Human Health Risk Assessment

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Health Risk Assessment - Overview

- What is being evaluated ?
- Approach and Methodology
- Technical Aspects of Health Risk Assessment
- Identification of Issues
- Exposure Assessment
- Toxicity
- Calculation of Risk
- Outcomes

Health Risk Assessment – What is Evaluated?

- "*Risk assessment provides a systematic approach to characterising the magnitude of the risks associated with environmental health hazards. All activities, processes and products have some degree of risk. The ultimate aim of risk assessment is to provide the best possible scientific, social and practical information about the risks*.." enHealth (2002)

- The assessment is not an epidemiological study or a survey and statistical analysis of existing health issues in the local community.
- The assessment provides an evaluation of risks to human health associated with the proposed GTP and follows approved regulatory guidance and industry best practice which is applied to the assessment of risks to human health associated with any site in Australia.
- Assessment must be robust, transparent and not overly complex, conservative or simplistic.

Approach and Methodology

- HRA has been undertaken in consultation with DEC and NSW Health.
- enHealth (2002) is principal guidance which also references the following;
  - National Environmental Protection Measure (1999);
  - ANZECC/NH&MRC (1992); and
  - Protocols/ guidelines recommended by ANZECC and NH&MRC and detailed in the document "The Health Risk Assessment and Management of Contaminated Sites" (CSMS 1991, 1993, 1996 and 1998);
  - World Health Organisation
- More specific guidance can be obtained from the US

Approach and Methodology

- Consistent with the methodology adopted for other risk assessments on and surrounding the Orica site. These include: Groundwater Investigations Risk Assessment, HCB Car Park Risk Assessment and the HCB Waste Destruction EIS.
- Focus of the assessment is the evaluation of off-site issues, however on-site issues have also been addressed.
- Conservative assessment has been undertaken (i.e. over estimate of the risks)

Technical Aspects of the HRA

- Issue Identification – review of the GTP and potential for emissions to air, water and soil on and off the site. Selection of key chemicals for further assessment.
- Exposure Assessment – Who may be exposed to the key chemicals and how? Quantification of exposure.
- Toxicity Assessment – What are the health effects associated with the key chemicals? How are they assessed? Quantification of toxicity effects.
- Risk Characterisation – Estimation of risks to human health by combining/comparing exposure assessment and toxicity assessment. Acceptability of risk?

Acute vs. Chronic

- Focus on chronic effects in HRA

DOSE	ACUTE EFFECT	CHRONIC EFFECT
1 measure of Whisky Consumed in 60 Min.	Minimal	None
1 bottle of Whisky Consumed in 60 Min.	Illness or Death	Minimal
1 measure of Whisky Consumed Every 60 Min. For 12 Hrs. Each Day, 365 Days Each Year	Minimal	Brain/Liver Damage
1 bottle of Whisky Consumed over a Year	None	None

Issue Identification

- This involves a review of the GTP process and studies which have been undertaken to identify and define emissions.
  - Exposures during construction
    - On-site soil and groundwater information for GTP site – exposure to chemicals managed under health and safety plan for the site.
    - Emissions to air (dust, vehicle emissions) – managed and controlled on the site.
    - No key issues identified for HRA

Issue Identification

- Operation of GTP
  - Extraction and handling of contaminated groundwater – sealed system with fugitive emissions to be managed and expected to be low
  - Storage, handling and use of process chemicals – Compliance with relevant workplace standards and safe work practices
  - Impacts to stormwater drainage system – proposed bunding and measures to control impacts on and off site
  - Impacts to wastewater and other process waste – discharges to be in accordance with licence agreement and regulatory guidelines for safe disposal.
  - No key issues identified for the HRA

Issue Identification

- Operation of GTP (cont.)
  - Treated water re-use or discharge via Bunnerong Canal to Brotherson Dock and Botany Bay
    - Quality of treated water to meet Australian Drinking Water Guidelines and ANZECC Water Quality Guidelines.
    - Expected water quality also screened against human health risk based levels (assuming recreational water contact).
    - All concentrations proposed meet relevant guidance and are less than the screening levels.
    - No key issues identified for the HRA

Issue Identification

- Operation of GTP (cont.)
  - Emissions to Air from Thermal Oxidiser
    - Air Quality Impact Assessment – meets regulatory requirements.
    - Additional review of air quality associated with emissions of VOCs, dioxins and mercury.
    - Screening of predicted ground level concentrations with health risk based criteria for air – screening levels modified (as agreed with DEC and NSW Health) for common urban air or background chemicals (modification factor of 0.1).

Issue Identification

- Normal Operation of GTP (cont.)
  - Emissions to Air from Thermal Oxidiser (cont.)
    - **Identified chemicals in air for further assessment in HRA (chloroform, carbon tetrachloride, EDC, vinyl chloride, trichloroethene and tetrachloroethene)**
    - **Identified persistent and bioaccumulative chemicals for multiple pathway assessment in HRA (dioxin, mercury and hexachlorobutadiene)**

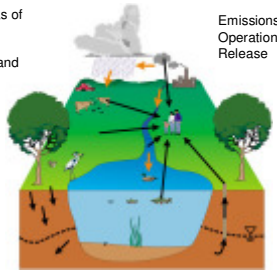
Issue Identification

- Accidental Releases
  - PHA provided assessment against regulatory guidance. Compliance with requirements identified.
  - Identification of possible worst-case releases to air (1 in 50,000 year failure frequency)
    - Increased emission of dioxin for up to 12 months
    - No destruction of chemicals in the thermal oxidiser for up to 12 hours. Concentrations in air well below acute and emergency release guidelines.
  - **Further evaluation of persistent and bioaccumulative chemicals required in HRA from releases**.

Key Issues Identified

Inhalation in all areas of chloroform, carbon tetrachloride, EDC, vinyl chloride, TCE and PCE

Multiple pathway exposure of dioxin, mercury and HCBD



Emissions during Normal Operations and Accidental Release

Exposure Assessment

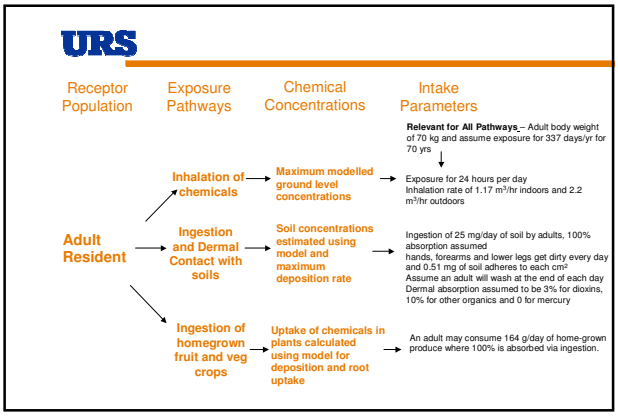
- Identify groups who may be exposed to the key chemicals (air emissions);
- How they may be exposed to the key chemicals;
- Identify the activities they may undertake; and
- Quantify exposure.

Exposure Assessment

- Identified the following for assessment:
  - **Residents (adults and children)**
    - Inhalation of key chemicals
    - Multiple pathway evaluation of persistent and bioaccumulative chemicals
      - Ingestion and contact with chemicals in soils
      - Ingestion of home-grown fruit and vegetables grown in soils
      - Exposure by infants from mother's milk.

Exposure Assessment

- **Recreational use in area**
  - Inhalation of key chemicals by adults playing golf or exercising at athletics field (or anywhere else)
  - Inhalation of key chemicals by children exercising at athletics field (or anywhere else – including at school)
- **Workers**
  - Inhalation of key chemicals at work



Exposure Assessment

- How is the assessment conservative?
  - Concentrations used are the maximum ground level concentrations predicted on site –
    - off-site residential, school and recreational areas less than 33% of the maximum.
  - Deposition of chemicals to soil is based on maximum deposition rate which occurs on site.
    - Off-site residential areas less than 69% maximum.
  - Models used to estimate soil, plant and milk concentrations simple and over estimate concentrations.
  - Emission of mercury based on no destruction.
  - Activity parameters based on worst case exposure.

Toxicity Assessment

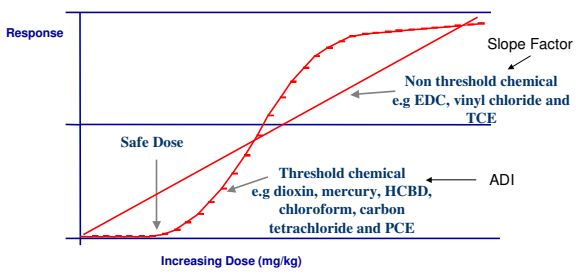
- Primary objective is to identify toxicity values for the key chemicals
  - Used to quantify health risk for a given exposure
- Prepare toxicity profile for profiles for key chemicals
  - Provide descriptive summary of toxicity
  - Ensure use of most appropriate toxicity value
- This has been undertaken following guidance from enHealth. Toxicity values reviewed by and agreed with DEC and NSW Health.
- Toxicity – chronic/acute, dose, dose responses and toxicity values.

Toxicity Assessment

- Dose: amount of exposure received
  - Quantity per unit body weight (mg/kg)
  - Quantity per unit area of skin surface (mg/square centimetre)
  - Volume or weight of substance in air per unit volume of air (ppm or mg/cubic metre)

Dose Response

Hypothetical Dose-Response Curves



Toxicity Assessment

- How is the toxicity assessment conservative
  - Typically based on studies in animals
  - Derivation of ADI's uses a number of safety factors which can vary from 100's to 1000's to account for limitations in study (species, duration etc)
  - Derivation of slope factor based on animal data for high doses – requires extrapolation to low doses evaluated in environmental assessments.

Risk Characterisation

Risk Characterisation

- The process of quantifying the health risks using exposure and toxicity assessment to enable assessment of significance.
- Characterise threshold and non threshold risks separately and differently

Non-Threshold Risk

Calculate an Incremental Lifetime Cancer Risk

Cancer Risk = Daily Chemical Intake/Cancer Slope Factor

Incremental probability of cancer risk associated with a given exposure, averaged over a lifetime.

- Cancer risk goals are very confusing and not technically based
  - 1 in 1,000,000 generally taken as "zero" and common goal
  - 1 in 100,000 often accepted as trigger for some action
    - » Further assessment or remediation
  - 1 in 10,000 considered unacceptable
- Population incidence of cancer is around 1 in 3

Threshold Risk

$$\text{Hazard Quotient} = \frac{\text{(Daily Chemical Intake + Background intake)}}{\text{ADI}}$$

Calculate for each key chemical

Hazard Index = HQ (chemical 1) + HQ (chemical 2) + ……..

Sum for each pathway within each receptor group.

Target HI <= 1

As this evaluation provides a comparison of the total intake of a chemical with the ADI, background intake is important.

Risk Characterisation

- Background Exposure – how much ?
  - Relevant to threshold chemicals only
  - Carbon tetrachloride – intake from food, water, soils and air typical for urban areas and may be as high as 33% of the ADI (67% intake allowed from GTP)
  - Mercury – intake in urban areas may be up to 50% of the ADI (50% intake allowed from GTP)
  - Dioxin – intake in urban areas may be up to 54% of the ADI (46% intake allowed from GTP)
  - HCBD – intake usually low, however 40% intake allowed from GTP to account for uncertainty (potential background exposure from HCB Car Park)

Risk Characterisation

- Calculated Risks from GTP
  - Normal Operation of the GTP
    - » Non-threshold risk < 1 in 1,000,000 for residents, recreational use and workers
      - – EDC presents highest risk
    - » Threshold HI < 1 for residents, recreational use and workers
      - – Dioxin presents highest risk
      - – For threshold chemicals the estimated intake via all pathways for residents is less than 4% of the ADI.

Risk Characterisation

- Calculation of Risk (continued)
  - Accidental Releases from GTP
    - » Non-threshold risk < 1 in 1,000,000 for residents
    - » Threshold HI < 1 for residents
      - – Dioxin (increased dioxin emission) and HCBD (worst-case release) contribute most to the risk.
      - – For threshold chemicals the estimated intake via all pathways for residents is less than 20% of the ADI.

Risk Characterisation

- Cumulative Risk:
  - Considered cumulative risks for emissions from BIP, HCB Car Park and groundwater (particularly along western margin):
    - » GTP contribution to total risks is small
    - » Cumulative risks for threshold and non-threshold below risk targets.

Outcomes of the HRA

- Risks to human health associated with the proposed GTP are low and considered to be negligible
- Mitigation and management measures, such as OH&S plans and and process controls detailed in PHA implemented.