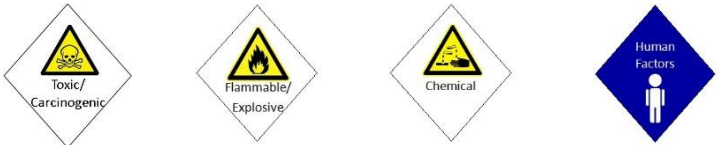

1. Introduction

1.1. Purpose

To protect workers from occupational illness associated with benzene exposure in the work environment. Where benzene exposures exceed legislated limits, supervisors must ensure that task-based control measures are instituted to reduce these exposures as close to zero as possible.

1.2. Application

This code of practice is to be followed any time Strike is working or directing work where there is confirmed or the potential for benzene exposure exceed the legislated limits.

1.3. Physical Properties

Benzene Chemical state:

a) **Description:** Clear, colorless-to-light-yellow liquid.
b) **Warning properties:** Sweet solvent odour at 1.5 to 5 ppm. Adequate warning for acute exposure, inadequate for chronic exposure as olfactory fatigue can occur.
c) **Specific gravity:** 0.88 (water = 1).
d) **Water solubility:** Slightly water soluble (0.07% at 20ºC).
e) **Flammability:** Flammable at temperatures (~ -11ºC), with a range of 1.2 to 7.8% (concentration in air).
f) **Incompatibilities:** Benzene reacts explosively with strong oxidizers, such as perchlorates and nitric acid, and many fluorides.

Typically, crude oils contain less than 1% benzene and natural gas condensates contain less than 6% benzene. Process chemicals such as amines and glycols may become contaminated with benzene and other hydrocarbons. In certain situations, benzene may be concentrated in hydrocarbon fluids from process equipment such as vapor recovery units (VRU's). Reservoir fluids such as produced water may be contaminated with benzene. Benzene and other hydrocarbons may be released from stacks, flares, hydrocarbon storage facilities, glycol dehydrators and other operations that involve crude oil or fuels. Benzenes can be found in the workplace inside dehy and treater buildings at some sites. Testing has indicated that benzene concentrations in the atmosphere were often over the permissible OEL range. Therefore, workers could be subjected to high exposure levels from time to time. Tasks such as opening and changing filters or bleeding down sight glasses inside these building would potentially overexpose workers in a short period of time.

1.4. Health Effects

Benzene exposure may result from inhalation of the vapor or skin contact with liquids and sludges containing benzene. Absorption of the vapor through the skin may also be possible.

Benzene entering the bloodstream through the lungs or skin will collect in the fatty areas of the body such as the brain, fat deposits, and bone marrow. In pregnant women, benzene will also pass through the placenta and may affect the fetus' development.

Acute Health Effects

Workers are usually exposed to benzene by inhaling the airborne vapours or by skin contact with the liquid chemical. The vapours in air can also be absorbed through the skin. This occurs to a much lesser extent than by direct contact with the liquid.

Short-term (acute) exposure to benzene at high concentrations can cause:

a) light-headedness
b) dizziness
c) headaches
d) confusion/disorientation
e) unsteady gait
f) drowsiness
g) nausea
h) vomiting
i) slurred speech

These effects are not usual at concentrations below 25 ppm and are more common at 50 to 150 ppm. As concentrations of benzene vapours in the air increase, the health effects become more severe (vertigo, confusion, loss of consciousness). Exposure to about 20,000 ppm for 5 to 10 minutes can cause death. Nose and throat irritation have also been reported after short-term exposure.

Chronic Health Effects

Prolonged or repeated contact with the skin causes redness, drying, and cracking because benzene dissolves and removes the protective natural oils from the skin. The most important health effect of benzene is its impact on the blood system. Benzene is a known human carcinogen that may cause leukemia. Benzene may also cause anemia, which is a precursor to leukemia. People experiencing anemia due to benzene exposure in the short term generally return to normal once they are removed from the benzene exposures. Studies of workers have shown that the damage to the blood system can occur with exposure to benzene at concentrations of 30 ppm to 120 ppm over a time period of 3 months to 17 years. Exposure to benzene below workplace occupational exposure limits (OELs) have not been shown to produce damage to blood cells.

2. Responsibilities

2.1. Management

Management is responsible to:

- Ensure workers have appropriate education/training to prevent benzene exposure
- Not assign work tasks to a worker for which they are not competent
- Providing the necessary equipment and PPE
- Engaging with the client/owner at the pre-job planning stage to identify and assess if and where benzene hazards expected to be encountered, and their concentrations
- Ensuring that this code of practice is utilized and adhered to by supervisors and workers

2.2. Supervisor

Supervisors are responsible to:

- Lead the safe work planning process – work scope, hazard assessment, hazard controls
- Ensure that workers undertake only the work that they are competent to perform
- Provide and assist in the pre-use inspection of all applicable PPE
- Ensure that this code of practice is utilized and adhered to by workers

2.3. Worker

Workers are responsible to:

- Participate in the safe work planning process (pre-job meeting and HIAC)
- Refuse to perform any work if it is deemed unsafe (until appropriate hazard controls can be implemented)
- Inspect any required PPE before use
- Follow the direction of the supervisor
- Adhere to the direction provided by this code of practice.

3. Training

- WHMIS training
- Strike internal PPE training
- Gas Detection/Testing

4. Hazard Identification, Assessment, and Control (HIAC)

It is important to know how much of the chemical is present before you begin work. This information can usually be estimated from information found on the Safety Data Sheet and from previous chemical analysis done of condensates and crude oils from the same production field or area. The type of work to be performed will also have an impact on worker exposure and risk to health. Benzene has a very low legislated occupational exposure limit (OEL) because of its potential to cause cancer. This low OEL results in strict workplace controls and increases the chance of exceeding these limits. Do not enter the work area unless you are properly trained and competent to do so.

Before beginning work in an area where benzene is present:

- Understand the requirements and limitations to the applicable permits.
- Identify and restrict workers in areas that will expose workers to benzene.
- Fully understand your role in the work, either as a person entering the area to complete the work, a safety watch, or a responder.
- Be aware of all egress points from the work area and muster area location.
- Refuse to do work where an unsafe condition exists or may be caused to exist.

Exposure Thresholds

The American Conference of Governmental Industrial Hygienists (ACGIH) has recommended the TLV (Threshold Limit Value) for benzene and is accepted in British Columbia and Saskatchewan. For the purposes of this code of practice Strike will also use the ACGIH OEL (Occupational Exposure Limit) for Alberta. Therefore, Benzene OEL for all operations is:

a) 8 hours: 0.5 ppm
b) 12-hours: 0.25 ppm
c) 15-minutes: 2.5 ppm

Verify levels against applicable current legislative standards in your jurisdiction

Gas Testing

Competent personnel will conduct gas testing (with detector tubes, passive monitors and/or direct measurement benzene detectors), before confined space entry takes place or when responding to spills where benzene may be present. It is the responsibility of the Prime Contractor to complete or arrange for all testing.

The gas test results will be used to determine:

- The need for additional control measures (e.g. draining, flushing, or dilution ventilation of equipment), and the required type of respiratory protection equipment.
- When it is safe to remove respiratory protection.

Task Identification

Table 1 identifies some of the tasks where benzene overexposure may be found, as well as recommended procedures to reduce exposures, and appropriate personal protective equipment required to reduce inhalation and skin absorption. Site-specific procedures and controls may also need to be developed where these recommended procedures are not specific enough to control benzene overexposure.

You will also need to conduct a hazard assessment (HIAC) and discuss as part of your pre-job meeting before conducting any work activity where benzene has been identified during the health surveys for your area.

Monitoring:

a) Task based; personal exposure monitoring should be conducted to identify tasks that expose workers above the OEL. Once these tasks have been identified, site specific controls should be instituted to reduce exposures.
b) Periodic general air monitoring should be conducted in buildings that have been found or have the potential to have benzene concentrations above 0.5 ppm.
c) Air monitoring should be conducted before and during turnarounds after equipment integrity has been broken to ensure workers are not exposed.
d) On-site monitoring can be done with direct reading instruments such as RAE monitors equipped with benzene specific tubes. Monitoring should be done by trained and qualified personnel.

5.0 Personal Protective Equipment

Respiratory Protection

Respiratory protection is required:

- During the time required to implement engineering controls or administrative controls.
- When engineering controls and work practices are not feasible.
- During emergencies involving potential exposure to high concentrations of benzene (i.e. above the Permissible Exposure Limits).

Approved respirators will be selected according to airborne concentrations of benzene or condition of use.

- 0.5 to 5.0 ppm: Half-face mask with organic vapor cartridge
- 5.0 to 25.0 ppm: Full-face mask with organic vapor cartridge
- Above 25 ppm: Self-Contained Breathing Apparatus (SCBA), or air-line pressure demand full face mask (SABA)
- Above 33 ppm: Personnel will not enter a space or atmosphere containing more than 33 ppm of benzene unless they are under air and wearing full protective clothing

Note: SABA air-line devices must have an attached 5-minute emergency egress air cylinder.

If the specified type of respirator is not available for use, default to a higher level of respiratory protection (e.g. if a full-face mask with organic vapor cartridge is not available, use SCBA or a supplied air full-face mask).

6.0 Emergency Response

In the event an emergency arises involving potential personnel exposure to benzene, the following actions should be taken without personal risk:

- Evacuate non-essential personnel.
- Remove or secure all ignition sources.
- Use non-sparking tools and explosion-proof equipment at all times.
- Consider wind direction; stay upwind and uphill, if possible.
- Carefully contain and stop the source.
- Protect bodies of water by using absorbents, if possible.
- For small fires, use Dry Chemical Powder (DCP), CO2, water spray or regular foam.
- For large fires, only use the water spray, fog, or regular foam.

Table 1: Benzene Control Options

Condition Recommended	*Approximate Potential Exposures*	*Control Procedures*	*PPE Requirements*
Changing glycol / amine / water filters, y strainers, and orifice plates.	**0 to 0.5 ppm**	1. Until engineering controls are instituted, worker must wear PPE. 2. Open containers of hydrocarbons are not allowed in buildings. Provide closed containers and store containers outside where possible. 3. Where possible, vent equipment to the outside with collection containers to prevent soil contamination. 4. Clean spills immediately as hydrocarbons generate Benzene vapours. 5. Conduct periodic air monitoring in buildings to ensure airborne concentrations are below 0.5 ppm.	1. Respirator with organic vapour cartridges. 2. Gloves of • Viton coated neoprene; or • Single use neoprene surgical style gloves, or • DuPont Barrier or Silver Shield inside neoprene or butyl rubber gloves.
Tank / Vessel Cleaning and/or Inspection.	**>5 ppm**	1. When using vacuum truck, it must be vented downwind from workers or wear proper PPE. 2. During steaming, if in vessel, personnel must wear PPE. 3. After steaming, measure Benzene in air before entering. Sumps or drains may contain benzene-containing fluids. Benzene concentrations above 0.5 ppm require personnel entering tanks to use PPE. Below 0.5 ppm PPE is not required except if skin contact with fluids is possible, then use gloves and chemical suit.	1. Air supplied respirator for concentrations above 5 ppm. 2. Gloves of • Viton coated neoprene; or • Single use neoprene surgical style gloves or • DuPont Barrier or Silver Shield inside neoprene or butyl rubber gloves. 3. Tychem 7500 or 9500 coveralls or rubber suits.
Opening systems for maintenance or repairs. (e.g. valve replacement, pipe repair, replacing valve controllers).	**> 3 ppm and < 5 ppm**	1. Ventilate general area if possible. 2. Monitor for Benzene concentrations. 3. Prepare for immediate cleaning up of fluids (spillage) after job completed. 4. Wash equipment before transferring to maintenance shop or indoor storage.	1. Respirator with organic vapour cartridges. 2. Gloves of • Viton coated neoprene; or • Single use neoprene surgical style gloves, or • DuPont Barrier or Silver Shield inside neoprene or butyl rubber gloves. 3. Tychem 7500 coveralls if contact with liquids minor, otherwise rubber suits.
Opening systems for maintenance or repairs. (e.g. valve replacement, pipe repair, replacing valve controllers).	**> 5 ppm**	1. Ventilate general area if possible. 2. Prepare for immediate cleaning up of fluids (spillage) after job completed. 3. Wash equipment before transferring to maintenance shop or indoor storage.	1. Air supplied respirator 2. Gloves of • Viton coated neoprene; or • Single use neoprene surgical style gloves, or • DuPont Barrier or Silver Shield inside neoprene or butyl rubber gloves. 3. Tychem 7500 coveralls if contact with liquids minor, otherwise rubber suits.

References/Additional Information

- COP 05 Lock Out / Tag Out
- SWP 33 Hazardous Materials/Products/Substances
- SWP 36 Monitoring for Escaping Hydrocarbon Gases
- SDS's (Safety Data Sheets)
- Energy Safety Canada Controlling Chemical Hazards Guidance Sheet Benzene
- WorkSafe Alberta Workplace Health and Safety Bulletin: Benzene at the Work Site

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