no risk to health. Alternatively, to apply a different process [or part of a process/activity] that does not create the hazard or can employ a less hazardous form of the substance [Refs. 28 & 33].

When choosing the Substitution or Elimination routes for control of risks, the practical decision making process mentioned in Figure 7.4.1 must be followed:

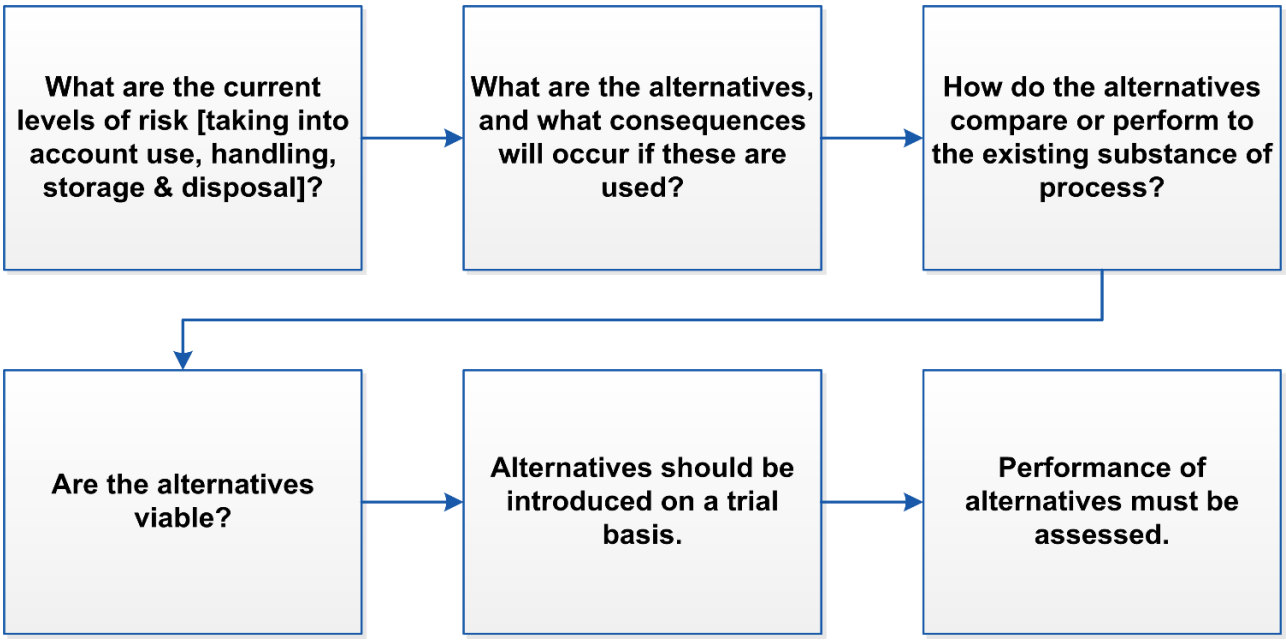


Figure 7.4.1: Elimination/Substitution Decision Making Pathway

Examples of the implementation of the element for process and material elimination or substitution are listed below.

(a) Process Substitution or Elimination

(i) Automated reagent dosing in water makers instead of manual weighing, mixing and addition of solid and liquid chemicals;

(ii) Pop riveting as a replacement for welded seams;

(iii) Cleaning surfaces with vacuum instead of compressed air to reduce dispersion of dusts and mists to the workplace;

(iv) Replacing manual metal-arc-welding [MMA] with metal inert gas welding [MIG] or tungsten inert gas welding [TIG] on stainless steel, where possible to reduce exposure to toxic metals. **International Agency for Research on Cancer has stated that chronic exposure to all welding fumes, including mild steel welding fume, can cause lung cancer (Ref. 92).** This measure will not reduce exposure to fumes, total metals or ozone, hence must carefully evaluated prior to application;

(v) Wet sanding or cutting during civil works to suppress release of airborne dusts;

(vi) Increasing the nozzle aperture size during spraying pesticides, to reduce mists and aerosols in the air; and

(vii) Introducing low maintenance equipment or planned preventative maintenance to minimize the frequency and extent of these activities and the associated exposure to hazardous agents.

(b) Substance Substitution

(i) Substituting a powder form with a liquid, to eliminate release of dust and particulate matter to the workplace air;

(ii) Replacement of lead-based and colophony-based fluxes in solder wire with lead and rosin free alternatives;

(iii) Replacement of diisocyanates [i.e. polyurethane] based paints and adhesives with epoxy or polyester based formulations;

(iv) Using liquid carbon dioxide for dry cleaning instead of chlorinated hydrocarbons [tetrachloroethylene] in laundries;

(v) Removing lead and chromate based paints from use; and

(vi) Use of non-silicate abrasive blasting material during blasting activity.

7.4.2. ENGINEERING CONTROLS

Engineering controls shall be considered when investigating effective routes for reducing risks of exposure to chemical agents. In essence, engineering controls encompass the application of one or more of the following measures.

(a) Dilution & Local Exhaust Ventilation

Workplace ventilation is divided into Dilution Ventilation [DV], Mechanical Dilution Ventilation and Local Exhaust Ventilation [LEV], as follows:

(i) Dilution Ventilation

This is general ventilation typically introduced by air conditioning systems, large HVAC systems, ceiling and desk fans or open windows. The principle is to introduce & circulate fresh air and thus dilute and displace existing airborne contamination. The incoming air moves the contaminants away to an exit point or vent and simultaneously introduces fresh air into the workplace.

(ii) Mechanical Dilution Ventilation

Mechanical dilution ventilation uses wall fans, roof exhaust fans, or other mechanical means to prevent airborne contaminants from entering a person's breathing zone.

(iii) Local Exhaust Ventilation

The ventilation where air contaminants are captured and removed by forced air current through hood and duct near the point of emission and discharged to the atmosphere outside the workplace.

This covers purposely designed systems which are located in the immediate vicinity of the process and are designed to capture the chemical agent before it is released to the workplace atmosphere. A typical LEV system comprises a capture hood, ducting to transport the airborne contaminants, a suction fan, an abatement or filtration system [depending on design and emission standards], and a chimney stack or vent to discharge the air to the external atmosphere.

LEV systems are significantly more effective in controlling exposure to hazardous agents in the workplace than Dilution Ventilation; however LEVs shall be scientifically designed and commissioned to meet the process demands and its varying operating parameters; as an example, the fume hood used in laboratories. Figure 7.4.2 illustrates the different types of local exhaust ventilation hoods.

Appropriate LEV calculations can be found using UK LEV Calculator provided in the link: http://www.hse.gov.uk/lev/calculator.htm [Ref 74].

Appropriate formulas can also be referred from ACGIH Industrial Ventilation Manual [Ref 36].

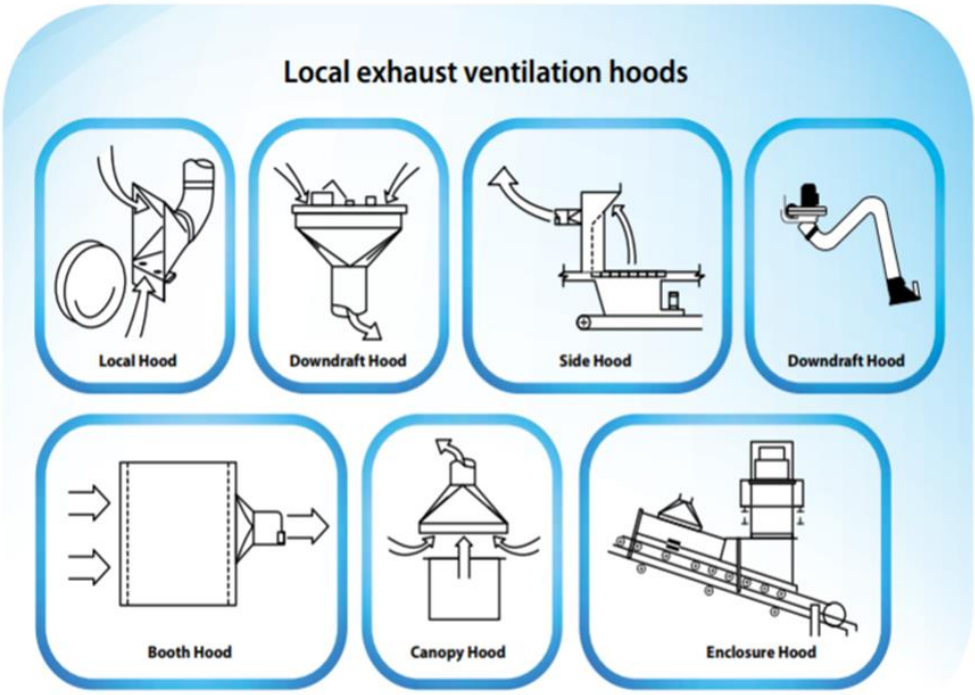


Figure 7.4.2: Types of Local Ventilation Hoods [Ref. 37]

Table 7.4.1 shall be referred to design velocities in a ventilation duct with respect to nature of contaminants. In addition to this Table, relevant ADNOC Engineering Standards can be referred as well.

Table 7.4.1: Range of Minimum Duct Design Velocities [Ref. 36]

Nature of Contaminant	Examples	Design Velocity
Vapours, gases, smoke	All vapours, gases, and smoke	Any desired velocity (economic optimum velocity usually 304.-609m/min (1000-2000 fpm)
Fumes	Welding	609-762 m/min (2000-2500 fpm)
Very fine light dust	Cotton lint, litho powder	762-914 m/min (2500-3000 fpm)
Dry dusts & powders	Fine rubber dust, Bakelite moulding powder dust, cotton dust 3000-4000	914-1219 m/.min (3000-4000 fpm)
Average industrial dust	Grinding dust, buffing lint (dry), silica dust, brick cutting, clay dust, limestone dust.	1066-1219 m/min (3500-4000 fpm)
Heavy dusts	Sawdust (heavy and wet), metal turnings, sand blast dust, wood blocks, brass turnings, cast iron boring dust.	1219-1371 m/min (4000-4500 fpm)
Heavy or moist	Moist cement dust, asbestos chunks from transite pipe cutting machines, buffing lint (sticky), quicklime dust.	1371 m/min (4500 fpm) and up

Figure 7.4.3 illustrates the different types of LEV hoods.

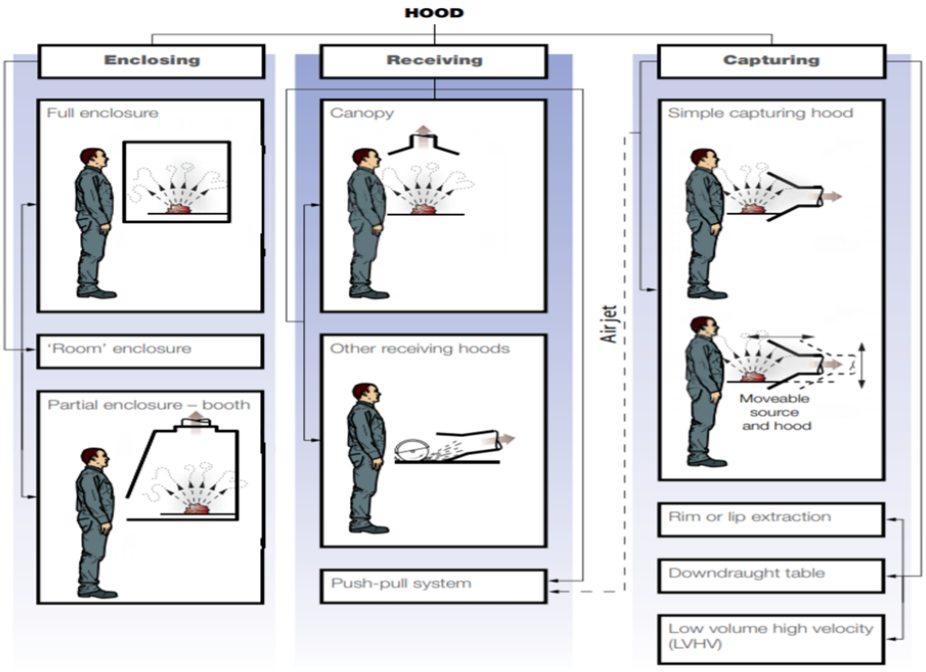


Figure 7.4.3: Type of Hoods [Ref. 37]

(iv) Portable /Mobile Fume Extractors (Mechanical Extraction /Ventilation)

Portable / Mobile Fume Extractors are used in various situations such as confined space and welding activities, and its function is to provide sufficient fresh air to replace the oxygen that is being used up by people working in the space, and to dilute and remove gas, fume or vapour produced by the work. This can be done by using a blower fan and trunking and/or an exhaust fan or ejector and trunking (provided that there is an adequate supply of fresh air to replace the used air). Fresh air should be drawn from a point where it is not contaminated either by used air or other pollutants.

United Kingdom Health and Safety Executive requires that any exposure to any welding fume shall be adequately controlled using engineering controls, typically local exhaust ventilation such as portable/mobile fume extractors (Ref. 92). Portable /Mobile Fume Extractors shall be routed away from possible sources of re-entry, and to a place that will not create additional risks. In all cases an airline or trunking shall be introduced at, or extend to, the bottom of the vessel to ensure removal of heavy gas or vapour and effective circulation of air; such airline or trunking should not hinder access to or egress from the confined space.

1. Moveable Extraction Duct Positioning

   Firstly, note the dimensions of the ‘face’ or opening on the extraction duct. Many common extractors have an elliptical hood. Take the shortest dimension (typically about 300mm) of the duct. The extraction shall be positioned about 1-2 times the diameter of the hood, vertically above the welding point. If it is much closer, the welder will often have problems seeing past the hood. If it is too far away (over 2x diameter) then fume will tend to disperse and a large proportion of the fume will not be captured.

   Placing the hood on a flat surface can help extend the ‘range’ of the hood. A hood placed on a flat surface is often effective at 2 x the diameter of the extractor hood.

2. Positioning a Flexible Extraction Hood

   The correct positioning of flexible extraction systems is vital to their effectiveness. When positioned properly, extraction does not affect the quality of welds.

   If long runs of weld are performed, then the moveable extraction hood should be repositioned. Most welders routinely reposition themselves after about an arm’s length of weld so they can maintain the correct welding. In practice, this is often after laying a weld of about 300 – 400 mm, positioning the extraction hood centrally over the weld run will usually be sufficient.

Note: All portable/mobile fume extractors shall be correctly used, suitably maintained and are subject to thorough examination and test where required.

3. Range of Capture Velocities for different Industrial Processes

   Table 7.4.2 shall be used for referring range of capture velocities of local exhaust hoods. In addition to this Table, relevant ADNOC Engineering Standards can be referred as well.

Table 7.4.2: Range of Capture Velocities for Local Exhaust Hoods [Ref 36]

Condition of Dispersion of Contamination	Example	Capture Velocity
Released with practically no velocity into quiet air.	Evaporation from tanks; degreasing, etc.	0.38-0.51 m/s (75-100 fpm)
Released at low velocity into moderately still air.	Spray booths; intermittent container filling; low speed conveyor transfers; welding; plating; pickling	0.51-1.02 m/s (100-200 fpm)
Active generation into zone of rapid air motion.	Spray painting in shallow booths; barrel filling; conveyor loading; crushers	1.02-2.54 m/min (200-500 fpm)
Released at high initial velocity into zone at very rapid air motion	Grinding; abrasive blasting; tumbling	2.54-10.2 m/min (500-2000 fpm)
Factors affecting choice of limit (lower/upper end of capture velocity range): ▪ Strengths of cross drafts due to makeup air, traffic, etc. ▪ Toxicity of contaminants produced by the source ▪ Exposures from other sources that reduce acceptable exposure from this source ▪ Quantity of air contaminants generated (e.g., production rate, volatility, time generated)		

(b) Good Housekeeping

Although this is not an obvious engineering control, good housekeeping relies on application of three basic elements, namely:

(i) removing obstructions;

(ii) proper placement of items; and

(iii) maintaining cleanliness of the workplace.

Thus, good housekeeping practices involve application of efficient working, defined cleaning routines and practical procedures for prevention, collection and disposal of wastes and spillages [Ref. 33]. Examples of this element for chemical agents include:

(i) Keeping lids on containers to eliminate evaporative losses;

(ii) Immediately dealing with surface spillages of powders or liquids;

(iii) Using spillage containment kits and absorbent materials;

(iv) Using vacuum cleaning [with HEPA filters] rather than brooms and brushes to clear debris and powders;

(v) Regular washing of PPE [e.g. gloves, boots, face shields] to eliminate the risk of skin contamination;

(vi) Regular cleaning of equipment and instruments [e.g. levers, buttons, handles, hand rails] after use to prevent cross contamination and exposure via skin contact; and

(vii) Correctly storing and disposing of contaminated rags into metal and fireproof bins.

7.4.3. ADMINISTRATIVE CONTROL

This element of control supports and maintains the implementation of engineering controls and ensures that other worker-dependent factors are also integrated into the overall control plan. Examples of administrative controls are:

(i) Implementation of planned preventative maintenance to all critical engineering controls, especially LEV systems;

(ii) Fitting area alarms and issue of personal exposure alarms [e.g. workers exposed to areas having high H2S levels; or entry into confined spaces];

(iii) Modification of work patterns and practices to minimize the number of people potentially exposed to hazardous agents; or to reduce exposure periods during a shift through worker rotation;

(iv) Issuance of Standard Operating Procedures, or Permit to Work clearly setting out safe chemical handling instructions;

(v) Delivery of regular induction and training programmes, refresher courses, and toolbox talks that provide awareness, information and training on hazards and control measures;

(vi) Ensuring that SDS, labelling and notifications are up-to-date and appropriately communicated;

(vii) Encouraging good housekeeping and personal hygiene standards;

(viii) Ensuring that all chemical facilities are equipped with up-to-date spill containment kits and adequate waste disposal arrangements;

(ix) Advising management and supervisory teams of the correct types of PPE to employ; and

(x) Creating an environment of cooperation and consultation between design & maintenance engineers, operations, and workers to ensure that the correct control measures are procured and implemented at the workplace.

7.4.4. PERSONAL PROTECTIVE EQUIPMENT

PPE for chemical substances is discussed extensively in the ADNOC Personal Protective Equipment Standard (HSE-OS-ST20, Ref. 78). This includes selection of PPE, respiratory protective equipment (RPE), hand protection, PPE maintenance, information/instruction/training, PPE standards, respirator fit testing, as well as positive pressure respirators.

7.5. SPECIFIC PRECAUTIONS FOR BENZENE (BENZENE CONTROL PROGRAM)

The ADNOC Group shall make available a benzene control program for the personnel who are or may be exposed to benzene at or above the action level 30 or more days per year; for personnel who have been exposed to more than 10 ppm of benzene for 30 or more days in a year; and for employees who use solvents containing greater than 0.1 % benzene. The benzene control program shall include a schedule for development and implementation of the engineering and work practice controls. These plans shall be reviewed and revised as appropriate based on the most recent exposure monitoring data, to reflect the current status of the program [Ref. 73]. More details are found in Appendix 5: Benzene Exposure and Monitoring.

7.6. STORAGE OF CHEMICAL AGENTS

Storage of chemical agents is extensively discussed in the ADNOC Hazardous Substances Standard (HSE-OH-ST13, Ref. 55). This includes selection of storage areas, segregation and separation requirements, special storage requirements for certain chemical substances, inventory and ventilation issues.

Chemical Storage Inspection Checklist has been provided in Appendix 1 for reference.

7.7. HEALTH SURVEILLANCE

Employees identified to be at high or high-medium risk to health caused by exposure to chemical agents including ACMs and MMFs shall be included in a programme of health surveillance and/or biological testing as described in ADNOC Health Screening and Surveillance Standard (HSE-OH-ST05) [Ref. 21], ADNOC Medical Guidelines and UAE Regulations.

7.8. CHEMICAL HSE ASSESSMENT

Initiation of any new chemical or changing existing chemical for plant or process use shall follow the ADNOC Group Management of Technical Changes Standard (HSE-OS-ST30, Ref. 79) and ADNOC Group Procurement Function relevant Procedures. In turn, ADNOC Group shall be responsible for conducting an HSE Assessment through the use of the ADNOC Chemical HSE Assessment form provided in Appendix 2.

The new chemical shall be reviewed for its requirement based on the safety data sheet provided, considering the evaluation of HSE risks and possible alternatives. Once an approval from the Safety, Occupational Health and Environmental team is obtained, the chemical undergoes field trial which adheres to the 'no cure no pay principle,' which means that chemical will only be procured if it is able to perform its expected purpose/use/function. Once the Quality Assurance and Quality Control team ensures it conforms to technical specifications, the chemical is procured by preparing a long-term purchase agreement with the vendor, depending on the plant/process forecasted demand. Appropriate training is provided by Site HSE to the end user which includes use of appropriate control measures aimed to mitigate exposure. Subsequent health risk assessment on use of the chemical shall be done depending on changes in occupational exposure limits, exposure monitoring results, or health surveillance results, if applicable. The Chemical HSE risk assessment process is summarized in Figure 7.8.1.

There is a list of chemicals that are restricted or banned for use in the United Arab Emirates, which shall be taken into consideration during the Chemical HSE risk assessment. Any banned/restricted chemical can be searched in the website www.hazmat.ae (Ref. 82).

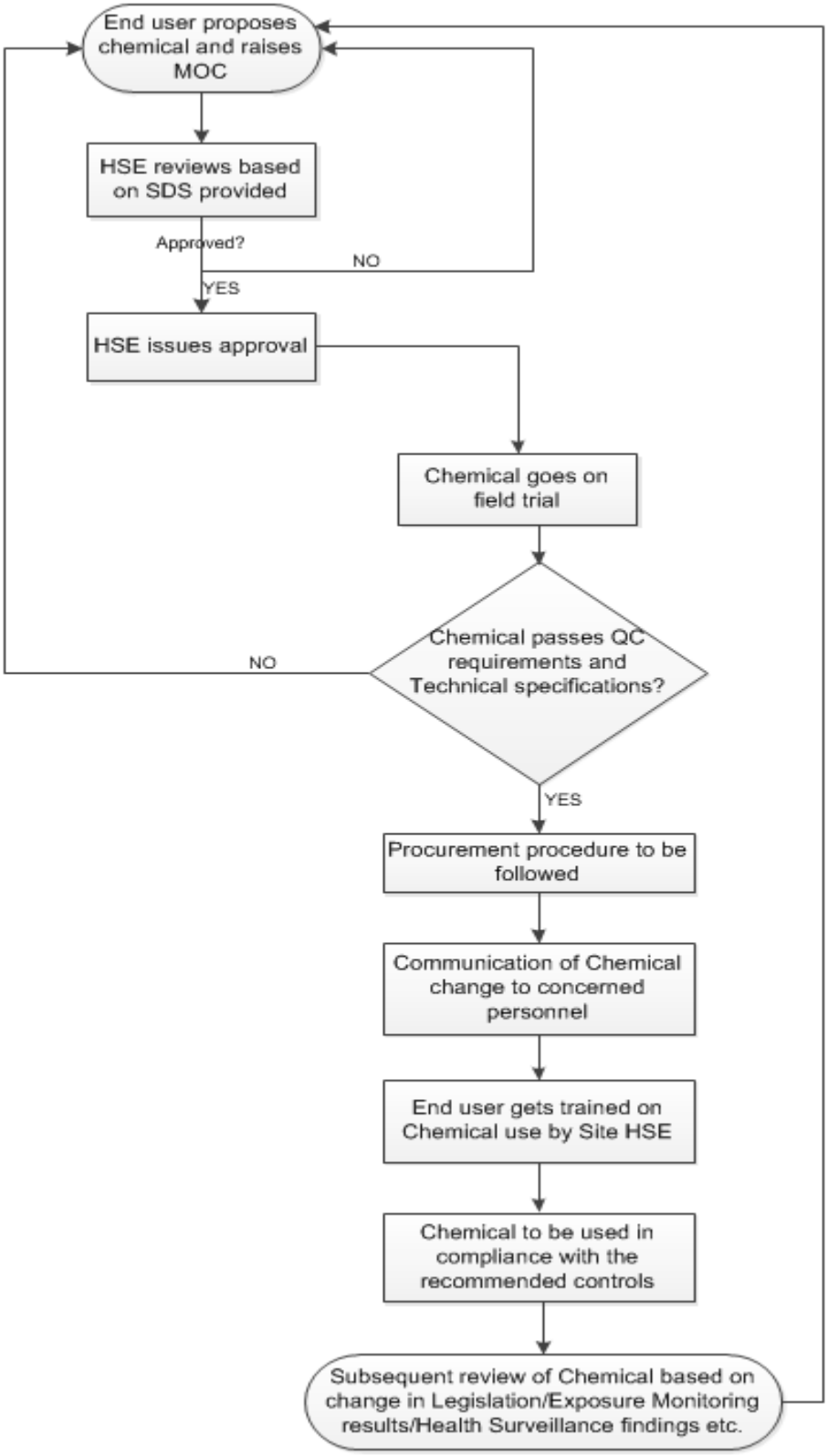


Figure 7.8.1: Summary of Chemical HSE Risk Assessment Process

7.9. CHEMICAL LIFE CYCLE MANAGEMENT

The purpose of chemical life cycle management is to ensure that chemicals and other hazardous materials are managed throughout their lifecycle to protect the environment and the health of workers, visitors, and the surrounding community. It covers the evaluation of chemical through the MOC process; procurement of chemical; transport and delivery of chemical by vendor to the ADNOC Group facility; identification of chemical and recording in procurement inventory; internal distribution of chemical to site and hazard communication to end user; application/use of chemical and subsequent storage; and treatment/final disposal.

The ADNOC chemical life cycle management can be summarized in Figure 7.9.1.

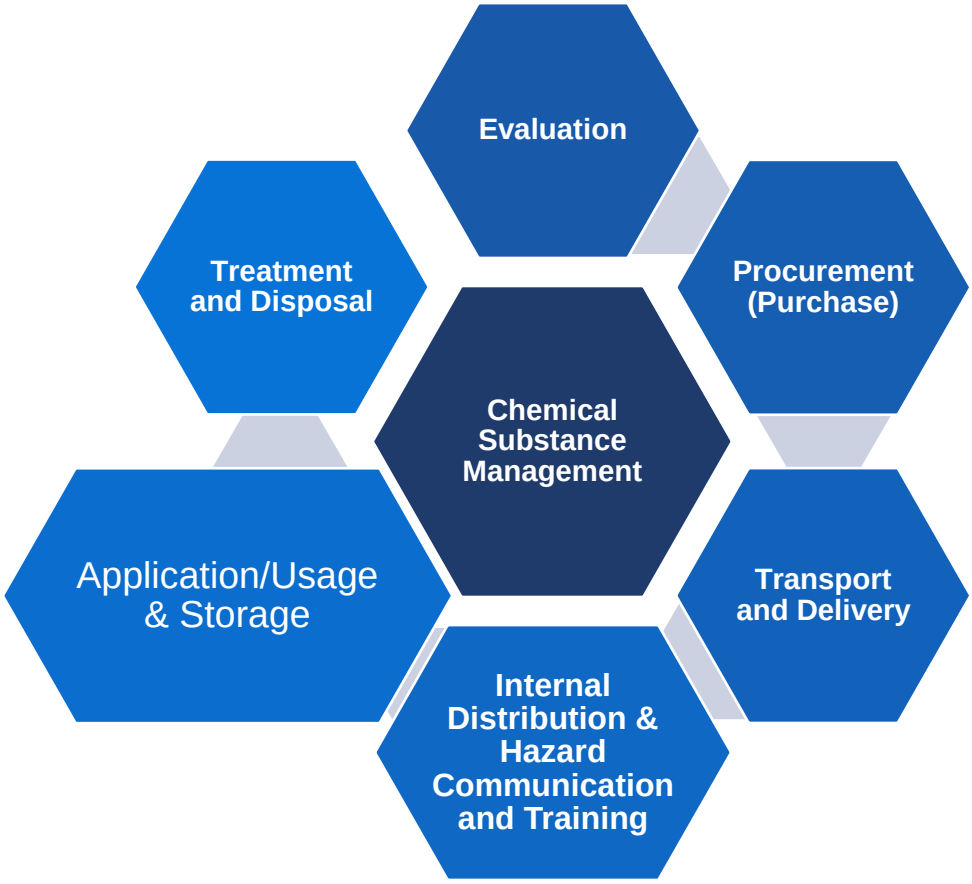


Figure 7.9.1: ADNOC Chemical Life Cycle Management Summary

Evaluation of any new chemical can be in the form of chemical needs assessment using the ADNOC Chemical HSE Assessment Form (Appendix 2), HSE screening and reviews during the HSEIA phase, and field trial with subsequent QA/QC check. Once approved, chemical is subsequently registered into the ADNOC HSE Chemical Register (Appendix 3).

Procurement mechanism involves procurement policy and processes, management of change, and registration of the chemical into the material inventory. Procurement of any new chemical will depend on existence of a long-term purchase agreement and operational/production need in a plant or process. More details can be found in the ADNOC Group Inventory Management Procedures (ADNOC/B&CSD/P&P/108, Ref. 80). The process for introducing a new chemical in a plant or process

shall strictly follow the Management of Change (MOC) process for new chemicals as indicated in the ADNOC Group Management of Technical Changes Standard (HSE-OS-ST30, Ref. 79). Any new chemical used in ADNOC Group shall have undergone the MOC process and shall be part of the ADNOC Approved Chemicals List.

Once the chemical is included in the Procurement inventory, chemical is transported onsite. However, the transporter has to obtain appropriate licenses before being allowed to transport a chemical (e.g., Chemical License from the concerned authority (Environment Agency Abu Dhabi), driving permit in using vehicle for transportation of hazardous materials) as well as observance of appropriate standards and regulations in:

- Road such as Federal Land Transport laws, Emergency Response Guidebook prepared by US Department of Transportation/Transport Canada (Ref. 83), ADR 2019 (Ref. 61);
- Marine such as Maritime Sector Transport Regulations of Department of Transport (Ref. 58), International Maritime Dangerous Goods Code (Ref. 35) and ADN 2017 (Ref. 62); and
- Air such as ICAO (Ref. 12).

In addition, appropriate training and competence shall be given to chemical transport personnel such as drivers, vessel masters and aircraft captains. More information can be found in the ADNOC Hazardous Substances Standard (HSE-OS-ST13, Ref. 55).

After delivery of chemical onsite, appropriate communication of hazard(s) posed by the chemical shall be relayed to ADNOC Group employees and contractors. This shall include the application of the Globally Harmonized System (GHS) Classification and Labelling of Chemicals and the use of safety data sheets. **Hazard communication includes ensuring training and competency for the end user in using a particular chemical and recognition of its risk(s).** More information can be found in the ADNOC Hazard Communication Standard (HSE-OS-ST27, Ref. 64).

Upon use, chemicals are managed through ADNOC legislative framework (e.g., Chemical Hazards Standard, Hazardous Substances Standard, Hazard Communication Standard, Risk Management Standard), hazard communication, periodic internal/external compliance audits, regulatory site inspections and annual chemical quantity declarations (e.g., Ministry of Foreign Affairs and International Cooperation compliance to OPCW, Ref. 59), HSEIA reviews, and occupational health risk assessments. Hazardous materials audits include but not limited to:

- ADNOC corporate audits
- Group Company internal audits
- Site and contractors audits
- Shareholders audits
- Third party audits (e.g., Ministry of Foreign Affairs and International Cooperation for OPCW-regulated chemicals)
- Random inspections

Used or expired chemicals shall be transported to ADNOC Hazardous Waste Disposal facility (i.e., BeAAT) in compliance with Federal Law No. 12 of 2018 on the Integrated Waste Management (Ref. 57). Appropriate waste disposal standards shall be followed in handling of chemical waste, such as the ADNOC Waste Management Standard (HSE-EN-ST04, Ref. 32) and applicable Centre for Waste Management (Tadweer) Regulations (Ref. 84). End users shall also be educated in chemical emergency response requirements, which is found in Section 7.11 of this document.

Components of ADNOC Chemical Life Cycle Management is discussed extensively in Figure 7.9.2.

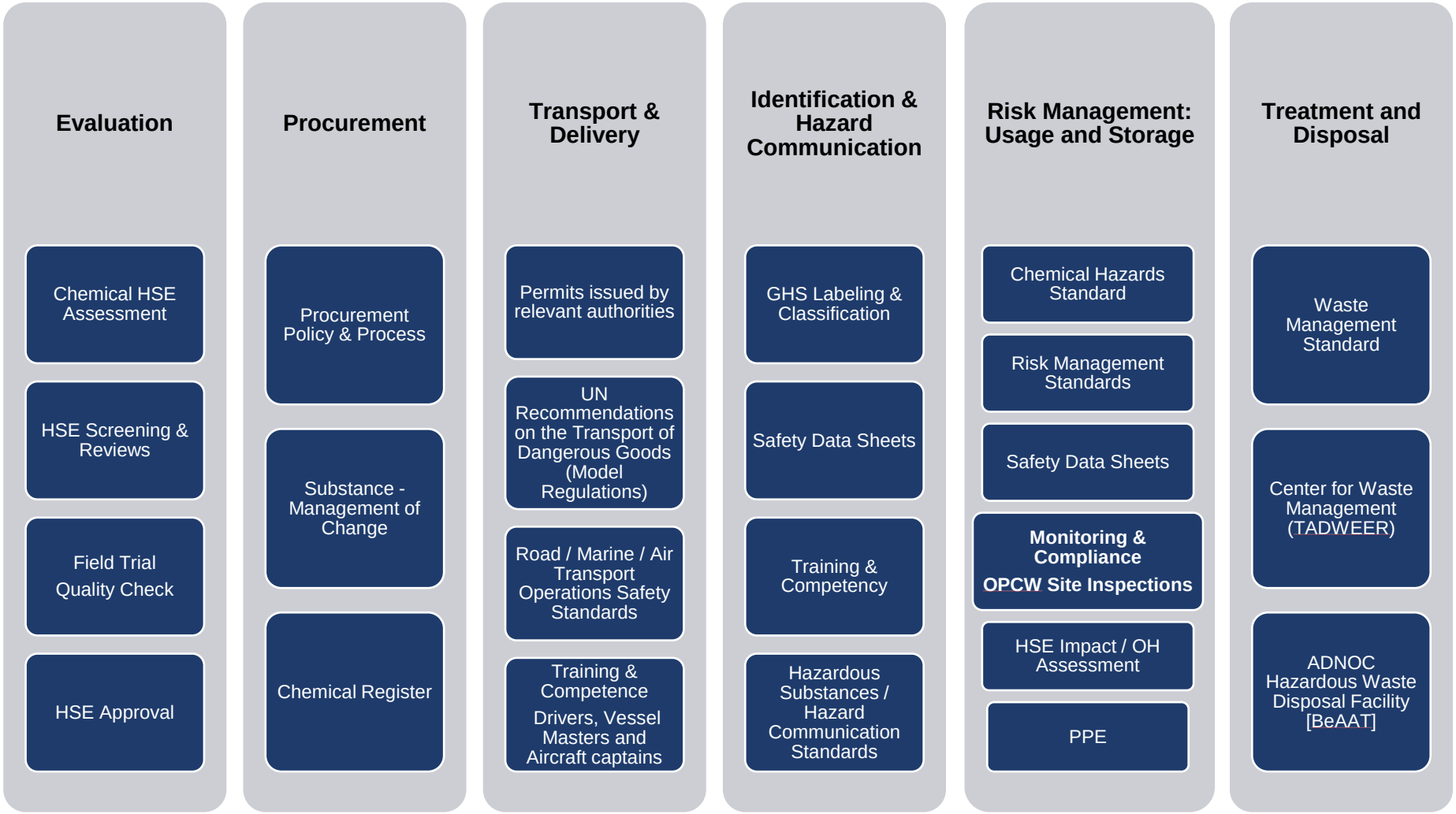


Figure 7.9.2: Components of ADNOC Chemical Life Cycle Management

7.10. CHEMICAL MANAGEMENT GOVERNANCE FRAMEWORK

ADNOC Chemical Management Framework is composed of three (3) hierarchical elements: Group Company Management System, ADNOC HSE Governance, and UAE Local & Federal Regulations as well as international convention guidelines. Refer to Figure 7.10.1 for the structural framework.

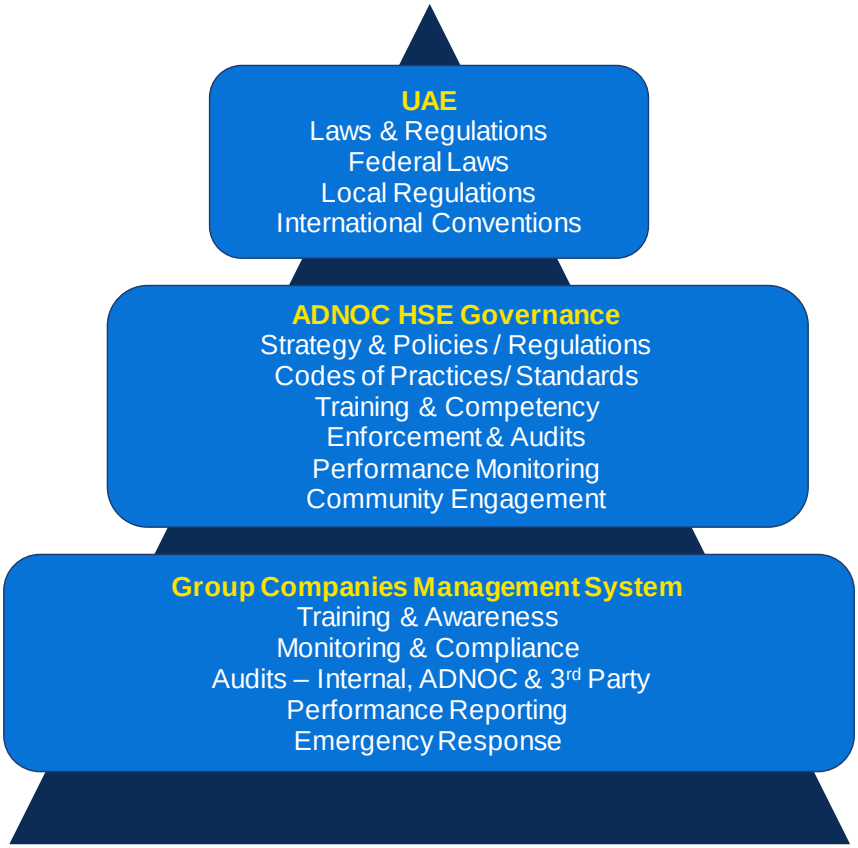


Figure 7.10.1: ADNOC Chemical Management Structural Framework

The framework of ADNOC Group Company's chemical management system is composed of employee training and awareness of chemicals used and present in the facility; periodic monitoring through occupational health risk assessments and conduct of internal, ADNOC and external audits; performance reporting in terms of chemical accident/incident occurrences; and chemical emergency response capabilities. The ADNOC HSE Governance framework on chemical management lies on development of appropriate standards (e.g., Chemical Hazards Standard, Hazardous Substances Standard, Hazard Communication Standard), development of appropriate training for ADNOC Group employees, enforcement of Standards developed, periodic audits, annual declaration of chemical quantities, data gathering and collection of Group Company performance in terms of chemical accident/incident occurrences, and community engagement.

Figure 7.10.2 provides a detailed ADNOC chemical management structural framework.

Figure 7.10.2: ADNOC Chemical Management Detailed Structural Framework

Management of chemicals in the United Arab Emirates is embedded in the Ministry of Climate Change's (MOCCAE) National Strategy on Chemical Management (Ref. 81), which states:

"The National Strategy for Integrated Management of Chemicals seeks to ensure the safe handling of high chemicals throughout their life cycle, from production until they are carefully disposed of. It provides an institutional framework for entities that license the trade, import, and suitable disposal of chemicals to prevent the illegal circulation of harmful substances."

Aside from MOCCAE's National Strategy, UAE chemical management strategy follows the relevant Federal and Local Regulations such as the Environment Agency of Abu Dhabi's guidelines, the Abu Dhabi Integrated Hazardous Management System, Tadweer hazardous waste disposal regulations (Ref. 84), and Abu Dhabi OSH Center (OSHAD) Codes of Practices. The Abu Dhabi Environmental Health and Management System (OSHAD-MS) adopted a code of practice which represents the key regulatory requirements for hazardous chemicals in Abu Dhabi, captured in OSHAD CoP 1.0 Hazardous Materials of June 2018 (Ref. 91). This code of practice stipulates that classification of hazardous materials by chemical manufacturers must comply with international model regulations, such as the Globally Harmonized System of Classification and Labelling of Chemicals.

ADNOC Group policies and regulations related to chemical management include but not limited to: ADNOC Group Sustainability Charter (Ref. 56), ADNOC HSE Standards (e.g., Chemical Hazards Standard, Hazardous Substances Standard, Hazard Communication Standard, Risk Management Standard), and Procurement policies and procedures (e.g., ADNOC Group Inventory Management Procedures, Ref. 80). Other federal regulations applicable include and regulations in road (e.g., Federal Land Transport laws), and marine (e.g., In Maritime Sector Transport Regulations of Department of Transport, Ref. 58).

Several international regulations form the basis of development on ADNOC policies related to chemical management. These include international conventions such as the Chemical Weapons Convention of 1997 which led to the formation of Organization of Prohibition of Chemical Weapons (OPCW) applicable to chemical precursors (Ref. 59); international conventions such as the Basel Convention of 1992 (Ref. 7), Montreal Protocol of 1997 (Ref. 8), Rotterdam Convention of 2004 (Ref. 6), and the Stockholm Convention of 2004 (Ref. 5).

ADNOC policies are based on UAE and international regulations, which include but not limited to:

- Ministerial Resolution No. 4/1 of 1981 on defining works that are hazardous or in which it is permissible to reduce the legally decided working hours, dated 6 January 1981;
- UAE Labour Law Federal Law No. 8 (1980) Labour Law and its Amendments;
- UAE Ministerial Order No. (32), 1982. Specifying Preventive Methods and Measures for Protecting Workers against Work Hazards;
- Federal Cabinet Resolution No. (39) of 2006, banning the import and production of asbestos;
- Abu Dhabi Emirate: Law 21 of 2005 for Waste Management;
- Federal Ministerial Decision No. (32) of 1982 on Protecting Employees from Hazards at Work;
- Federal Law No. 24 of 1999 for the Protection and Development of the Environment – Regulation for Handling of Hazardous Materials, Hazardous Waste and Medical Waste;
- Cabinet Decree (12) of 2006 Regarding Regulation Concerning Protection of Air from Pollution (Ref. 63);
- Interim Guideline for the Disposal of Asbestos/ACM Waste at Landfill (Tadweer. 16/1);
- CWM Technical Guideline: Management of Asbestos/Asbestos Containing Material (ACM) in the Emirate of Abu Dhabi (CWM.TG/8);

- United States OSHA 29 CFR 1910.1200 on Hazard Communication (Ref. 60);
- United States Pipeline and Hazardous Materials Safety Administration Code of Federal Regulations Parts 100 – 185 (Ref. 83);
- United Kingdom Health and Safety Executive's Control of Substances Hazardous to Health (COSHH) (Ref. 28);
- United States Environmental Protection Agency's Toxic Substances Control Act (TSCA, Ref. 9);
- United Nations Economic Commission for Europe's ADN17/ADR17 concerning the International Carriage of Dangerous Goods by Inland Waterways and International Carriage of Dangerous Goods by Road (Refs. 61 and 62);
- International Maritime Organization/International Maritime Dangerous Goods Code (Ref. 35);
- International Civil Aviation Organization's Technical Instructions for the Safe Transport of Dangerous Goods by Air (Ref. 12);
- United Nations Economic Commission for Europe's Globally Harmonized System of Classification and Labelling of Chemicals (Ref. 4); and
- United Nations' Recommendations on Transport of Dangerous Goods (Model Regulations, Ref. 13).

With regard to enforcement, ADNOC has an HSE Chemical Register in place; periodic surveillance and monitoring through conduct of occupational health risk assessment; internal/ADNOC/external audits; annual declaration of chemical quantities; and performance reporting in terms of chemical accidents/incident occurrences; chemical hazard communication of its employees and contractors through training and awareness; chemical emergency response; and chemical waste treatment and disposal at BeAAT ADNOC Central Waste Management Facility. End users of chemicals shall comply with the management processes at each step of the chemical's life cycle.

7.11. CHEMICAL EMERGENCY RESPONSE

Chemical emergencies can arise from various scenarios, which include but not limited to chemical transportation and shipping accidents, chemical-related fires and explosions, toxic chemical leaks, and chemical spills due to improper handling of chemicals during retrieval and transport. Chemical transportation accidents can include derailment of rail cars and tank trucks, accidents involving cargo planes, marine vessels and courier vehicles that handle chemicals which can cause accidental spill or release. These emergencies can involve human health risks as well as environmental damage.

7.11.1. DEVELOPMENT OF CHEMICAL EMERGENCY RESPONSE PLAN

OH can provide vital insight into the health risks associated with chemical emergency response scenarios aimed in achieving the safest emergency response action. A site-specific emergency response plan shall include incident management guidance for the chemical hazards scenario, developed based on the input provided by the OH/IH SME, to advise emergency responders on what viable actions to undertake.

More details on the chemical emergency response plan requirements can be found in the ADNOC Hazardous Substances Standard (HSE-OS-ST13, Ref. 55), ADNOC Emergency Response Plan Standard (HSE-CE-ST05, Ref. 87), and ADNOC Fire and Rescue Services Standard (HSE-OS-09, Ref. 88).

7.11.2. ERP AUDITING

One aspect of the occupational health audit shall focus on the PPE for the emergency responders to assure that it is appropriate for the hazards that might be encountered. Equipment used for emergency response must be inspected periodically and documented to ensure that it is still available in the

designated location; effective, clean and ready to use. The storage location must be assessed to determine whether they are accessible during emergency situations or whether they are too close to an identified risk area (Ref. 68).

Health surveillance of emergency responders shall be up-to-date. Health examinations, medical approval for respirator use, and respirator fit testing shall be documented. The names of employees for whom medical limitations (e.g., respirators, weight limits) have been determined during health surveillance shall be noted to prevent responder emergencies occurring from unrealistic expectations of their abilities. For more information, please refer to the ADNOC Health Surveillance and Screening Standard (HSE-OH-ST05, Ref. 21).

7.11.3. NOTIFICATION OF CHEMICAL-RELATED INCIDENTS AND ACCIDENTS

All near misses, incidents and accidents related to chemical exposures shall be subject to ADNOC Incident Notification, Reporting & Investigation Standard [Ref. 85].

7.12. ASBESTOS CONTAINING MATERIALS (ACM)

7.12.1. OVERVIEW

Asbestos is a mineral-based material that is resistant to heat and corrosive chemicals. Inhalation of asbestos fibres may cause cancer (mesothelioma) and other severe respiratory diseases. Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated and/or altered. Asbestos-containing material (ACM) means any material containing more than 1% asbestos [Ref. 39].

According to the US-Environmental Protection Agency [EPA], there are six types of asbestos minerals. All forms of asbestos are carcinogenic but are of a slightly different chemical composition and crystalline structure. These are described in Table 7.12.1 [Refs. 38 and 40].

Table 7.12.1: Types of Asbestos [Ref. 39]

Asbestos Type	Description, Uses & Application
Chrysotile [also known as White Asbestos] 	This is the most commonly used form of asbestos and can be found in roofs, ceilings, walls and floors of homes and businesses. It is less likely than other types to be inhaled. Automobile brake linings, pipe insulation, flange gaskets and boiler seals may have this type of asbestos.
Amosite [also known as Brown Asbestos] 	This was used most frequently in cement sheets and pipe insulation. It can be found in ceiling tiles and in thermal insulation products. Like most of the other forms of asbestos, it has needle like fibres.
Crocidolite [also known as Blue Asbestos] 	This is fibrous in nature, allowing it to break apart easily and become airborne mostly as fine dust particles. This is seen as the most dangerous type of asbestos. This type was used less than any of the other asbestos minerals because it did not have the same heat-resistant qualities.
Tremolite [Grey, green or sometimes transparent]	This type is not often used commercially, but it can be found in low grade, industrial talc powders. It is also found in certain fillers used in paints, sealants and roofing materials.

Asbestos Type	Description, Uses & Application
	
Anthophyllite [Grey-Brown] 	This is a natural insulator with good flexibility. It was one of the least used types, but can be found in cement tiles, mostly in roofing and plumbing items like gaskets and sealing agents.
Actinolite 	This form of asbestos has a harsh texture and is not as flexible as the others. It is most often found in metamorphic rock. Its fibres are easily inhaled when they are disturbed. It is used in insulation and fireproofing material.

In line with the Federal Cabinet Resolution No. (39) of 2006 on Banning the Import and Production of Asbestos, it is ADNOC's policy not to install asbestos or asbestos containing materials (ACM) in any of its worksites or operations. **The ultimate goal is to phase out all asbestos and ACM from ADNOC Group premises. Where existing installations contain asbestos or ACM that are damaged, deteriorating or inadequately sealed, such materials shall be removed and replaced with a suitable non-asbestos material**.

(a) Legal Requirements

Section 4.0 Laws and Regulations mention the main legislative requirements related to asbestos within the United Arab Emirates. All the requirements listed within in Standard shall be adhered to.

(b) Potential ACM Sources

Asbestos has been in use in one form or another for the past 6000 years, however since the global industrialization and because of its great versatility; asbestos has found a place in a broad spectrum of applications. The materials presented and shown below represent some common places where asbestos can be found [Ref. 39]. Figure 7.12.1 illustrates various potential sources of ACM.

				
Fire Blanket	**Insulation Board**	**Ceiling Tiles [showing damage]**	**Suspended ceiling in corridor**	**Vinyl floor tiles**

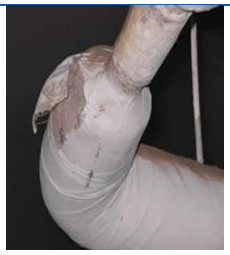
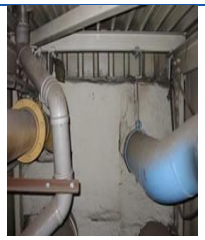
				
Downpipes & Building Cladding	**Corrugated roofing materials**	**Pipe lagging**	**Loose towelled wall covering**	**Pipe lagging & Rope**
				
Sprayed asbestos underside of roof	**Textured wall & ceiling covering**	**Panelling on electrical cupboards**	**Tape flash guards in fuse box**	**Composite Steel & asbestos fire doors**

Figure 7.12.1: Potential ACM Sources [Ref. 39]

7.12.2. HEALTH EFFECTS

Asbestos is a Category 1 human carcinogen as per IARC [Ref 71]. When asbestos-containing materials [ACMs] are disturbed or damaged (intentionally, or accidentally) dust particulates containing fine fibres are released into the workplace and are subsequently inhaled through the respiratory system into the lungs where they cause serious health effects. There are four main diseases caused by asbestos [Refs. 40 & 41].

(a) Mesothelioma

Mesothelioma is a rare form of cancer that principally affects the pleura (the external lining of the lung) and the peritoneum (the lining of the lower digestive tract). This form of cancer is always fatal to the affected individual.

(b) Lung Cancer

Lung cancer, this is always fatal to the affected individual, but is difficult to diagnose from other forms of lung cancers [e.g. smoking-related cancers]. However, this form of cancer causes as many deaths as mesothelioma.

(c) Asbestosis

This is a form of pneumoconiosis defined as lung fibrosis caused by the inhalation of asbestos fibres. The disease is characterised by scarring and inflammation of the lung tissue. It is an irreversible condition with no cure.

Symptoms include shortness of breath, persistent cough, fatigue, laboured and rapid breathing and chest pain. These can seriously affect normal daily activity and lead to various complications which can be fatal.

It is generally recognised that heavy asbestos exposures are required in order to produce clinically significant asbestosis within the lifetime of an individual. Individuals with asbestosis are at a higher risk of developing lung cancer if they are smokers.

(d) Non-Malignant Pleural Thickening

This is a non-cancerous condition affecting the outer lining of the lung (the pleura). It includes two disabling forms of disease, diffuse pleural thickening and the less serious pleural plaques. In addition, some individuals can develop pleural effusion which is excess fluid builds up in the pleural space. The pleural space is the area between the lungs and the chest wall.

7.12.3. ACTIVITIES LIKELY TO ENCOUNTER OR DISTURB ASBESTOS

Due to the potential prevalence and abundance of asbestos, particularly in older facilities, any personnel who work on the fabric of a building or a structure, or who shall be responsible for civil works, removal and maintenance are likely to be at risk of encountering or disturbing asbestos containing materials.

It is not practicable to cover all of the ACM-related activities that are undertaken within ADNOC Group or by their Contractors; however a list of some of the main SEGs who can possibly encounter ACMs are listed below:

(i) Electricians, plumbers, joiners, and plasterers;

(ii) Roof repairers; demolition & civil workers;

(iii) Painters & decorators;

(iv) Fire alarm installer;

(v) HVAC engineers;

(vi) Phone & data engineers and cable layers;

(vii) Plant maintenance personnel; and

(viii) Automobile mechanics handling brake liners.

7.12.4. RISK ASSESSMENT OF ACM

Asbestos fibres are odourless, invisible to naked eye, and the health effects of exposure take years to manifest. However, as long as ACMs are not damaged, or are located in areas where they are inaccessible [e.g. covered over or painted] and cannot be disturbed or damaged, then they pose a negligible risk to health. Asbestos is only a hazard when fibres become airborne and are inhaled by an individual or groups of people. Conversely, people or workers may be at risk of exposure to asbestos when one or more of the following conditions are encountered:

(i) The site, location or facility has been constructed prior to the year 2006;

(ii) The location, nature and condition of ACMs have not been identified before the work had commenced;

(iii) The location, nature and condition of ACMs have been identified, but the information has not been communicated prior to commencement of the work;

(iv) Procedures for safe working with ACMs have not been produced or communicated; and/or

(v) Procedures for safe working with ACMs have been produced and communicated, but Contractors chose not to follow them for a number of reasons (e.g. time and cost savings; no effective supervision; lack of training and awareness).

It is the responsibility of ADNOC Group & their Contractors to manage asbestos where there is:

(i) A likelihood that the facility may at some time in its history used or installed ACMs in the fabric of its buildings; or used ACMs in its plant and equipment; and

(ii) The likelihood of an employee conducting an activity which is likely to disturb or damage ACMs, thereby posing a risk to health and well-being of workers and personnel occupying the premises or facilities where work is being carried out.

It has to be recognised that risks will vary with circumstances and can arise from normal occupation of a building or from inadvertent disturbance during the refurbishment and demolition of premises. In that respect, ADNOC Group and their Contractors must [Ref. 38]:

(i) Take all reasonable steps to determine the location of ACMs;

(ii) Presume 'suspected' materials to contain asbestos, unless there are sound and logical reasons not to do so;

(iii) Generate and maintain a written record of the location of the ACMs and presumed ACMs;

(iv) Assess and monitor the condition of ACMs and presumed ACMs;

(v) Assess the risk of exposure from ACMs and presumed ACMs;

(vi) Prepare a detailed written Management Plan outlining the actions and measures that are necessary to manage the risk to ALARP.

Risk assessment of asbestos can be done qualitatively using the UK HSE Material and Priority Scoring Tool (Ref. 89). The material and priority scores are added to come up with a total overall score. The higher the total overall score, the worse the condition of the ACM is, which means the higher the ACM poses as a human health risk. Higher total overall score also means higher priority shall be given to the ACM for it to be removed or managed. For quantitative risk assessment of asbestos, refer to Section 7.12.6 of this Standard.

A well-conducted and competent asbestos survey will always be concluded by generation of a detailed, written report which is the foundation of the Asbestos Register. In summary, the Asbestos Register – provided in Appendix 4 and the associated risk assessment are the foundations of the Asbestos Management Plan. Figure 7.12.2 provides a summary of asbestos management planning.

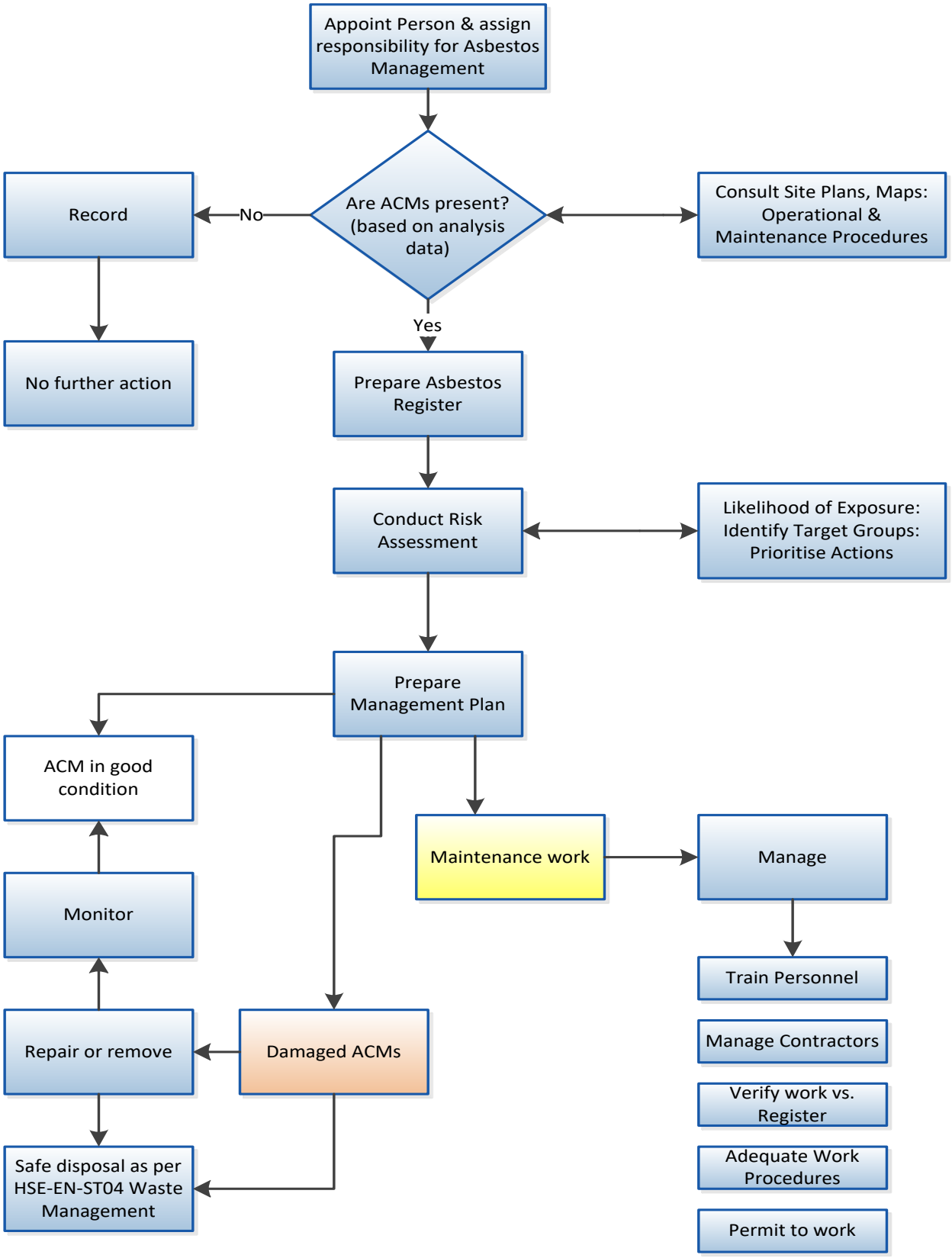


Figure 7.12.2: Summary of Asbestos Management Planning

7.12.5. ASBESTOS IDENTIFICATION SURVEYS

The Asbestos Survey plays a critical role in the management of asbestos in ADNOC Group and Contractor facilities. In essence, the survey has to provide sufficient information for (refer to Figure 7.12.3).

Figure 7.12.3: Asbestos Surveys

The Purpose of Asbestos Identification Surveys are as follows:

(i) To help manage asbestos in the premises;

(ii) To provide accurate information on the location, amount and condition of asbestos-containing materials (ACMs);

(iii) To assess the level of damage or deterioration in the ACMs and whether remedial action is required;

(iv) To use the survey information to prepare a record of the location of any asbestos, commonly called an asbestos register and an asbestos plan of the building(s); and

(v) To help identify all the ACMs to be removed before refurbishment work or demolition.

As a rule, the Asbestos Survey must achieve three principal objectives [Ref. 38]:

(i) As far as reasonably practicable, it must identify and record the location, extent and type of any presumed or known ACMs;

(ii) It must inspect and record information on the accessibility, condition and surface treatment [i.e. finish] of any presumed or known ACMs; and

(iii) It must determine and record the asbestos type, either by collecting representative samples of suspect materials for laboratory identification, or by making a presumption based on the product type and its appearance.

(b) Who will Undertake the Surveys

Asbestos survey shall be conducted by an **Independent Licensed Asbestos Supervising Consultant.** As per Section 6.0 Roles and Responsibilities, the Supervising Consultant ensures that any sampling/identification being undertaken is done in strict requirements of the Standard. The Supervising Consultant shall also monitor any works involving ACM.

(c) Survey Types and When to Do Them

There are three levels of survey that can be undertaken to identify if asbestos-containing materials are present.

(1) Type 1: Presumptive (Location and Assessment)

This is done as the first step to search for any suspect ACMs in the building. The purpose of the survey is to locate, as far as reasonably practicable, the presence and extent of any suspect ACMs in the building and assess their condition. All areas shall be accessed and inspected

as far as reasonably practicable, or shall be presumed to contain asbestos. There is no need to sample and analyse for asbestos (or the absence thereof) at this stage.

(2) Type 2: Sampling Survey (Standard sampling, identification and assessment)

This is done once certain areas/materials inside the building been presumed to contain asbestos have been completed. Representative samples are collected and analysed for the presence of asbestos. If the material sampled is found to contain ACM (at least 1%), similar materials used in the same way in the building shall be strongly presumed to contain asbestos.

(3) Type 3:Pre-Demolition/Major Refurbishment (Full Access Sampling and Identification Survey)

Once the material is found to contain ACM, this type of survey is done to locate and describe, as far as is reasonably practicable, all ACMs in the area where the refurbishment work will take place or in the whole facility, if demolition is planned. A full sampling program is undertaken to identify possible ACMs. The survey is intrusive and involves destructive inspection, as deemed necessary, to gain access to all areas, including those that may be difficult to reach or inaccessible under normal conditions.

7.12.6. EXPOSURE MONITORING

Conducting air monitoring surveys shall be carried out as a means of assessing the exposures of personnel working with asbestos. In some circumstances [e.g. where ACMs have been found to be in a poor condition, or where the work may impact on neighbouring personnel] there may be a requirement to perform following types of airborne sampling:

- **Background sampling** to establish fibre concentrations before any activity which may lead to airborne asbestos contamination;
- **Static sampling** to assess asbestos fibre concentrations inside enclosures before entry for a visual inspection;
- **Leakage testing** to ensure that the steps taken to prevent the enclosure from leaking are and remain effective, and it is not releasing airborne respirable fibres;
- **Reassurance sampling** to confirm residual asbestos fibre concentrations are less than 0.01 f/mL, such as after the removal of an enclosure;
- **Clearance indicator sampling** for reoccupation on completion of asbestos removal work.

The procedures for air sampling shall be carried out in accordance with the UK HSE guidelines [Ref. 46]. Personnel conducting the sampling must be competent in asbestos sampling techniques.

The exposure limit for asbestos is 0.1 asbestos fibres per cubic centimetre of air (0.1 f/cm^3). However, this control limit is not a 'safe' level and exposure from any work activities involving asbestos must be reduced to ALARP below the exposure limit [Ref. 46].

Contractors who shall be engaged to analyse samples of asbestos must have a valid accreditation to ISO 17025 specific to asbestos/IH analysis from a recognised accreditation body [Ref. 47].

7.12.7. COMPETENCY & QUALITY ASSURANCE

Asbestos surveys shall be carried out either by in-house personnel or by an external contractor. Regardless of the route chosen, the surveyor must be competent to carry out the work required and that the laboratory used for analysis of bulk samples is proficient in carrying out these tasks [see Table 7.12.2].

The Duty Holder assigned for Management of Asbestos within ADNOC Group must not appoint or instruct any Asbestos Supervising Consultant to carry out the surveys unless they can demonstrate appropriate competence [Ref. 38].

The competency conditions are that the surveyor must:

(i) Have sufficient training, qualifications, knowledge, experience and ability to carry out their duties in relation to the survey and to recognise their limitations;

(ii) Have sufficient knowledge of the specific tasks to be undertaken and the risks which the work will entail;

(iii) Be able to demonstrate independence, impartiality and integrity;

(iv) Have and follow an adequate quality management system; and

(v) Be able to carry out the survey in accordance with recommended guidance [The most comprehensive guidance on asbestos surveying is given in Health Safety Guideline (HSG 264) from UK HSE [Ref. 42]

Table 7.12.2: Competency Requirements involved in ACM Assessment

Party	Competency Requirement
Organizations	▪ Can demonstrate that they are technically competent to undertake surveys for ACMs through accreditation to ISO/IEC 17020, issued by a Certification Body operating internationally or within the UAE. ▪ All surveying organisations must have a quality management system (i.e. comprising a Quality Assurance and Quality Control schemes) in place to ensure the highest standards are being followed.
Individual Surveyors	▪ Can demonstrate that they are technically competent to undertake specified surveys through holding 'personnel' certification from a Certification Body operating internationally or within the UAE for this activity under ISO/IEC 17024.
Laboratories	▪ Organisations who carry out bulk analysis for asbestos identification must demonstrate that they conform to the requirements of ISO/IEC 17025 and must be accredited by a recognised Accreditation Body, operating internationally or within the UAE.

7.12.8. ASBESTOS SURVEY REGISTER

A well-conducted and competent Asbestos Survey Report shall always be concluded by the generation of a detailed, easy to read and to use, written report which forms the foundation of the Asbestos Register provided in Appendix 4. The latter is a streamlined document which makes use of the critical data and findings of the Asbestos Survey Report (see Table 7.12.3).

As a guide, the ADNOC Group or Contractor must expect to receive a report [in electronic format or as hard copy] comprising the following headings [Ref. 42].

Table 7.12.3: ASBESTOS SURVEY REPORT

Report Section	Section Description
Executive Summary	A brief description of the scope, type and extent of the survey and a summary of the most important information, including:
	▪ Locations with identified (or presumed) ACMs;
	▪ Areas not accessed (specific to the survey and not generic), with reasons for lack of access;
	▪ ACMs found with high material assessment scores;
	▪ Clear guidance and recommendations on any actions, priorities and if possible, milestones.
Introduction	An explanation of the scope of the work, the purpose, aims and objectives of the survey.
General Site & Survey Information	▪ Name & address of organisation conducting the survey; ▪ Surveyor names;
	▪ Name & address of person who commissioned the survey;
	▪ Name & address of the facilities surveyed;
	▪ Date of report;
	▪ Date(s) of the survey;
	▪ Description of areas/activities included in the survey;
	▪ Description of any areas/activities excluded in the survey, and why;
	▪ Survey methodology (i.e. reference methods);
	▪ Type of survey, and if more than one type has been used and where they apply within the facility;
	▪ Any variations or deviations from the methodology; and
	▪ Agreed exclusions and inaccessible areas or activities (with reasons) specific to the survey and not generic.
Survey Results	A table format summarising the findings, and supported by marked-up plans (footprints, or diagrams) showing the location of ACMs and presumed ACMs. The table must contain the following information, as deemed relevant:
	▪ Exact location of the ACMs;
	▪ Extent of the ACMs;
	▪ Product type;
	▪ Level of identification of the ACM (presumed, strongly presumed or identified); and
	▪ Asbestos type in the ACM (see Table 7.12.1);
	▪ Accessibility of the ACM;
	▪ Amount of damage or deterioration;
	▪ Surface treatment (if any);
	▪ Material assessment score or category (high, high-medium, medium, low); and

Report Section	Section Description
	▪ Any actions required from the material assessment.
	Where suspect materials have been proven to be asbestos-free (e.g. by sampling and laboratory verification), a separate table showing details of these materials should be presented.
Conclusions & Actions	A summary of the locations or activities where asbestos was found and the products/items which contain asbestos. This section should be an 'easy-to-read guide' for the ADNOC Group or for the Person responsible for Management of Asbestos. The section must also contain a list of any actions identified in the material assessment and their respective degree of urgency (i.e. Immediate, Middle; or Longer term).
Bulk Analysis Results	Certificates of analysis showing the analytical results of the samples taken.
Appendices	This section should typically include: ▪ Photographs showing the material sampled, its condition and location and its surrounding environment. ▪ Site plans marked with the location of samples taken.

7.12.9. USE OF ASBESTOS REGISTER

The Asbestos Register shall be:

(i) Made available to anyone planning to initiate maintenance and related work, so it can be consulted before the work is authorised;

(ii) Consulted for all work which may disturb the fabric of the building, involve building services, or an activity that is likely to use or encounter ACMs. These include simple and short duration work such as single hole drilling or attaching items to walls, changing gaskets, replacing brake liners, etc.;

(iii) Kept in convenient locations and be easily accessible;

(iv) Passed to contractors as early as possible (e.g. at tender or engagement stage of work) so that appropriate precautions, procedures and controls shall be planned and employed. Providing information to the Contractor when they arrive on site will not provide sufficient time for the correct control arrangements to be put into place. The ADNOC Group must ensure that the contractor acknowledges the presence of ACMs and will implement controls; and

(v) Available to Contractors and employees on request.

7.12.10. WORKING WITH ACM

Work with ACM shall only be limited to maintenance and removal of the asbestos containing material, as per the requirements of this Standard. However, work with ACM carries a risk of exposure through the inhalation of airborne asbestos fibres. For that reason, **ADNOC Group does not permit working with ACMs unless it is performed by fully competent, certified and qualified personnel, who use adequate controls and robust permit-to- work systems.**

Under certain circumstances, some tasks might involve incidental exposure to locations where ACMs are present. Based on this consideration, a number of essential rules that must be adhered to are presented in the following subsections and these are intended to provide procedures to all personnel who might be

involved in removal activities involving ACMs. Any removal work, regardless of its duration, intensity or location, involving ACMs must not commence unless it has been cleared and permission has been issued by the ADNOC Group HSE Department.

(a) Before Starting Work

It is the responsibility of all ADNOC Group and their Contractors to check whether the planned works or activities may involve contact with ACMs. To that end, the ADNOC Group or Contractor shall inspect and review a current version of the Asbestos Register and check whether it covers the specific area of the building or the activity where work is planned [Ref. 42]

Rule No. 1	If there is no Asbestos Register or Asbestos Management Plan - Work Must Not Commence.

(b) Training, Supervision & Information

Rule No. 2	Everyone, whether they are ADNOC Group Employees or Contractors, who work with, or may disturb ACMs, must be properly trained [See Note Below].
Rule No. 3	Supervisors must ensure that workers follow the correct working procedures and rules.
Rule No. 4	All other workers that may be nearby must trained of what work is going on nearby, where it is, and why it is being done.

Note: Training must include detailed information on:

(i) Recognising asbestos;

(ii) Health effects caused by exposure to ACM fibres and dusts;

(iii) The added risks to health of smoking when working with ACMs;

(iv) The uses and likely locations for ACMs in facility or activity;

(v) Type and extent of work permitted by ADNOC Group and this Standard;

(vi) Control & mitigation procedures to protect against exposure;

(vii) Permitted working methods and procedures;

(viii) Permitted and recommended equipment to do the job properly;

(ix) Choosing, using and maintaining personal protective equipment;

(x) Cleaning and decontamination of area and clothing at end of work;

(xi) Emergency procedures; and

(xii) Correct waste disposal of ACM-containing debris

Rule No. 5	A thorough risk assessment must be conducted before commencing work that may involve disturbing or handling ACMs.

The aims of the risk assessment must be:

(i) To decide if it is practicable to conduct the work or activity in a manner that avoids [i.e. Elimination] the risk of asbestos exposure;

(ii) If Elimination is not practicable, to identify who might be at risk and the level of possible asbestos exposure from any work or activity; and

(iii) To decide what work methods or systems of work are necessary to provide effective control of the risks to health.

(c) Decision on who needs to carry out work

Rule No. 6	ADNOC Group must not conduct any asbestos removal work using in-house personnel. This work must be contracted to licensed contractors who are approved by the Competent UAE/Abu Dhabi Authority in Asbestos.
Rule No. 7	Asbestos-containing wastes must only be transported or disposed of by licensed contractors who are approved by the Competent UAE/Abu Dhabi Authority in Asbestos.

The 'Duty Holder' responsible for Management of Asbestos at the ADNOC Group must discuss planned activities with line managers and supervisors and decide on, what type of work is planned, as indicated below [Ref. 39]:

(i) Removal: as part of a major refurbishment of premises; or replacing thermal insulation on plant & equipment.

(ii) Maintenance activities: for example general civil works such drilling holes to attach fittings or pass cables through; painting; or cleaning. This category also includes removal of gaskets, replacing ceiling tiles, replacing brake linings, etc.

Rule No. 8	Removal work with ACMs must be carried out by a licensed contractor. This includes work on asbestos coating and asbestos lagging; and work on asbestos insulation or asbestos insulating board (AIB) where the risk assessment clearly demonstrates that the fibre release will be high, such as when the material is damaged, or the work will extend over a long period [see Rule 9]. A licensed contractor has to be approved by the Competent UAE / Abu Dhabi Authority in Asbestos.
Rule No. 9	In the context of this Standard, short duration work means: "One person doing the work for less than one hour; or a group of people doing the work for a total of less than two hours, in any seven consecutive days. The total time spent by all workers must not exceed two hours. This includes time spent setting up, cleaning and clearing up".
Rule No. 10	Work that does not normally require a licensed contractor includes work on asbestos-containing textured coatings and asbestos cement provided they are in good condition. This is on the provision that Rule 2, 3, 4, 5, 9 & 11 are applied.

A Decision Flow Chart is presented in Figure 7.12.9 to enable ADNOC Group and Contractors decide on the most appropriate course of action to follow when planning work that may involve handling or disturbing ACMs.

(d) Removal of Asbestos-Containing Material

The plan for the removal of ACMs shall be reviewed or updated to ensure that it incorporates any additional requirements for the removal of ACM. These requirements will as a minimum include:

(i) packaging of any removed ACM;

(ii) estimated amount of ACM to be removed;

(iii) type of ACMs to be removed;

(iv) transportation arrangements for ACMs;

(v) disposal arrangements;

(vi) containment arrangements; and

(vii) Clean-up/decontamination.

Preparation activities include minimizing the number of people present and gathering the correct tools, PPE, decontamination materials, barricades, warning signs, etc. at the workplace before any work commences.

Before ACMs removal, plastic sheeting (for containment) shall be placed on the floor or other surfaces that may become contaminated with asbestos dust. If the ACMs removal work is not being carried out in an enclosure, the surfaces to be worked on shall be cleaned by either wet wiping or vacuuming to minimize exposure from the disturbance of asbestos fibres that might be on the surfaces prior to the commencement of removal tasks.

(i) Wet and Dry Methods of Removing ACM

Wherever reasonably practicable, dry ACM shall not be worked on. Techniques that prevent the generation of airborne asbestos fibres shall be used. The following methods shall be used for removing ACM, except when cleaning up ACMs debris.

1. Wet Spray Method (Preferred Method)

- The ACM shall be saturated through its full depth and maintained in a wet condition;
- In many instances it is helpful if a wetting agent (surfactant), such as detergent, is added to the water, as this facilitates more rapid wetting of the ACM;
- A manually controlled, consistent low pressure coarse spray, such as from an adjustable pistol grip garden hose, is recommended for this purpose;
- The design of the spraying equipment will depend on the availability of a water supply and access to the area to be sprayed;
- With this method, a water spray shall be applied in a manner that:
  - ensures the entire surface of the ACM is saturated; but
  - Minimizes runoff.
- While the water sprayed in copious amount, and shall not be so forceful that the water droplets generate dust when they hit the surface of the ACM;
- When cutting equipment is being used to remove an ACM that is friable, the water spray shall be directed at the site of the cut and the wetted material be removed during the cutting process;
- The wetted ACM shall be removed in sections, immediately placed in appropriately labelled asbestos waste containers and appropriately sealed. Any small sections that might be dislodged shall be collected and appropriately disposed of as asbestos waste. This is the **preferred removal method.** It shall only be used, however, if:
  - the ACM is not covered with other materials such as calico or metal cladding, which require prior removal;
  - there is no reinforcing wire or other similar restriction on removal;
  - the ACM is not coated with paint or mastic;
  - No live electrical conductors are present and no damage to electrical equipment can arise from the ingression of water; and

- Although airborne asbestos fibres are significantly suppressed when the wet spray method is used, they are not entirely eliminated, so effective respiratory protection is also essential.

2. Dry Removal Method (Least Preferred)

- The dry removal method shall be used only if:
  - The wet spray method is not appropriate (e.g. if there are live electrical conductors or if major electrical equipment could be permanently damaged or made dangerous by contact with water).
- Accordingly, if the dry removal method has to be used the following factors shall be considered and employed, as determined by risk assessment:
  - the work area shall be fully enclosed with plastic sheeting (at least 200 µm thick) and maintained at a negative pressure (at least 12 Pa water gauge);
  - all personnel involved in the removal operation shall wear full face, positive pressure, supplied air respirators;
  - the ACM shall be removed in small, pre-cut sections with minimal disturbance, so as to reduce the generation of airborne asbestos fibres as much as reasonably practicable; and
  - Waste material shall be immediately placed in appropriate wetted containers; and in some situations HEPA vacuum cleaners can be used to minimise airborne asbestos fibres. If it is reasonable practicable to use HEPA vacuum cleaners, shadow vacuuming techniques shall be employed. In order to achieve the required efficiency, the air speed at the extraction point shall be at least 1 m/sec and the nozzle shall be large enough and placed close enough (at a distance not more than the diameter of the nozzle) to provide efficient collection of airborne fibres.

(e) Local Exhaust Ventilation

When removal of high-risk asbestos-containing materials takes place, the work should be carried out inside a specially constructed ventilated enclosure to prevent the spread of asbestos outside the work area connected to Local Exhaust Ventilation.

The exact ventilation requirements for each enclosure shall be determined on an individual job basis (based on enclosure size/volumes, building layout etc.). However, while extract system flow rates cannot be specified in detail, experience has shown that in many cases **a flow rate of about 0.2 m^3/s for each 100 m^3 of enclosed volume (100 ft^3/min per 1000 ft^3)** appear to give a satisfactory performance. **This is equivalent to approximately 8 air changes per hour in the enclosure** (Ref. 53). Where there are difficulties in obtaining an effective seal, it may be necessary to over extract to compensate. Extraction rates shall not be excessive, causing damage to the integrity of the enclosure (e.g., collapsing in on itself).

(f) Asbestos Removal Tools and Equipment (see Figure 7.12.4)

(i) Tools

Care shall be taken while selecting tools for asbestos removal site. Manual operated hand tools shall be used for asbestos removal work. Power tools shall be avoided because of the possibility of internal contamination, which commonly occurs with such devices. In is preferred to use manually operated hand tools.

If manually operated hand tools are not appropriate, low speed battery powered tools in conjunction with wet methods for dust control are preferred.

(ii) Connection of Tools to Local Exhaust Ventilation

Battery operated tools shall be fitted with a local exhaust ventilation, dust control hoods whether other dust control methods (e.g. use of wet removal methods) are determined to be unsuitable. Consideration shall be given to the use of shadow vacuuming techniques if a LEV dust control hood cannot be attached and no other dust control method is used.

After asbestos removal work all tools shall be decontaminated. A constant low pressure water supply is required for wetting down asbestos. High pressure spray equipment shall never be used.

High efficiency vacuum cleaners (Class H) with HEPA filters rated for industrial purposes shall be used for asbestos cleaning activities. Domestic vacuum cleaners shall not be used.

Using a Class H vacuum cleaner and a drill cowl

Control measures: shadow vacuuming and using plastic enclosures as local extraction

(Picture Source: http://www.hse.gov.uk/pubns/guidance/em4.pdf)

Figure 7.12.4: Asbestos removal tools and equipment [Ref. 66]

(iii) Spray Equipment

A constant low pressure water supply is required for wetting down asbestos. High pressure spray equipment shall never be used.

(g) Security Signs and Barriers

The asbestos removal site shall be clearly defined to ensure that nonessential people do not enter and to clearly delineate the removal site.

Potential entry points to the asbestos work shall be posted with 'Danger Sign' (refer to Figure 7.12.5). Danger signs shall be weatherproof and appropriately secured. All barriers and danger signs shall remain in place until a clearance to reoccupy is granted.

Figure 7.12.5: Danger Signs and Barriers for presence of ACM in a location/area

The following work conditions will NOT require the presence of a licensed asbestos contractor:

- Short duration 'maintenance' work with firmly bonded ACMs that are in good condition, and include asbestos cement, bitumen, plastic, resin, rubber, roofing felt, paper linings, cardboard, textiles, gaskets, washers and rope etc.
- Short duration 'maintenance' work involving ACM which is in good condition

Short durations work such as maintenance and removal of asbestos insulation, removal of textured decorative coatings where the ACMs are badly damaged or destroyed (e.g. scraping off or chiselling out) must require a Contractor-approved by Competent UAE/Abu Dhabi Authority in Asbestos.

Rule No. 11	All asbestos-related work and handling must not commence unless it has been cleared and permission has been issued by the ADNOC Group HSE Department.

(h) Personal Protective Equipment

(i) Respiratory Protective Equipment

All personnel working with ACMs must use the correct type and range of PPE. The appropriate types will be determined by the Risk Assessment, but it is the responsibility of the ADNOC Group, particularly the 'duty holder' and OH/IH SME of Asbestos to ensure that the PPE used is suitable and adequate to provide protection to workers engaged in ACM work. More details on RPE requirements for asbestos can be found in the Personal Protective Equipment Standard (HSE-OS-ST20, Ref. 78), although certain provisions not mentioned in that Standard are found below.

1. Disposable RPE

Disposable RPE must always be [Ref. 44]:

- Stored in a suitable safe and clean location before use;
- Examined in accordance with the manufacturer's instructions before use (pre examination) to make sure it is not damaged and is in good working order; and
- Disposed of as asbestos waste after use.

A pre examination of RPE must be carried out and thus must include the following checks on the condition of:

- Straps;
- Face piece, including the seal and nosepiece; and
- Exhalation valve, if fitted.

A seal check must be carried out to make sure that the RPE properly fits the wearer. A copy of the manufacturer's user instructions must always be available to the wearer. This will give information on simple fit checks, such as those involving blocking filters and inhaling to create suction inside the mask so any leakage can be detected.

<u>Recommended Respirator Filter for ACMs</u>

The recommended respirator filter for dealing with ACMs shall be N, P or R type which means that the filter is 99.97% efficient in capturing ACMs.

2. Non-Disposable RPE

Effective protection from non-disposable RPE is dependent on maintaining the equipment in good condition and in working order. This is made by sufficient cleaning and decontamination and by carrying out regular checks and examinations. There are three (3) separate examinations which must be carried out on non-disposable RPE:

- Pre-examination which needs to be carried out by a competent person before the RPE is issued to a wearer;
- Regular periodic examinations by a competent person to make sure that the RPE is in efficient working order; and
- Post-examination, which is carried out by the wearer before the using the RPE.

All wearers of non-disposable RPE must have received sufficient training to be able to complete the necessary checks.

3. Respirator Capabilities and Limitations [Ref. 70]

One parameter commonly used in determining maximal capability of respirator use is the **Maximum Use Concentration (MUC).** The **MUC** is the maximum atmospheric concentration of a hazardous substance from which personnel can be expected to be protected when wearing a respirator. The respirator MUC for a given chemical is the Assigned Protection Factor (APF) of the respirator or class of respirators times the exposure limit of that chemical.

The maximum use concentration of a respirator is based on several factors including the APF, immediately dangerous to life and health (IDLH) concentrations, and regulatory limits. A respirator may not be used at a concentration greater than the exposure limit times the APF for the respirator. In addition, air purifying and airline respirators may not be used at concentrations greater than the IDLH.

(ii) Protective Clothing

Protective clothing requirements for asbestos can be found in the Personal Protective Equipment Standard (HSE-OS-ST20, Ref. 78).

(iii) Removal of contaminated protective clothing

Protective clothing shall be:

1. Removed before taking off the RPE;
2. Removed before leaving the work area for any reason (including for meal breaks, other breaks and at the end of the shift); and
3. Cleaned before removal. Ideally, a class ‘H’ (conforming to BS 8520- 3:2009) vacuum cleaner fitted with suitable attachments shall be used. In other circumstances and depending on the risk assessment, wet wiping may be adequate.

A few typical examples of RPE and Protective clothing are shown in Figure 7.12.6.

Tyvek® Disposable Overalls fitted with a hood

Over Shoes

Respiratory Protective Equipment [Rated to FFP-3]

Figure 7.12.6: Examples of Typical RPE & PPE used for Asbestos Work [Ref. 44]

(i) Decontamination

Decontamination must be carried out by the trained and authorized personal to work on asbestos. They shall be equipped with appropriate PPE as identified in the risk assessment. Asbestos dust or debris shall be collected in a safe manner and the asbestos work area decontaminated paying attention to all walls, fittings and furnishings. Tools and equipment used during the removal task shall be decontaminated using either wet or dry decontamination procedure.

Personal decontamination shall be undertaken each time employee leaves the asbestos work area and at the completion of the asbestos maintenance or service work. Personal decontamination shall be done within the asbestos work area where recontamination cannot occur.

A decontamination unit shall be provided consisting of three (3) separated compartments:

(i) A "clean" area to store and dress into uncontaminated clothing;

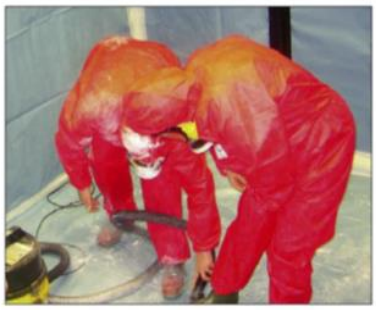
(ii) An area with shower and wash basin facilities supplied by hot and cold or warm water, soap and individual towels; and

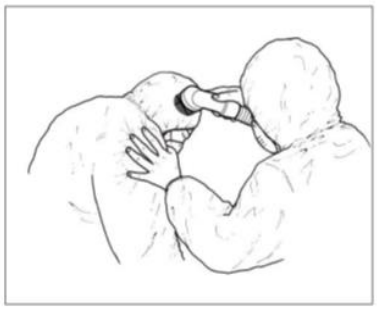
(iii) A "dirty" area to remove and store contaminated clothing.

Decontamination unit shall be kept clean at all times and ventilated when in use. The ventilation shall be by a fan fitted with a high efficiency filter (at least 99.97% efficient) in the dirty end. The airflow direction shall be from the "clean" to "dirty" area.

The decontamination unit shall have direct access from the working area and be effectively sealed. Where this is not possible, then a "transit" working situation is to be established, (see attached examples of different working procedures). An illustrative Decontamination practice is shown in Figure 7.12.7.

Make sure you restrict access





'Buddy' cleaning using a Class H vacuum cleaner

Figure 7.12.7: Asbestos Decontamination Practices [Ref. 67]

(j) Personnel Decontamination

(i) Personal decontamination shall be undertaken each time employees leave the asbestos work area and at the completion of the asbestos maintenance or service work. Personal decontamination shall be done within the asbestos work area where recontamination cannot occur.

(ii) Asbestos-contaminated PPE shall not be transported outside the asbestos work area except for disposal purposes.

(iii) Before work clothes and footwear worn during asbestos work are removed from the asbestos work area for any reason, they shall be thoroughly vacuumed with an asbestos vacuum cleaner with HEPA filter shall be used to remove any asbestos fibres, and the footwear shall also be wet wiped.

(iv) Respiratory protective equipment shall be used until all contaminated disposable coveralls and clothing has been vacuum cleaned and/or removed and bagged for disposal, and personal washing has been completed.

(v) Personal hygiene and careful washing are essential. Particular attention shall be paid to the hands, fingernails, face and head.

(vi) If only small quantities of non-friable ACM are being removed, a competent person may decide, on the basis of a risk assessment, that the following personal decontamination procedure can safely be used, instead of a full decontamination unit:

1. all visible asbestos dust/residue is removed from protective clothing, using an asbestos vacuum cleaner with HEPA filter and/or wet wiping;
2. the protective clothing is taken off (while still using a respirator) and placed in an asbestos waste bag;
3. Disposable protective clothing is preferred. If non-disposable clothing is used, it shall be completely wetted before double bagging, labelled and sent to a laundering facility capable of laundering asbestos-contaminated clothing. The laundering of contaminated protective clothing in employees' homes is strictly prohibited;
4. Disposable respirators shall then be discarded as asbestos waste. Non-disposable respirators shall be removed and thoroughly cleaned; and
5. After removing the respirator, employees shall wash their face and hands, paying particular attention to their fingernails.

(k) Clearance Testing

It is reasonably practical to clean the working area following asbestos removal/remediation thoroughly enough for the respirable airborne fibre concentration to be **below the limit of**

quantification of 0.010 fibres/ml as the **'clearance indicator' threshold** [Ref. 53]. This threshold value is used in the interpretation of reassurance and background samples.

(l) Site Assessment for Reoccupation

Following asbestos removal, the premises must be assessed to determine whether they are thoroughly clean and fit for reoccupation (or, as appropriate, demolition).

(m) Washing and Change Facilities

The type and extent of washing and changing facilities provided by the ADNOC Group must be determined by the type and amount of exposure indicated by the risk assessment. In any event suitable facilities shall be provided and these must include:

(i) Toilet facilities;

(ii) Facilities for washing and changing prior to working with asbestos; and

(iii) An area to eat and drink.

(n) Transportation of Asbestos Waste

Asbestos / ACM waste transportation shall be carried out by Centre for Waste Management Abu Dhabi (CWM) licensed registered service provider (RSP). The vehicles that transport industrial or commercially sourced waste asbestos must hold CWM waste transportation permit and registered with CWM.

All waste must be double bagged/ double wrapped in plastic sheeting (approximately 200 µm thick) with correct hazard danger sign attached.

(o) Waste Disposal

All debris or wastes generated from work or contaminated with ACMs must be labelled as hazardous and double bagged (see Figure 7.12.8).

Figure 7.12.8: Asbestos Waste - Double Bagged

Asbestos-containing wastes must only be transported or disposed of by licensed contractors who are approved by the Competent UAE / Abu Dhabi Authority in Asbestos, as per Rule # 7.

Figure 7.12.9 provides a summary in the form decision flowchart on handling ACM.

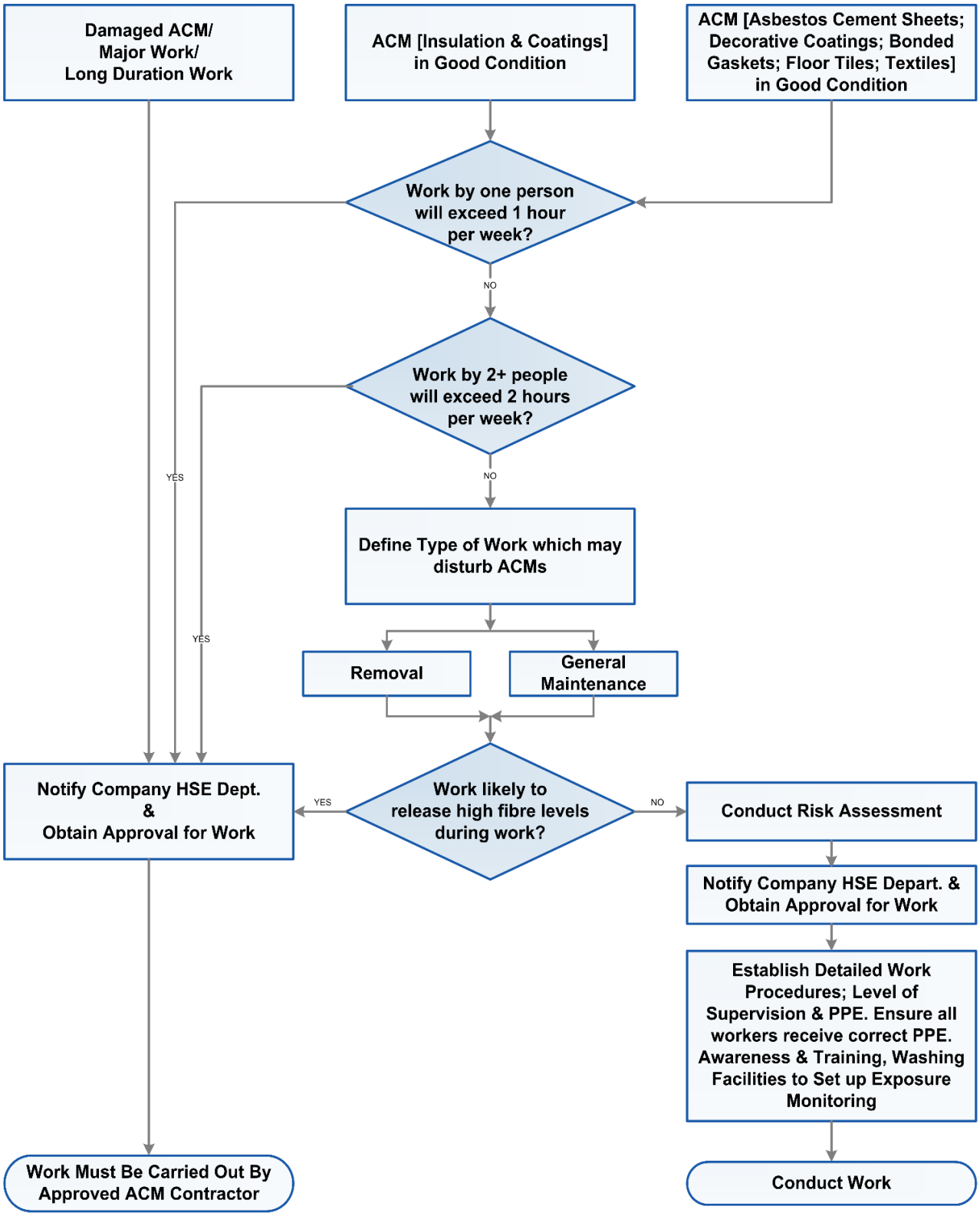


Figure 7.12.9: Decision Flow Chart for Handling of ACM

7.13. MANMADE MINERAL FIBER/MAN-MADE VITREOUS FIBER/SYNTHETIC VITREOUS FIBERS (MMMF/MMVF/SVF)

There are many manmade fibres are used in workplace, particularly concern are fibres with diameters of <3 µm, which can reach the pulmonary regions of the lung (respirable fibres). Although fibres (up to 20 µm diameter) can theoretically deposit in the thoracic region of the lung and may potentially be of concern, it is the finer diameter respirable fibres that are generally acknowledged to be most important predictor of hazard and risk for cancers of the lung.

These include: synthetic, some semi-synthetic fibres (e.g. cellulosic fibres) which are sometimes referred to as machine-made (or manmade) organic fibres (MMOFs) and also a range of other non-organic fibres, and specialist technical fibres, including various types of carbon fibres and nanofibers (Figure 7.13.1).

Manmade mineral fibres can be divided into three main types, based on the starting materials:

(i) Silicate minerals e.g., refractory ceramic fibre

(ii) Cellulose

Cellulose is the primary structural component of plants, also called plant material fibres 'cellulose fibres'. Examples of cellulose fibres are:

1. Cotton;
2. Linen;
3. Rayon;
4. Bamboo;
5. Hemp;
6. Jute; and
7. Rayon (this is altered by people, but plant based).

(iii) Mineral Wool

Mineral wool are classified as manmade Mineral Fibres, rock wool, slag wool, Synthetic Vitreous Fibres. Synthetic vitreous fibres, particularly glass wool, rock wool, and slag wool, are used for thermal and acoustical insulation for homes, other buildings and appliances. Refractory ceramic fibres are mainly used for high temperature insulation, such as for furnaces.

Mineral wool insulation is unique and highly versatile product. Its exceptional thermal properties contribute hugely in process, oil and gas, manufacturing and textile industry. Additionally, the structure of mineral wool - a mat of fibres which prevents the movement of air – coupled with its long-term stability, gives it a unique ability to combat noise pollution and promote safety by reducing the risk of fire.

Mineral wool insulation is made from molten glass, stone or slag (industrial waste) that is spun into a fibre-like structure and which creates a combination of properties that no other insulation material can match. There are two types of mineral wool product: glass wool insulation and stone wool insulation.

Inorganic rock or slag are the main components (typically 98%) of stone wool. The remaining 2% organic content is generally a thermosetting resin binder (an adhesive) and a little oil. Glass wool products usually contain 95% to 96% inorganic material.

Mineral wool made from blast furnace slag (waste) is sometimes known as slag wool. Glass wool is made from sand or recycled glass, limestone and soda ash.

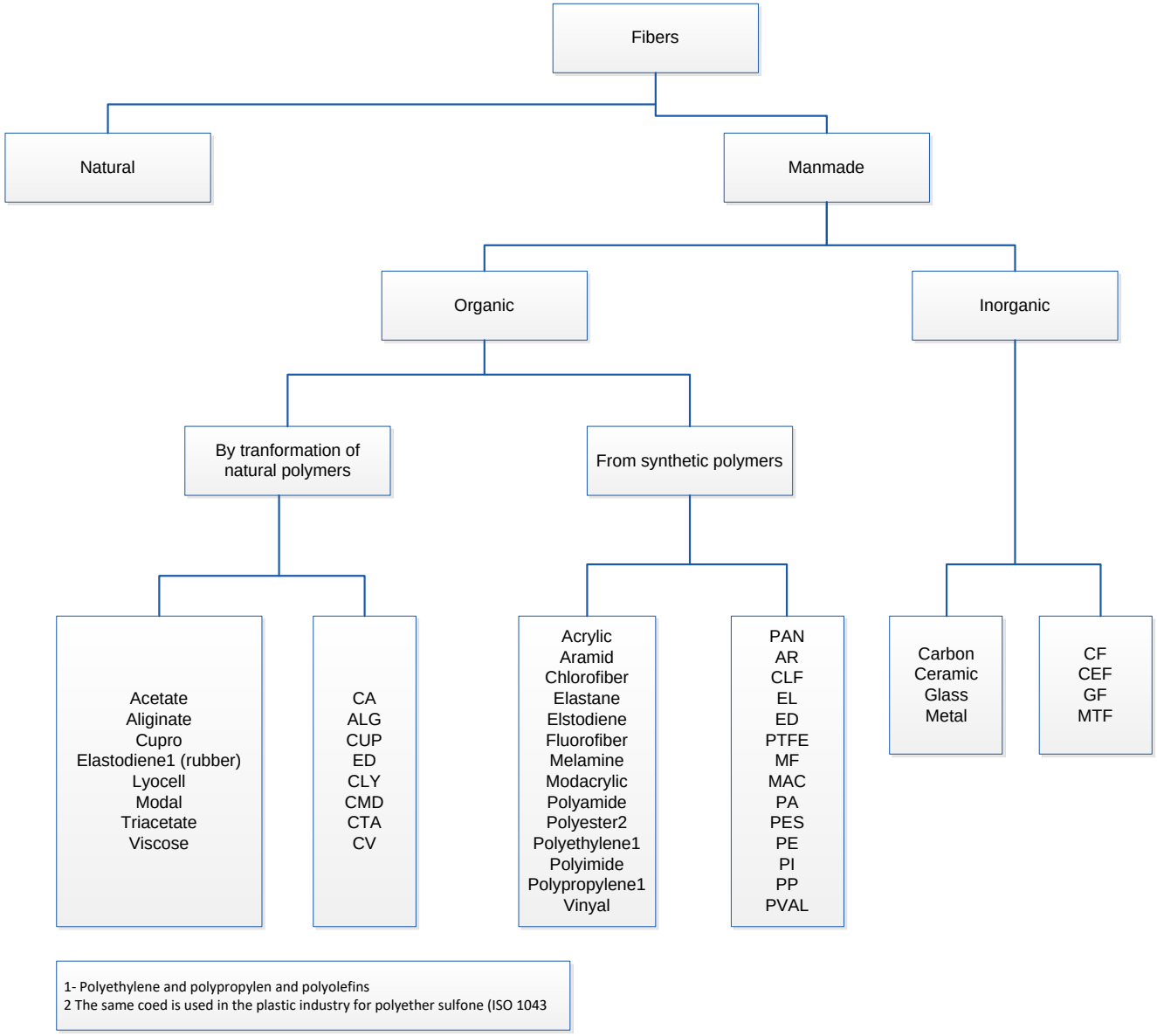


Figure 7.13.1: Type of MMMF and their classification [Ref. 65]

7.13.1. CARCINOGENICITY OF MMMF/MMVF/SVF

The listings below are essentially an extension of the International Agency for Research on Cancer (IARC) listings for fibres. The IARC classifications group has also been given.

(i) Group 1 is carcinogenic to humans;

(ii) Group 2 is used when it is found to be carcinogenic in animal experiments (the number of species and type of in vivo test will decide whether it is 2A: probably carcinogenic to humans or 2B: possibly carcinogenic to humans); and

(iii) Group 3 are not classifiable as to their carcinogenicity to humans.

IARC classify fibre glass wool insulation to Group 3, “not classifiable as to its carcinogenicity in humans.” Thus, IARC does not consider Fibre Glass Wool Insulation (FGWI) to be a potential human carcinogen (as IARC, 2002). However, **refractory ceramic fibres are classified as “possibly carcinogenic to humans.**”

7.13.2. OTHER HEALTH EFFECTS OF MMMF/MMVF/SVF

Results from animal experiments have led to conservative classifications of certain synthetic mineral fibres as possible human carcinogens such as refractory ceramic fibre. Specifically, insulation glass wool, continuous glass filament, rock (stone) wool, and slag wool are not classifiable as to their carcinogenicity to humans.

There are a number of other health effects arising from exposures to fibres. They include the following:

(i) Mechanical irritant effects of the eyes, nose and skin;

(ii) Dermatitis (atopic eczema);

(iii) Endotoxin induced effects;

(iv) Obstructive lung disease (e.g. asthma, bronchitis);

(v) Other chronic effect (cough, dyspnoea, loss of lung function); and

(vi) Interstitial lung diseases (e.g. follicular bronchiolitis);

(a) Sources or SEGs Exposed to MMMF/MMVF/SVF

Workers in facilities that manufacture or process fine mineral fibres, and workers installing insulation in a home or building may be exposed.

(i) Fine mineral fibres may be released to the environment from industries manufacturing or processing such fibres, and from the demolition of homes in which insulation materials contain fine mineral fibres; and

(ii) The primary route of human exposure to fine mineral fibres is by **inhalation** and **dermal contact** from occupational exposure.

A list of some of the main jobs or tasks that can fall within the risk category are listed below:

(i) Electricians, plumbers, joiners, and plasterers;

(ii) Roof repairers; demolition & civil workers;

(iii) Painters & decorators;

(iv) HVAC engineers;

(v) Phone & data engineers and cable layers; and

(vi) Plant maintenance personnel (while removing Glass Wool used for thermal insulation under metal cladding from pipeline).

An additional problem for users is that after being exposed to high temperatures (greater than 1000℃) for prolonged periods as can happen in kilns and furnaces, it is known that RCF at the surface of the lining devitrifies to crystalline phases including cristobalite, a form of crystalline silica which can cause silicosis. Exposure to simulated 'after-service' fibres did not produce significant excess tumours in animal studies.

It should also be borne in mind that after firing for a prolonged period of time at high temperatures (greater than 1000℃), RCF at the surface of kiln/furnace linings will devitrify to crystalline phases including crystalline silica, which is also a hazardous material, with a UK-HSE Maximum Exposure Limit (MEL) of 0.3mg/m^3 (8-hour TWA) (Ref. 76). Therefore, during plant maintenance when the lining is disturbed, workers could be exposed to both RCF and crystalline silica.

(b) Airborne MMMF/MMVF/SVF and its Measurement

Most MMMF production processes give a wide range of particle sizes, with median diameters of a few micrometres in the bulk material. However, in MMMF aerosols the median number diameter would be less than 1 micron, because the small diameter fibres stay airborne longer. On average, fibres with greater diameters tend to be longer, but there is a wide range of lengths at each diameter. In some production processes, sub micrometre fibres can be rare.

It is not necessary to monitor routinely using both gravimetric and number concentration, but only by the method best suited to the material in question. The relevant airborne limit is the one which would be exceeded first if exposure were increased, either by raising the mass of dust or the fibre count in the atmosphere.

In most cases it will be the gravimetric limit. It will almost always be possible to deduce which is the appropriate limit from the type of fibre being used:

(i) For mineral wools (and for almost all ceramic fibres), it may be assumed that the gravimetric limit value will be reached before the number concentration value, and only gravimetric measurements will be needed;

(ii) For special purpose or superfine fibres, the airborne number concentration will usually be reached first; and

(iii) For continuous filament fibres, it is unlikely that the airborne number concentration limit will ever be reached.

The sampling flow rate should lie in the range 0.5 to 16.0 l.min^{-1} and its duration will be determined by the purpose of the measurement being undertaken (Ref. 77).

For testing compliance against the WEL, an 8-hour time-weighted average concentration may be needed (e.g., 0.5 l.min^{-1} for the whole shift), which may also be derived from two or more consecutive samples. A much shorter sampling duration (e.g., 8 l.min^{-1} for 15 minutes) may be appropriate for task-specific sampling (Ref. 77).

When employing fixed point sampling, the sampling cowls should be positioned at approximately 1–2 m above floor level, away from any walls or large obstructions. The sampling procedures are otherwise the same as for personal sampling.

(c) Exposure Limits

OSHA has defined following exposure limits for various types of MMMFs, found in Table 7.13.1.

Table 7.13.1: Exposure Limits for Synthetic Vitreous Fibre

EXPOSURE LIMITS FOR SYNTHETIC VITREOUS FIBER	
ACGIH TLV-TWA	
Synthetic Vitreous Fibres	Continuous filament glass fibres** : 1 f/cc, A4
	Glass wool fibres** : 1 f/cc, A3
	Rock wool fibres** : 1 f/cc, A3
	Slag wool fibres** : 1 f/cc, A3
	Special purpose glass fibres** : 1 f/cc, A3
	Refractory ceramic fibres** : 0.2 f/cc, A2
**Respirable fibers > 5µm aspect ratio ≥ 3:1 as determined by the membrane filter method at 400-450X magnification (4mm objective), using phase contrast illumination. A2 Suspected Human Carcinogen A3 Confirmed Animal Carcinogen with Unknown Relevance to Humans A4 Not Classifiable as a Human Carcinogen	
NIOSH REL - TWA	
Fibrous glass dust, Mineral wool fibre (synthetic vitreous fibres)	3 f/cm^3 (fibres ≤ 3.5µm in diameter & ≥ 10µm in length)

7.13.3. RISK ASSESSMENT OF MANMADE MINERAL FIBERS

Manmade mineral fibres (MMMF/ MMVF/SVF) are odourless, invisible and the health effects of exposure take years to manifest themselves. MMMF is only a hazard when fibres become airborne and are inhaled by an individual or groups of people. Conversely, people or workers may be at risk of exposure to MMMF when one or more of the following conditions are encountered:

(i) The site, location or facility is unknown or unfamiliar to the workers;

(ii) The location, nature and condition of MMMF/MMVF/SVF have not been identified before the work had commenced;

(iii) Workers are unable or untrained to identify MMMF/MMVF/SVF;

(iv) The location, nature and condition of MMMFs have been identified, but the information has not been communicated prior to commencement of the work;

(v) Procedures for safe working with MMMF/MMVF/SVF have not been produced or communicated; and/or

(vi) Procedures for safe working with MMMF/MMVF/SVF have been produced and communicated, but workers chose not to follow them for a number of reasons (e.g. time and cost savings; no effective supervision; lack of training and awareness).

It is the responsibility of ADNOC Group & their Contractors to manage MMMF/MMVF/SVF where there is likelihood of an employee conducting an activity which is likely to disturb or damage MMFs, thereby posing a risk to health and well-being of workers and personnel occupying the premises or facilities where work is being carried out.

Guidelines on how to conduct health risk assessment of MMMFs can be found in Appendix 3 of the Occupational Health Risk Management Standard (HSE-OH-ST03, Ref. 25).

7.13.4. PRECAUTIONS IN THE USE OF MMMF/MMVF/SVF

Exposure to fibres should be prevented or, if this is not reasonably practicable, adequately controlled. The number of people liable to be exposed to MMMF/MMVF/SVF and the duration of their exposure should always be kept to the minimum necessary for the work. The following are examples of the precautions which should be observed when using/handling MMMF/MMVF/SVF.

(a) Dust Control

The production of dust should be minimized by:

(i) enclosing dusty processes as far as reasonably practicable;

(ii) Using exhaust ventilation, e.g., when cutting fibre blanket/modules. The work should be positioned close to the hood/ducting to ensure that as much dust as possible is captured;

(iii) keeping fibre materials wrapped when not in use and handling them as little as possible;

(iv) Buying in correct size and which are pre-wrapped, e.g., in polythene. This will reduce dust during cutting, handling and installation;

(v) Designating 'contaminated' areas, where exposure may occur and keeping these as separate as possible from other work operations. Such areas should have warning signs to indicate the risk and the precautions to be taken. Spread of dust from these areas should be prevented; and

(vi) Wherever possible, thoroughly wetting fibre in its original form before removal from existing plant. (Sampling has shown that wetting can reduce the amount of dust in air by at least a factor of 10).

During maintenance work, e.g., removing linings from kilns/furnaces where high levels of dust can be predicted, the operation should be wholly or partially enclosed, e.g., with plastic sheeting. This would be particularly important if the job was being done during normal working hours and other workers could be exposed to dust. Enclosure will, of course, give rise to higher local levels of dust and the enclosure itself should be mechanically ventilated; existing extraction systems (e.g., the kiln/furnace ventilation system) could be utilised for this purpose; with extracted air filtered or discharged directly to atmosphere (subject to environmental protection legislation). Otherwise a 'Type H' vacuum cleaner fitted with high-efficiency filtration should be used.

(b) Personal Protective Equipment

Personal protective equipment for MMMF/MMVF/SVF can be found in the ADNOC Personal Protective Equipment Standard (HSE-OS-ST20, Ref. 78). However, specific requirements for MMMF/MMVF/SVF not mentioned in that Standard are mentioned below:

(i) Protective Overalls

Protective overalls shall be worn when handling MMMF/MMVF/SVF. For dusty operations, loose-fitting one-piece disposable overalls, preferably with a hood, should be used, and disposed of at the end of each shift. Thought should be given to minimising exposure to any residual dust clinging to overalls when they are being taken off. Wearing gloves when handling MMF/MMVF/SMVF will help prevent skin irritation.

(ii) Respiratory Protective Equipment

All personnel working with MMMF/MMVF/SVF must use the correct type and range of PPE. The appropriate types will be determined by risk assessment, but it is the responsibility of the ADNOC Group or the ‘duty holder’ for Management (OH SME) of MMMF/MMVF/SVF to ensure that the PPE used is suitable and adequate to provide protection to workers engaged in MMMF/MMVF/SVF removal work.

Table 7.13.2 provides typical type of work and suitable respirator to be used, while handling/installing removing of MMMF/MMVF/SVF.

Table 7.13.2: RCF RPE Requirements [Ref. 46]

Refractory Ceramic Fibres (RCF) – Summary of PPE Requirements	
Type of Work	Respirator Type
Cutting and installing Rockwool blanket, block, board or modules	N100 dual cartridge half-mask respirator
Cutting and Installing fully encapsulated duct wrap	
Cutting and installing fully encapsulated duct wrap	N95 air purifying respirator
Cutting and installing unencapsulated duct wrap	N100 dual cartridge half-mask respirator
Removing refractory insulation	
Removing refractory insulation	N100 full face piece respirator or a powered air purifying respirator (PAPR) with HEPA filters.
Glass Fibre and Mineral Wool – Summary of PPE Requirements	
Type of Work	Respirator Type
Fireproofing Spray Application	
Sprayer	N95 air purifying respirator
Feeder	N95 air purifying respirator
Disturbing Sprayed Fireproofing Materials	
Dry Waller/Bricklayer/Sheet metal worker/Electrician/Pipefitter	N95 air purifying respirator
Pipe, duct and boiler insulation	
Insulating Ceiling Tiles	N95 air purifying respirator
Removal, maintenance and demolition	
Removal and storage of blanket insulation	N95 air purifying respirator
Removal, storage and clean-up of ceiling tiles	N95 air purifying respirator
Demolition	N95 air purifying respirator

1. Disposable RPE must always be [Ref. 46]:
   - Stored in a suitable safe and clean location before use; and
   - Examined in accordance with the manufacturer's instructions before use (pre examination) to make sure it is not damaged and is in good working order.

   A pre examination of RPE must be carried out and thus must include the following checks on the condition of:

   - Straps;
   - Face piece, including the seal and nosepiece;
   - Exhalation valve, if fitted.

   A face-fit check must be carried out to make sure that the RPE properly fits the wearer. A copy of the manufacturer's user instructions must always be available to the wearer. This will give information on simple fit checks, such as those involving blocking filters and inhaling to create suction inside the mask so any leakage can be detected.

2. Non-Disposable RPE

Effective protection from non-disposable RPE is dependent on maintaining the equipment in good condition and in working order. This is made by sufficient cleaning and decontamination and by carrying out regular checks and examinations. There are three (3) separate examinations which must be carried out on non-disposable RPE:

- Pre issue examination which needs to be carried out by a competent person before the RPE is issued to a wearer;
- Regular periodic examinations by a competent person to make sure that the RPE is in efficient working order; and
- Post use examination, which is carried out by the wearer before the using the RPE.

All wearers of non-disposable RPE must have received sufficient training to be able to complete the necessary checks.

3. RPE Filter Efficiency

As per NIOSH, the following RPE filter efficiencies shall be followed:

- Up to 5X REL (Recommended Exposure Limit): APF = 5) any quarter mask respirator.
- Up to 10X REL: (APF = 10) any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face pieces) except quarter-mask respirators.
- Up to 25X REL: (APF = 25) any supplied air respirator operated in a continuous flow mode (APF = 25) any powered, air-purifying respirator with a high efficiency particulate filter.
- Up to 50X REL: (APF = 50) any air purifying, full face piece respirator with an N100, R100, or P100 filter.
- Up to 1000X REL: (APF = 2000) Any supplied-air respirator that has a full face piece and is operated in a pressure-demand or other positive-pressure mode

The following filters may also be used:

N99, R99, P99, N100, R100, P100.

(c) Housekeeping and Waste Disposal

A good standard of housekeeping should be maintained to prevent secondary exposure from settled dust. Waste and off-cuts should be removed frequently. Cleaning should be carried out by a method which does not give rise to dust, i.e. not dry sweeping. Any residual material should be vacuumed with a suitable industrial vacuum cleaner fitted with high efficiency (HEPA) filtration. Wherever possible, waste materials should be wetted.

Waste fibre should be carefully placed directly into heavy duty plastic bags. If the material is thrust too vigorously into the bag, dust will be blown back out. All waste should be double-bagged in heavy-duty plastic bags and clearly labelled to indicate the contents.

(d) Information, Instruction and Training

All workers should be given the appropriate information, instruction and training to enable them to appreciate the hazards and risks from MMMF/MMVF/SMVF and why it is important for them to observe the correct precautionary measures, e.g., wearing respirators and maintaining good standards of housekeeping and hygiene.

8. COMPLIANCE ASSURANCE

ADNOC will conduct compliance audit of this Standard at approximately three-year intervals. These Audits will be in addition to GC's internal audits and where required, ADNOC will take steps to minimise overlap and duplication between ADNOC Corporate and Group Companies internal audits.

The main audit deliverable is a formal and structured report for the attention of GC Management and the respective ADNOC Directorate.

8.1. REVIEW CYCLE OF RISK ASSESSMENT

Risk assessment of chemical hazards shall be subject to review if one or more of the following conditions apply:

(i) Significant changes have occurred to the processes, raw materials, or to the plant and equipment;

(ii) Occurrence of significant occupational health incident; and

(iii) Additional legislation, guidance or international information has been released or come to light to alter the definition and the appreciation of the hazards and risks.

8.2. PERFORMANCE KPIS

Table 8.2.1: Chemical Health Hazard KPIs

No.	KPI	Targets
1.	Periodic Submission of Health Hazard Risk Register specific to Chemical hazard to ADNOC GHSEF and subsequent resubmission on periodic basis.	100% completion
2.	HSE Assessment of New/Existing Chemical using Site-Based form and periodic submission of ADNOC HSE Chemical Register	100% completion

9. REFERENCES

1. CAS Registry, American Chemical Society, 2012.
2. Control of Substances Hazardous to Health Regulations 2002, UK Health and Safety Executive.
3. Strategic Approach to International Chemicals Management (SAICM), International Conference on Chemicals Management (ICCM), Dubai, 4–6 February 2006.
4. Globally Harmonized System of Classification and Labelling of Chemicals (GHS); United Nations Economic Commission for Europe (UNECE), 2002.
5. Stockholm Convention, global treaty to protect human health and the environment from persistent organic pollutants (POPs); 17 May 2004.
6. Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, Rotterdam, 2004.
7. The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal; 1992.
8. The Montreal Protocol 1997.
9. United States Environmental Protection Agency. Chemicals under the Toxic Substances Control Act (TSCA).
10. Registration, Evaluation and Authorization and Restriction of Chemicals (2007) and the Classification, Labelling and Packaging Regulations (2008).
11. Modern Industrial Hygiene, Recognition and Evaluation of Chemical Agents, 2nd edition, J L Perkins, ACGIH, 2008. ISBN 978-1-882417-75-9.
12. Decision of the Council of International Civil Aviation Organization. Technical Instructions for the Safe Transport of Dangerous Goods by Air, 2015-2016 edition.
13. United Nations. United Nations Recommendations on the Transport of Dangerous Goods Model Regulations Volume 1, 17th Revised Edition.
14. Guidance on the compilation of a Safety Data Sheets, version 1.1, European Chemical Agency, Doc Ref: ECHA-2011-G-08.1-EN, 2011.
15. ISO 11014-1:2003 Draft Safety Data Sheet for Chemical Products.
16. American National Standard for Hazardous Industrial Chemicals-MSDS Preparation (ANSI Z-400.1-2004).
17. U.S. Department of Labour, OSHA, 29 CFR 1910.1200, HAZCOM.
18. What is an Adverse Health Effect? Environmental Health Perspectives, October; 52: 177–182 (1983).
19. Barron's Anatomy, 2nd Edition, 2010, ISBN 0 7641 6159 8.

20. Health Effects of Hazardous Substances, BOHS Module W507, 2010.
21. ADNOC Health Screening & Surveillance Standard, HSE-OH-ST05.
22. Occupational Exposure Limits, papers presented at Workshop # 12, International Occupational Health Association, Rome, 2010.
23. Permissible Exposure Limits, Occupational Safety & Health Administration – US Department of Labour, http://www.osha.gov/dsg/topics/pel/index.html.
24. EH40/2005 Workplace exposure limits, Containing the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations (as amended), UK Health & Safety Executive, 2nd edition, ISBN 978 0 7176 6446 7, 2011.
25. ADNOC Occupational Health Risk Management Standard, HSE-OH-ST03.
26. Methods for the Determination of Hazardous Substances (MDHS), Health & Safety Laboratory, http://www.hsl.gov.uk/publications/mdhs.aspx.
27. NIOSH Manual of Analytical Methods, Center for Disease Control and Prevention, http://www.cdc.gov/niosh/docs/2003-154/method-i.html.
28. Control of Substances Hazardous to Health (CoSHH), Health & Safety Executive, 2002. http://www.hse.gov.uk/coshh/.
29. A short guide to the Personal Protective Equipment at Work Regulations, INDG174 (rev1), Health & Safety Executive, 2005.
30. Selecting protective gloves for work with chemicals, INDG330, 2000.
31. Chemical Storage Guidelines, Center for Disease Control and Prevention.
32. ADNOC Standard on Waste Management, HSE-EN-ST04
33. J L Perkins, Control of Chemical Agents, Volume 3, Modern Industrial Hygiene, ACGIH, 2011. ISBN 978-1-607260-47-9
34. Fundamentals of Industrial Hygiene by Barbara A. Plog and Patricia J. Quinlan, 6th ed., 2012. Chapter 22, pp. 679-683.
35. IMDG Code: International Maritime Dangerous Goods Code Volume 1. Retrieved from https://law.resource.org/pub/us/cfr/ibr/004/imo.imdg.1.2006.pdf
36. American Conference of Governmental Industrial Hygienists. Industrial Ventilation: A Manual of Recommended Practice for Design, 30th edition.
37. Local Exhaust Ventilation (LEV) Guidance, published in Jan 2014 by Health Safety Authority, UK.
38. US Environmental Protection Agency. Learn About Asbestos. Retrieved from https://www.epa.gov/asbestos/learn-about-asbestos
39. Asbestos image gallery. UK Health & Safety Executive, 2012.
40. What Are Asbestos-Related Lung Diseases? National Heart, Lung and Blood Institute, http://www.nhlbi.nih.gov, 2012.
41. Asbestos, UK Health & Safety Executive, www.hse.gov.uk. 2012.
42. Asbestos: The survey guide, HSG264, 2nd edition, Health & Safety Executive, 2012, ISBN 978 0 7176 6502 0.
43. Advice on non-licensed work with asbestos, Asbestos Essentials, Non-Licensed Tasks, a0, Health & Safety Executive, 2012.
44. Em6 Asbestos Essentials: Personal Protective Equipment (including RPE) Equipment and method sheet. United Kingdom Health & Safety Executive, 2017.
45. Task Manual, Asbestos Essentials, Health & Safety Executive, www.hse.gov.uk/asbestos/essentials/index.htm, 2012.

46. Asbestos: The analysts' guide for sampling, analysis and clearance procedures, HSG 248, 2005, ISBN 978 0 7176 2875 9. Downloadable from: http://www.hse.gov.uk/pubns/books/hsg248.htm
47. The Control of Asbestos Regulations, 2012, UK-HSE.
48. Managing and working with Asbestos, Control of Asbestos Regulations, Approved Code of Practice, L143 (2nd ed.), Health & Safety Executive, 2013.
49. Fundamentals of Industrial Hygiene by Barbara A. Plog and Patricia J. Quinlan, 6th ed., 2012. Chapter 22, pp. 679-683.
50. United States OSHA Medical Evaluation Questionnaire (Appendix C of 29 CFR 1910.134).
51. EAD-EQ-PCE-TG-16 Technical Guidance Document for Storage of Hazardous Materials, Environment Agency Abu Dhabi.
52. US OSHA Regulation 1910, sub part 2, Standard number 1910.001(b)
53. UK HSE Asbestos : for the licensed Contractor Guide 2006, ISBN: 9780717628742 , Series Code : HSG247
54. UK HSE Guideline on Respiratory Protective Equipment at Work, A Practical Guide, Fourth Edition 2013
55. ADNOC Hazardous Substances Standard, HSE-OS-ST13
56. ADNOC Sustainability Report 2009: ADNOC and its Group of Companies Sustainability Charter, page 1.
57. United Arab Emirates Federal Law No. 12 of 2018 on the Integrated Waste Management.
58. United Arab Emirates Department of Transport. Maritime Sector Transport Regulations (General and Port Operations), 2nd edition. October 2010.
59. Organization for the Prohibition of Chemical Weapons. Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on their Destruction.
60. United States Occupational Safety and Health Administration. 29 CFR 1910.1200. Hazard Communication. Retrieved from https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10099&p_table=STANDARDS
61. ADR applicable as from 1 January 2019 European Agreement Concerning the International Carriage of Dangerous Goods by Road, Volumes 1 and 2.
62. UNECE. European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN 2017).
63. Cabinet Decree (12) of 2006 Regarding Regulation Concerning Protection of Air from Pollution, https://www.ead.ae/Documents/PDF-Files/Federal-Bylaw-12-Air-pollution-2006-English-translation.pdf
64. ADNOC Hazard Communication Standard, HSE-OS-ST27
65. Research Report 503, An inventory of fibres to classify their potential hazard and risk, Health & Safety Executive, 2006
66. United Kingdom Health and Safety Executive. Using a Class H vacuum cleaner for asbestos. Retrieved from https://www.hse.gov.uk/pubns/guidance/em4.pdf
67. United Kingdom Health & Safety Executive. Personal Decontamination: Asbestos Essentials. Retrieved from https://www.hse.gov.uk/pubns/guidance/em8.pdf.
68. American Industrial Hygiene Association. The Occupational Environment: Its Evaluation, Control and Management 3rd edition. Chapter 44: Emergency Planning and Crisis Management in the Workplace.
69. TSI, CBRN Mask Protection Assessment Test System 8020M

70. American Industrial Hygiene Association. The Occupational Environment: Its Evaluation, Control and Management 3rd edition. Chapter 40: Respiratory Protection.

71. International Agency for Research on Cancer. Asbestos (Chrysotile, Amosite, Crocidolite, Tremolite, Actinolite and Anthophyllite). Retrieved from https://monographs.iarc.fr/wp-content/uploads/2018/06/mono100C-11.pdf

72. Barbara A. Plog and Patricia J. Quinlan. Fundamentals of Industrial Hygiene, 5th ed. National Safety Council.

73. US OSHA 1910.1028 on Occupational Safety and Health Standard, Toxic and Hazardous Substances: Benzene.

74. Health and Safety Executive. LEV Calculations. From: http://www.hse.gov.uk/lev/calculator.htm

75. American Conference of Governmental Industrial Hygienists. Industrial Ventilation: A Manual of Recommended Practice for Design, 30th edition.

76. United Kingdom Health and Safety Executive (2008). Hazards from the Use of Refractory Ceramic Fibre OC 267/3. Retrieved from: http://www.hse.gov.uk/foi/internalops/ocs/200-299/267_3v2.htm

77. United Kingdom Health and Safety Executive (2014). Machine-made fibres: Airborne number concentration and classification by phase contrast light microscopy.

78. ADNOC Personal Protective Equipment Standard, HSE-OS-ST20.

79. ADNOC Group Management of Technical Changes Standard, HSE-OS-ST30.

80. ADNOC Group Inventory Management Procedures, Version 2.0, 27 June 2018 (ADNOC/B&CSD/P&P/108).

81. United Arab Emirates Ministry of Climate Change and Environment (MOCCAE). Team to Execute National Strategy for Integrated Management of Chemicals Holds First Meeting in Dubai, 28 July 2019.

82. Integrated Hazardous Materials Management System – United Arab Emirates. https://www.hazmat.ae/overview.jsp

83. United States Department of Transportation and Transport Canada. 2016 Emergency Response Guidebook. Retrieved from: https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/ERG2016.pdf

84. Tadweer: The Center of Waste Management Abu Dhabi. Standard Operating Procedure for Licensing of Hazardous Waste Service Providers in the Emirate of Abu Dhabi (CWM.SOP.PR/01).

85. ADNOC Incident Notification, Reporting & Investigation Standard, HSE-GA-ST04.

86. ADNOC HSE Risk Management Standard, HSE-RM-ST01.

87. ADNOC Emergency Response Plan Standard, HSE-CE-ST05.

88. ADNOC Fire and Rescue Services Standard, HSE-OS-09.

89. United Kingdom Health and Safety Executive. Material and priority scoring tools. Retrieved from: http://www.hse.gov.uk/asbestos/assets/docs/materials-priority-scoring.pdf

90. OSHAD-SF Code of Practice CoP 1.10 – Management of Asbestos Containing Materials. July 2016.

91. OSHAD-SF Code of Practice CoP 1.0 - Hazardous Materials Version 3.1. June 2018.

92. Health and Safety Executive Safety Alert. Change in Enforcement Expectations for Mild Steel Welding Fume. Retrieved from: https://www.hse.gov.uk/safetybulletins/mild-steel-welding-fume.htm

10. APPENDICES

APPENDIX 1 Chemical Storage Inspection Checklist

APPENDIX 2 Site-based Chemical HSE Assessment Form

APPENDIX 3 Chemical Register

APPENDIX 4 Asbestos Register

APPENDIX 5 Benzene Exposure and Monitoring

APPENDIX 1 CHEMICAL STORAGE INSPECTION CHECKLIST

Asset		**Date:**	
Building:			
Inspected by:			
Supervisor: (name and signature	ADNOC Group HSE Manager: (name and signature)	Corporate HSE:	
Element		**Y/N/NA**	**Comments / Hazard**
Y = Up to standard (adequate), N = Below standard (action required), NA = Not Applicable			
1. Layout			
1.1 Area is tidy and well kept			
1.2 Adequate storage area provided			
1.3 Floor is free of obstructions and not-slippery			
1.4 Pathways are sufficiently wide for traffic			
1.5 Can be opened from the inside without a key			
1.6 Chemicals stored away from heavily travelled areas.			
Actions: (include person responsible and target completion date)			
2. Site			
2.1 For flammables store, flame proof lighting provided			
2.2 Lighting is adequate (Day and Night if applicable)			
2.3 Lighting covers and fittings are secure			
2.4 Area is free from strong odours. Ventilation is sufficient to prevent build-up of offensive odours?			
2.5 Ventilation is adequate (all extraction fans are functional and in good working condition)			
Actions: (include person responsible and target completion date)			
3. Emergency Procedures			
3.1 Written procedures posted in prominent locations			
3.2 Extinguisher of appropriate type easily accessible (not closer than 1 meter to fume cupboard)			
3.3 Tag on extinguisher has been checked in the last 6 months			
3.4 Alarm can be heard in the area (if applicable)			
3.5 Escape routes are clear			
3.6 No trap points in event of fire			
3.7 Emergency and hazard signage is clearly visible			
3.8 Emergency telephone numbers post clearly			
Actions: (include person responsible and target completion date)			
4. First Aid Facilities			
4.1 Kits accessible within 5 minutes			
4.2 Kits are stocked and contents are in-date			
4.3 Names and contacts of first aiders displayed			
Actions: (include person responsible and target completion date)			
5. Chemical Storage			
5.1 Chemical Inventory and SDS available			
5.2 Containers are labelled with chemical name and Class diamonds			

HSE Management System
Occupational Health Management Standards
Chemical Hazards
Chemical Storage Inspection Checklist
APPENDIX 1

Asset		**Date:**	
Building:			
Inspected by:			
Supervisor: (name and signature	ADNOC Group HSE Manager: (name and signature)	Corporate HSE:	
Element		**Y/N/NA**	**Comments / Hazard**
5.3 Chemicals are stored correctly, segregated, bunded and separated from all drains			
5.4 All store users inducted			
5.5 Safe Working Practices documented			
5.6 Chemical quantities kept within storage capacity			
5.7 There is security/restricted access to store areas?			
5.8 Chemicals kept in appropriate cabinets (if applicable)			
5.9 Chemicals are stored in completely separate storage rooms from gas cylinders			
5.10 Is there appropriate secondary containment to prevent the spread of major spills?			
5.11 All hazardous materials containers are properly labelled (indicating the chemical's identity, the manufacturer's name and address, and appropriate hazard warnings.)			
5.12 All shelving is compatible with chemicals stored			
5.13 Spill kits are available and maintained			
5.15 Posted signs are adequate (i.e. Chemicals Hazards, Required PPE, etc.)			
5.16 Ready access to eyewashes and emergency showers			
5.17 Are all containers free from leaks or damage?			
Actions: (include person responsible and target completion date)			
6. Manual Handling			
6.1 Frequently used items are within easy access between knee and shoulder			
6.2 Heavy items stored at waist height			
6.3 Stepladders or safe steps are available to access items stored on high shelves			
6.4 Trolleys are available for heavy items and loads			
6.5 Stored items adequately secured and stable			
Actions: (include person responsible and target completion date)			
7. General Store			
7.1 Warning and safety signs in good condition			
7.2 Procedure, plant and equipment manuals are current and available			
7.3 Store free of food and drink			
Actions: (include person responsible and target completion date)			
8. PPE			
8.1 Correctly stored			
8.2 Well maintained and in good condition			
8.3 Ready access to eyewashes and emergency showers			

HSE Management System
Occupational Health Management Standards
Chemical Hazards
Chemical Storage Inspection Checklist
APPENDIX 1

Asset		**Date:**	
Building:			
Inspected by:			
Supervisor: (name and signature	ADNOC Group HSE Manager: (name and signature)	Corporate HSE:	
Element		**Y/N/NA**	**Comments / Hazard**
8.4 Signage of PPE requirements displayed			
8.5 Required PPE available			
Actions: (include person responsible and target completion date)			
9. Cylinder Safety			
9.1 Gas cylinders stored securely			
9.2 Specialised trolleys are available for moving gas cylinders			
9.3 All cylinders at least 3m away from ignition sources and combustible material			
9.4 Are empty cylinders separated and identified as empty?			
Actions: (include person responsible and target completion date)			
10. Waste Disposal			
10.1 Waste containers are provided and labelled with Class Diamonds			
10.2 Waste is segregated and stored appropriately away from drains			
10.3 Spill kits are available			
10.4 Garbage/organic waste containers are covered and frequently evacuated to prevent smell and insects infestation.			
Actions: (include person responsible and target completion date)			
Other Comments :			
General Recommendations :			

APPENDIX 2 SITE-BASED CHEMICAL HSE ASSESSMENT FORM

Environmental Assessment:

1. Ecological Information (*as per Section 12 of SDS)*

Biodegradability/Biodegradation	
Bioaccumulative Potential (Log Kow or BCF)	
Soil Mobility (Kod or Koc)	

2. Potential accidental releases to sea (Yes or No):
☐ Yes ☐ No

3. Potential accidental releases to land (Yes or No)
☐ Yes ☐ No

4. Control/Mitigation of Airborne Emissions, if any:

Existing Control	Mitigation Measures

5. Waste Management/ Spill Control Cleanup Measures (Soil and Water)

Spill location pathway:
Spill recovery method: Recommended recovery method (mechanical, chemical, incineration)
Recovery rate, if applicable:
Disposal Considerations (as per Section 13 of SDS):

6. Remarks

Legend for Environmental Assessment:

Kow: n-octanol water partition coefficient. This is defined as the ratio of the concentration of a chemical in n-octanol and water at equilibrium at a specified temperature. It is mathematically defined as:

Kow = concentration of octanol/concentration in water

Values of Kow are unitless and usually expressed as logKow, a relative indicator of the tendency of an organic compound to adsorb to soil and living organism. Substances with high logKow values tend to adsorb more readily to organic matter in soils or sediments because of their low affinity for water.

BCF: Bioconcentration Factor

Kd: soil adsorption coefficient. Measures the amount of chemical substance adsorbed onto soil per amount of water. It is mathematically defined as:

Kd = concentration of chemical in soil/concentration of chemical substance in water

Koc: organic carbon-water partition coefficient. It is mathematically defined as:

Koc = (Kd * 100)/% organic carbon

Kd or Koc measures the mobility of a substance in soil. A very high value means it is strongly adsorbed onto soil and organic matter and does not move throughout the soil. A very low value means it is highly mobile in soil.

Recovery Rate: chemical quantity recovered from spill/chemical quantity released from spill

Occupational Health Assessment:	
HEALTH RISK RATING of most hazardous component (refer to Table 4, page 42 of the OHRM standard, HSE-OH-ST03):	
Health Effects: Acute: Chronic:	
GHS Health Hazard Category:	
☐ Acute toxicity ☐ Skin corrosion/irritation ☐ Serious eye damage/eye irritation ☐ Respiratory/skin sensitization ☐ Germ cell mutagenicity	☐ Carcinogenicity ☐ Reproductive toxicity ☐ Specific target organ toxicity (single exposure) ☐ Specific target organ toxicity (repeated exposure) ☐ Aspiration hazard ☐ None of the options mentioned
Identify Engineering Controls used, if any (tick option below).	
☐ Local Exhaust	☐ General Dilution
☐ Scrubber	☐ Filter
☐ Closed Loop System	☐ Others, please specify:
Respiratory Protection used, if any:	Respirator Cartridge used, if any:
Respiratory Protection (if required): ☐ Half Facepiece ☐ Full Facepiece ☐ Supplied Air ☐ Self-contained breathing apparatus ☐ Other (please specify):	Cartridge Filter Selection: (separate masks and filters) ☐ Organic Vapour (A) ☐ Acid Gas (B) ☐ Multi-Gas ☐ P78 gas mask ☐ N/R/P95 type ☐ N/R/P98 type ☐ High efficiency particulate air (HEPA) filter ☐ Other (please specify):

Occupational Health Assessment:	
Chemical Glove Type used, if any: ☐ Butyl Rubber ☐ Natural Rubber ☐ Neoprene Rubber ☐ Nitrile Rubber ☐ Viton Rubber ☐ Other (please specify):_____ Foot Protection used, if any: ☐ Boots ☐ Overboots ☐ Overshoes ☐ Booties ☐ Boot covers ☐ Other (please specify): _____	Eye Protection used, if any: ☐ Safety Glasses ☐ Chemical Goggles ☐ Face shield ☐ Other (please specify): _____ Body Protection used, if any: ☐ Bib-style apron ☐ Hood with visor ☐ Disposable coverall (collar, zipper, cuffs) ☐ Disposable 2-piece splash suit ☐ Totally-encapsulating chemical suit ☐ Other (please specify): _____
Is chemical regulated by local/federal/international regulation?	
☐ Yes	☐ No
Please specify applicable regulation(s):	
Recommendations, if any:	

Note: Most HAZARDOUS component refers to the chemical ingredient that has the highest severity rating.

Safety Assessment:						
Fire Hazard Properties						
Flammability	☐Flammable	☐Non Flammable	☐No data	**Flash Point (in Celsius, IF FLAMMABLE)**		☐No data
Chemical Reactivity and Incompatibility (as per Sections 7 and 10 of SDS)						
GHS Physical Hazard Category		☐ Explosive(s) ☐ Flammable gas(es) ☐ Aerosol(s) ☐ Oxidizing gas(es) ☐ Gas(es) under pressure ☐ Flammable liquid(s) ☐ Flammable solid(s) ☐ Self-reactive substance(s) & mixture(s)		☐ Pyrophoric liquid(s) ☐ Pyrophoric solid(s) ☐ Self-heating substance(s) & mixture(s) ☐ Emit flammable gas(es) with water ☐ Oxidizing liquid(s) ☐ Oxidizing solid(s) ☐ Organic peroxide(s) ☐ Corrosive to metals ☐ None of the options mentioned	
Fire Fighting Measures (as per Section 5 of SDS)						
Suitable Extinguishing Media						**Unsuitable Extinguishing Media**
☐ DCP	☐ Foam	☐ Gas Suppression (CO2, Inert Gas)	☐ Water Spray	☐ Sand	☐ Others	
Emergency Response Requirements, if any (as per Section 6 of SDS):						
Storage and Handling Requirements, if any (as per Section 7 of SDS):						
Additional Information, if any:						

Overall Evaluation based on review by all parties (TO BE DECIDED BY ENVIRONMENT, SAFETY AND OCCUPATIONAL HEALTH team)	
	Recommended
	Not recommended
	Recommended with the following limitations:
HSE Safety Advisor/Engineer/Specialist:	**Signature and Date:**
HSE Environmental Advisor/Specialist:	**Signature and Date:**
HSE Industrial Hygienist/OH Advisor/Specialist:	**Signature and Date:**
END USER/PROCESS OWNER CONFIRMATION (site)	
I confirm that I have considered and understand the chemical to be used and the associated hazards. I am satisfied that all of the hazards have been identified and that the control measures to be followed will reduce the risks to as low a level as reasonably practicable.	
End User/Process Owner:	**Signature and Date:**

APPENDIX 3 ADNOC HSE CHEMICAL REGISTER

Name of Company/Service Unit:
Site :
Department:
Name of Preparer:
Job Title:
Date last updated:

Chemical/Product/ Brand Name	Vendor Details	Contractor-owned, ADNOC Product or Raw Material?	Hazardous (Y/N)?	CAS #	Date of SDS issue/Date last revised	GHS Health Hazard Classification?	Dangerous Goods? (Y/N)	Location/Plant	Dangerous Goods Class	Regulated Chemical? (Y/N)	Approved by HSE? (Yes/No)	Date of HSE Approval	Electronic SDS File or Link/HSE Chemical Approval Form Attachment

APPENDIX 4 ASBESTOS REGISTER

Corporate Asbestos Risk Register															
Name of the ADNOC Group /Service Unit:															
Date of Last Revision:															
S. No	Location	Site	Date of Survey	Product Type/Description	How much? (Quantity)	Accessibility	Condition	Surface Coating Type	Asbestos Type	Material/Assessment Score	Priority Assessment Score	Total Overall Score (Material + Priority + Assessment Score)	Test Results (% Asbestos content)	Follow up actions (include target date)	Responsible Party

APPENDIX 5 BENZENE EXPOSURE AND MONITORING [REF 73]

The Benzene Exposure Monitoring Program applies to ADNOC Group and its Contractor who work in areas or perform tasks that could cause exposure to benzene.

Exposure Limits

Benzene exposure shall not exceed 1.0 part per million (ppm) unless respiratory protection is used as per ADNOC Standard HSE-TS-ST06, Personal Protective Equipment.

An Action Level of 0.5 ppm as an 8-hour TWA shall be used to determine additional monitoring, medical surveillance, and additional employee training.

Exposure Monitoring

Exposure monitoring is managed by the ADNOC Group OH/IH SME.

Monitoring Frequency

At minimum, representative 8-hour TWA exposures shall be determined on the basis of at least one sample representing the full-shift exposure for each job classification in each work area where benzene-containing materials are present.

1. If full-shift sampling reveals employee exposures at or above the Action Level (0.5 ppm as an 8-hour TWA) but at or below the PEL, monitoring shall be repeated for that position at that location at least every year.
2. If sample results reveal exposures above the PEL, the monitoring for that group of employees shall be repeated at least every six months.

Note: ADNOC Group may alter the monitoring schedule from every six months to annually or may terminate monitoring altogether if two consecutive measurements taken at least seven days apart reveal exposure levels below the Action Level.

1. Where initial monitoring shows results below the Action Level, monitoring for that employee or group of employees may be discontinued until:
   (a) there is reason to believe that employee exposure levels might have changed; or
   (b) once every five years; or
   (c) As directed by the ADNOC OH/IH SME.

Area monitoring and /or surveys shall be performed after the clean-up of spills, ruptures, leaks, or other emergency exposures involving benzene-containing materials. This monitoring shall be performed to ensure that benzene levels have returned to levels below 1.0 ppm.

Exposure monitoring will be conducted within 30 days of:

1. the introduction of new benzene-containing materials into the workplace, or
2. A change in the production process, control equipment, personnel, or work practices that may result in new or increased exposures to benzene.

Monitoring Methods

(a) Employee exposure levels shall be determined from personal breathing zone air samples that are representative of the employee's normal workday and routine tasks.

(b) Breathing zone air samples shall be taken with collection media such as charcoal tubes, organic vapour monitor (OVM) badges, etc.

Notification of Monitoring Results

(a) Affected employees shall be notified of the results of any benzene exposure monitoring within 15 days of receipt of the results.

- This notification shall be in writing.
- Notification shall be sent to each employee or be posted in an appropriate, easily accessible location.

(b) Whenever the PEL is exceeded, affected employees shall be notified of the corrective action being taken to reduce employee exposure to below the PEL.

- This notification shall be in writing.
- Notification shall be sent to each affected employee or posted in an appropriate, easily accessible location.

Regulated Areas

(a) ADNOC Group and its Contractor shall establish regulated areas wherever the airborne concentration of benzene exceeds, or can reasonably be expected to exceed, 1.0 ppm.

Examples of locations that might be temporarily designated as regulated areas for benzene include:

1. An empty gasoline storage tank with an internal benzene airborne concentration of 1.0 ppm or greater.
2. The site of an uncontrolled release, based on the volume of material spilled and the concentration of benzene.

(b) The regulated area shall be demarcated from the rest of the work site by physical means or signs that limit access to only authorized, properly equipped personnel.

(c) Signs with the following warning shall be posted at all entrances to the regulated area:

DANGER
BENZENE
MAY CAUSE CANCER
HIGHLY FLAMMABLE LIQUID AND VAPOR DO NOT SMOKE
WEAR RESPIRATORY PROTECTION IN THIS AREA
AUTHORIZED PERSONNEL ONLY

Regulated Areas

(a) Appropriate respiratory equipment shall be used if airborne benzene concentrations exceed 1 ppm.

1. Respiratory protection shall also be used in emergency situations (i.e. to perform clean-up actions inside the 'hot zone'), if the airborne benzene concentration is unknown and suspected to be above 1ppm.
2. Organic vapour cartridges on air-purifying respirators worn to prevent benzene exposure shall be changed out at the beginning of each shift or if breakthrough is suspected.

All personal protective equipment shall be used in accordance with the ADNOC Standard HSE-ST06 on Personal Protective Equipment.

Medical Surveillance

Health Screening and Surveillance Program shall be made available to employees exposed to benzene. More details can be found in the ADNOC Health Screening and Surveillance Standard, HSE-OH-ST05.