RADIATION SAFETY INDUCTION
Radiation

Radiation is a part of our every day life

• The various types of radiation include
  • sunlight
  • ultraviolet radiation
  • microwave radiation
  • infrared radiation
  • radio waves; and
  • ionising radiation

Our discussion here is limited to ionising radiation only
What is the Difference?

What makes ionising radiation different from other types of radiation is its **ionisation property**

Ionisation can inflict damage to cells of living organisms
Ionising Radiation

- Ionising radiation is broadly classified into two types
  - natural radiation
  - man made radiation

- **Natural radiation** comes from natural sources such as the solar system and the earth

- **Man made radiation** is from various radiation sources invented by man in the last few decades
Natural Ionising Radiation

- MilliSievert (mSv) is the unit of radiation dose measurement
- On average (worldwide) we receive 2-3 milliSievert (mSv) of natural radiation dose in a year
- In some parts of the world the natural radiation dose is 30-40 mSv per year, due to the presence of large amounts of radioactive mineral sands or granites, with no ill effects
- We are exposed to natural radiation even when inside our homes - mainly due to the inhalation of radon gas - radon gas emanating from the earth’s surface can get trapped inside rooms
Man Made Ionising Radiation

- The sources of man made radiation include
  - x-rays
  - cancer therapy machines
  - nuclear power stations
  - uranium mines
  - laboratories
  - atomic tests
  - nuclear weapons

- Some of them are useful to humanity but others are not
We Support Peaceful Uses of Nuclear Energy

- Uranium produced at Beverley Mine is used only for the peaceful purpose of electrical power generation in nuclear power plants around the world
- Users must meet all international and Australian safeguards to prevent military use
Uranium

- Uranium is a natural element like copper and gold and is present all over the earth.
- There is more uranium at the sea bed than on the land.
- At some places like Beverley and Roxby Downs the concentration of uranium is large enough to make mining economically viable.
- The final product made at Beverley is Uranium Ore Concentrate (chemical name is uranyl peroxide).
- It is yellow in colour and is in powder form.
Uranium and Radioactivity

- Uranium is a radioactive element and it emits **two** different types of radiation
  - **alpha radiation**
  - **gamma radiation**

- When you work at the mine site, low levels of alpha and gamma radiation are present at the
  - plant and
  - wellfield
Uranium and Radioactivity

• Radiation levels in exploration drilling areas of the mine site and exploration areas are very low and comparable to that of natural background radiation.

• Radiation levels present in the active wellfields are generally higher than that of exploration areas but lower than that of the plant (except near the filter banks) area because of the low concentration of uranium in the mining solution.

• In the plant the uranium is more concentrated and that results in an increase in radiation levels compared to that of wellfield.
Radiation and Health

- Low levels of radiation do not cause cancer, death or hereditary effects.
- Radiation causes health problems in humans only when they are exposed to very high levels of radiation (many times that experienced at Beverley).
- Such high levels of exposures are usually associated with:
  - radiation accidents
  - atomic explosions
- The chances of exposure to high levels of radiation is practically NIL at Beverley.
Radiation Dose Limits

• Employers cannot legally expose an employee to a large radiation dose

• There are International Regulations on occupational radiation exposure

• The permitted annual radiation dose to an employee working in a radiation establishment is 20 mSv
What We Mean by Low and High Levels of Radiation

• Radiation doses received by employees at Beverley are at the low end for example
  • average yearly radiation dose to an employee working at Beverley is less than 1mSv
  • maximum yearly radiation dose to an employee working at Beverley is around 5mSv

• In comparison, the radiation doses that may be needed to cause health effects in humans are a short term dose of
  • 1000 mSv that may cause cancer in future or
  • 10,000 mSv that would cause death in a few days
Alpha Radiation (α)

• Alpha radiation
  – is much less penetrating than gamma radiation
  – Can travel only a few centimetres in air
  – Can be easily stopped by paper, plastic, water, etc
  – Will not pass through skin or clothes

• Since alpha radiation cannot pass through the outer dead layer of skin it is not considered an external radiation hazard

• Alpha can pose an internal radiation hazard if it is breathed in or ingested as radioactive dust or radon gas

• Therefore controls are needed
Gamma Radiation (γ)

- Gamma radiation
  - Is a more penetrating radiation
  - Can travel long distances in air (a few metres)
  - Can only be stopped by dense materials like steel, concrete, lead or water

- Since it can pass into the human body, gamma radiation is considered as an external radiation hazard

- People can be exposed to more gamma radiation either by spending too much time near a source or by being too close to a source

- Controls are needed
Source of Radiation at Beverley - Uranium

- **Uranium** is a source of
  - alpha radiation and
  - gamma radiation

- The main sources of Alpha radiation from uranium are
  - yellow cake dust in the Drier and Packaging area
  - plant and wellfield solutions

- Gamma radiation mainly comes from
  - wellfield filter banks
  - most of the tanks and pipes in the plant which contain uranium at different concentrations
Source of Radiation at Beverley - Radon Decay Products

- **Radon decay products** (RnD products, or “radon”) are a source of radiation
  - radiation

- RnD products are
  - released at low levels during drilling
  - present inside the wells and sealed pipes in the Wellfields
  - present inside the pipes and tanks that contain radioactive material in the plant

- RnD products in the Wellfields are **not** a significant issue due to dilution by wind

- Tanks like the IX columns in the Plant are a significant source of RnD products
Source of Radiation at Beverley – Logging Sources

- **Logging sources** are
  - used for bore hole neutron logging
  - sources of *gamma and neutron radiation*
  - handled by trained operators

- Keep a safe distance of 3 metres when the logging is in progress
Sources of Radiation at Beverley – PFN Tool

• The PFN tool
  – is a specialised tool for measuring uranium in drill holes
  – emits neutron radiation when energised
  – is handled by trained operators

• Keep a safe distance of 3 metres when logging is in progress

PFN Tool Calibration Facility
Minimising Radiation Exposure – Alpha Radiation

• The basic principles for minimising exposure from alpha radiation are
  – minimise spills and dust generation (spills when dried can be a source of radioactive dust)
  – use proper Personal Protective Equipment (PPE)
    • respirators to prevent inhalation of radioactive dust and radon gas when required
    • gloves, boots and overalls to prevent body contamination
  – maintain good personal hygiene
    • wash hands and face before eating, drinking or smoking
    • shower and change at the end of the shift as well as after Radiation Work Permit (RWP) jobs
    • do regular personal contamination scans before leaving work areas
Minimising Radiation Exposure – Gamma Radiation

• The basic principles for minimising exposure from Gamma Radiation are
  – Spend less time near a radiation source
    • reducing the time spend to half will reduce the radiation dose received to half
  – Keep maximum distance from a source
    • doubling the distance from a source will reduce the dose by a factor of four
  – Use suitable shields if necessary
    • shields like iron, lead or concrete can reduce gamma radiation levels significantly (e.g. storage containers for logging sources)
Access Control

• Access control minimises cross contamination

• Most locations within the plant and wellfields are grouped into three areas

  1. **Controlled Area**
     • includes drier, packing room and packing warehouse

  2. **Supervised Area**
     • includes within the plant concrete bund, evaporation ponds, radioactive waste storage area and wellfields

  3. **Clean Areas**
     • Include control room, lab, workshops, power house, change rooms, offices, etc

Eating, smoking and drinking (other than from water containers) is not permitted inside the plant fence or wellfields except in designated areas
Personal Protective Equipment (PPE)

• Use of proper PPE eliminates personal contamination including inhalation/ingestion of radioactive materials

• It thus minimises internal radiation exposure

• The most common PPE used for radiation protection at site are
  – respirators, gloves, overalls and gumboots

Different jobs need different PPE

If in doubt ask your Supervisor or Radiation Safety Personnel
Personal Hygiene

- Personal hygiene has an important role in minimising internal radiation exposure
  - wash your hands and face before eating, drinking or smoking
  - use hand contamination meters before leaving work areas
  - changing clothes at the end of the day is compulsory for all mine workers as is showering for certain workgroups
  - work clothes and boots are to be left in the plant change rooms and are not to be taken to camp
Hand Contamination Meters

- **Hand contamination meters** are
  - for checking radioactive contamination on hands, boots and clothing
  - placed at
    - plant entrance
    - decon room
    - packing warehouse
    - back of admin office
    - mine geo’s office
    - selected wellhouses
    - E&D male change room
    - control room
  - for checking **alpha contamination** only
  - **cannot** be used on **wet surfaces** (if your hands are wet dry them before using the meter)

Take care not to touch the silver foil of the sensor

Always fill in and initial the log sheet kept next to the meter
Employee Dose Estimations

• Radiation doses to all employees at Beverley are calculated on a quarterly basis.

• Alpha dust dose is calculated from
  – area dust sampling
  – personal dust sampling

• Radon decay (RnD) decay products dose is calculated from
  – area radon sampling
  – personal radon sampling

• Gamma dose is taken from radiation badges.

• When you are issued with personal monitoring devices use them properly.

• Your total radiation dose is the sum of
  – alpha dose + RnD dose + gamma dose.
Standard Operating Procedures (SOPs)

• SOPs are available for routine and some non-routine jobs - they help minimise radiation (and general safety) risks

• Read these SOPs and familiarise yourself before starting jobs - they tell you what permits are required

• Clear any doubts with your Supervisor or Safety Personnel

• Suggestions and feedback are always encouraged
Confined Spaces - also see General Safety Induction

• Many of the confined spaces at site contain radiation
  – e.g. IX columns, elution tanks, precipitators, thickeners etc
  – ponds are also treated in a similar fashion

• Permits are required to enter any confined space and include
  – confined space permit
  – radiation work permit
  – hot work permit (if necessary)

• PPE and monitoring equipment are compulsory during confined space entries
Radiation Clearance of Items

• All items used in the plant, wellfield or other active areas of the mine site require **Radiation Clearance** prior to their removal from site including
  – your personal items like clothing, boots, etc
  – tools and equipment
  – vehicles

• To obtain a clearance you must
  – clean and dry the item
  – inform the radiation personnel
  – provide the address of the consignee as well as the consignment note number (if sending items by KJM truck) to the radiation personnel
Waste Disposal

Two different types of wastes are generated at site

- **Radioactive Waste**
  - dispose in lined 200 L steel drums

- **Non-radioactive wastes**
  - dispose in green plastic wheelie bins

- Drums and bins are available at
  - different locations in the plant and
  - in front of all wellhouses

If unsure about the nature of the waste contact the Radiation Advisors who can check it for radioactive contamination
Scanning of Waste

- All alleged non-contaminated wastes from the plant and wellfield must be scanned and cleared by a Radiation Advisor before disposal in the general waste dump.

- No radioactive wastes are to be disposed of in general waste dump.
Please complete the Radiation Safety Quiz that you have been given and move to next section.

You may take a copy of the "Radiation Worker’s Handbook"