

# Underground Refuge Chambers

International Mines Rescue Conference

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# Underground Refuge Chambers

Introduction

Brief Overview of Olympic Dam Mine - Australia

Overview of 20 Person Refuge Chambers

Overview of 100 Person Refuge Chamber under construction at Olympic Dam Mine.

# Olympic Dam – Brief Overview

- Discovered in 1975
- Fully integrated processing facility from ore to concentrate to metal
- Workforce of 3,000, majority residential in Roxby Downs
- Poly-metallic orebody with 8.4Bt resource – copper, uranium, gold, silver



# Olympic Dam Mine - Production

## Mine:

- Ore Hoisted – 28,500 t/day (~10Mt/year)
- Development – 70m/day (25km/year)

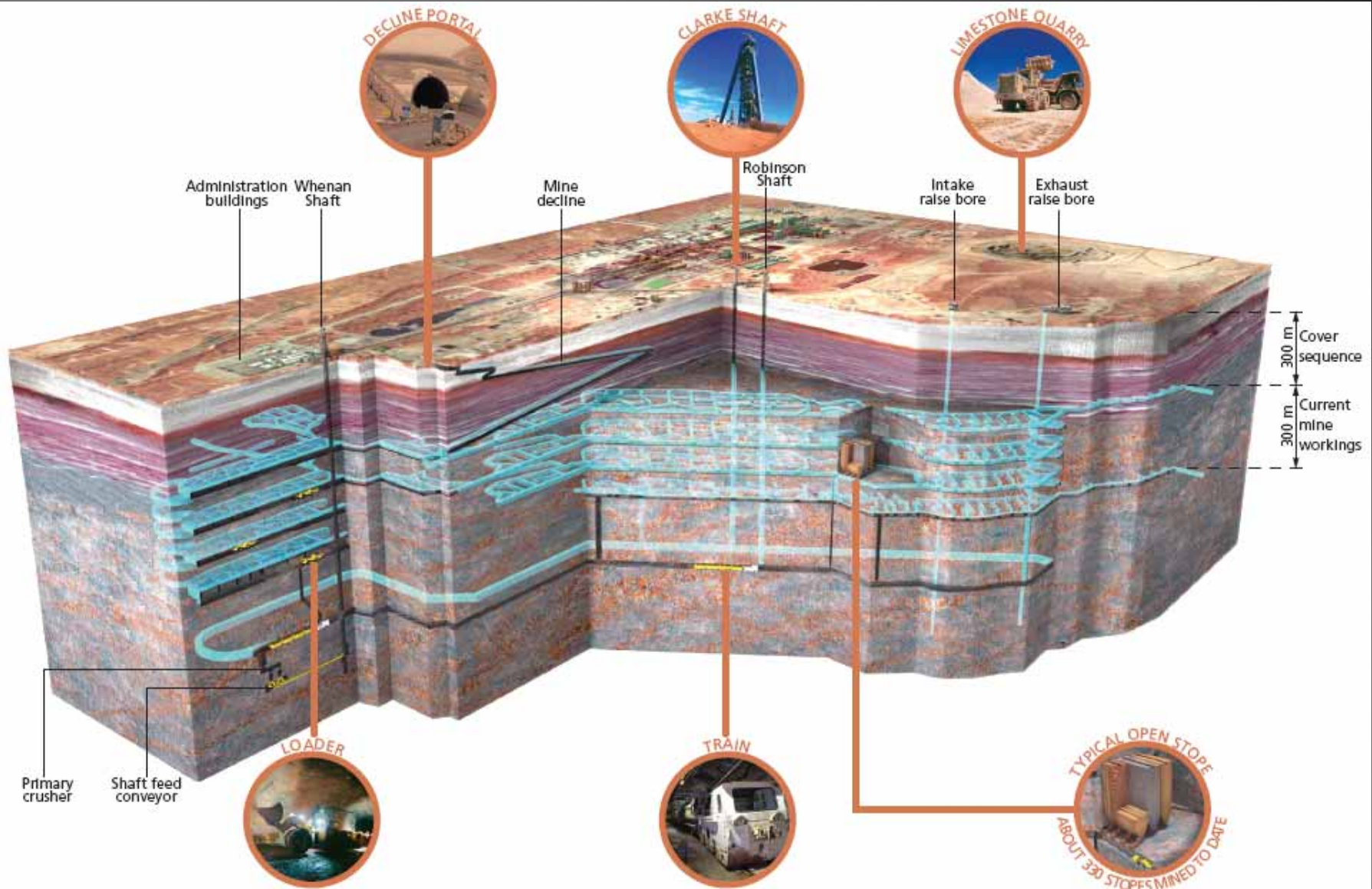
## • Process:

- Copper - 190,000 t/year
- Uranium - 4,500 t/year
- Gold - 110,000 oz/year
- Silver - 800,000 oz/year





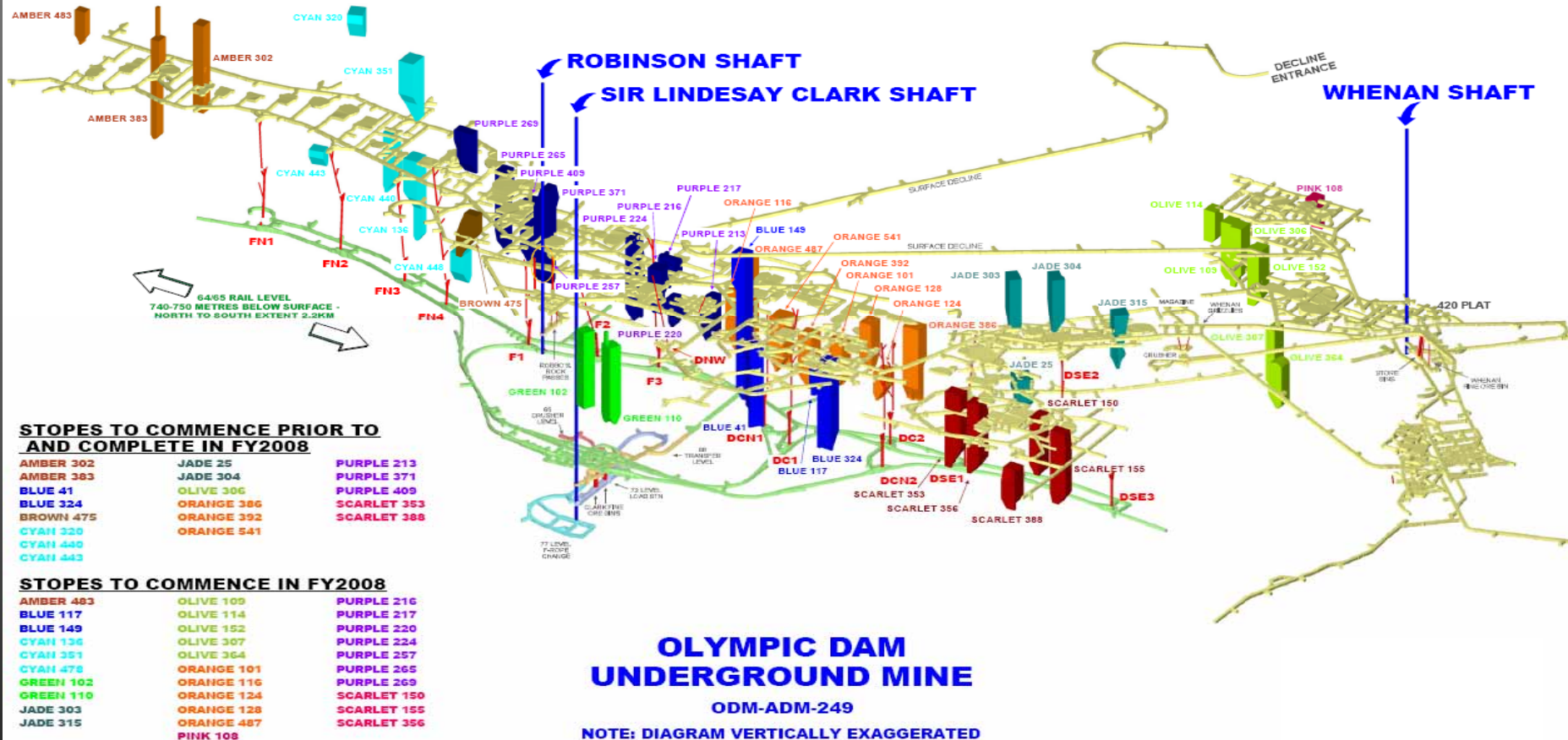
# Underground mine layout



# Stope Production

## STOPES IN PRODUCTION FOR FY2008

DEVELOPMENT SHOWN IS ONLY PART OF  
TOTAL UNDERGROUND DEVELOPMENT



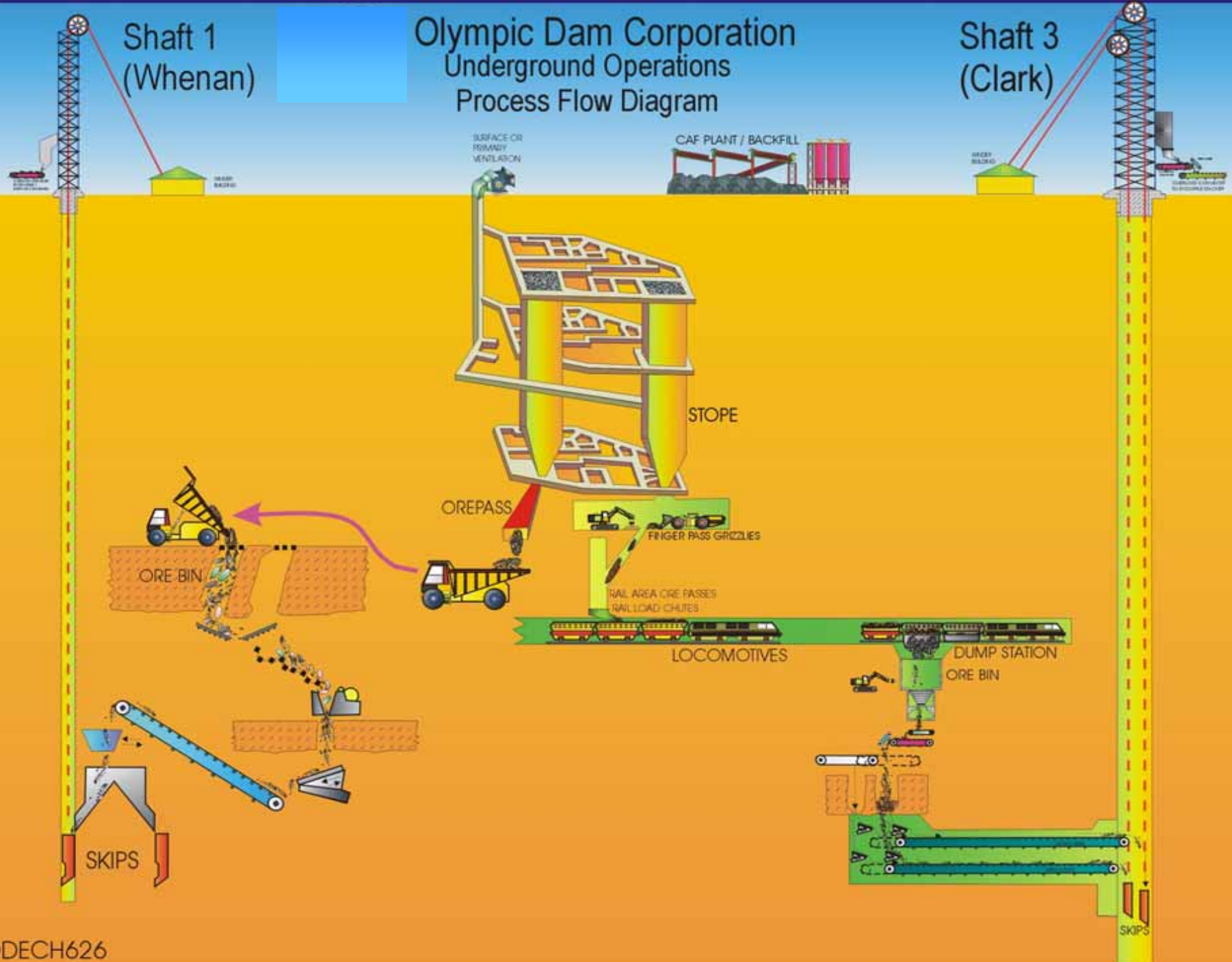
- Mining upwards of 40 stopes per year with a 20Mt per year design front
- Average 250,000t per stope (up to 600,000t)
- Dimensions of 30m X 30m X 120-180m (upwards of 280m)



Shaft 1  
(Whenan)

# Olympic Dam Corporation Underground Operations Process Flow Diagram

Shaft 3  
(Clark)



# Olympic Dam Machinery

## Drilling





# Mining the Stopes

## Blasting



# Olympic Dam Machinery

Bogging





# Olympic Dam Machinery

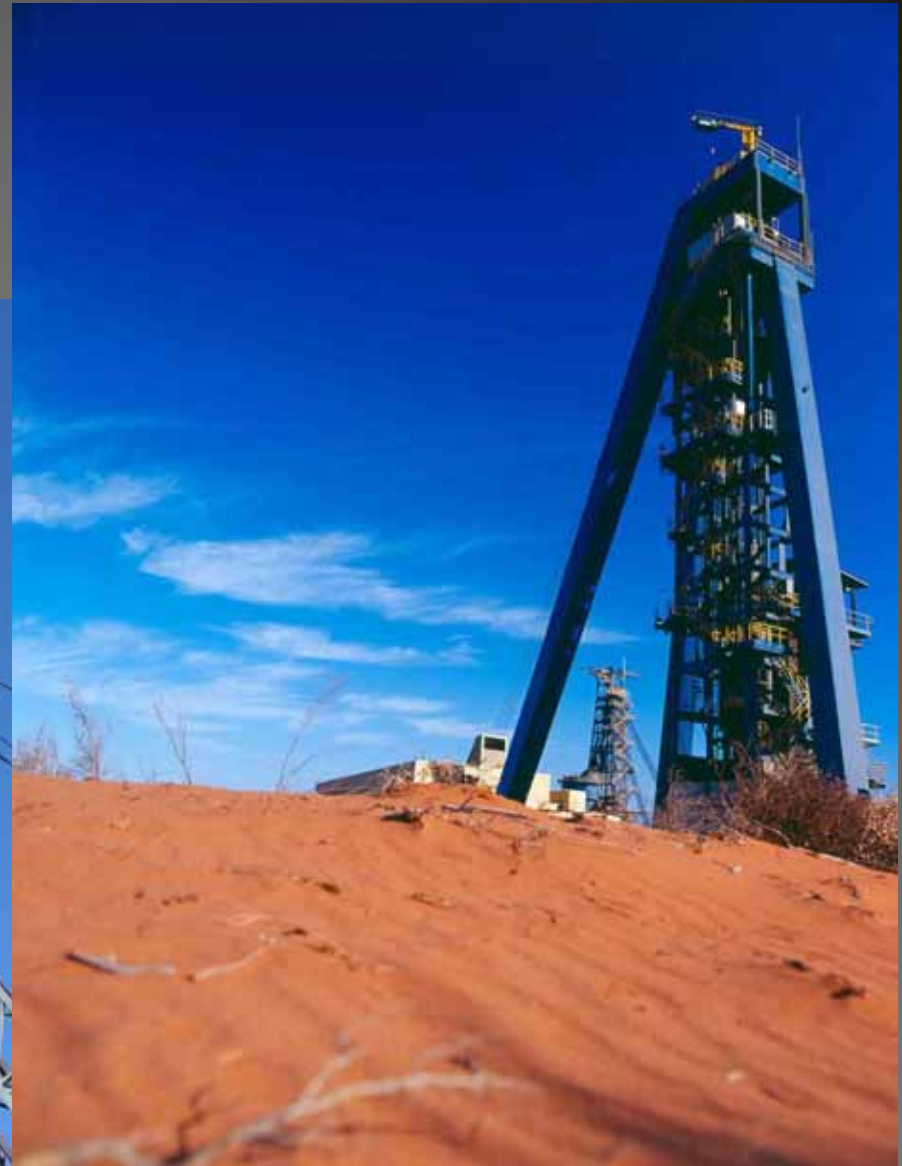
## Production





# Moving the Ore

## Ore Handling – Surface



# Moving the Ore

## Ore Handling – Surface



# Underground Mining Risks

Please take a moment to consider the major risks at your mine, or think of an emergency situation which may arise at your underground mine.

Would this occurrence lead to a situation where the underground workforce would be exposed to dangers outside of their control?



# Underground Mining Risks

- No matter where you mine around the world, I am sure we all face similar risks to our underground workforce and infrastructure.
- Whether you are working an Underground Coal or Hard Rock Mine, your operation will encounter similar major risks.

## **Major Risks Include -:**

- Underground Fire / Explosion – Machinery Fires
- Uncontrolled Flooding or Inundation
- Rock Falls / Entrapment
- Atmospheric Contamination / Gas outbursts – Firing Fumes
- Ventilation Failure / Dust accumulation
- Plus many more – Vehicle Collisions, Hazardous materials, Explosives incidents, Electrical incidents etc.

# Underground Mining Risks

- Dependant upon the particular risks an individual underground mine faces, escape and refuge strategies differ from mine to mine.
- Safe Havens or Refuge Chambers have been used in both the Underground Coal and Metalliferous Mining industry around the world now for many years.

# Underground Mining Risks

- Most Australian Coal mines employ escape strategies to enable the underground workforce to safely escape from the mine should an emergency occur. This is of course due to the abundance of fuel (coal) and possible generation or accumulation of flammable gas.

Safe Havens or Self Rescuer Change Over Stations have often been used in conjunction with this strategy.

- Australian Metalliferous mines tend to opt for the refuge strategy, which provides safely equip Refuge Chambers or Safe Havens to accommodate the workforce whilst the emergency is dealt with by Emergency Response Crews.



# Traditional 20 Person Refuge Chamber / Safe Haven



# Traditional 20 Person Refuge Chamber / Safe Haven

There are a number of manufacturers of these chambers, which can be supplied in various sizes with different options fitted.

At Olympic Dam mine, we utilise 11 of these chambers underground, with the following basic specification.

- 20 person capacity
- 36 hrs duration
- Air conditioned
- Equipt with communications, drinking water and first aid supplies
- Chemical toilet fitted
- Connected to filtered mine compressed air supply (primary means of supply)
- On board Oxygen supply and Carbon Dioxide scrubbing unit (secondary means of supply)
- Connected to the mine power supply
- 36 Hour back up battery supply (dependant on the air-conditioning load)

# Traditional 20 Person Refuge Chamber



Mine Compressed Air Supply and Filter Assembly



# Traditional 20 Person Refuge Chamber



Internal Layout

# Traditional 20 Person Refuge Chamber



CO2 Scrubber and  
Oxygen Supply  
Manifold

# Traditional 20 Person Refuge Chamber



Oxygen Supply Regulator

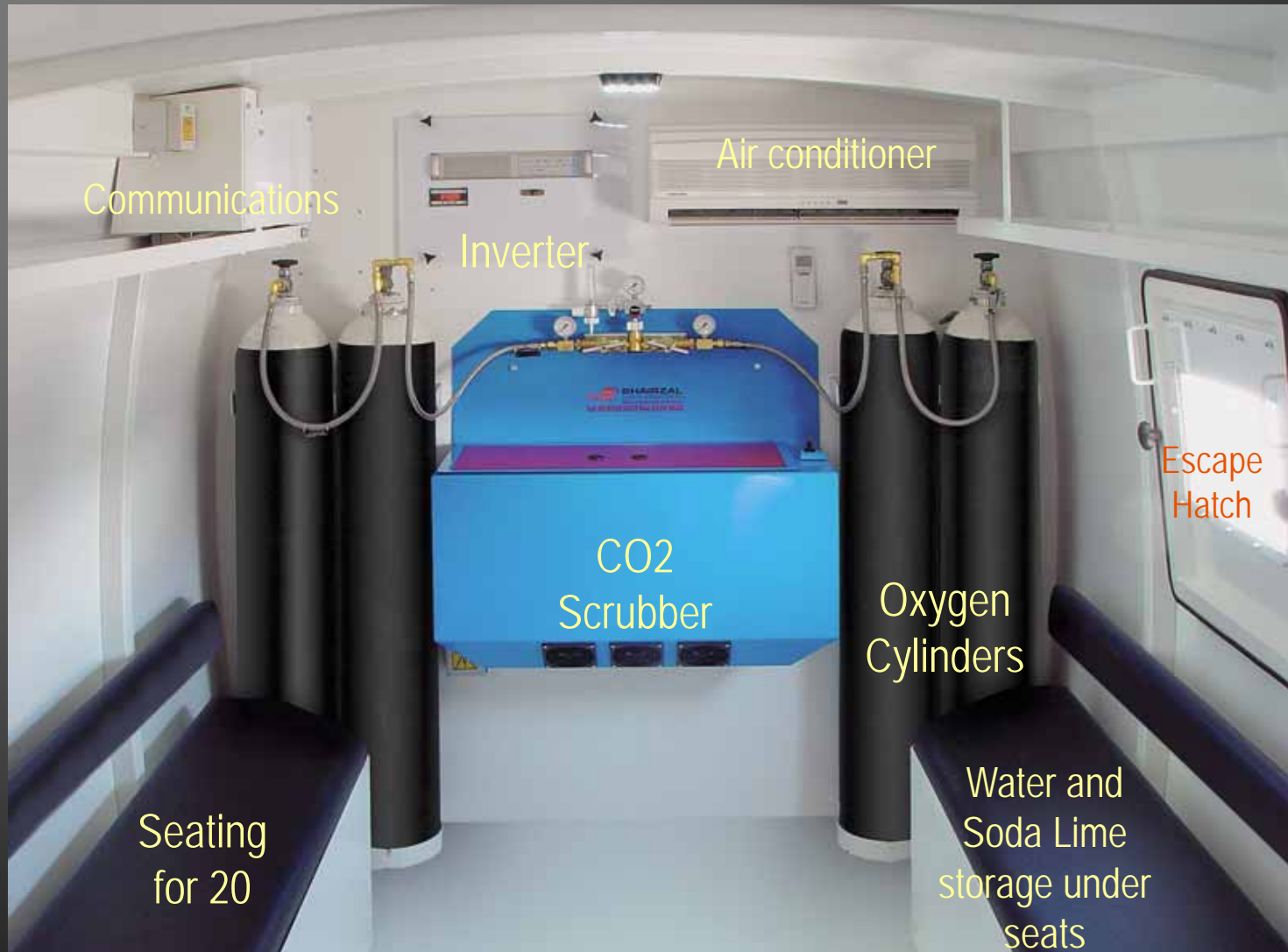
# Traditional 20 Person Refuge Chamber



Electrical Inverter – DC Battery to 240 Volt AC



# Traditional 20 Person Refuge Chamber



# Traditional 20 Person Refuge Chamber

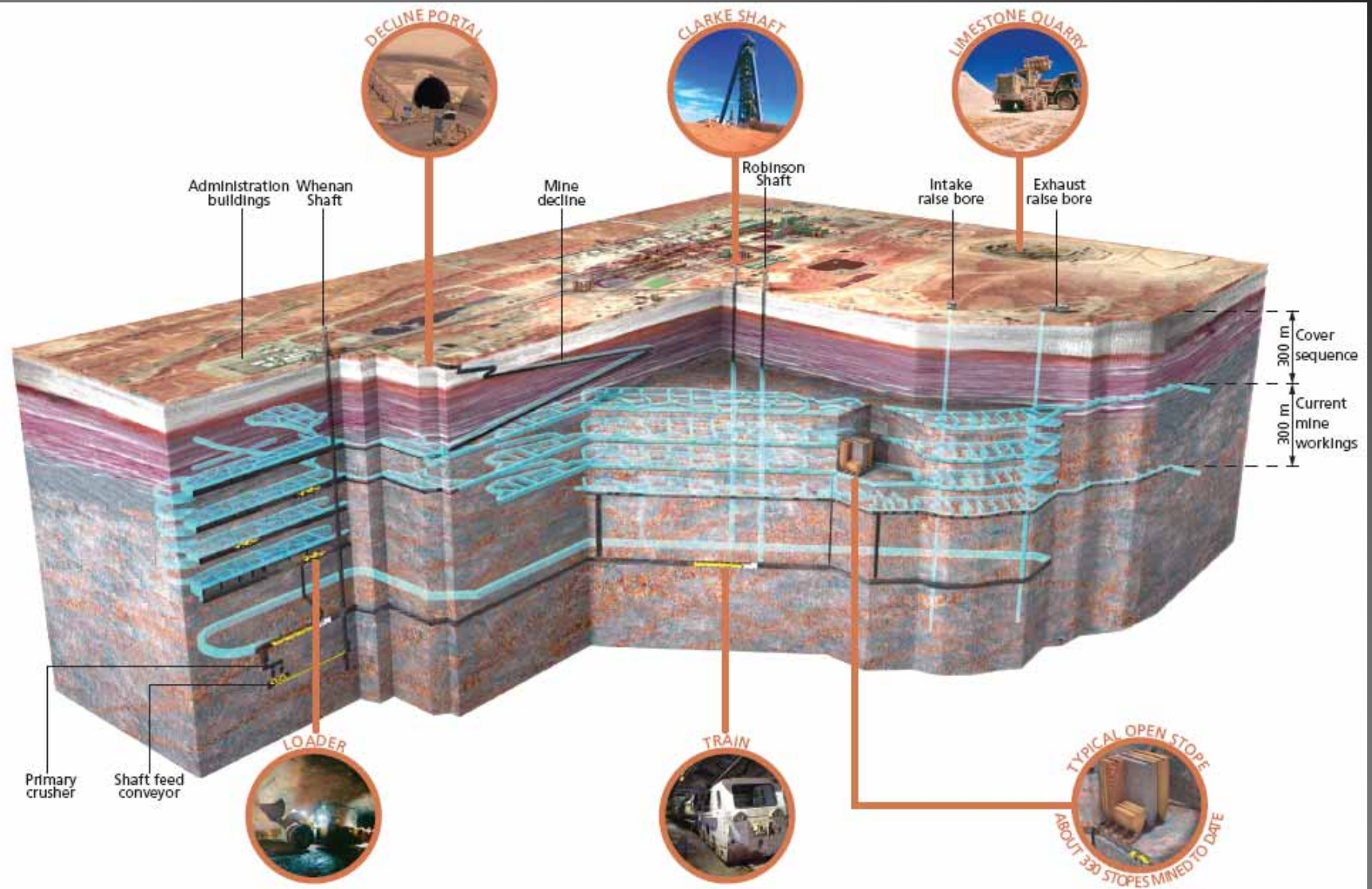
## LIMITATIONS AND CONSTRAINTS OF THE DESIGN

- Current units on site have a 20 Person maximum capacity
- Cramped conditions for occupants if filled with 20 persons
- Effectiveness doubtful if the single air conditioner failed
- Mine compressed air supply purity not guaranteed and could easily be lost in a fire situation due to services burning through
- Back up battery supply duration is reduced if the air conditioner load is excessive
- Costly to inspect and maintain
- Drinking water supply of 360 litres – Toilet capacity of 15 litres ?

# Refuge Chambers

- How do we improve on the traditional Refuge Chamber design ?
- How do we accommodate large numbers of people within a Refuge Chamber ?
- How do we minimise contamination of the atmosphere within the Refuge Chamber as people enter ?
- How do we guarantee the duration of the Refuge Chamber ?

# Underground mine layout





# The Way of the Future – 100 Person Refuge Chamber

As described, Olympic Dam Mine is serviced by the downcast Clarke Haulage Shaft.

The base of this shaft is below the active mine workings, and is adjacent to the main underground rail and crusher facilities.

This area of the mine can have at times, up to 100 persons working in and around the area for maintenance.

The Ore Skips fitted to this winder can also be used for man riding to the surface during an Emergency Evacuation from the mine.

These points were major factors in deciding to construct an Emergency Refuge Chamber in this area of the mine, that had capacity for at least 100 persons, with a 36 hour duration.

Investigations were made as to the feasibility of such a project, and various options were considered.

A joint design and construction project has been initiated with Draeger technology.

# The Way of the Future – 100 Person Refuge Chamber

- 100 Person Emergency Refuge
- Main features
- Location
- Construction
- Contamination prevention systems
- Positive pressure system
- Breathing air systems
- Internal and external atmospheric monitoring
- Electrical considerations
- Toilet facilities



# The Way of the Future – 100 Person Refuge Chamber

- The Refuge cuddy measures 30 mts x 5.5 mts x 4.5 mts
- Additional ground support has been installed.
- Reinforced cement shotcrete has been applied to the backs and sides of the refuge.
- The floor of the Refuge has been concreted.
- All internal walls and airlock will be constructed from steel mesh and coated with reinforced cement shotcrete.
- The main front wall will be constructed from steel and reinforced cement shotcrete, which will be both blast and fire proofed.
- The entry main entry door will be both blast and fire proofed.
- A loading dock and stairwell will be located externally.



# The Way of the Future – 100 Person Refuge Chamber

- The internal airlock door will be gas tight.
- The entry doors will be electrically interlocked, connected to gas detection devices to monitor the air quality within the airlock, then connected to an air shower within the airlock corridor, which will activate a rapid flow of compressed breathing air into the airlock should contaminants be present during entry.
- The discharged air from the airlock is vented to the outside atmosphere via a high flow non return valve.
- The interlock system allows only one door to be open at any time.
- This system will minimise the risk of outside contaminants entering the Refuge as people enter in an emergency.
- There will be a key operated by pass system installed to disable the system for maintenance purposes.

# The Way of the Future – 100 Person Refuge Chamber

- The Refuge will be equipped with a simple to operate positive pressure system, which supplies a constant dosage of cylinder breathing air, once initiated.
- The Refuge will contain Carbon Dioxide scrubbers for CO<sub>2</sub> removal.
- Refuge Chamber internal and external atmospheres will be monitored at all times, with this information relayed to the surface control room monitoring system.
- A back up electrical generator will be housed within the Refuge plant room, which will automatically start if mine power is lost.
- A dual refrigerated air conditioner will be fitted to the main room.
- Green / Red flashing strobe lights and external siren will be in place, to aid in locating the Refuge in an emergency.

# The Way of the Future – 100 Person Refuge Chamber

- Radio and Telephone communications will be fitted.
- Lighting will be installed to all areas.
- First Aid supplies and blankets will be stored in sealed cupboards.
- Potable water will be connected to the Refuge.
- A 5000 litre potable water tank will be fitted within the Refuge as a back up supply.
- Two toilets and a wash tub will be fitted in the plant room area, and connected to a 6000 litre sewerage storage tank, located below the loading dock floor.

# The Way of the Future – 100 Person Refuge Chamber

- Cost Savings

The cost of the construction of this 100 man Refuge Chamber was analysed against the cost of providing traditional 20 man Refuge Chambers

There is a substantial cost saving to the organisation, not only in the construction, which can be greatly minimised by using on site labour and in house contractors to build the structure, but also in the maintenance of the Refuge, as required maintenance will be carried out on one set of systems, versus at least five sets of systems, if the traditional units were used

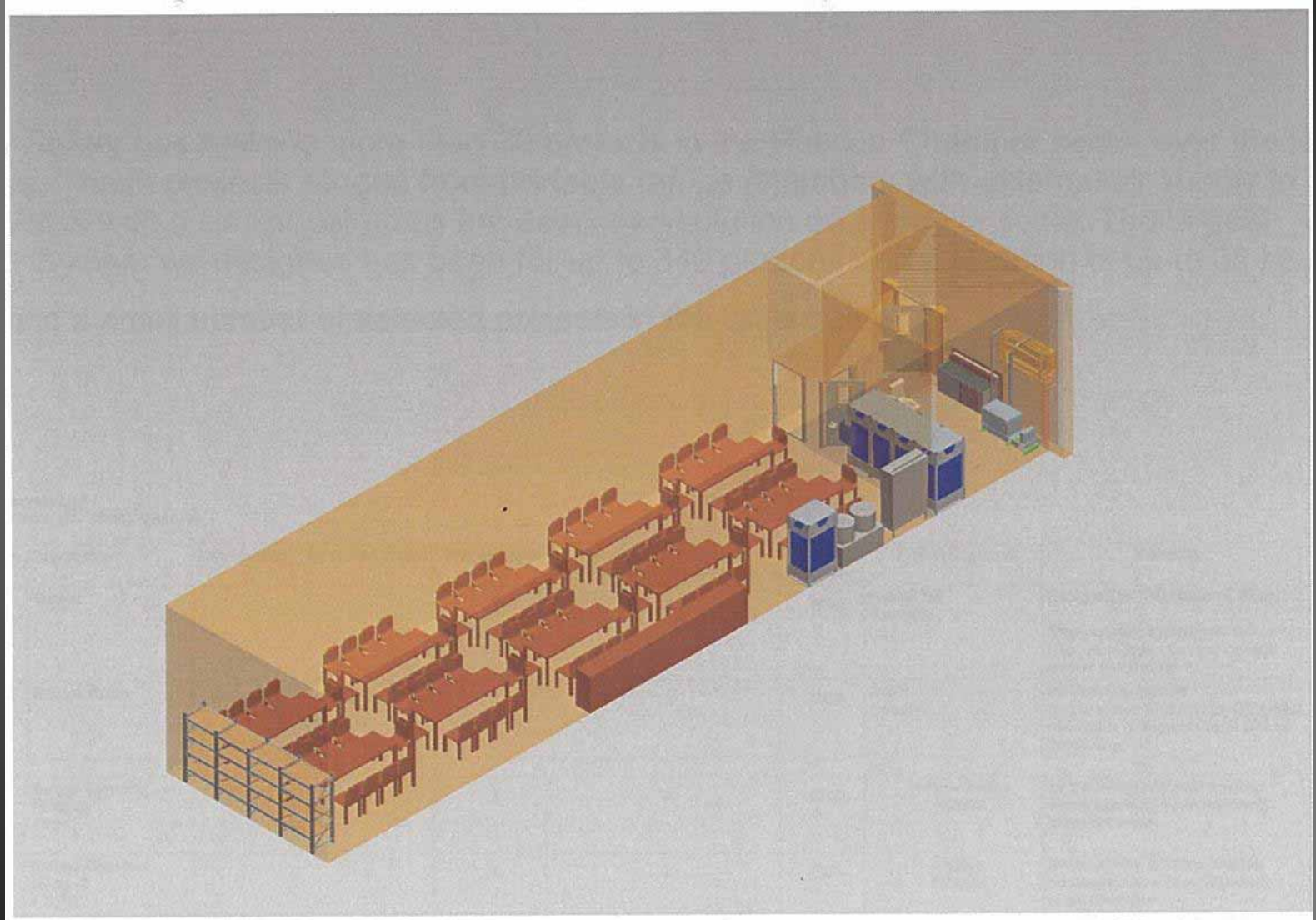


# 100 Person Refuge Chamber



Example of the main refuge area

# 100 Person Refuge Chamber Image Drawing



Concept drawing of the refuge

# Example of Air Tight Door



Examples of the gas tight door

# Examples of Breathing Gas Delivery Systems



Breathing Air storage



Gas delivery system



# Example of CO2 Scrubbing System



Carbon Dioxide scrubbing cartridges

# Example of Fixed Environmental Monitoring System



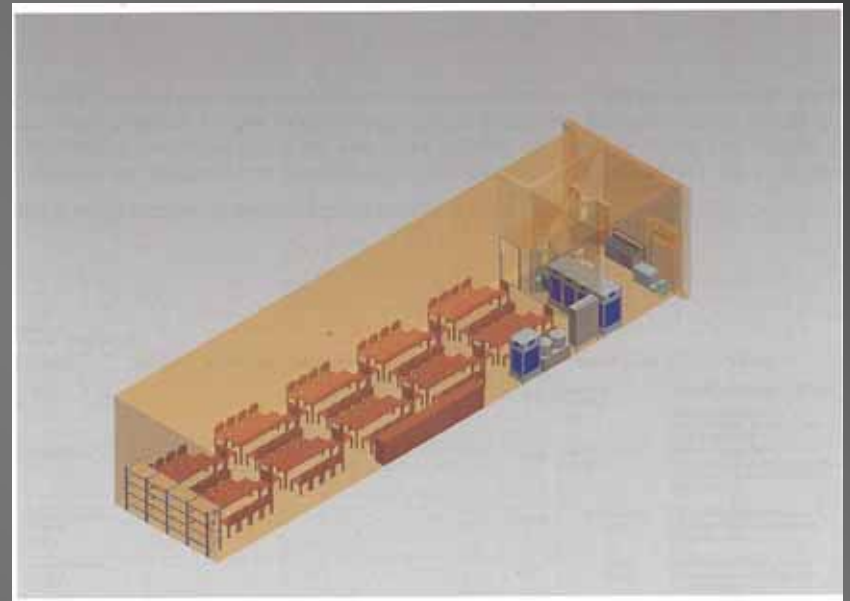
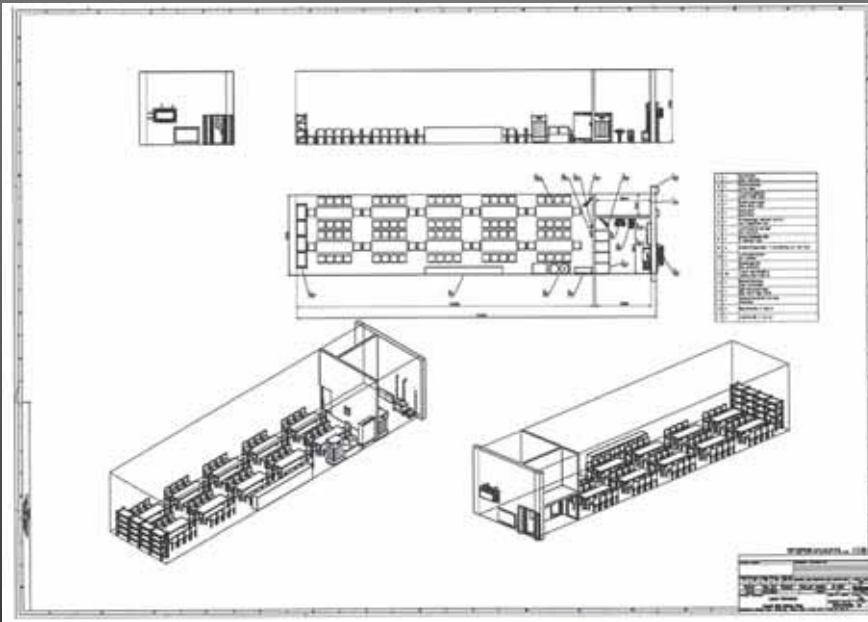
Atmospheric monitoring system

# Example of Emergency Generator Power Supply



Back up electrical generator

# Schematic & Chamber Image Drawings



Concept drawings

# 100 Person Refuge Chamber



Question Time – Thank you