OFFSHORE NORGE

131– Offshore Norge Recommended guidelines for identification, assessment, control and follow-up of benzene exposure

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PREFACE

These guidelines have been prepared as part of the industry project on the chemical working environment in the oil and gas industry. They have been recommended by the Offshore Norges expert networks on occupational hygiene and on health and the working environment, the HSE Managers Forum and the operations committee. They have also been approved by the director general of Offshore Norge. Responsibility for the guidelines rests with the Offshore Norge manager for HSE.

The work group which has developed the guidelines comprised representatives from the following companies:

- ExxonMobil
- ConocoPhillips
- Statoil
- A/S Norske Shell
- Marathon
- BP
- Talisman
- Portside
- Proactima

The responsible manager at Offshore Norge is the HSE manager, who can be contacted via the switchboard at +47 51 84 65 00.

These guidelines have been prepared with broad-based participation by interested parties in the Norwegian petroleum industry, and are owned by Offshore Norge on behalf of the industry. Offshore Norge is responsible for their administration.

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1 INTRODUCTION

1.1 Purpose

These guidelines have been produced to support the enterprises in the work of identifying, assessing, controlling and following up exposure to benzene in the petroleum industry. The recommendations can be implemented in the companies' own strategies and governing documents.

All enterprises are duty-bound to identify where benzene exposure may occur, to assess the exposure with the aid of competent personnel and to implement measures (barriers) which can reduce and control exposure so that health damage is avoided. The quality of these barriers shall be checked regularly. Necessary information and training shall be given.

1.2 Regulations and occupational exposure limits

Pursuant to the Norwegian Working Environment Act, the employer has a duty to ensure a fully acceptable working environment. The regulations on execution of work require the employer to prevent employees being exposed to hazardous and carcinogenic substances. If a closed system is not technically feasible, the employer must ensure that exposure is as low as possible and at a fully acceptable level.

Measures which eliminate exposure shall be preferred ahead of technical arrangements which reduce the possibility of exposure, measures which reduce exposure, and operational measures which reduce exposure. Use of personal protective equipment (PPE) shall be regarded as a temporary measure.

Benzene has a threshold limit value (TLV) of 1 ppm. This is the figure for eight-hour shifts. For offshore tours with 12-hour shifts, the TLV is normally set at 0.6 ppm.

Internationally, the ACGIH's TLV of 0.5 ppm (eight hours) and short-term exposure level (STEL) of 2.5 ppm is widely used. NIOSH operates with a TLV of 0.1 ppm (REL eight hours) and a STEL of 1.0 ppm. Benzene is IDLH at concentrations above 500 ppm (0.05 per cent).

The biological exposure index (BEI) in urine (SPMA) is set at 25 µg/g creatinine.

1.3 Terminology

ACGIH	American Conference of Governmental Industrial Hygienists
ALARP	As low as reasonable practicable
AML	Acute myelogenous leukaemia
BEI	Biological exposure index
IARC	International Agency for Research on Cancer
IDLH	Immediately dangerous to life or health (concentrations)
NDT	Non-destructive testing
NIOSH	National Institute for Occupational Safety and Health, USA
REL	Recommended exposure level
SPMA	S-phenylmercapturic acid: benzene metabolite – marker for benzene in urine
Stami	National Institute for Occupational Health, Norway
STEL	Short-time exposure level, 15 min of exposure
TLV	Threshold limit value

1.4 References

- Forskrift om utførelse av arbeid (regulations on execution of work) http://www.lovdata.no/for/sf/ad/ad-20111206-1357.html
- Forskrift om tiltaks- og grenseverdier (regulations on measures and limits) http://www.lovdata.no/for/sf/ad/ad-20111206-1358.html
- Activities regulations http://www.lovdata.no/for/sf/ad/ad-20100429-0613.html (only in norwegian)
- ACGIH: 2013 TLVs and BEIs
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- S Thorud et al: P*røvetakings- og analysemetoder – beste praksis*, National Institute for Occupational Health, 2011. http://www.stami.no/provetakings-og-analysemetoder-beste-praksis
- Offshore Norge recommended guidelines for health monitoring of employees exposed to chemicals, no 130. http://norskoljeoggass.no/en/Publica/Guidelines/Health-working-environment-safety/Working-enviornment/130-Recommended-guidelines-for-health-monitoring-of-employees-exposed-to-chemicals/
- Offshore Norge recommended guidelines for fit testing of respiratory protective equipment, no 133. http://norskoljeoggass.no/en/Publica/Guidelines/Health-working-environment-safety/Working-enviornment/133-Recommended-guidelines-for-fit-testing-of-respiratory-protective-equipment/

2 BENZENE IN THE PETROLEUM INDUSTRY

Benzene represents one of the biggest chemical health hazards related to the production and refining of petroleum products. It occurs naturally in oil and gas reservoirs, and follows the whole production chain.

Benzene is a known carcinogen and mutagen. Good systems and routines for identification, assessment, control and follow-up are therefore required.

2.1 Physical properties

Benzene (C_6H_6) is a colourless aromatic hydrocarbon. It is volatile and vaporises quickly. The vapour is heavier than air and can spread along the floor. Benzene is extremely flammable.

Molecular formula	C_6H_6
Index no:	601-020-00-8
CAS no:	71-43-2
EC no:	200-753-7
Form:	Colourless liquid
Melting point:	5.5°C
Boiling point:	80.1°C
Vapour pressure:	94.8 mm Hg (0.1247 atm) at 25°C
Density:	0.87 g/cm^3
Solubility in water:	1.8 g/l
Stability:	Dangerously reactive with concentrated mineral acids, halogens, melted sulphur. Dissolves non-polarised rubber.

2.2 Health hazards

Benzene is classified as:

- carcinogenic (IARC category 1)
- mutagen
- toxic with inhalation, skin contact and swallowing
- extremely flammable

In addition, benzene can cause lung damage when swallowed and irritate eyes and skin.

In an occupational context, benzene is mainly absorbed through inhalation and skin contact.

Acute exposure to high concentrations of benzene can cause trembling, confusion, unconsciousness and death, while exposure to low concentration can lead to dizziness, irritation and headache. Aspiration to the lungs can cause pneumonia, which may be fatal. Skin contact can result in redness, soreness, itching, headache and dizziness.

Potential long-term effects of benzene exposure include eczema, cracking of the skin, anaemia, leukaemia (AML) and genetic damage.

2.3 Occurrence in the petroleum industry

Benzene occurs to a greater or lesser extent in all process streams in the production or processing of oil and gas. Crude oil in offshore production normally contains 0-1 % of benzene. The concentration of benzene in natural gas condensate can be as high as 10 %.

Benzene will also occur in solution in produced water. Its content in refineries can vary from 0 to 60 % in different production streams. Benzene can also occur as a pollutant in solvents, paint and oil-based mud containing aromatics.

Benzene exposure occurs primarily through leaks in closed systems or when these systems must be opened for sampling, product transfer, inspection and maintenance of equipment, and transport (loading on/discharging from ships or road/rail tankers).

Sources of benzene exposure outside work include emissions from various types of vehicles, petrochemical plants and various combustion processes. Benzene is also one of the components in tobacco smoke.

3 RISK ASSESSMENT

When assessing the health risk associated with benzene, it is important to:

- identify where benzene is to be found
- identify job tasks where personnel may be exposed directly or indirectly to benzene through the respiratory system or skin
- make an assessment of the exposure level
- identify the need for controls
- use competent personnel.

3.1 Identifying benzene

Benzene is a part of the main process stream in an oil installation, but is also found in support systems and waste streams. The same applies to refining. Benzene occurs in many contexts together with other hydrocarbons, but will in most cases be the chemical which poses the biggest health risk. As a rule, this means that controlling exposure to benzene also ensures control of most other hydrocarbons hazardous to health. Whether this is actually the case, however, must always be assessed locally.

It has been demonstrated on a number of installations that exposure to n-hexane correlates with exposure to benzene. In the event, that must be taken into account in the risk assessment.

Appendix 1 provides examples of equipment which should receive particular attention in the risk assessment.

3.2 Groups particularly exposed to risk

Personnel working with equipment and systems which contain benzene are defined as groups particularly exposed to risk. High exposure levels are often related to opening equipment and systems, including transfer, maintenance, sampling and inspection activities.

The following personnel categories are expected to have jobs which could involve exposure to benzene:

- production/process operators
- maintenance personnel (mechanical, instrumentation)
- cleaning staff (tanks, for example)
- laboratory technicians
- inspectors (NDT)
- drilling personnel
- deck crew on ships
- terminal personnel and warehouse workers
- lorry drivers
- technical marine managers, cargo managers.

Contractors often perform the same types of maintenance operations on different installations, and this group of workers could therefore be more frequently exposed to benzene.

3.3 Job tasks involving possible exposure

The job tasks listed in Table 1 are expected to involve possible benzene exposure. Who does the work could vary from installation to installation. When identifying possible benzene exposure focus should be on these job tasks. The list presents a set of examples and is not in order of priority.

Table 1: Example of job tasks which may involve a high level of benzene exposure

Opening hydrocarbon equipment
Entering tanks
Mechanical work on hydrocarbon equipment or systems for produced water or glycol
Cleaning/steaming/ventilation of tanks, separators, piping, etc
Connecting/disconnecting hoses
Flowline inspection (disassembly of valves, chokes, orifices, etc)
Sending and receiving pigs
Changing and cleaning filters
Changing desiccants
Maintaining and testing metering and regulation equipment
DepressurizationDrainage
Level-metering
Sampling of oil, condensate and produced water
Analysis and lab work
Bunkering
Waste handling
Soil surveys

3.4 Occupational hygiene measurements

Benzene measurements should be conducted to document the level of exposure in various jobs. This calls for specialised equipment and expertise.

Choice of respiratory protection and other PPE should be based on results from these measurements.

Measurements should also be carried out to verify the effect of measures and barriers to benzene exposure.

3.4.1 Measurement strategy

A measurement strategy should be established by qualified occupational hygienists.

Measurements should be conducted for all jobs where possible benzene exposure is identified. A basic survey based on a validated sampling methodology is recommended to provide the foundation for internal company guidelines on the use of simpler, less accurate methods. When exposure cannot be monitored continuously, a statistical assessment of the exposure measurements should be carried out.

3.4.2 Modelling

Modelling benzene exposure could be useful when assessing earlier exposure and different exposure scenarios. For a more detailed guide to using models to estimate chemical exposure, see *Mathematical Models for Estimating Occupational Exposure to Chemicals*.

3.4.3 Direct-reading instruments

Direct-reading instruments have been developed to measure the concentration of benzene in the air. Such devices should be simple to use, low in weight and highly available, have low cross-sensitivity and sufficient detection range, and preferably be EX approved.

Instruments based on colorimetric chemical sensors (CCSs), such as the Dräger CMS, have proved to be the most robust in operation. Photoionisation detectors (PIDs) with scrubber, such as UltraRae or PhotoCheck Tiger, have proved demanding in use, because of cross-sensitivity/interference, sensitivity to water vapour, pollution of the sensor and calibration requirements.

Good but less portable instrument are also available based on infrared spectrophotometry and gas chromatography (GC).

A form has been developed (appendix 2) to ensure effective registration of all necessary parameters related to the use of direct-reading instruments.

3.4.4 Personal air monitoring

Personal air monitoring can be conducted with an absorption tube and a pump. The equipment is attached in the respiration zone. The tube must be sent off for analysis. This is often done in connection with assessing job tasks.

Personal sampling can also be carried out with a dosimeter in the respiration zone. The meter is sent to a lab for analysis.

For an overview of validated sampling methods for personal and stationary sampling of benzene in the working atmosphere, see the Stami report on *Prøvetakings- og analysemetoder* and the NIOSH sampling manual (appendix 5).

3.4.5 Biological exposure monitoring

Biological exposure monitoring can be used to assess the total exposure to benzene. An advantage of this method is that the adequacy of personal barriers (respiratory protection, gloves, etc) can be assessed. Biological exposure monitoring is a simple way of assessing exposure for personnel who are not directly involved in the specific job (peripheral personnel).

The use of SPMA in urine is recommended. An example of a sampling form is provided in appendix 3.

4 RISK CONTROL

The most important control measure will be to design the facility to minimise personnel exposure. This can otherwise be controlled by technical means (such as closed sampling systems or chemical cleaning in closed systems), administrative measures (such as safety instructions or work procedures) and the use of PPE.

4.1 Design and technical measures

Account must be taken of possible benzene exposure when designing and engineering new facilities or modifying existing ones. Since a safe level of benzene exposure is difficult to envisage, risk assessments and measures should be based on the ALARP principle

Because benzene is carcinogenic, the regulations on executing work require that all systems containing benzene are closed. This must be taken into account when designing solutions for sampling, maintenance, cleaning and so forth, and is particularly important for long lead items such as separators, scrubbers and the like.

This means that technical solutions shall be implemented where they are available. Areas where benzene exposure is a hazard shall be signposted.

Technology for closed systems for sampling points, drainage and cleaning (“cleaning in place”) is available and must therefore be implemented. Extractor ventilation (portable and fixed) can be used to reduce benzene exposure during maintenance and sampling activities.

4.2 Procedures and safety instructions

The enterprise should have clear guidelines for classifying installations and equipment, and for implementing occupational hygiene measurements, risk assessments, and selection and use of PPE.

Procedures/safety instructions need to be prepared for work on opening hydrocarbon equipment and for work on process equipment which has been in contact with hydrocarbon process flows. The same applies to produced water systems, since these can be subject to benzene concentrations. The following considerations should be included in the procedure/safety instructions:

- categorisation of plant and equipment
- identified job tasks with a probability for benzene exposure
- technical and operational measures for reducing and controlling exposure
- instructions for using PPE
- criteria for assessing exposure measurements with the aid of direct-reading instruments
- training and information.

The procedure shall be supported by a risk assessment based on the results of occupational hygiene measurements from the relevant facility, experience from corresponding work inside and outside the enterprise, and a plan for occupational hygiene measurements of benzene exposure, including a plan for biological exposure monitoring.

Specific procedures may be required for tasks with a probability of high benzene exposure, such as cleaning tanks, work in enclosed spaces and so forth. These procedures shall be part of the work permit system.

4.3 Turnarounds

Turnarounds present special challenges for benzene exposure. Planning to avoid exposure is therefore important. All jobs shall be reviewed with an eye to exposure and protection. The plan should be ready in good time before the turnaround begins to allow for measures and necessary training. Occupational hygienists should be involved in the planning.

4.4 Information and training

The necessary information and training must be provided on the basis of the identified risk and the measures adopted to reduce it. Where PPE is used to prevent exposure, users must have adequate training in its use.

Before work involving possible benzene exposure starts, everyone involved shall be briefed on the exposure risk and the measures adopted to control it.

Training must be provided at the same level for all personnel involved, including contractor employees. The training shall be documented.

4.5 Personal protective equipment

PPE must be used when exposure cannot be eliminated by other means. The choice of such equipment shall be made by competent personnel together with representatives of the operations organisation and the safety delegate. Before masks are used, they must be individually fitted and tested. See the Offshore Norge recommended guidelines for fit testing of respiratory protective equipment, no 133.

Table 2: Respiratory protection

Benzene concentration	Respiratory protection
Possible/registered benzene exposure below the threshold limit value	Mask with A2 filter is recommended only for short-term operations (< one hour). For longer durations, a mask with compressed air or powered respiratory protection with a suitable filter is recommended.
Over the threshold limit value	Full mask with compressed air or powered respiratory protection with a suitable filter. Mask with A2 filter recommended for short jobs (< one hour) only. Combined filter must be used when necessary. Protection factor and safety margin (because of leaks) must be considered. The upper exposure limit for protective equipment must be specified. All aspects must be taken into account, such as work in enclosed spaces.

Routines should be developed for changing filters and other maintenance of respiratory protection.

Nitrile gloves are recommended. The penetration time must be specified.

The effect of the PPE should be documented – with the aid of biological exposure monitoring, for example.

Appendix 4 presents an example of a company's protective equipment regime for work on hydrocarbon equipment.

4.6 Exposure surveillance

Where a risk assessment indicates that the working environment should be monitored for benzene, a programme shall be drawn up for periodic occupational hygiene measurements, possibly including biological exposure monitoring. Suppliers must have access for doing the necessary assessment of the workplace.

The measurement programme shall be produced by qualified personnel with occupational hygiene expertise.

4.7 Health surveillance

The employer shall ensure that all employees exposed to benzene are subject to suitable health checks where available. That also applies to the employer of contractor personnel. These checks will form the basis for preventive measures in the company or other measures which reduce the health risk for workers. The latter shall be informed about the requirement for health checks before work begins.

The employer shall ensure that a register is kept of all employees exposed to benzene. Inclusion criteria must be developed for health monitoring, and for the register of personnel exposed to benzene.

Health checks shall be carried out by qualified medical personnel. See otherwise Offshore Norge recommended guidelines for health monitoring of employees exposed to chemicals, no 130.

APPENDIX 1: Examples of equipment for inclusion in a risk assessment

The process facility should be characterised to clarify whether special control measures are needed. The complexity of the process plant should be taken into account.

Table V1: Overview of benzene content related to type of facility

Benzene content (typical) in production streams, tanks	Offshore production facilities (platforms/FPSOs)	Land-based production facilities (refineries)	Ships	Terminals (loading/ discharging of ships, depots for loading/discharging road tankers)	Service stations
> 10%		X	X		
1-10%	X	X	X		
0-1%	X	X	X	X	X

Categorisation of benzene – offshore production facilities

Production flows containing benzene including the following.

Flows containing > 1% benzene:

- natural gas condensate (up to 10%)
- sludge (closed drainage system)

Flows containing 0.1-1% benzene:

- crude oil
- glycol system – gas dewatering

Flows containing < 0.1% benzene:

- all other flows

The following equipment should be priority areas for risk assessments. This list is neither exhaustive nor in order of priority:

- separators
- coalescers
- pig traps (launching and receiving)
- hydrocyclones
- gas dewatering facilities
- hydrate inhibitors in pipeline systems
- flowlines, including metering and regulation in crude oil flowlines (and probably condensate)
- filters ahead of crude oil coolers and coolers
- filters, pumps, etc, for closed drainage systems
- LNG stabilisers.

Separators

A good deal of sampling is related to separators which could cause exposure. Closed systems shall be assessed. In addition, possible exposure relates particularly to opening all or parts of separators and their maintenance.

Coalescers
Particular risk is associated with opening/entering coalescers. Sand containing a good deal of crude oil residues will be left inside, and can cause benzene exposure.

Pig traps
Receiving pigs, in particular, can lead to exposure. Small quantities (about five to 10 litres) of a blend of crude, wax and water often accompanies a pig when it is extracted. Many pig traps are poorly designed in terms of chemical exposure (and ergonomics). Some installations can accordingly find that relatively large quantities of crude oil come out of the receiver with the pig. Launching pigs involves lower exposure, but is not necessarily exposure-free. Technical measures could be possible (steaming before opening, for example).

Hydrocyclones
Hydrocyclones are part of the water treatment system, and are regularly blocked by the build-up of asphalt-like coatings (a black, sticky substance with considerable oil residues). They must then be opened. The “spears” (typically 50-70 of them, usually about 1.5 metres long) must be removed, and both they and their containers must be cleaned. This job usually takes one-two days, with much benzene exposure at times (particularly when the spears are extracted). Hydrocyclones can be washed without being opened (“cleaning in place” – CIP). They must nevertheless be opened occasionally. Exposure should be lower with CIP, since much of the coating is removed in advance.

Gas dewatering
Exposure can occur when condensate is separated, and because TEG/MEG can become polluted. Draining condensate, replacing filters and other maintenance could lead to exposure. Closed outlets reduce exposure, but exposure is difficult to control when changing filters.

Hydrate inhibitors in pipelines
Some installations use MEG as a hydrate inhibitor in pipelines. But MEG can be contaminated with benzene. The issue is the same as with gas dewatering.

Flowlines
Flowlines as well as metering and regulation in flowlines for crude oil (and condensate)
Cargo pumps and so forth are included here. A good deal of metering equipment often has filters upstream which can become blocked and need cleaning. Metering and regulation equipment must also be maintained regularly, which means flowlines have to be opened. The equipment often contains small crude oil residues. The loading pumps typically have filters upstream which also become blocked regularly. But precautions can be taken, such as drainage.

Filters for crude oil coolers and coolers
Most installations have crude oil coolers, and these often have filters upstream which regularly become blocked with a scale-like substance. They are usually removed and cleaned with high-pressure jetting, which can give benzene exposure. CIP could be relevant for some of this equipment.

Filters pump, etc., for closed drain systems
Crude oil and condensate are drained in closed systems, which can incorporate filters. These are cleaned regularly, and the equipment must be maintained. Such work can require drainage, which may cause benzene exposure. Certain installations also have tanks in this system, where the operator must check the level by opening a hatch or water jetting the tank after draining off the content. Such operations can cause a high level of benzene exposure.

Sampling
Samples are taken of oil, gas and produced water at various stages in the process.

Floatation cells and degassing tanks
Some installations experience problems because the floatation cells become blocked (same type of substance as the hydrocyclones). Opening/cleaning can cause benzene exposure. So can regular maintenance of equipment in the floatation cell (such as skimmers). The degassing tank normally poses no great risk, but some exposure can occur when it is opened.

Categorisation of benzene – land-based production facilities

Oil refineries carry out complex processes to produce refined products. Refinery streams which contain benzene include the following.

Flows containing > 1% benzene:
- benzene heartcut (30-60%)
- naphtha (such as LVN, LCN, HVN, PFM/reformate, FRN, raffinate (up to 20%))
- isomerate*
- sludge

Flows containing 0.1–1% benzene:
- crude oil
- petrol
- alkylate
- isomerate*
- FCC naphtha

Flows containing < 0.1% benzene:
- all other flows

* Isomerate flows normally contain 0.1-1% benzene, but this content can in some cases reach > 1%.

The following equipment should be priority areas for risk assessments. This list is neither exhaustive nor in order of priority:

- sampling points
- drainage
- dipping in tanks
- filter changes/cleaning (filters are typically placed between the pumps and the loading arm)
- lab facilities in general, emptying and cleaning sample bottles, storage
- loading/discharging of ships (dock and deck workers)

APPENDIX 2: Form for registering measurements made by direct-reading instruments

Time and place	
Date (dd.mm.yyyy):	……
Time (hh.mm):	……
Facility:	……
Dept/module:	……
Tag no, equipment	……
In/out	……

Meteorological data	
Wind force (m/s):	……
Dominant wind direction (°):	……
Temperature (°C):	……
Precipitation (mm):	……

Work and chemicals	
Task:	……
Duration of task:	……
Job title of person exposed:	……
Type of process stream/agency:	……

Barriers	
Poss type of respiratory protection:	……
Poss ventilation:	……

Measurements			
Instrument:			
Description of sampling point		Average measured value (ppb)	
Sampling point 1:	……	Limit value 1:	……
Sampling point 2:	……	Limit value 2:	……
Sampling point 3:	……	Limit value 3:	……
Sampling point 4:	……	Limit value 4:	……

(reverse of the form)

Possible sketch of the location and position, plus supplementary comments.

APPENDIX 3: Information sheet and declaration of consent. Urine samples for analysis of SPMA – biomarker for benzene exposure

SPMA (S-phenylmercapturic acid) is a conversion product (metabolite) of benzene which separates out in the urine. Studies have shown a good correlation between the level of benzene in the air being breathed and the amount of SPMA in urine, even with very low levels of benzene in the air.

Normal occupational exposures to benzene involve handling/production of crude oil and refined oil products (mainly petrol) and special laboratory work where benzene is used (very few cases today). In addition come very special work conditions, such as heating of PVC (vinyl), which gives off benzene fumes. The commonest source of benzene exposure in everyday life is active or passive smoking, petrol fumes and exhaust fumes from motor vehicles. Apart from petrol, few other "everyday" chemical blends contain benzene today.

Since a great many people will be subject to a certain amount of benzene exposure in their everyday lives (active or passive smoking, petrol fumes, exhaust gases from petrol engines), most individuals will have a certain background level of SPMA in their urine. This level will normally be higher among smokers. In this type of survey, it accordingly normal to take a urine sample before potential work exposure, and then preferably after an absence of some time from work. In order to interpret the results we get from the background analysis more accurately, it is therefore important that we obtain information about possible sources of benzene exposure you could encounter in your everyday life. We would accordingly ask you to complete the attached questionnaire.

I have read the information and consent to my participation in this investigation by providing a urine sample and completing the questionnaire:

_____

Name in block capitals

_____ _____

Place Date

_____

Signature

A copy is provided to the person giving consent. The original is retained by the health department.

Questionnaire related to taking urine samples for analysis of SPMA – biomarker for benzene exposure in offshore work.

To improve interpretation of the results we obtain after the background analysis of SPMA, it is important that we learn about possible sources of benzene exposure you could experience in your daily life. We would accordingly be grateful if you could complete this questionnaire.

Personal ID no_____(related to health service registration form)

Date/approx time_____/_____(Sample 1)_____/_____(Sample 2)

Smoker?:_____(yes/no) If yes, roughly how many cigarettes per day?_____

If yes, roughly how long between last smoke and giving a sample?:
Sample 1:_____Sample 2:_____

Are you subject to passive smoking on a daily basis?:_____

Occupational details

Job:_____
Work done before providing Sample 2:_____

Protective equipment:_____

Do you have other jobs when not offshore?:_____

If so, what kind of job(s)?:_____

Other exposure in daily life
Have you taken Strepsil or Repsils throat tablets in the past five days?:_____

Are you subject to other possible exposures to benzene or other chemicals in your daily life (see the information sheet)?

_____

_____

All information will be treated in confidence and anonymised in relation to analysis personnel at the laboratory. Personal identification is only possible from the coded list held by the company health service/department. You can ask for this information to be deleted at any time.

APPENDIX 4: An example of a protective equipment regime for work on hydrocarbon equipment[1]

Green jobs

Generally speaking, green jobs are work on hydrocarbon systems where exposure to hazardous chemicals is not expected. Standard offshore garments such as boiler suits, hard hats, protective goggles, nitrile work gloves and protective footwear are required. Experience indicates that green jobs occur where smaller piping (diameter less than six inches) and volumes are broken, providing the systems are aired for at least 10 minutes before work starts. Assessments are not normally required for green jobs.

Yellow jobs

Yellow jobs are work which involves a moderate potential for exposure to hydrocarbons, low radioactive (LRA) substances or mercury, but which takes place in ventilated areas/the open air. These are typically jobs which involve breaking large hydrogen pipes and piping systems (diameters greater than six inches). The following PPE shall be used:

- half mask respiratory protection (such as Sundstrøm half mask with ABEK1-HgP3 combination filter) or powered respiratory protection with filter (Procap)
- tightfitting goggles or full mask/Procap
- nitrile gloves.

Yellow+

If the work involves the risk of hydrocarbon spills or leaks, or measurements reveal levels of mercury in the air above 3 µg/m^3 or radioactivity above 10 Bq/g, a protective chemical suit of the Microchem 4000 type and rubber boots shall be worn.

After the equipment has been aired out for a minimum of 10 minutes, measurements shall be taken to provide the basis for the choice of PPE in the further work. The ABEK1-Hg-P3 combination filter must not be used for more than 50 hours (replace earlier if penetration/odour is detected in the filter). The supplier's instructions for use shall be observed. The mask body is washed in mildly soapy water, dried and stored in a bag or closed container. The date when the filter is first used shall be noted on it.

Bearded people shall use an alternative to a half mask (fan-assisted or compressed air respiratory protection), since beards will weaken the seal between face and mask.

Red jobs

These jobs involve a high potential for exposure to hydrocarbons, LRA substances and mercury. Experience indicates that they involve entry to tanks after coarse cleaning, breaking of large hydrogen systems/volumes (pipe diameters above 36 inches), or collection of spills which require a high level of PPE.

[1] This is *one* example from a single company. The manufacturer's name is used for equipment, even though alternatives exist which could well be better. Generally speaking, a steady improvement in PPE is to be expected.

Generally speaking, the following PPE shall be used with red jobs:

- compressed air respiratory protection
- chemical suit of the Microchem 4000 type
- long nitrile gloves (Granberg Nitrisafe, for example)
- rubber boots.

Black jobs

This is work which involves a very high potential for exposure to hydrocarbons, LRA substances and mercury. Experience indicates that coarse cleaning (water jetting and vacuum suctioning) of separators and other hydrocarbon tanks are classified as black jobs.

The following PPE shall be used:

- compressed air respiratory protection
- chemical suit of the Trellchem Super T-ET type with integrated protective boots and chemical-resistant gloves.

Purple jobs

These jobs involve hot work on hydrocarbon systems.

The following PPE shall be used:

- compressed air respiratory protection
- flame-retardant protective garments and gloves, as well as disposable nitrile gloves inside the flame-retardant gloves.

In the event of hot work combined with entry to enclosed spaces, the occupational hygienist shall be contacted to support an assessment of whether additional barriers are required.

Type of job	H_2S (ppm)	Benzene (ppb)	Mercury (µg/m3)	LRA (Bq/g)	PPE
White	Jobs which do not involve exposure				
Green	< 1	< 50	< 3	< 10	Normal clothing: • standard PPE • nitrile gloves
Yellow	1-10	50-2 500	< 3	< 10	In addition • half mask with ABEK1-Hg-P3 filter (Sundstrøm) • tightfitting protective goggles
Yellow+			3-30	> 10	In addition: • Microguard 4000 • boots
Red	> 10/ entry	> 2 500/ entry	>30/entry	Entry	In addition: • compressed air respiratory protection
Black	Entry with coarse cleaning				• compressed air respiratory protection • Tellchemm super T-ET with integrated boots and gloves
Purple	Hot work on hydrocarbon systems Contact occupational hygienist for hot work combined with entry				• compressed air respiratory protection • where threat of contact with liquids exists, nitrile gloves inside the welding gloves

Appendix 5: Niosh on benzene

Benzene

Synonyms & Trade Names Benzol, Phenyl hydride					
CAS No. 71-43-2	**RTECS No.** CY1400000			**DOT ID & Guide** 1114 130	
Formula C_6H_6	**Conversion** 1 ppm = 3.19 mg/m^3			**IDLH** Ca [500 ppm] See: 71432	
Exposure Limits **NIOSH REL** : Ca TWA 0.1 ppm ST 1 ppm See Appendix A **OSHA PEL** : [1910.1028] TWA 1 ppm ST 5 ppm See Appendix F				**Measurement Methods** **NIOSH** 1500 , 1501 , 3700 , 3800 ; **OSHA** 12 , 1005 See: NMAM or OSHA Methods	
Physical Description Colorless to light-yellow liquid with an aromatic odor. [Note: A solid below 42°F.]					
MW: 78.1	**BP:** 176°F	**FRZ:** 42°F	**Sol:** 0.07%	**VP:** 75 mmHg	**IP:** 9.24 eV
Sp.Gr: 0.88	**Fl.P:** 12°F	**UEL:** 7.8%	**LEL:** 1.2%		
Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.					
Incompatibilities & Reactivities Strong oxidizers, many fluorides & perchlorates, nitric acid					
Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact					
Symptoms irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]					
Target Organs Eyes, skin, respiratory system, blood, central nervous system, bone marrow					
Cancer Site [leukemia]					
Personal Protection/Sanitation (See protection codes) **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contaminated **Remove:** When wet (flammable) **Change:** No recommendation **Provide:** Eyewash, Quick drench				**First Aid** (See procedures) **Eye:** Irrigate immediately **Skin:** Soap wash immediately **Breathing:** Respiratory support **Swallow:** Medical attention immediately	
Respirator Recommendations (See Appendix E) **NIOSH** **At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:** (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus **Escape:** (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister Any appropriate escape-type, self-contained breathing apparatus Important additional information about respirator selection					
See also: INTRODUCTION See ICSC CARD: 0015 See MEDICAL TESTS: 0022					

http://www.cdc.gov/niosh/npg/npgd0049.html